The Epidemiology of Maternal Mortality in Southern Tanzania

PhD thesis

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I *, Claudia Hanson, confirm that the work presented in this thesis is my own. Where information is derived from other sources, I confirm that this has been indicated in the thesis*

[redacted]

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Abstract

With a view to strengthening systems for maternal health, this study presents a comprehensive analysis of determinants of uptake of care and pregnancy-related mortality, with the main emphasis on distance to care.

Data on geographical positioning (GIS), socio-demographic information, birth histories and deaths in women of reproductive age were collected during a household census in five rural districts of Southern Tanzania in 2007. Deaths reported as pregnancy-related were followed up by verbal autopsies. Health facility census information collected in the same area in 2009 was used. Data limitations included 30% either missing or low quality GIS data and missing birth histories for 9% of women.

The analysis included 507 pregnancy-related deaths and 64,098 live births. Major deficiencies in quality of care provided in health facilities were identified. Although 75% of women lived within a distance of 4.6km to a facility providing delivery care, overall institutional delivery was low with 29% of all births in hospital and 11% in first-line facilities. Seventy-two percent of women living <5km away delivered in hospital and levels declined rapidly thereafter with no evidence of confounding. In contrast, less than 30% of women delivered in a first-line facility even if they lived less than 1km away. Overall pregnancy-related mortality was high at 712 deaths per 100,000 livebirths (95% Confidence Interval 652-777), with 32% due to haemorrhage. There was weak evidence of higher mortality with increasing distance to hospital, which was accentuated if the analysis was restricted to direct maternal deaths. Sensitivity analysis restricting analysis to the 70% of households with good quality GIS data did not alter conclusions.

There was no evidence that low uptake of care at first-line facilities was explained by distance or socio-demographic factors. Deficiencies in quality of care influence both care uptake and mortality suggesting that investments in quality should be prioritized.

List of Abbreviations

AIDS	Acquired immune deficiency syndrome
ANC	Antenatal care
AMTSL	Active management of the third stage of labour
BEmONC	Basic emergency obstetric and neonatal care
CEmONC	Comprehensive emergency obstetric and neonatal care
CI	Confidence interval
DHS	Demographic and health survey
D&C	Dilation and curettage
EmONC	Emergency obstetric and Neonatal care
FIGO	International Federation of Gynaecologists and Obstetricians
GIS	Geographical information system
IHME	Institute of health metrics and evaluation
JHPIEGO	John Hopkins Program for International Education in Gynecology and Obstetrics
HIV	Human Immunodeficiency Virus
LiST	Lives Saved Tool
IPTi	Intermittent preventive treatment for malaria in infants
IPTp	Intermittent preventive treatment for malaria in pregnancy
INSIST	Improving Newborn Survival in Southern Tanzania
Km	Kilometre
INTER-VA	Interpreting verbal autopsy
MM-ratio	Maternal mortality ratio
MM-rate	Maternal mortality rate
MDG	Millennium development goal
MCHA	Mother and child health aides
MVA	Manual Vacuum Aspiration
OR	Odds ratio
RR	Relative risk
PDA	Personal digital assistant
PMDF	Proportion of maternal deaths among female deaths
PMTCT	Prevention of mother-to-child transmission
PNC	Postnatal care
SE	Standard error
SPA	Service provision assessment
STI	Sexually transmitted infections
USD	United states dollar
UNICEF	United Nations Children's Fund
VCT	Voluntary counselling and testing
WHO	World Health Organization

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Contribution of the student to the study

This thesis is based on secondary data analysis of information collected during a large household census in almost 900,000 people in southern Tanzania in 2007 and a health facility census in the same area in 2009. The student had no role in conception and implementation the household census but some role in the design of questions assessing elements of quality of obstetric care for the health facility census. The student conceived the conceptual framework for the data analysis presented in this thesis, carried out a quality assessment of the data and the data analysis and the interpretation of results. The student had worked in the respective study area from 2001-2003 as an obstetrician attached to the Lindi Regional Health Management Team and had thus qualitative knowledge and experience of the health care situation and problems in seeking care. During this time the student was also included in a study on unmet obstetric need for obstetric care in Mtwara where results were published. The student is also involved in an intervention study to improve the quality of care (http://www.equip-project.eu/) implemented in two of the five districts where the census was carried out. She has traveled to Mtwara regularly since 2010 to support this project.

Chapter 1: Background and Objectives

This chapter will briefly introduce the subject of maternal mortality followed by the overall and specific objectives of this thesis. The background includes a section on measurement issues to determine levels and causes of maternal mortality, followed by a literature review of determinants of maternal mortality. Evidence of the effectiveness of the main interventions used to address the high burden of pregnancy-related deaths is given. Measurement issues in assessment of maternal health and distance are also included in the background. In the last section, the health system in Tanzania is described including the main strategies followed in Tanzania to reduce the high levels of maternal mortality and available information on levels of maternal mortality.

1. Introduction

Progress towards the Millennium Development Goal (MDG) 5a —reducing maternal mortality by 75% between 1990 and 2015—is slow in many parts of the world. The total number of maternal deaths in 2010 is estimated, according to the most recent publication from WHO and partners, at 287,000 deaths, a decline of 47% from 1990 levels [1]. Similarly, the Institute of Health Metrics and Evaluation (IHME) estimated the global number of maternal deaths to be 273,465 in 2011 [2].

Earlier figures from the same institutes had proposed a higher total number in 2008 (358,000 [3] and 342,900 [4] by WHO and partners and IHME, respectively). The 25% reduction in the total number of maternal deaths within two years may reflect better data availability and statistical methodologies, but also the accelerating progress in maternal health in some parts of the world. Overall, the annual reduction in maternal mortality was estimated at 3.1% and 1.9% between 1990 and 2010 and 1990 and 2011 respectively in the two publications [1, 2]. By the estimates in both publications, the annual rate of reduction in maternal mortality is slower than the 5.5% annual reduction needed to reach MDG 5.

Both the WHO and IHME publications, report that the highest maternal mortality ratios (MM-ratios) are found in sub-Saharan Africa and South Asia. For the year 2010, regional MM-ratios of 500 and 220 per 100,000 livebirths were reported for sub-Saharan Africa and South Asia, respectively, according to WHO estimates [1]. Many countries, particularly in sub-Saharan Africa, are not likely to reach the MDG5 even if major efforts are made. However, some regions in the world such as North Africa and Eastern Asia, have made steady progress, reducing some MM-ratios by over 60% during the period between 1990 and 2010, in line with the MDG.

The WHO estimated in the past that 80% of maternal mortality is due to **direct causes** and 20% is due to **indirect causes** [5]. Newer estimates propose that a larger proportion is due to indirect causes [6, 7]. All estimations of the distribution of the different causes of maternal death in low- and middle-income countries are based on a limited number of studies from demographic sites or on special maternal mortality studies, which all have their methodological limitations [8]. Abortion-related deaths in particular might be underrepresented in population-based studies using verbal autopsy [6]. Special reproductive age mortality surveys seem better at revealing the burden of abortion-related deaths [9]. Information on the determinants and causes of maternal deaths at the country level are needed to evaluate progress in maternal health [10-12]. The Countdown group and the Commission on Information and Accountability for Women's and Children's Health both point to the need for improved data availability to inform policy makers [7, 13]. Moreover quality and equity is of growing concern [14-16].

2. Objective of the Study

This thesis aims to describe the epidemiology of maternal mortality in 2007 in rural southern Tanzania. As they are key in reducing mortality, accessibility and quality of maternal care are viewed as the main determinants of maternal mortality. In light of this view, the overall and specific objectives of this thesis are:

Overall objective:

To describe and analyse the causes and determinants of maternal mortality in southern Tanzania, in particular, exploring the relationship between mortality and access to maternal care, and to discuss the policy implications of the findings.

Specific objectives are:

- To describe the accessibility and quality of maternal care provided at hospitals and first-line health facilities
- To develop an index for the quality of maternal care provided at first-line health facilities to summarize quality levels of care
- To describe and analyze the impact of individual, household, and ward-level factors on uptake of maternal care and maternal mortality with particular emphasis on distance to care
- To synthesise and interpret results to give health policy and planning recommendations.

3. Introduction into the Conceptual Framework and Content of the Background

The thesis aims to analyse a range of determinants of uptake of care and maternal mortality as available from the household and health facility census. A hierarchical organised framework is used to describe the influence of individual, household and contextual factors on the uptake of maternal care and pregnancy-related mortality (Figure 1).

The key question examined is how accessibility—defined as the straight-line distance to health facilities—influences uptake of care (delivery at first-line facilities[1], delivery in a hospital and birth by Caesarean section) and pregnancy-related mortality.

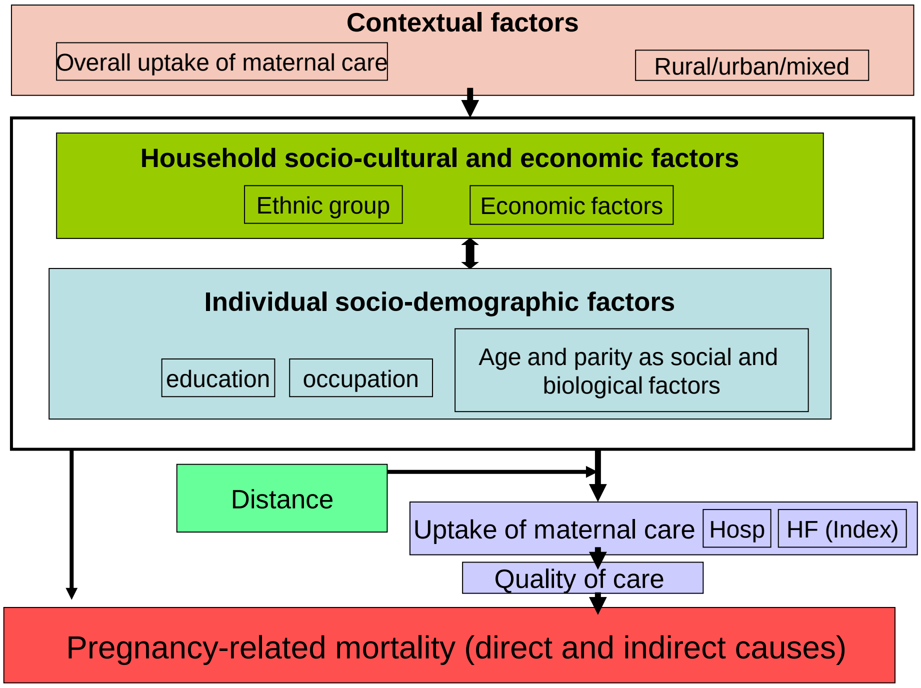

Figure 1: Conceptual framework of the thesis

Factors included in the analysis are 1) individual level factors such as education and occupation as well as age and parity; 2) household level factors, such as the ethnic group and wealth quintile and 3) contextual factors such as the overall uptake of maternal care in the wards and the classification of the ward.

[1] First-line facilities describe the first level of formal health facilities which are called dispensaries and health centres in Tanzania. A description of the care available in dispensaries and health centres is available in the section describing the health system in Tanzania(p 77)

The relevance of these factors is reviewed in the background chapter. The search strategy used to identify relevant literature differed for different sections. For the introduction to maternal mortality and measurement issues the literature review is based on key documents published by WHO and experts on maternal mortality. A search using the key work ‘verbal autopsy’ was conducted in 2010 and updated in January 2012. The selection of studies included was done to present the main aspects including key limitations in performing and analysis verbal autopsies.

The review on determinants of maternal mortality is based on different search approaches. First, all articles published in PubMed since 2000 under the key word ‘maternal mortality’ were reviewed for information on factors associated with or determinants of maternal mortality. Secondly, in 2007 for my MSc thesis in epidemiology I conducted a systematic literature review on the effects of age and parity on maternal mortality. Relevant papers were retrieved through searches in PubMed, POPLINE and EMBASE databases from inception to September 2008, using a combination of medical subject headings and key words including maternal age, adol*, maternal age over 35, teenage pregnancy, parity, multipara, birth interval and inter-pregnancy interval, birth-spacing together with maternal mortality. Relevant retrieved articles were also hand searched for further literature. No language restriction was applied. This review was updated in September 2008. I obtained complete manuscripts for the 229 relevant papers identified when searching the databases. The retrieved papers were reviewed based on used predefined criteria such as definition of outcome, sample size, study design, completeness, and information on confounders for further analysis [17]. I identified 74 cohort, cross-sectional or case-control studies that had analysed the relationship between age, parity and maternal mortality out of which I included 42 studies in the meta-analysis (Table 73 in annex). A major deficiency of almost all studies was that no analyses of age or parity adjusted for potential confounders were available.

All these papers retrieved in 2007 and 2008 were reviewed for the section on determinants of maternal mortality for information on mortality by socioeconomic determinants. The papers were not systematically assessed in regard to their quality. The presented information does not represent a systematic review, which is why no summary estimates are presented.

For the section on quality of care a search in PubMed was done using the search strategy “quality of care" AND (indicator* OR framework OR assessment)”. The search gave 4342 hits within the last 5 years. In addition the key words “client perspective” and “client-perceived quality of care” were used. Titles and abstracts were reviewed to identify articles which presented frameworks or a method of indicator development to investigate into the quality of care. In addition the WHO homepage on the World Alliance for Patient Safety was consulted. Most articles reported on the identification of key quality of care indicators for various clinical areas. A few were review articles reviewing frameworks for quality of care.

Finally, the review on papers published to describe the health system and the situation of maternal health in was based on a PubMed review done in 2009 and updated in January 2012 using the key word ‘maternal’ and ‘Tanzania’ retrieving articles published since 1994. In addition a PubMed search using the names of key scientists known to publish regularly studies on maternal health in Tanzania was done. The strategy was complemented by reviewing published Demographic and health survey (DHS) and Service Provision Assessments (SPA) and the WHO webpage. The six building block framework of WHO was used as a framework to describe the health system [18].

4. Measurement Issues in Maternal Mortality

Maternal mortality is defined as a death of a woman while pregnant or within 42 days of termination of pregnancy, irrespective of the duration and site of pregnancy, from any cause related to or aggravated by the pregnancy or its management, but not from accidental or incidental causes [1].

In addition to the underlying cause of death, antecedent and contributing causes should be recorded. An underlying cause of maternal mortality is a disease or injury that initiates the sequence of morbid events leading directly to the death. A contributing cause is defined as a condition that may exist prior the development of the underlying cause of death and contributes to the death [19, 20].

Recommendations for the categorisation of maternal deaths have distinguished between direct and indirect causes of death. **Direct maternal deaths** include death due to obstetric causes such as postpartum haemorrhage, puerperal sepsis, or abortion. **Indirect maternal deaths** are defined as those resulting from previous existing diseases, or diseases that developed during pregnancy, which are not due to direct obstetric causes, but aggravated by the physiological effects of pregnancy, during delivery or in the postpartum period. Examples include deaths due to malaria, anaemia, existing cardiac or renal diseases, or HIV/AIDS. Incidental causes of maternal death include suicide. **Coincidental causes** of death include external causes that are thought to have no causal link to pregnancy, for example, car accidents [20].

The importance of consistent inclusion of indirect causes of maternal death, such as deaths due to malaria or HIV in pregnancy, has been stressed, particularly in settings with high HIV prevalence [10]. A recent publication proposes to further separate death due to unanticipated complications of management and unknown causes of death [21, 22]. The category of unanticipated complications of pregnancy was added to allow tracking trends in iatrogenic causes of death, for example, deaths due to Caesarean section. Further, new recommendations suggest to include deaths due to suicide in pregnancy, as a consequence of puerperal psychosis and postpartum depression, as “other direct maternal deaths” [20].

The International Classification of Disease (tenth revision) [19] also includes an alternative definition for maternal death that is more practical: A ***pregnancy-related death*** is the death of a woman while pregnant or within 42 days of termination of the **pregnancy, irrespective of the cause of death.** This definition thus includes accidental and incidental causes of death and makes it possible to have estimates without establishing a cause of death analysis. A pregnancy-related death is thus solely defined by the timing of death relative to pregnancy, childbirth and the post-partum period and is likely to overestimate the true number of maternal deaths. To which extent pregnancy-related mortality overestimates true number of maternal deaths has been a matter of debate. Estimations for over reporting range from 18% to 41% [23]. Others have argued that it is reasonable to assume that the error of inclusion of non-maternal deaths is counterbalanced by the common omission of deaths due to induced abortion in population-based surveys using siblings methods[2] [23].

Main statistical measures of maternal mortality are:

Maternal mortality ratio (MM-ratio): Number of maternal deaths during a given time period per 100,000 livebirths during the same time period

Maternal mortality rate (MM-rate): Number of maternal deaths in a given time period per 100,000 women of reproductive age during the same time period

Lifetime risk of maternal death: the probability of maternal death across a woman's reproductive life, usually expressed in terms of odds

Proportion of maternal deaths among female deaths (PMDF): Number of maternal deaths during a given time period divided by all causes of death of women of reproductive age, usually defined as 15-49 years [24].

The MM-ratio uses the number of livebirths as a denominator [1]. However, the preferred denominator to describe the risk of deaths in pregnancy and childbirth would be the number of pregnancies, and would thus include also pregnancies resulting in abortion[3] and stillbirth[4]. Only a few demographic surveillance sites such as in Bangladesh [25] document pregnancies. Historically, there have been some attempts to document stillbirths, but the documentation of livebirths has always been judged to be more accurate and thus became the preferred denominator [26].

Maternal mortality is a part of the all-cause mortality in the group of women of reproductive age. Estimates can be derived from different sources: 1) vital registration (birth and death

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[2] Sibling's methods are using reports of brother and sisters about living and diseased brothers and sisters to generate mortality rates.

[3] Abortion is defined as any termination of pregnancy by the removal or expulsion from the uterus of a fetus or embryo prior to viability

[4] Any death of fetus after 20 (or 24) weeks of gestational age or at least 500g weight (variety of definitions are used)

registrations) and sample vital registration with verbal autopsy; 2) population sample surveys where sibling methods are used (direct and indirect sisterhood method); 3) household census with complete birth and deaths ascertainment; 4) reproductive age mortality surveys using a variety of sources to identify all deaths among women of reproductive age; and 5) sentinel sites (demographic sites with documentation of births and deaths and subsequent verbal autopsies.

Another option is to use informant-based methods based on village informant networks. This method requests village heads or volunteers networks to list all deaths of women of reproductive age in their communities and define whether they are pregnancy-related. The listing exercise is followed by a visit to the deceased relatives to confirm or correct the details on age and pregnancy status [27]. This method was used in Indonesia and was able to identify an estimated 85% and 71% of pregnancy-related deaths, respectively, depending whether heads of neighbourhood units or health volunteers were used to identify deaths [27].

Siblings' methods include the indirect and direct sisterhood method. The indirect method asks sisters about all ever-married sisters (born to the same mother), whether they are still alive or have died and whether the dead sisters died while they were pregnant, or during childbirth, or six weeks post-partum. The MM-ratio is approximated by the lifetime-risk of death calculated from age specific sister units of risk exposure and the reported pregnancy-related deaths and the total fertility rate of the population [28][5].

The data requirement for the direct sisterhood method are more demanding and respondents are asked to provide a birth history of her mother, including the current age of all living siblings and the age at death and years since death for all deceased siblings. The information allows the calculation of the MM-rate from which the MM-ratio can be calculated when the general fertility rate of the same population is available [23].

Each of these methodologies has inherent weaknesses in estimating the true level of maternal mortality. Civil registration with death certification by a medical professional is seen as the best method to ascertain maternal deaths [29, 30]. Misclassification and underreporting of maternal deaths is common; even in countries with good quality and complete vital registration. Often documentation of indirect, associated, and late maternal deaths is incomplete [31-33].

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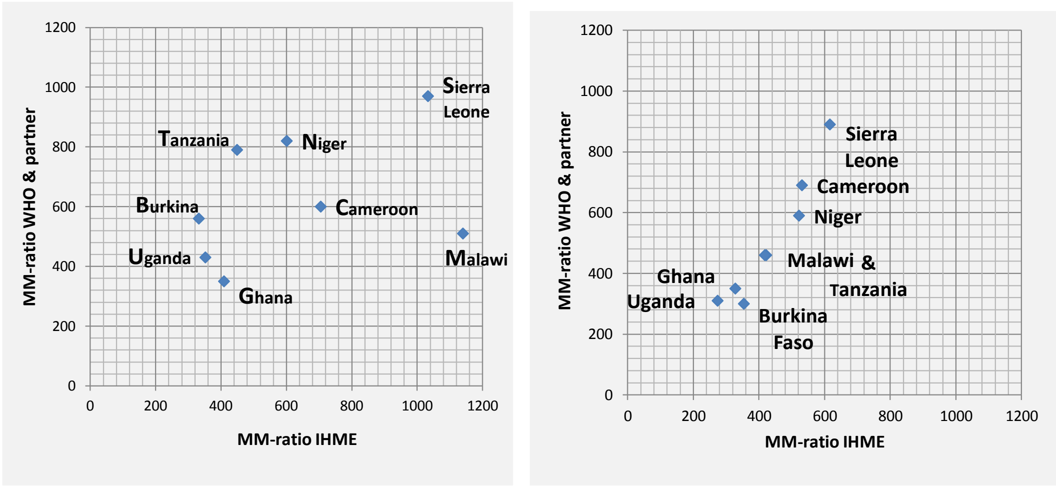
[5] (1-Lifetime risk) =(1-MM-ratio)$^{\text{Total fertility rate}}$

In low and middle income countries, maternal mortality estimates are often derived from household surveys, predominantly DHS and more recently also from Multiple Cluster Information Surveys [34]. Both household surveys use the direct sisterhood methods. A major disadvantage of the direct sisterhood method as used in the DHS (but also the indirect method) is that estimates are produced for a time in the past and cover commonly a period of five to ten years prior to the survey.

Although estimates based on the indirect and direct sisterhood methods are constrained by the fact that they i) estimate pregnancy-related mortality ratio but not the true MM-ratio, ii) suffer from large confidence intervals because a limited numbers of households are generally included and iii) produce estimates in the past [23], they nevertheless produce population-based estimates. This is in contrast to the 1980s where maternal mortality data were largely only available from health facility and hospital statistics [35]. Facility statistics are prone to be incomplete in places where most women deliver and die at home. The selection of the population utilizing the services affect the representativeness of the levels and pattern of maternal mortality of facility-based data [12].

Country based estimates are regularly published since a decade by WHO and partners [3, 24, 36, 37]. In 2010 and 2011 IHME also published estimates [2, 4]. The estimates are based on available country data such as vital registration where judged complete, the DHS estimates on maternal mortality or other national sources such as special surveys. Data are adjusted for underreporting and misclassification. While the latest estimates published by the WHO and partners and the IHME have been relatively consistent for mortality estimates at the global and regional level, this is not so at the country level [1, 2]. Figure 2 compares the estimates from WHO and partners and IHME for 2008 and the revised estimates from the same groups for 2010/2011 [1-4].



Comparison of data from
WHO and partners and IHME
for 2008
WHO et al. 2010 & Hogan et al. Lancet 2010

Comparison of data from
WHO and partners and IHME
for 2010/2011
WHO et al. 2012 & Lozano et al. Lancet 2011

Figure 2: Comparison of MM-ratios from WHO and IHME for selected countries

The differences seen between the estimates provided by the four publications highlight the problems in getting reliable figures on maternal mortality from countries where estimates rely on surveys using the sibling methods.

Reasons discussed for the variations between estimates provided by the two groups are: differences in adjustment for misclassification and under-reporting; different adjustments for HIV; and the use of sub-national data by IHME. Moreover, differences in life tables used to calculate the proportion of maternal deaths occurring in women of reproductive age due to maternal causes (PMDF) explains some of the variations [29].

Some countries have used census data to obtain information on pregnancy-related mortality [38, 39]. Although this approach decreases the uncertainty around the maternal mortality estimates introduced through sampling, incompleteness of data on both births and deaths is a concern and major adjustments might be needed [8, 40, 41]. Another approach increasingly used is sample vital registration with verbal autopsy method. India and China have established such systems to monitor maternal mortality [42, 43].

Methodological aspects of ascertainment of causes of death including maternal deaths

Ideally, a medical professional captures maternal mortality and causes of death through vital registration systems and death certification. However, in the majority of countries where maternal mortality is high, vital registration does not exist or is incomplete [1]. In some of these countries, verbal autopsies of deaths ascertained from demographic sites are used. Relatives or caretakers of the deceased person are interviewed to investigate symptoms, signs, and circumstances of the death. The information is then interpreted and analysed to assign a probable cause of death. This procedure is based on the assumption that most causes of death can be distinguished by their signs and symptoms, and that these can be accurately recognised, recalled, and reported by lay respondents. However, the validity of the approach is influenced by several factors including the type of illness leading to the death, the design and content of questionnaires, and how collected information is analysed [44].

Standardized questionnaires are used for verbal autopsies that mostly include a combination of an open-ended and a checklist-based section to investigate the cause of death. WHO suggests the use of three different questionnaires for three age groups: 1) 0-4 weeks (the neonatal period); 2) 4 weeks to 14 years; and 3) 15 years and above [44-48]. Most verbal autopsy classification systems are based on the organ-based classification system of the tenth revision of the International Classification of Diseases[19].

There has been much debate around the methods for assigning the cause of death. The verbal autopsy questionnaires can be interpreted: through physician review; by using a pre-defined or expert algorithm; or through a data-derived algorithm based on logistic regression, neural networks, decision trees, or probability density [49]. In addition, Murray et al. described another method called the “Symptom Pattern Method” [50].

In many sites, physician review is used. Commonly, two physicians independently assign a cause of death using the information collected during the interviews and a third physician might be consulted if the causes identified by the physicians differ [44]. Inter-observer reliability is often moderate. Also physician review is criticised because of high costs and use of scarce resources of highly trained professional [44].

Several validation studies have been done to cross-validate physician review based on verbal autopsy questionnaires with standard diagnosis obtained from hospital records. Reasonable sensitivity and specificity with in a positive predictive value of over 50% has been shown for most diseases including direct maternal causes of death [45, 51-53]. Diseases with distinct features like injuries or tetanus, and also direct maternal causes of death, have higher validity than some infectious diseases, particularly in areas where malaria is very common [54]. A multisite validation study based on 12,542 verbal autopsies that employed defined clinical diagnostic criteria as a gold standard estimated that around 50% of individual cause of death assignments using the physician review were in concordance with the cause of deaths based on clinical records [55]. A problem associated with physician review in some places is the high number of unresolved cases when more than one physician is assigning the cause of death [56] and the low repeatability [57].

Expert-based algorithms coding is based on algorithms using signs and symptoms elaborated by health experts. Byass developed this method further using a Bayesian approach to define the probability of a given cause of death based on the presence of a particular symptom or sign (also called InterVA) [58]. Relatively high agreement of 40-80% comparing InterVA with physician-review-based cause of deaths assignment was reported using this method in several studies [59-62]. A recent large multi-country study with 12,542 verbal autopsy cases comparing the cause of death ascertainment using the InterVA method with a defined clinical diagnostic gold standard suggested that InterVA is inferior to physician review. On the individual level, the InterVA achieved concordance in only about 25% of cases, less than the physician review where concordance of 50% was reported [63]. However, this study also had weaknesses which could be responsible for the low performance of InterVA. Firstly the study only provided information on the relationship between cause of deaths assigned using InterVA and hospital diagnosis on deaths for which a diagnosis based on strict clinical diagnostic criteria from tertiary health facilities was available. These deaths were thus a highly selected set of causes of deaths with a large proportion of deaths due to non-communicable diseases. Further, InterVA was not conceived to identify many of the relatively specific causes of deaths but only a limited number of causes of deaths.

The latest version, the InterVA-4 tool has taken several shortcomings of the previous version into account and includes now 62 different cause of death groups and is based on the revised 1012 WHO verbal autopsy tool [64]. Certain apparent over- and under-diagnosis and lack of differentiations between various cancers have been taken into consideration.

All validation studies face the difficulty that the reference standard or the gold standard used is unlikely to reflect the causes of deaths in the overall population, as they rely on death certificates from hospitals. Hospital deaths do not represent deaths in populations where most deaths occur at home. Also, information bias might be introduced by using hospital audits as a reference standard. The caregivers interviewed might recall important signs and symptoms, or even a diagnostic test and a diagnosis given by health providers. In contrast, if the death was at home, no such information might be available. Although the afore mentioned large validation study tried to overcome some of these obstacles [55, 63], limitations have to be considered, particularly regarding the extent to which the hospital reference data reflect the true variety of signs, symptoms, and causes of disease in the population [44, 51, 65].

Studies on maternal mortality using verbal autopsies

Few studies have used verbal autopsy to investigate the causes of maternal deaths [57, 66-73]. Setel et al estimated a positive predictive value of direct and indirect maternal death of 60% and 50% respectively, comparing 1,912 deaths in Tanzania using hospital notes and diagnosis as a reference [53]. Another multi-centre validation study indicated a positive predictive value of 70% and 67% for institutional direct and indirect maternal deaths, respectively, using hospital notes as a standard [57]. The Bayesian approach, as described above, has also been used to assign causes of maternal death. Results from 258 verbal autopsies of women of reproductive age from Burkina Faso indicated more cases of pregnancy-related sepsis compared to physician review, but fewer non-pregnancy-related infections and HIV-related deaths. For other causes, the results were broadly comparable (no figures available)[72]. In another setting in Burkina Faso, only 7% of pregnancy-related deaths due to haemorrhage were reported, whereas pregnancy-related sepsis was the most predominant cause of mortality (30%) when using the Bayesian approach [73]. However, the study lacked a comparison with health-facility-based assignment of cause of death for further validation.

5. Determinants of Maternal Mortality

The determinants of maternal mortality reviewed in this section include **socio-cultural factors** such as education, marital status, ethnicity, race and religion; **biological factors** such as age, parity and birth spacing; **economic factors** such as wealth or poverty indices, income, and women's and husbands' occupations; and the **geographical accessibility** of health care such as urban or rural residence or distance to the nearest health facility.

Socio-Cultural Determinants

Education

A few studies indicate a protective effect of education on maternal mortality, but the size of the effect varies between the studies. One reason for this is that different measurements are used to assess education.

Education level is often assessed by years of schooling and categories span from any or no schooling to more differentiated assessments such as one-to-four (or six) years of schooling, or primary, secondary, or university-level education. The UNESCO International standard Classification proposes to use the categories: primary (one-to-six years), lower secondary (seven-to-nine years), upper secondary (10-12 years) and post secondary/tertiary education. This has been used in a Global Survey on Birth Outcomes by WHO [74]. Other studies have used literacy as the measurement of educational level. Maternal education has predominantly been assessed; few studies investigated the association between paternal education and maternal mortality.

The pathway by which education might influence maternal mortality is via increased utilisation of health care but also better health status. Better education might also reflect family and childhood background, which might reduce the likelihood of harmful traditional practices such as food restriction being present in familial norms and beliefs [75]. Higher education might also correlate with higher social and economic status, factors that are often described as reducing maternal mortality. Education has consistently been recognised as an important determinant of other health outcomes as well, for example infant mortality [76].

Several studies indicate a protective effect of higher maternal education on maternal mortality (Table 1). Data from a study of Kenyan government hospitals in 1993, Magadi et al estimated a reduced maternal mortality, odds ratio (OR 0.56, 95%CI 0.3 – 1.1) in women with secondary education compared to women with only primary education [77]. A population-based study in Guinea-Bissau reported a 60% increase in mortality among women with no schooling compared to women with any schooling (OR 1.6, 95% CI 0.9 – 3.8) [78]. Hoyert estimated, based on national data from the United States and Canada, a 50% protective effect of more than 12 years of schooling compared to 12 or fewer years (MM-ratio 6.3 compared to 9.5 per 100,000 respectively) [79]. These findings are similar to other reports from the United States [80, 81]. A significant effect of reduced mortality with more years of formal maternal education was reported from Matlab, Bangladesh, which compared odds of maternal mortality between women with one-to-four, five-to-seven or eight or more years of education with no education (OR 0.8, 95% CI 0.7 – 1.1; OR 0.6, 95% CI 0.4 – 0.7; OR 0.4, 95% CI 0.2 – 0.5 respectively)[25]. In Egypt, illiterate women had a seven-fold higher MM-ratio than women with secondary school education [82]. Also, in a slum in Delhi, India, the odds of dying were two times higher in illiterate women than in literate women (OR 2.2, 95% CI 1.2 – 3.9)[83]. A multi-country study supported by the WHO indicated that the effect of education was even present in women who delivered in a hospital. The odds of dying were three times higher in women with no education compared to women with post-secondary or tertiary education (Adjusted OR of 2.7, 95% CI 1.6 – 4.5) This study provides some evidence that increasing education has an effect on maternal mortality beyond increasing uptake of care [74].

However, a few studies reported no association between education and maternal mortality [84-87]. Some of these studies were smaller case-control studies and might have missed the effect due to small numbers.

As mentioned above, the effect of education on maternal mortality might, to a large extent, work through improved access to care. The effect of education on access to skilled attendance seems to be consistent, strong and dose-dependent as Gabrysch and Campbell stated in recent review [88]. Education is also reported to be associated with birth by Caesarean section [89, 90]. Additionally, the uptake of antenatal care (ANC) is strongly influenced by education, as indicated by a recent review [91].

Table 1: Association between socio-cultural factors and maternal mortality

Publication and country	**Setting and study type**	**Method**	**Association with education**	**Association with marital status**	**Association with ethnicity, race or religion**
Magadi et al 2001 [77] **Kenya,**	Government hospitals from 16 districts and provincial hospitals in 1993	Multi-level logistic model including 58,151 obstetric admissions and 182 deaths	Reduced mortality in women with secondary education or higher compared to none or primary education (OR 0.56, 95% CI 0.3	Not significant in crude analysis (mortality 0.36 in never/previou sly married and 0.30 in married women)	NA

			– 1.1)		
Høj et al 2002 [78]**Guinea-Bissau**	Population-based cohort, 1990 – 1996	Logistic regression including 85 maternal deaths and 10,846 pregnancies	Increased mortality in women with no schooling compared to schooling over one year (OR 1.61, 95% CI 0.89 – 3.84)	NA	OR ranged between OR 1.2, 95% CI 0.3 – 3.7 and OR 2.0, 95% CI 0.9 – 4.4) in different ethnic groups compared to the ethnic group with lowest mortality
Mbizvo et al 1993 [87] **Zimbabwe**	Community-based study including 175 cases and controls matched on the same level of care (home, clinic or hospital)	Logistic regression based on matched case-control study	No evidence of an association between education and mortality (OR 0.6, 95% CI 0.2 – 1.8 and OR 1.2, 95% CI 0.2 – 7.5 in the two areas included comparing no education with form three-to-four education	Being single compared to being married in a polygamous marriage increased the risk of deaths in the age-adjusted analysis for two provinces (adjusted OR 6.1, p<0.001 and OR 1.6, p=0.34)	No evidence of an association between Protestant, Catholic, or other religions and mortality in either crude or age-adjusted analysis
Abdullah et al 1992 [82]**Egypt**	Population based cohort in Assiut	Logistic regression based on 29 maternal deaths among 8,656 pregnant women	Mortality ratio per 100,000 pregnancies is 430 in illiterate women, 118 in primary school leavers and 64 with secondary school education or higher	N/A	N/A
Kwast and Liff, 1988 [86], **Ethiopia**	Population-based survey 1983	Logistic regression based on 29 cases and 8,684 controls	No effect of no schooling or one year schooling compared to seven years of schooling or more in adjusted analysis (OR 0.6, 95% CI 0.1 – 2.1)	No association between marital status and mortality (OR 0.6, 95% CI 0.1 – 2.8) comparing single to married women in adjusted analysis	N/A
Okonafua et al 1992, **Nigeria**	Hospital-based study1989 – 1991	Crude odds ratios based on 35 deaths compared to 35 women admitted with similar	Women with primary education compared to no education had a reduced risk of mortality (OR	N/A	N/A

		complications	0.07, no CI available)		
Fikree et al 1994[84], **Pakistan**	Population-based cohort 1984 – 1989	Crude odds ratios based on 34 maternal deaths and 12,112 births	Mortality was similar in illiterate compared to literate women (0.8, 95% CI 0.3-1.8)	N/A	N/A
Fikree et al 1997 [85], **Pakistan**	Population-based, cross-sectional study 1989 – 1992	218 deaths and 1,043 controls	Mortality was similar in illiterate compared to literate women (OR 1.0, 95% CI 0.5 – 2.0)	Higher mortality in divorced women compared to married women (OR 17.9, 95% CI 6.2 – 62.7)	N/A
Chowdhury et al 2007 [25] Matlab **Bangladesh**	Population-based cohort1976 – 2005	Adjusted OR based on 769 maternal deaths and 215,779 pregnancies	Adjusted OR 0.4 (95% CI 0.2 – 0.5) comparing mothers with eight or more to no years of education	NA	Adjusted OR 1.1 (95% CI 0.9 – 0.4) comparing mothers with Hinduism as their faith to Islam
Aggarwal 2007 [83], **India**	Community-based study in slums in Delhi	Case-control study based on 70 cases and 384 controls	Illiteracy compared to literacy in women and husbands increased mortality (OR 2.16, 95% CI 1.19 – 3.92 and OR 1.91, 95% CI 1.13 – 3.21)	N/A	N/A
Alauddin 1968 [92], **Bangladesh**	Population-based cohort in a rural district, 1982 – 1983	Mortality ratios by risk group based on 48 maternal deaths	Mortality ratios per 100,000 livebirths were 323, 822, 1431 and 870 in women with no education, literate women, women with primary education and women with secondary education, respectively	N/A	N/A
Ganatra et al [93], rural west Maharashtra, **India**	Population-based case control study 1993 – 1995	Crude ORs based on 121 maternal deaths identified by multiple-	Crude OR of 2.8 (95% CI 1.6 – 4.6) for risk of maternal death comparing husbands with	N/A	N/A

		source surveillance and complication matched controls	no education to husbands with more than 10 years of education		
Theme-Filha et al [94] , **Brazil**	Population-based cohort in Rio de Janero 1993 – 1996	Mortality ratios based on 222 deaths and 388,789 livebirths	Mortality ratios decreased from 164 per 100,000 livebirths in women without primary school education to 58 with primary, 37 with secondary and 28 with superior education.	N/A	N/A
Karlsen et al, 2011 [74], **Africa, Asia and Latin America**	Multi-country study, 24 countries in Africa, Asia and Latin America, 2004-2008	Cross-sectional study in 373 health facilities	Adjusted OR of 2.7 (95% CI 1.6 – 4.5) for risk of maternal death comparing women with no to women with post-secondary or tertiary education	Adjusted OR of 1.8 (95% CI 1.3 – 2.5) for risk of maternal death comparing unmarried to married women	N/A
Kaunitz et al 1884[95] Indiana, **United States**	Case control design, 1975 – 1982	Comparison of the MM-ratio in a study group (6 deaths) with MM-ratio in State of Indiana	N/A	N/A	MM-ratio 872 in members of faith assembly compared to nine in the State of Indiana
Hoyert et al 2000 [79] **United States and Canada**	Population-based cohort, 1982 – 1997	Mortality ratios based on 327 deaths and 3,874,574 livebirths	Mortality ratio is 9.5 deaths per 100,000 in women with 12 years of schooling or fewer and 6.3 in women with more than 12 years of schooling	Mortality around 60% higher for unmarried women compared to married, but the difference was not seen when white and black women were analyzed separately	Mortality around 20 per 100,000 livebirths in black women compared to around 5 per 100,000 in white women
Andersson et al 2000 [96] **Sweden**	Population-based cohort in the 19th century	Computation of relative risk between categories based on 1,237 maternal	N/A	Mortality was higher in unmarried compared to married women, relative risk	N/A

		deaths and 150,932 livebirths		(RR 1.3, 95% CI 1.0 – 1.8)	
Kayem et al 2011, **United Kingdom**	National cohort, participants were identified through two surveillance systems	Computation of adjusted OR comparing women who died and women who survived selected complications	N/A	N/A	Adjusted OR of 2.4 (95% CI1.2 – 4.91) in black Caribbean and African women compared to white women

Marital status

Marital status is generally measured with the categories single, married, divorced, or widowed. The difference between monogamous or polygamous marriage is not commonly assessed. The pathway indicating how marital status might influence maternal mortality could be through influencing a woman's socioeconomic situation and decision-making power.

Some studies indicate that single or divorced mothers have an increased risk of dying, but often the effect is small when adjusted for other factors (Table 1). In Zimbabwe, maternal mortality was six times higher in single women compared to married women in the age-adjusted analysis in one province (OR 6.1, p<0.001) but not on the other province (OR 1.6, p=0.34) [87].

In Addis Ababa, no evidence of a reduced risk of death in married compared to single women was observed in the adjusted analysis (OR 0.6, 95% CI 0.1 – 2.8)[86]. Fikree et al reported a maternal mortality ratio that was 18 times higher in divorced women compared to married women in Pakistan (OR 17.9, 95% CI 6.2 – 62.7)[85]. Various studies from the United States reported a one-and-a-half to two-fold increase in the risk of maternal mortality in unmarried women compared to married women, but no adjusted OR are available from these studies. The effect of marital status was not seen if the analysis was done for black and white women separately [79, 80, 97]. A study from Sweden based on data from the 19th century indicated a small increase in the risk of maternal mortality among unmarried mothers compared to married mothers [relative risk (RR) 1.3, 95% CI 1.0 – 1.8] [96].

Ethnicity, race and religion

Ethnic group or race is sometimes included in studies on determinants of maternal mortality. However, the variable "ethnic group" might be a proxy measure of socio-cultural factors, where people live (location) and accessibility of health care. Maternal mortality studies are often not powered to detect differences in mortality by ethnicity (Table 1). However, in the United States, a difference in maternal mortality between the black, Hispanic, and white populations is consistently reported, and several studies indicate at least a fourfold higher risk of maternal deaths in the black population compared to the white population [79, 98-102]. A study in the United Kingdom comparing mothers who died with mothers who survived from specific causes of maternal morbidity also reported higher mortality in black Caribbean and African women [103].

A very interesting example of how religious beliefs can influence maternal mortality is a study from Kaunitz et al, where a much higher MM-ratio (872 compared to nine in the respective state) was found in a religious group in Indiana, the United States, due to avoidance of obstetric care [95].

Economic factors

Economic factors or socioeconomic position have been measured traditionally using income or consumption expenditure, or the occupations of women or their husbands. More recently, an asset-based approach to measure socioeconomic position has been used in many studies such as the DHS [104]. Information on household-based assets is collected during household surveys. To construct an asset index, the most common weighting method used is the principal components analysis [105].

The pathway through which economic situation might influence maternal mortality is through influencing access to maternal care and better overall health. Financial accessibility is not only influenced by the economic situation of the mother or her family, but also by the extent to which costs are actually incurred in the use of health care. Costs for health care might include direct and indirect fees at health facilities, transport costs—particularly in emergency situations—as well as opportunity costs. In most studies, economic factors showed an association with maternal mortality. Lack of money is commonly cited as a main barrier to accessing care in qualitative studies, and primary reason for maternal death [106-108].

In a case-control study in Addis Ababa, Ethiopia, Kwast and Liff reported that mortality was higher in women where the annual family income was below 24 United States Dollar (USD) compared to over 150 USD (adjusted OR4.6, 95% CI 0.7 – 27.9) (Table 2). Also, women who were maid/janitors compared to women who were housewives had a higher risk of dying (adjusted OR 3.2, 95% CI 1.0 – 9.8) [86]. In Matlab, Bangladesh, a protective effect of higher wealth was reported (crude OR 0.5, 95% CI 0.4 – 0.6) when comparing the least poor mothers to the poorest mothers). No effect was observed after adjustment for other socioeconomic factors [25]. In Burkina Faso, pregnancy-related mortality was lower in the two least poor quintiles, but the confidence intervals were overlapping [73].

Mbassi et al reported, based on data collected in tertiary hospitals in Cameroon, that the hospital based MM-ratio was 13 times higher in women without income compared to women with stable income (MM-ratio of 218 per 100,000 deliveries in women with stable income to 2,800 in women without income). Okonta et al [109] described a MM-ratio of 1,229 in the poorest and 106 in the richest groups in Nigeria respectively based on the social class of the husband. Fikree et al [84] reported no association between assets in a household and mortality in Pakistan. Another study carried out in Pakistan reported that household assets, the type of housing, availability of electricity and water supply were associated with maternal mortality [85].

Bell et al [73] reported a 30% lower mortality in women in the highest compared to the lowest wealth group in Burkina Faso[MM-ratio 480 (95% CI 379 – 580) in lowest wealth group and 328 (95% CI 244-412) in the highest wealth group].

However, in a few studies, no association was found between mortality and economic solvency, like in rural Bangladesh and in Zimbabwe [87, 92]. Christian et al found no association between land and radio ownership or roof material with pregnancy-related mortality in Nepal [110].

Table 2: Association between economic factors and maternal mortality

Publication and country	Setting and study type	Method	Association with employment	Association with other wealth measurements including income
Abdullah et al 1992 [82]**Egypt**	Population based cohort	Logistic regression based on 29 maternal deaths among 8,656 pregnant women	Mortality ratio is 379 in unemployed and 79 per 100,000 pregnant women in employed women (p=0.087)	N/A
Kwast and Liff, 1988 [86], **Ethiopia**	Population-based survey in Addis Ababa	Logistic regression based on 29 cases and 8,684 controls	Mortality was higher in women who were maids/janitors compared to women who were housewives (adjusted 3.2,95% CI 1.0 – 9.8)	Mortality was higher (although not significant) in women where the family income was below 24 USD compared to over 150USDper year(adjusted OR4.6, 95% CI 0.7 – 27.9)

Mbizvo et al. 1993 [87] **Zimbabwe**	Community-based study including 175 cases and controls matched on the same level of care	Logistic regression based on matched case-control study	N/A	Crude OR 1.2 (95% CI 0.4 – 4.3) in women living in households with less than 150 Zimbabwe dollars compared to more than 600 Zimbabwe dollars income per year	
Okonta et al. 2002[109] **Nigeria**	Hospital-based cohort (teaching hospital in a rural environment)	Computation of mortality ratio based on 104 maternal deaths and 13,391 deliveries	N/A	Mortality ratios increased from by husbands' social class* (121, 498, 636, and 1,229 maternal deaths per 100,000 livebirths patients in classes two-through five respectively, with the exception of class one, with a ratio of 1065) *methodology of measurement of social class not explained	
Bell et al 2008 [73] [73], **Burkina Faso**	Two rural districts, cross-sectional study	385 pregnancy-related deaths, 88,000 livebirths	N/A	MM-ratio of 480 (95% CI 379 – 580) in the lowest wealth group and 328 (95% CI 244 – 412) in the highest wealth group	
Mbassi et al. 2011[111] **Cameroon**	Hospital-based study in severe tertiary maternity centres	249 maternal deaths compared with 34,898 deliveries	The MM-ratio was 218 per 100,000 deliveries in women with stable revenue and 608 in women with unstable revenue (business, farming) and 2,800 in women without income	N/A	
Fikree et al. 1994[84], **Pakistan**	Population-based cohort 1984 – 1989	Crude odds ratios based on 34 maternal deaths and 12,112 births	Not gainful maternal occupation compared to gainful occupation increased mortality (OR 3.8, 95% CI 1.1 – 13.0)	Paternal unemployment compared to being employed increased mortality (OR 5.9, CI 1.5 – 22.5)	No association between asset ownership and mortality (OR 1.5, 95% CI 0.6 – 4.7 comparing mothers with of less than three compared to four or more household assets)
Fikree et al. 1997 [85], **Pakistan**	Population-based, cross-sectional study 1989 – 1992	218 deaths and 1,043 controls, adjusted for biological and background factors	No significant difference observed for gainful employment compared to being a housewife (OR 1.9, 95% CI 0.6 – 1.7)	Inferior housing construction (Kutcha compared to Pucca) increased mortality (adjusted OR 1.5, 95% CI 1.3 – 3.2), similarly, not having potable compared to having potable water increased mortality (adjusted OR 1.5, CI 1.1 – 2.1)	

Alauddin 1968 [92], **Bangladesh**	Population-based cohort in a rural district, 1982-1983	Mortality ratios by risk groups based on 48 maternal deaths	N/A	Mortality ratios were 313, 565, 621 and 915 per 100,000 livebirths in women from households where the economic status was characterized as hardship, deficit, solvent and surplus, respectively
Chowdhury et al 2007 [25] Matlab **Bangladesh**	Population-based cohort 1976 – 2005	Adjusted ORs based on 769 maternal deaths and 215,779 pregnancies	N/A	Crude OR 0.5 (95% CI 0.4 – 0.6) comparing mothers from the least poor wealth group the poorest wealth group. No effect after adjustment for other socio-economic factors
Christian et al. 2008, **Nepal**	Population-based cohort	120 maternal deaths and 25,580 pregnancies		OR of maternal deaths from multiple logistic regression were 0.7 (95% CI 0.5-1.2) for women who owned land compared to no land and 0.6 (95% CI 0.4-1.1) for women living in a household owning a radio compared to living in a household with no radio
Andersson et al 2000 [96], **Sweden**	Population-based cohort in the 19th century	Computation of relative risk	Mortality was higher in white collar workers than farmers or craftsmen (RR 1.15, 95% CI 0.71 – 1.87)	N/A

Geographical Accessibility of Health Care

Different measures are used to describe the impact of geographical accessibility of health services on maternal mortality. Commonly, the place of living is categorized as rural or urban. Some authors have reported the distance to health services. A few publications have distinguished between distance to a first-line health facility and distance to hospital care. Also, travel time has been used.

Geographical accessibility might influence maternal mortality by predicting how fast and easily maternal health services can be reached for primary delivery care or in the case of obstetric complications. However, the determinant "place of living" might also be a proxy of socioeconomic status, as the urban population is often wealthier and better educated.

Almost all studies that have investigated place of living have revealed higher maternal mortality in rural areas and among women with longer distances to maternal health care (Table 3). Ronsmans et al [112] reported higher MM-ratios in rural areas (MM-ratio 601, 95% CI 529 – 679) than in urban areas (MM-ratio 241, 95% CI 172 – 330) in West Africa (RR 2.5, 95% CI 1.8 – 3.6). Tuerkyilmaz et al [113] also described approximately twofold higher pregnancy-related mortality in rural settlements than in urban settlements (MM-ratio 54 versus 28) in Turkey, with large differences between regions spanning from a MM-ratio of 12 in west Anatolia to a MM-ratio of 93 per 100,000 livebirths in north-eastern Anatolia. Koum reported from Cambodia that the MM-ratio was almost seven times higher in women from provinces outside the capital than in the capital Phnom Penh. The MM-ratio was estimated to be 310 (95% CI 170 – 523) in women from Phnom Penh and 2,090 (95% CI 1,443 – 2,923) per 100,000 livebirths in women from other provinces. However, the information warrants careful interpretation, as the hospital served as a referral centre [114].

In Sweden in the 19th century, women living in an urban or sawmill district were at a one-and-a-half-times greater risk of dying from direct obstetric causes compared with women living in agricultural district (RR 1.6, 95% CI 1.3-2.0) suggesting that at that time, living in an urban area boded disadvantages for maternal health[96].

In Guinea, Høj et al [78] reported a sevenfold higher MM-ratio if the mother lived more than 25 km from a hospital compared to 5 km from a hospital (OR 7.4, 95% CI 1.6 – 132.4 adjusted for region, outcome of pregnancy and multiple pregnancies). The maternal mortality was also higher if the mother lived more than 15 kilometres from a health facility compared to less than 1 km from a health facility (OR 1.5, 95% CI 0.7 – 3.1).

In Pakistan, women living more than 40 miles from a hospital compared to those living less than 40 miles than from a hospital had a one-and-a-half times higher risk of maternal mortality (adjusted OR 1.3, 95% CI 0.9 – 1.8) [85]. Aggarwal et al reported a sevenfold higher maternal mortality (OR 6.8, 95%CI 3.8 – 12.4) comparing women who lived more than 5 km to less than 5 km from the nearest health facility in a bivariate analysis (no multivariate analysis available) using a case-control design to study mortality in slums Delhi, India [83].

In rural Burkina Faso, Bell et al [73] reported a 50% higher MM-ratio in women living more than 5 km from a health facility compared to less than 5 km from health facility in one district but not another [MM-ratio 429 (95% CI 333 – 525) in <5 km compared to 292 (95% CI 222 – 363) in >5 km in one district and (MM-ratio 506 (95% CI 453 – 584) in <5 km compared to 537 (95% CI 425 – 648) >5 km in the other). However, distance was not associated with pregnancy-related mortality in the final analysis [115].

Table 3: Associations between distance and maternal mortality

Publication and country	**Setting and study type**	**Method**	**Distance measure-ment**	**Association with distance**
Ronsmans et al. 2003, [112] **West Africa**	16 sites in west African countries collected between 1988-1998	Ecological study based on population-based data from demographic sites (rural areas) and census in urban areas, 257 deaths	Rural/ Urban	MM-ratio was 2.5 times higher in rural compared to urban areas (RR 2.5, 95% CI 1.8 – 3.6)
Türkyyilmaz et al. 2009 [113], **Turkey**	Study based on data from the national maternal mortality study followed by a reproductive age mortality study	Ecological study comparing MM-ratios by region and type of settlement (rural/urban)	Rural/ Urban	MM-ratio was 53.7 in rural settlements and 28.2 in urban settlements
Koum et al. 2002 [114], **Cambodia**	Hospital-based study	49 maternal deaths and 6,089 deliveries	Residence (urban or other province)	MM-ratio is estimated at 310 (95% CI 170 – 523) in women from Phnom Penh and 2,090 (95% CI 1,443 – 2,923) from other provinces
Andersson et al.2000 [96] **Sweden**	Population-based cohort in the 19th century	Computation of relative risk between categories based on 1,237 maternal deaths and 150,932 livebirths	Agriculturals compared to urban or sawmill district	Risk of deaths comparing agricultural district to urban or sawmill district: RR 1.6, 95% CI 1.3-2.0 for direct obstetric deaths and 1.3, 95% CI 1.1-1.5 for pregnancy-related deaths
Hoy et al. 2002 [78]**Guinea-Bissau**	Population-based cohort, 1990-96	Logistic regression including 85 maternal deaths and 10,846 pregnancies	Distance to health centre and distance to	Increased mortality in women living more than 15 km from health centre compared to less than 1 km (OR 1.48, 95%

			hospital (method of measurement not specified)	CI: 0.66 – 3.11) Increased mortality in women living more than 25 km from hospital compared to women living within 5 km of a hospital (OR 7.4, 95% CI 1.6 – 132.4 adjusted for region, outcome of pregnancy and multiple pregnancies)
Fikree et al. 1997 [85], **Pakistan**	Population-based, cross-sectional study 1989 – 1992	218 deaths and 1,043 controls	Distance to hospital (method of measurement not specified)	Distance to hospital of more than 40 miles compared to less than 40 miles increased mortality, although not statistically significantly (adjusted OR 1.3, 95% CI 0.9 – 1.8)
Aggarwal 2007 [83], **India**	Community-based study in slums in Delhi	Case-control study based on 70 cases and 384 controls	Distance to Health centre (method of measurement not specified)	Distance of more than 5 km to a health centre compared to less than 5 km increased mortality (OR 6.8, 95% CI 3.75 – 12.36)
Bell et al. 2008 [73], **Burkina Faso**	Two rural districts, cross-sectional study	385 pregnancy-related deaths, 88,000 livebirths	GIS based straight-line distance measurement between households and health facilities	MM-ratio 50% higher in households more than 5 km from a health facility compared to those less than 5 km from a health facility in one district but not the other [MM-ratio 429 (95% CI 333 – 525) in <5 km compared to 292 (95% CI 222 – 363) >5 km] Virtually no difference was seen in the other district [MM-ratio 506 (95% CI 453 – 584) in <5 km compared to 537 (95% CI 425 – 648) >5 km]

Biological Factors

Age

Age is commonly assessed using five-year intervals for categorisation (15-19, 20-24, etc.). Some studies use larger intervals like 15-24, 25-35, and above 35 to avoid too few cases in each category. Age is known to be a biological risk factor, but age is also a socio-cultural proxy, as age influences the status of a woman in the society.

In general, a J-shaped relationship between age and maternal mortality is observed, with increased risk in young mothers (commonly defined below 18 or 20 years) and those above 35 years of age, [116, 117].The pathway for how age might influence maternal mortality in young mothers is via physical immaturity of the pelvis and an increased risk for obstructed labour and anaemia [118, 119]. But little is known to which extent this association is confounded by other socio-economic factors.

Older mothers have a higher risk of eclampsia and placenta previa. Jacobson et al calculated an increased odds ratio for severe eclampsia of 1.29 (95% CI 1.16 – 1.44) and for placenta previa of 4.10 (95% CI 3.55 – 4.73) in women aged 40-44 compared to women aged 20-29 after adjusting for several risk factors including parity and pre-existing maternal disease [120].

In 1984, Trussell and Pebley [121] calculated that the risk of dying from maternal causes could be reduced by 24.6% if no births would take place below age 20, above 39, and above a parity of five. Other authors estimated similar effects of avoiding births at the extremes of childbearing age [122, 123]. In a review, Marston and Cleland also concluded that there is a clear potential health benefit from avoiding birth at the age extremes. However, they argue that it is hard to calculate the extent of mortality reduction, as estimates adjusted for parity and socioeconomic status are not available [124].

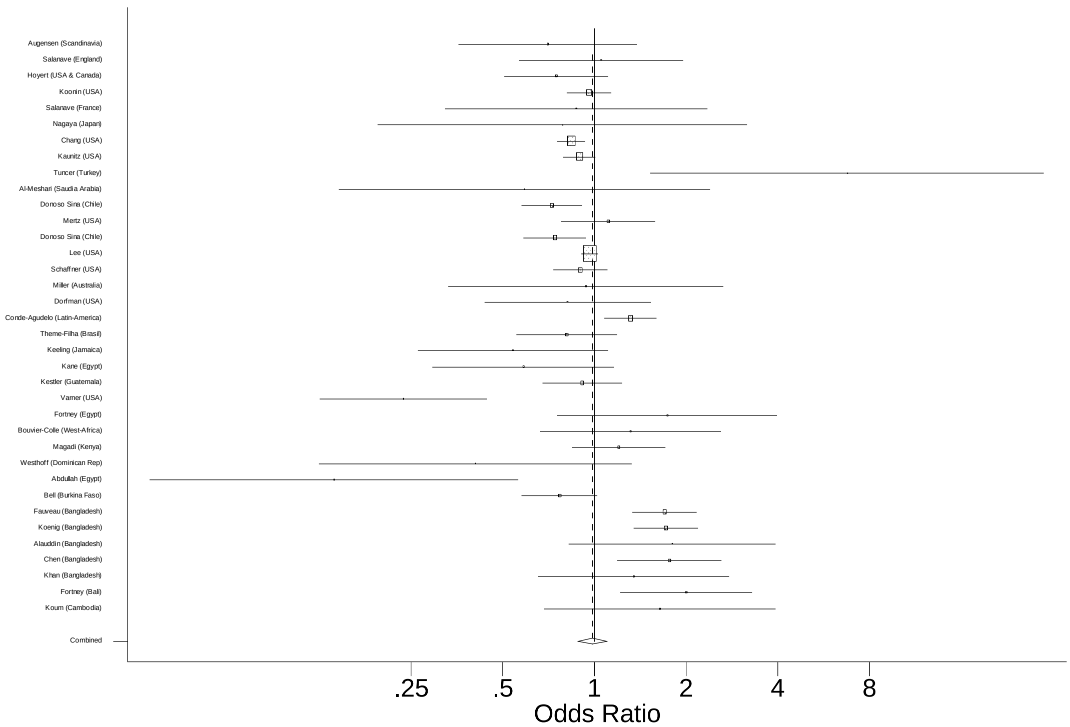


Figure 3: Pregnancy-related mortality risk in women <20years compared to 20 – 35 years

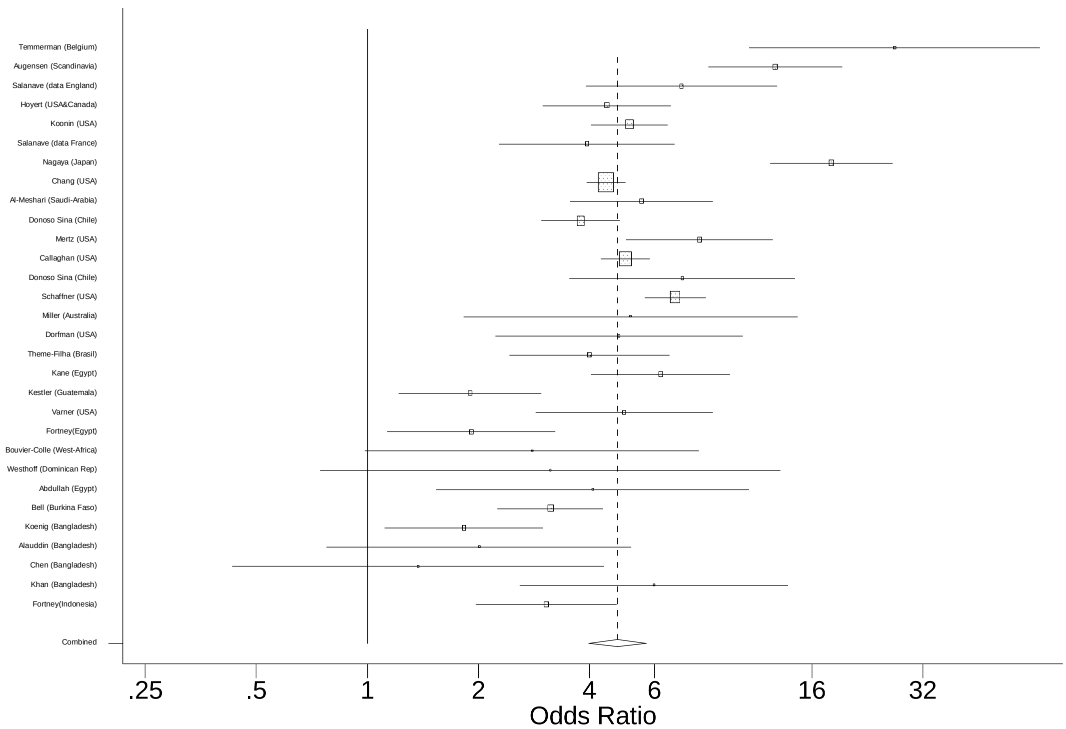


Figure 4: Pregnancy-related mortality risk in women >40 years compared to 20 – 35 years

A meta-analysis based on a systematic review done by myself supports the evidence that births in older age of childbearing age are of higher risk (Figure 4). Young age (below 20 years) was associated with mortality in low income countries. There was evidence of a risk increase in settings where the MMR is above 200 (OR 1.3, 95% CI 1.0-1.7) (Figure 3, Table 4). The odds of dying were high above 40 years, but the effect differed according to the setting. In countries with a high MM-ratio, women above the age of 40 had a threefold (OR 2.8, 95% CI 2.3 – 3.6) increased risk of dying compared to women aged 20 – 35. Women in a low mortality setting face a more than sixfold increased risk of dying when the same age groups were compared (OR 6.5, 95% CI 5.1 – 8.4). However, no study included in the meta-analysis had adjusted for parity and socio-economic variables, thus, the estimations have to be interpreted with caution[125].

Table 4: Pooled risk estimates for the factors maternal age below 20 and over 40 years compared to 20-35 years

	Pooled OR of Risk factors (95% CI, p- value of Heterogeneity Test)			
	<20 years		**age 40 +**	
	pooled OR	**No of studies**	**pooled OR**	**No of studies**
fixed -effects model	1.0 (0.9-1.0)	*36*	4.9 (4.6-5.2)	*30*
random-effects model	1.0 (0.9-1.1; p<0.001)	*36*	4.8 (4.1-5.7; p<0.001)	*30*
MMR <26	0.9 (0.8-1,0; p=0.18)	*12*	6.5 (5.1-8.4; p<0.001)	*12*
MMR 27-200	0.9 (0.7-1.0; p<0.001)	*12*	4.3 (2.9-6.3; p<0.001)	*9*
MMR >200	1.3 (1.0-1.7; p<0.001)	*12*	2.8 (2.3-3.6; p=0.02)	*9*
Hospital based	1.0 (0.6-1.9; p<0.001)	*6*	5.3 (3.8-7.5; p=0.77)	*2*
Population based	1.0 (0.9-1.1; p<0.001)	*30*	4.7 (3.9-5.7;p<0.001)	*28*

In addition, age is a social attribute which influences access to care. In their review, Gabrysch and Campbell [88] concluded that higher age positively influences access to care. However, as parity often negatively influences care seeking behaviours, the effect is only seen in studies using multiple regression models adjusting for confounders [126]. There is some evidence that the effect of age on health seeking behaviours differs between continents. Different from southeastern Asia and south Asia, young women in sub-Saharan Africa have a similar proportion of births attended by a skilled provider than older women [127].

Parity

For parity, a J-shaped association with maternal mortality has been suggested [116, 123]. The risk of death is higher in first births and in higher order birth (above five or more pregnancies). Different categories are used for higher birth orders; sometimes gravidity is used rather than parity. Parity defines the number of previous deliveries (stillbirths and livebirths) whereas gravidity counts all pregnancies whether resulting in an abortion, stillbirth or a livebirth.

The biological pathway for how parity could affect maternal mortality might be due to the greater risk of obstetric complications during the first pregnancy, in particular, a higher rate of eclampsia, malaria infection, and obstructed labour. For mothers having had five or more previous births, a higher rate of postpartum haemorrhage has been reported [128, 129].

Table 5: Pooled risk estimates for the factors maternal age parity above five compared to 1-5 previous births

	Pooled OR of Risk factors (95% CI, p- value of Heterogeneity Test)	
	pooled OR	**No of studies**
fixed -effects model	1.9 (1.7-2.1)	*16*
random-effects model	2.2 (1.7-2.9;p<0.001)	*16*
MMR <26	5.5 (3.9-7.8; p=0.5)	*2*
MMR 27-200	2.2 (1.6-2.9; p=0.45)	*3*
MMR >200	1.9 (1.5-2.5; p<0.001)	*11*
Hospital based	3.2 (2.0-5.2; p<0.001)	*6*
Population based	1.8 (1.4-2.4; p<0.001)	*10*

A higher rate of maternal deaths among primiparous or highly multiparous women has been described in many studies. The systematic review done by myself and Joanna Schellenberg [125] calculated a pooled risk estimate for the first birth to be an odds ratio of 1.4 (95% CI 1.1 – 1.9) compared to women with one-to-five previous births (data not shown). Higher parity women with more than five previous births had 2.2 (95% CI 1.7 – 2.9) times the risk of dying compared to women with fewer previous births (Table 5). The pooled mortality estimates for women in low income settings and hospital-based studies warrant careful interpretation as few studies are available and hospital settings present a selected population. Risk estimation could not be adjusted for age or socioeconomic factors as no information was available on this from the studies included in the review. Marston and Cleland also concluded that it might be difficult to distinguish the effects of parity from the effects of age [124].

In addition to the biological effects of parity, a negative impact of higher parity on health care seeking has been described [88, 91].

Spacing

The evidence on the effect of birth interval on maternal mortality is scarce. Two reviews have been undertaken, one by Ronsmans and Campbell [130] and one published by Conde-Agudelo [131]. Both found few studies with relevant information.

One of the first studies on the subject, published in 1944, reported no evidence of an effect of short birth interval on maternal mortality [132], but included only a few cases (16 maternal deaths). Ronsmans and Campbell 1998[130] found in a case-control study in Bangladesh that a birth-to-conception interval of less than nine months only slightly increased the risk of maternal mortality (adjusted OR depended on how the inter-pregnancy interval was modelled for missing data, results were between 1.3 , 95% CI 0.8 – 2.1 and 1.4, CI 0.8 – 2.2). Fortney and Zhang 1998 [133] calculated the effects of short birth intervals (<12 months) and reported an OR of 1.7 (95% CI 0.9 – 3.1) in random (not matched) controls and an OR of 2.4 (95% CI 0.9 – 6.3) in matched controls in a case-control study. Also, Høj et al 2002[78] found that short intervals (0-to-18 months) increased the risk of maternal mortality, but not significantly at the 95% level (OR 1.72, 95% CI 0.6 – 3.5). The only study reporting a statistically significant association between birth spacing and maternal mortality is from Conde-Agudelo 2000 [134]. This study used pooled data from Latin America and the Caribbean to achieve a sufficient sample size. An adjusted (for 13 factors) relative risk of 2.5 (95% CI 1.2 – 5.4) was found for inter-pregnancy-intervals of zero-to-five months. Also a higher risk for longer inter-pregnancy-intervals over five years is reported.

Summary of Findings

Few population-based studies report socioeconomic factors as they contribute to maternal mortality. There are few studies indicating that education is inversely associated with maternal mortality, including two population-based studies from sub-Saharan Africa, four from Asia and a large hospital-based study from three continents [25, 74, 78, 82, 83, 92, 93]. The evidence that race has an association with maternal mortality is reported from the United States [79, 98-102]. There is no clear evidence that marital status, religion or ethnic group has an association with maternal mortality. There is also no clear indication that occupation is associated with maternal mortality, whereas there is some evidence from larger population-based studies from Burkina Faso and Bangladesh that women living in a poorer compared to richer households are more likely to die [25, 73]. Also the evidence whether distance to a health facility increases the risk of a pregnant women dying is unclear. Only one population-based study from Burkina Faso has used a clearly defined distance measurement (GIS-based straight-line distance) to examine the association between distance and maternal mortality, and this study was not able to establish clear evidence of an association. Much more is known about the association between the demographic risk factors like age and parity and maternal mortality, but studies lack adjustment for confounding factors [117].

6. Interventions to Reduce Maternal Mortality

Skilled Attendant at Birth

A skilled attendant at birth is one of the key strategies to reduce maternal mortality today [135]. The skilled attendance strategy does not only imply that a trained health staff with midwifery skills (skilled attendant) is available at birth, but also that an enabling environment is put in place to support the skilled attendant to perform life-saving interventions [136]. Although the term skilled attendant should best be used for a provider having comprehensive midwifery skills, in the absence of studies that examine their skills, all nurses, midwives and clinicians are normally counted as skilled attendants [137, 138]. It is important to note that the following studies are using information on 'skilled attendant' defined as the presence of a health worker at birth assessed by asking women's report in household surveys. Ideally information on 'skilled attendance' which would imply in-depth studies on actual skills of health workers (see more section on assessment of maternal death p 58) but such assessments are rare.

Much of the evidence supporting the importance of skilled attendance for the survival of mothers and their newborns is derived from historical studies in Europe and the United States, and a few middle income countries [139-141], or ecological studies indicating an inverse association between the proportion of birth with a skilled attendant and maternal mortality [142-144]. Buor and Bream used a few determinants in an ecological explanatory model for maternal mortality and found that skilled delivery (-0.592, $p \leq 0.01$) was a significant predictor of maternal mortality, followed by life expectancy (-0.489, $p \leq 0.05$), and a country's gross national product (-0.543,$p \leq 0.05$)[145]. In a paper from Betrán et al. [146] three variables, the proportion of deliveries by a skilled attendant [parameter -0.016, standard error (SE) 0.004, $p<0.0001$], infant mortality (parameter 0.013, SE 0.004, $p<0.0003$) and health expenditure per capita (log parameter –0.272, SE 0.075, $p<0.0004$) were able to explain 90% of the variations in maternal mortality at country level. Scott and Ronsmans reviewed the evidence from ecological studies and concluded that causal inference is tentative and there is poor controlling of confounders [147].

More recent country examples from Bangladesh support evidence of the importance of skilled attendance for maternal mortality reduction, but also underline the need for a functioning health system and other interventions like the promotion of family planning [25, 148]. A recently published paper reviewing factors that might have contributed to the successful reduction of maternal mortality in Bangladesh, Bolivia, Cambodia, Gambia, Morocco and

Rwanda indicated that improved uptake of skilled attendant is likely to have contributed to a decline in maternal mortality, except in Bangladesh [149]. In these countries, remarkable increases in the proportion of birth attended by a skilled attendant between 20 – 50% were observed in the same period that a reduction of maternal mortality was described, but not in Bangladesh [149]. Similar to the observation in Bangladesh, an appraisal of the maternal mortality decline in Nepal could not clearly associate the decline in maternal mortality with the increase in birth attended by a skilled attendant [150].

Evidence from intervention studies on the effect of skilled attendance on the reduction of maternal mortality is lacking. An evaluation of an intervention study, "Strengthened Skilled Attendance Program" in Burkina Faso reported that a 30% decline (adjusted OR 0.7, 95% CI 0.4 – 1.1) in the area included in the skilled attendance program during the time of implementation. However, mortality reductions were also observed in the comparison districts and the differences between the intervention and the two comparison districts were not statistically significant (p=0.439 and p=0.278, no OR available) [90].

At the individual level, the association between birth attended by a skilled attendant and maternal mortality is even more complex. Research examining the effect of a community-based midwifery program in Indonesia revealed that maternal mortality was higher in women delivering with a skilled attendant than without in all wealth groups except the wealthiest [151]. Similarly, the early neonatal death rates were higher in Indonesia for deliveries attended in public facilities than at home [89]. In other studies examining individual-level effects, the expected reduction of maternal mortality when delivering with skilled health providers was not observed in Pakistan nor in Senegal [84, 152, 153]; however, in other settings, lower maternal mortality was found [93, 95, 153].

Higher institutional MM-ratios have been described in many settings and might be due to self-selection and care-seeking in case of complications. Moreover, access to birth attended by a skilled attendant does not automatically imply access to skilled emergency obstetric care and life saving obstetric surgery due to deficient quality [147].

Uptake of birth attended by a skilled attendant varies a lot in relation to the factors described above, such as age, education, distance, and household economy [88, 126, 127, 151, 154]. As most factors might, to a large extent, work through increased uptake of skilled care, skilled attendant might be on the causal pathway between factors such as education or wealth and mortality reduction.

Emergency Obstetric Care

The term emergency obstetric care is used to describe a set of interventions needed to save a mother's life in case of complications. Often Basic Emergency Obstetric Care (BEmONC) and Comprehensive Emergency Obstetric Care (CEmONC) are distinguished (see section 1.5 assessment of quality of maternal care)[155, 156].

A review done by Paxton et al. [157] provides evidence that emergency obstetric care is effective in reducing maternal mortality. The evidence is mainly derived from ecological studies in which relatively strong inverse correlations between MM-ratio and Caesarean section were observed [112]. Country analyses from Malaysia and Sri Lanka point to the importance of emergency obstetric care [148]. Also, country experiences from Nepal and Bangladesh suggest that access to emergency obstetric care might be an important driver of mortality reductions [150]. Further, the six assessments done by the Unmet Obstetric Need (UON) network in West Africa and Tanzania indicate that countries with high maternal mortality have very low levels of surgical intervention [158].

Intervention studies also support the impact of emergency obstetric care. An evaluation of the reduction in maternal mortality in Matlab, Bangladesh over 30 years supports the importance of facilitating access to emergency care. When comparing mortality in the intervention area and comparison area, a skilled attendance strategy improved uptake of emergency obstetric care, and where emergency obstetric services were close by, a lower MM-ratio was observed [25, 159].

In an uncontrolled study using before-and-after analysis, it was reported that improved access to emergency obstetric care (better transport and communication + financial support + improved quality of care at the hospital level) reduced institutional maternal mortality in rural Mali by 50% within two years after the start of implementation [160].

However, emergency obstetric care interventions, primarily Caesarean section, may also bear health risks. An investigation into risks of Caesarean section across 24 countries in 273 health facilities with 286,565 deliveries in Asia, Africa and Latin America indicated a threefold higher risk of dying if the mother had a Caesarean section without indication compared to a spontaneous birth (adjusted OR 3.1, 95% CI 0.8 – 13.2). The risk of death and severe maternal morbidity comparing birth by antepartum Caesarean section without indication and spontaneous birth was highest in Africa (adjusted OR 71.3, 95% CI 32.16 – 158.6) followed by Asia (adjusted OR 2.1, 95% 1.0 – 4.4) and Latin America (adjusted OR 1.9, 95% CI 0.8 – 4.9).

These data provide some evidence that Caesarean sections bear health risks, which cannot be explained by the reasons why a Caesarean section is done and that these risks seem to be much greater in Africa than Asia and Latin America[161].

The determinants of access to Caesarean section or other major surgical interventions have been the subject of several studies, which have highlighted major differences between and within countries, with regard to urban and rural settings, wealth and education [158, 162, 163]. Caesarean section may also need to be considered on the causal pathway explaining how place of residence, wealth and other individual factors influence maternal mortality.

Antenatal Care

Antenatal care is an intervention package including a wide range of preventive and curative interventions. The interventions that are included in an antenatal care programme differ between countries. Some interventions are context-specific like the intermitted preventive treatment of malaria in pregnancy (ITPp).

Review articles published in the 1990s questioned the long standing claim that ANC is effective in reducing maternal morbidity and mortality [164, 165]. Investigations into the effectiveness of several single interventions to improve maternal, newborn and child health commonly included in the package concluded that effective interventions might be: iron and folate supplementation; blood pressure screening for high risk groups; dipsticks in urine for detection of infection and hypertensive disorders; and detection, prevention and treatment of sexually transmitted infections, in particular, syphilis. However, the effectiveness of other interventions such as symphysis fundus measurement and palpation of the abdomen to detect malpresentation depend heavily on the skills of the provider. The risk approach, aiming at distinguishing high-risk and low-risk births, has been generally questioned, as the predictive value of most criteria is low [166, 167].

In recent years, a more focused and time reduced approach (only four visits) has been recommended. The recommendation is based a on randomized trial undertaken in the 1990s across different settings, which proposed that a more focused approach with fewer visits had a similar effect on maternal and perinatal outcomes compared to an approach with more visits [168, 169].

Studies that compared mortality in women with and without having attended ANC found, in general, higher mortality in women who did not seek care. Koum reported a significant six-fold increase in maternal mortality in Cambodia among women who did not attend any ANC [114].

In Addis Ababa, a twofold increase in mortality for women without ANC compared to those who attended ANC was reported [86]. In a study of a slum in Delhi, an almost threefold increase in mortality among women not registered for ANC was reported [83].

These studies suggest that attendance of ANC reduces maternal mortality. However, there are two possible pathways to highlight how ANC reduces maternal mortality. First, women attending ANC might also be more likely to utilise skilled attendants at birth because they are more educated, richer, live closer to a health facility or face complications. Uptake of ANC and skilled attendance at birth might overlap, but uptake of skilled attendance might be the critical factor reducing mortality. Secondly ANC might also have an effect independent of skilled attendance, for example, by reducing mortality due to preventive interventions such as tetanus vaccination, IPTp and bednets to prevent malaria and giving important information about the importance of professional intrapartum care [170].

Family Planning

Family planning was, together with antenatal care, the first intervention widely made available in low- and middle-income countries as part of the GOBI-FFF[6] strategy supported by UNICEF in the 1980s [171]. Later, the importance of family planning for maternal health was reconfirmed as family planning became one of the four pillars of the Safe Motherhood strategy [5]. Today, a three tiered strategy of skilled attendance, emergency obstetric care, and comprehensive reproductive health services including family planning is suggested [172, 173].

The pathway through which family planning influences maternal mortality is threefold: by lowering fertility and thereby lowering the MM-rate; by avoiding unwanted births thus preventing unsafe abortion and thereby lowering the MM-ratio; and by reducing births in high-risk age and parity groups and thereby also lowering the MM-ratio.

It has been estimated that family planning prevents 187 million unintended pregnancies per annum, including 60 million unplanned births and 105 million abortions. Based on this figure, it is estimated that 140,000 – 150,000 lives are saved every year [174]. Ahmed et al. estimated that contraceptive use averted 272,040 (uncertainty interval 127,937 – 407,134) maternal deaths (44% reduction) in 2008 [175], a level also proposed in recent publication by Cleland et al [117]. Stover and Ross concluded that during the past 10 years, there has been a 5 – 35% decline in maternal mortality, which could be attributed to changes in parity distribution [176].

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[6]Growth monitoring, oral rehydration therapy, breastfeeding, immunisation, family planning, female education, and food supplementation

Country analyses confirm the impact. A comprehensive analysis of the reduction of maternal mortality in Matlab, Bangladesh emphasised the importance of family planning for the reduction of maternal mortality [25]. Also, fertility reductions have been discussed as an important factor in the maternal mortality decline in Nepal [150]. Jain (2011) calculated that 22 – 39% of the decline in MM-ratio in Bangladesh, India, and Pakistan was due to the fertility decline [177]. Neither the population growth rate nor the contraceptive prevalence rate was a significant predictor for MM-ratio in the regression model used by Betrán et al. (parameter estimates not available)[146]. In the analysis of determinants of maternal mortality by Buor and Bream [145], the total fertility rate was also not significantly associated with the MM-ratio (parameter estimate 0.192). The actual impact of family planning on the MM-ratio is difficult to estimate.

Table 6: Summary of evidence of strategies to reduce maternal mortality

Intervention	Pathway	**Evidence**
Birth attended by a skilled attendant	Prompt management of complications or referral to higher level care	**Reduced mortality** *Historical studies*[139-141, 148] *Ecological studies* : [142-145] Unclear result from intervention study [90] Individually-based studies indicating higher mortality (self-selection bias?) [84, 151-153] Individual studies indicating a lower mortality (predominantly in countries with higher skilled attendance): [93, 95, 153]
Emergency obstetric care Basic and comprehensive	Management of life threatening complications	**Emergency obstetric care reduces mortality** *Review*: [157] *Historical studies: [148]* *Ecological studies: [112, 178]* *Intervention studies: [25, 160, 179]*
Antenatal care Package with variable content	Prevention, detection and treatment of complication	Selected interventions are highly effective to reduce morbidity [166, 167] **Protective effect on mortality:** *Cohort studies*: [114] *Case-control studies:*[77, 83, 86]
Family planning	Preventing unwanted births and births in high risk groups	**Model based estimation** of reduction of MM-ratio by around 15% by avoiding birth in mothers <20 and>40 years of age[121-123, 125] Theoretical effect of changes in parity distribution [176] **Country analysis** [25, 148, 177]

7. Quality of care

This review first presents definitions of quality of care with frameworks, domains, characteristics or elements proposed to support the definition of quality. Secondly a few applications of such frameworks and models to establish a set of indicators in a specific health area are outlined. The third part reviews frameworks and models for patient satisfaction or client-centred care and introduces some important limitations of measuring patient satisfaction.

Quality of care is a multidimensional concept which has been defined by the Institute of Medicine as ”the degree to which health services for individuals and populations increase the likelihood of desired health outcomes and are consistent with current professional knowledge”. Further, six aims around the core need for high-quality health care were identified 1) safety, 2) effectiveness, 3) timeliness, 4) efficiency, 5) equity, 6) patient-centredness [180]. This is broadly similar to the European context frameworks in which the cornerstones effectiveness, efficiency, access, patient safety, continuity, acceptability, appropriateness, satisfaction, and patient experiences are used [181].

The utmost importance of patient safety as a core element of quality of care is highlighted by WHO and supported by the World Alliance for Patient Safety [182]. Thus thinking around quality of care is rooted in the Hippocrates Oath “First do not harm” dating more than 2000 years back. Another factor in conceptualising quality of care is the increased availability of ‘evidence’ in many areas of medicine as presented by the Cochrane Collaboration and related initiatives [183, 184]. Health system performance and quality of care can be seen a related concept as both i) assessment of quality of care and ii) health system performance are based on very similar frameworks and assessment criteria and both have, the highest attainable health, measured by impact indicators, as an endpoint [185].

Frameworks of quality of care which are predominantly based on the landmark work of Donabedian propose that quality of care should be assessed by including input, process and outcome indicators [186, 187]. This is similar to health system performance frameworks such as the one published by WHO and the International Health Partnership (also known as IHP+) [188]. Frameworks proposed for maternal and child health assessment also broadly follow this same model with assessment of progress along the effect line using input, process, output, outcome, and impact indicators [189, 190].

A few reviews have been published specifically looking into assessment models and conceptual frameworks in the field of maternal health. Morestin et al in defined key domains within a framework of structure, process and outcome for maternal care [191]. Some of the key domains, such as organisational resources as an aspect of structure are not routinely found in other frameworks but could be seen as aspects of health system governance and leadership [192]. A framework proposed for the assessment of skilled attendance at birth by Adegoke et al [193] follows the flow of input (in this paper called structure), process and outcome and divides the necessary inputs into i) availability of skilled attendants and ii) the enabling environment. Quality improvement and management aspects are categorized under processes and not in the category of inputs as proposed by Morestin et al [191] and in health system frameworks [190]. Many of the aspects listed under the 'enabling environment' could be categorised into the domains of the health system building blocks [18], indicating the close relationship between quality of care and health system thinking.

A recent literature review of definition and models of quality of care in maternal and neonatal health identified different models defining quality of care from five different distinct perspectives [194]. The first model describing "dimensions of the health system" is represented by the model of Donabedian defining structure, process and outcome [186]. Another model proposes "characteristics of quality" being accessibility, availability, affordability, equity and effectiveness [195]. Ovrevreit defined three main "perspectives of quality" being 1) client quality, 2) professional quality, and 3) management quality [196]. Others have used "elements of quality" ranging from elements of resources, referral and information systems to experience of care [197]. The elements of quality in family planning services by Bruce is another example which uses "elements of quality" model [198]. Raven et al [194] proposed to use all these five models of quality of care to assess the quality in maternal and neonatal care in a comprehensive way.

Based on these frameworks and models outlined above, health care areas, services units and departments have often established their own set of indicators specific to diseases and patients characteristics. Delphi methods with at least two rounds of expert consultations are used to define sets of indicators appropriate to the respective medical field [199]. Kötter et al [200] reviewed the literature on approaches used to select quality indicators based on guidelines and proposed a six step approach from 1) topic selection, 2) guideline selection, 3) extraction of recommendations, 4) indicator selection, 5) practise test and finally 6) implementation. Van Engen-Verheul et al [201] proposed a modified Rand Method including

1) expert and patient panels, 2) literature research and 3) review of guidelines. The innovative aspect was the inclusion of a patient panel.

Schull et al underlined the importance of using indicators where evidence exists that there is a clear link between process and outcome indicators, thus improvements in process of care result in better outcomes In addition indicators should reflect a potentially serious and common gap in health care performance [202].

In summary, a growing body of work has been published to conceptualise quality of care and to define frameworks and important domains to be included in assessments. Processes of indicator developments and selections are often – although not always - based on such frameworks and models. Literature reviews including evidence reviews, Delphi methods with consensus and consultation are commonly used to define final indicator sets.

Client satisfaction

Client satisfaction is increasingly seen as an important outcome of care; health systems and quality of care frameworks include satisfaction with care as an outcome indicator together with key health outcomes [190, 203]. Client satisfaction has been suggested as part of the indicator sets to define the 'right to health' [204].

Table 7 gives an overview about recent published papers (last five years) investigating patient satisfaction in different contexts. Some of the papers suggest how best indicators of patent satisfaction might be developed. Qualitative formative research [205, 206] and asking clients about the importance of each of the indicator [207] are aspects which are proposed by several authors. Particularly the publication from Sixma et al 1998 has guided several assessments of client satisfaction in different health areas in the Netherlands [208]. The domains included vary widely. Typically client satisfaction along different stations of health care seeking (admission, procedure and discharge) is assessed.

However, although satisfaction with care is an important outcome measure, it has been criticised for its subjectivity [209]. Investigations into assessment methods suggest that satisfaction is influenced by the interval between a health care service and the assessment of services [210]. Moreover client characteristics such as education or age influence patient satisfaction. Hekkert et al [211] recommended based on a multilevel analysis of patient satisfaction to adjust endpoint values of client satisfaction for age, health status and education when using such an indicator to compare different services. Jayadevappa et al [212] hypothesised that satisfaction to be comprised of three dimensions 1) patient level attributes

2) satisfaction with treatment choice/decision and processes and 3) satisfaction with outcomes [212], thus also proposing that patient level attributes are important to consider.

Table 7: Studies investigating into client satisfaction

Author, year	**Type of paper**	**Clinical area**	**Indicator domains**	**Comments**
Bokhour et al, 2009 [205] **United States**	Primary research study on indicator development	Epilepsy	Final list of patient-generated included • Referral to self-help groups • Referrals to social service • Written educational materials • Information on side effects • Information on a variety of treatment options	Model of indicator development for client satisfaction based on qualitative research and clinicians expert ranking on appropriateness, feasibility and necessity
Jayadevappa et al. 2009[212] **United States**	Primary research using 20-item prostate cancer specific health-related quality of life questionnaire and a 8-item standardised satisfaction questionnaire	Prostate cancer	The study uses the conventional model of structure, process and outcomes and defines three dimension of outcome • Health related quali of life • Complications • Survival These three outcome measures are hypothesised to have an impact pn satisfaction of care together with patient characteristics and environmental and social characteristics.	Measurement of satisfaction with care was closely related to health-related quality of life measurements
Hekkert et al, 2009 [211] **The Netherlands**	Research study examining the effect of patient characteristics on satisfaction	Patient satisfaction in academic and general hospitals	6 domains of satisfaction • Admission procedur • Nursing care • Medical care • Information • Patients autonomy • Discharge and aftercare • Overall satisfaction	Age, health status and education appeared to be the most important factors for patient satisfaction
Sixma et al.	Framework	Rheumatic	Indicators were rated by	Authors underline

1998 [208] **Netherlands**	development and assessment,	patients	importance, performance and quality impact indices (product of importance and performance) Domains were • General process • General structure • Category-specific indicators • Regional indicators (disease specific)	the that the users perception of the importance of the component should be included in satisfaction studies The framework is widely in the Netherlands and the generic questionnaire quality of care from the perspective of patients (QUOTE)-questionnaire has been adapted to several disciplines
Bos et al. 2012 [207] **The Netherlands**	Development and evaluation of a consumer quality index using a 84-item questionnaire	Accident and emergency department	5 domains • Attitude of the healthcar professionals • Information and explanation • Environment • Leaving the department • General information and rapidity of care	Authors also included an assessment of importance of the respective item
Kleefstra et al 2012[213] **The Netherlands**	Adaptation of the Core questionnaire for the assessment of Patient Satisfaction' (COPS)	Day care services	Inclusion of two more dimensions (pre-admission visits and operation room) to the care questionnaire which included admission, nursing care, medical care information, autonomy and discharge	5-point Lickert scale used
Babikako et al. 2011 [214] **Uganda**	Primary research, factor analysis	Tuberculosis	Use of adapted 13-item patient satisfaction questionnaire with three domains • Quality care • Responsiveness • Management	Acceptable internal consistency and tool judged to be effective for assessing care satisfaction
Agha & Do 2009 [215] **Kenya**	Research study based on Kenya service provision assessment	Family planning	Client satisfaction defined by 12 points all answered positively such as no problem with waiting time, ability to discuss with provider,	

			explanations, privacy availability of medicines, etc.	
Tuncalp et al 2012 [216] **Ghana**	Qualitative study in women experiences severe complications	Obstetric near miss	3 dimensions • Enabling policy environment • Experience of care • Provision of care	Experience further shaped by severe maternal morbidity experience
Duong et al. 2004 [217] **Vietnam**	Use of an pre-tested 20-item questionnaire	Pregnant and postnatal clients	4 domains • Health care delivery • Health facility • Interpersonal care • Access to services	Feasibility, reliability and validity was assessed satisfactory using factor analysis
Hansen et al 2008 [206] **Afghanistan**	Factor analysis of 8-item questionnaire using a 4-point Lickert-scale	Primary care	8 items • Cleanliness • Staff courteous and respectful • Trust in skills and abilities of health workers • Good job • Easy to get the medicines • Costs reasonable • Privacy • Overall satisfaction	Internal consistency was appropriate. Indicator development was based on intensive formative research

Another relevant concept is this area is patient-centredness which is defined by five conceptual dimensions 1) Biopsychosocial perspective, 2) Patient-as-person, 3) Sharing power and responsibility, 4) therapeutic alliance, and 5) Doctor-as-a person [218]. The World Health report 2009 also strongly underlined the need to put the expectations and needs of the clients in the centre of care, and defines client-centred care as i) focus of health needs, ii) ensuring personal relationship iii) comprehensive, continuous and person-centeredness iv) shared responsibility within the community and along the life-cycle and v) patient as a partner [219]. Theses domains of client-centeredness could also be used to define important aspects of client satisfaction.

In summary, there is an increasing body of literature available on the importance of client satisfaction as an outcome indicator to measure quality of care and health system performance [190, 219]. Table 7 has listed publications which aimed to assess client satisfaction in very different settings. Morestin et al included in their review assessment tools to assess client satisfaction in the field of obstetric care [191]. Thus, much work has been done in recent years to identify indicators and assessment tool. However, no internationally recommended definition of such an indicator of client satisfaction or a standard assessment has yet been identified [220, 221].

8. Standard Assessments and Categorization of Maternal Care

For a review of methods of assessment of maternal health, it is not only important to review the assessment tools but also the defined intervention packages and the levels of care at which they should be implemented. Such defined intervention packages determine assessments and use of indicators. This section includes conventional definitions of quality of maternal care, assessment tools, and also the intervention packages used in the Lives Saved tool (LiST) [222, 223] and the new WHO essential list [224].

The most widely used standardized indicators to monitor maternal health are outcome indicators such as the proportion of births in health facilities (institutional delivery), births attended by a skilled attendant, and the proportion of births by Caesarean section as well as the impact indicator MM-ratio. These outcome and impact indicators are commonly derived from household surveys. Process and output indicators are less developed, maybe partly because they demand other methods than household surveys, such as health facility census or reviews of patient files.

Comprehensive assessment tools have been developed such as the Safe Motherhood assessments promoted by the WHO and others [225, 226], which provide a comprehensive overview of services and available resources, but do not summarise the results into a limited number of indicators. A few assessment approaches summarise care into a single index based on interventions packages or defined skills; an example of this is the skilled attendance index [137].

Concepts and assessment of birth attended by a skilled attendant and skilled attendance

One of the most important indicators in the provision of maternal care is the proportion of births attended by a skilled attendant, which also constitutes the main indicator to measure progress towards the Millennium Development Goal 5a. The "skilled attendant" indicator is defined simply by the presence of a skilled health worker (doctor, nurse, or midwife) at birth. Data on skilled attendants are based on women's reports of which health cadres were present at birth. This definition is used for international comparative statistics such as MDG monitoring [221]. The cadres included as 'skilled attendants' vary from country to country. The number of years of in-service and the content of the training required to be counted as a skilled attendant has not been standardised. In addition countries have increasingly opted for shorter trainings to close the human recourse gap [227]. Thus international statistics are compromised by recall and reporting bias owing to asking women about cadres of health workers present during birth and the increasing variety of cadres included as skilled attendants [228].

Besides this definition of the "skilled attendant" there is also a comprehensive "skilled attendant concept" for provision of care during pregnancy and childbirth that is endorsed by the WHO, ICM[7], and FIGO[8][136]:

> *"A skilled attendant is a health professional – such as a midwife, doctor or nurse – who has been educated and trained to proficiency in the skills needed to manage normal (uncomplicated) pregnancies, childbirth and the immediate postnatal period, and in the identification, management and referral of complications in women and newborns."*

This "skilled attendant concept" further includes skills and interventions that should be part of the technical ability of a skilled attendant (see box 1). These skills include vacuum extraction and manual vacuum aspiration for the management of incomplete abortion.

Box 1: List of required skills and abilities of a skilled attendant
Reference:[136]

The list of skills and abilities required includes 26 functions including • Communication and education in holistic and "women-centred" care • ANC and postpartum care • Monitoring of labour including foetal wellbeing with use of the partograph • Management of normal vaginal delivery including Active Management of Third-Stage of Labour (AMTSL)	• Care of the newborn including initiation of breastfeeding • Identification of life-threatening conditions of the mother and the newborn • Vacuum extraction or use of forceps • Manual vacuum aspiration for the management of incomplete abortions • Symphysiotomy

The concept of a skilled attendant is further expanded to "skilled attendance," which also includes the enabling environment, or in other words, the overall capacity of the health system to support the skilled attendant with necessary drugs, supplies and equipment as well as an effective referral system [142]. This concept was used in the construction of the skilled attendance index. The index is based on a review of delivery records and summarizes the quality of care into a composite measurement [137].

[7] ICM International Confederation of Midwifes,
[8] FIGO International Federation of Gynaecologists and Obstetricians

Another much used indicator is the proportion of "institutional deliveries". This term is defined by the place of birth (home, facility). In many countries, birth by a skilled attendant equals institutional delivery, as trained health attendants provide delivery care predominantly in health facilities. The two estimates might differ, however, if the health provider who predominantly attends deliveries in health facilities is not considered to be "skilled," such as nurse assistants or auxiliary midwives, or when midwives attend home births, as promoted in Indonesia.

The emergency obstetric care assessment concept

An important and well established concept in the assessment of maternal health is emergency obstetric and neonatal care (EmONC), which was first introduced in 1997 [229]. The revised version, published in 2009, includes eight indicators aimed at measuring progress in an operational perspective as availability, access to, use of, and quality of EmONC services. The eight indicators are: 1) availability of EmONC services; 2) geographical distribution of EmONC services; 3) proportion of births in EmONC facilities; 4) met need for EmONC; 5) Caesarean section as a proportion of all births; 6) direct obstetric case fatality rate; 7) Intrapartum and very early neonatal death rate; 8) and proportion of deaths due to indirect causes in EmONC facilities [156]. In particular, the first indicator, "availability of EmONC services" has been widely employed. This indicator is based on seven BEmONC and two additional CEmONC care signal functions (see box 2).

Box 2: Signal functions used to define basic and comprehensive EmONC facilities

Reference: [156]

Basic EmONC signal functions	**Comprehensive EmONC signal functions**
1. Administer parental antibiotics 2. Administer uterotonics drugs 3. Administer parental anticonvulsants for pre-eclampsia and eclampsia 4. Perform manual removal of placenta 5. Perform removal of retained products 6. Perform assisted vaginal delivery 7. Perform newborn resuscitation	(1-7) All of those included in basic EmONC 8. Perform blood transfusion 9. Perform surgery (e.g. Caesarean section)

A particular characteristic of this EmONC concept is that, instead of measurement of the availability of services or readiness to cope with certain complications, the assessment inquires whether the signal functions have been actually performed in the past three months. Facilities only qualify as BEmONC or CEmONC facilities when all seven or nine functions have been performed in the three months prior to the assessment. However, as certain functions, in particular assisted vaginal deliveries (use of vacuum extraction or forceps delivery), are not routinely taught and promoted in all countries, additional categories such as BEmONC-1 or CEmONC-1 have been introduced, specifying that the facility has the capacity to perform all other signal functions except assisted vaginal delivery [230, 231]. A particular weakness of the BEmONC and CEmONC concept is that it is not based on a well-defined and evidence-based implementation package. In particular, it is debatable whether assisted deliveries should be part of the basic package at lower level health facilities.

Categorization used in the Lives Saved Tool

LiST is an evidence-based tool for estimating the impact of a selected intervention on maternal, newborn and child mortality on the basis of indicators for coverage and quality along the continuum of care. LiST does not aim to measure quality of care but it categorises levels of care and defines elements of 'essential care', which is why it is listed in this section. The tool distinguishes three levels of care for mothers and their babies: 1) essential childbirth care, which includes the presence of a skilled attendant and a list of key skills that should be provided; 2) BEmONC; and 3) CEmONC according to the established definition. The important novelty here is the definition of "essential childbirth care", which includes seven key interventions (see Box 3) [223].

Box 3: Essential childbirth care according to LiST

Reference: [223]

Skilled birth attendant +

1. Clean delivery
2. Monitoring onset and progress of labour with partograph
3. Monitoring maternal and foetal well-being during labour, identify maternal/foetal distress and taking appropriate action including referral
4. Manage normal vaginal delivery (including breech delivery)
5. AMTSL
6. First line management of haemorrhage and hypertension in labour, referral as needed
7. Pain relief, hydration

Recently, the WHO and partners published a summary of essential interventions to reduce reproductive, maternal, newborn and child mortality [224]. Although this list of essential interventions does not provide a framework for monitoring, it packages interventions that should be implemented at the primary and referral levels. Although the wording of the different interventions is slightly different from the LiST tool, the packages are broadly comparable. Here also, AMTSL and first-line management of postpartum haemorrhage are mentioned as essential interventions at the primary level (Figure 5).

Strength and Limitations of the Assessment Tools

It has been widely acknowledged that the internationally established “skilled attendant indicator” is only a rough approximation of both the “skilled attendant” and “skilled attendance” concepts. A few assessments and frameworks have been published assessing skilled attendance with more rigour [137, 138, 193, 232]. These assessments have been based on individual assessment of the knowledge of midwives or review of patient files. They give a much clearer picture of the quality of care provided during childbirth than the “skilled attendant indicator” alone. However, the drawback of the proposed tools is that they are time consuming, which makes nationally-representative assessments unfeasible and costly.

A shortcoming of the current monitoring of progress in skilled attendant is also that the indicator is reflecting coverage rather than quality. No indicator to monitor implementation level of essential elements of skilled attendance has been established, such as coverage of AMTSL, clean delivery, or others. In contrast, for ANC quality indicators are well established (e.g. women being vaccinated against tetanus)[233]. This lack of indicators to measure quality aspects of the skilled attendance concept might be partly because there has never been a unanimous agreement of what should be offered at which level of care (Figure 5). In particular, it is debated whether parenteral application of uterotonics for prevention (in AMTSL) and care of postpartum haemorrhage and manual removal of placenta (which are part of the EmONC concept) should be essential childbirth care interventions, as proposed by the WHO et al 2011 [224] and recommended earlier in the definition of a skilled attendant [136].

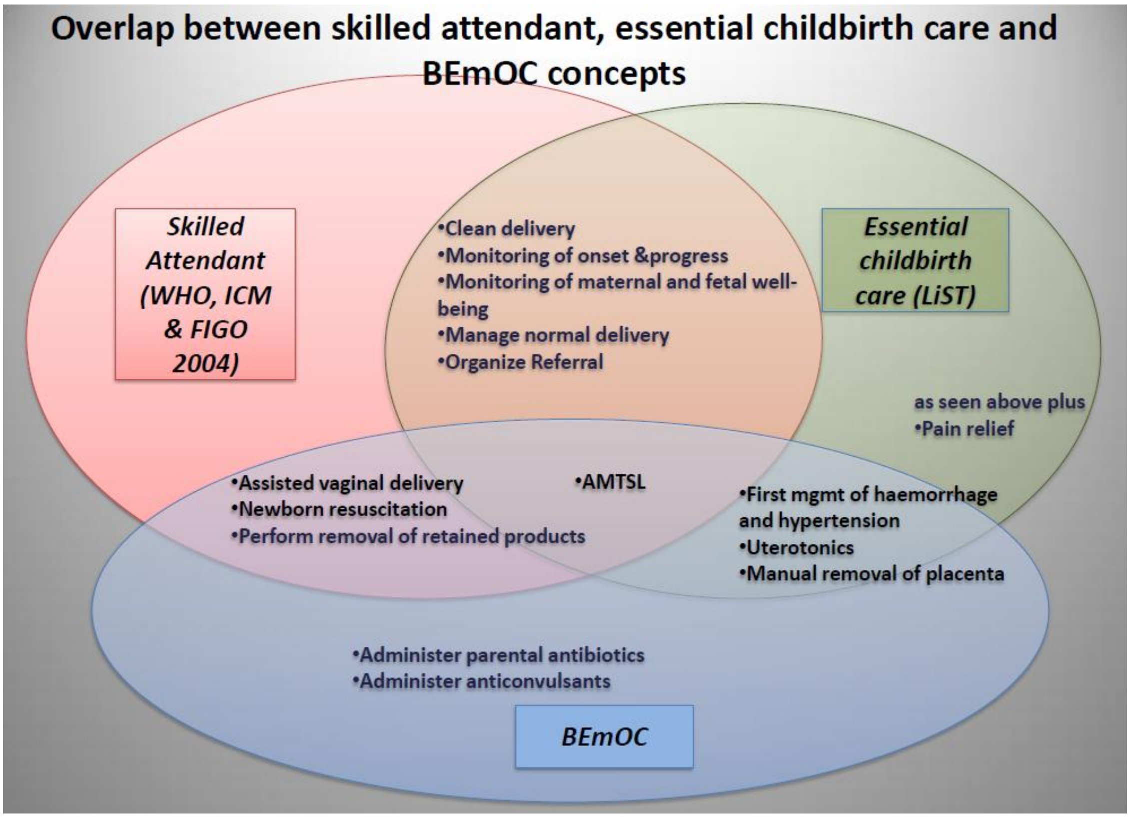

Figure 5: Skilled attendant, essential childbirth care and BEmONC concepts

Although the assessment of maternal care based on the EmONC concept has become one of the most applied assessment approaches in the provision of maternal health—besides using the "skilled attendant indicator"—this method is not without shortcomings. Figure 6 aims to illustrate the factors which are measured by the EmONC approach. The indicators primarily aim to measure to what extent women with complications are cared for and thus to what extent the health system is able to cope with women with complications. Whether the respective intervention is available in a facility depends on the functioning of a health system but also other factors which the indicator does not primarily intend to measure, such as the epidemiological background and health care organisation. Figure 6 tries to disentangle factors which the EmONC-indicator aims to measure (shaded in red) and factors the indicator does not aim to measure (shaded in blue) but impact the level of the indicator.

To illustrate, for a signal function to be performed in a health facility a woman with the respective complication needs to seek care in a health facility. How frequent such complications are seen and thus how often signal functions are carried out depends much on the number of women being cared for at facilities, thus the size of the population in the catchment area. The number of complications seen will also depend on the epidemiological context such as birth rate and the extent to which preventive interventions are implemented. In places where AMTSL is fully implemented, severe haemorrhage should be 50% lower [234]. The incidence of abortion complications depends on fertility preferences and availability of family planning and abortion services. A few of the complications are common, such as postpartum haemorrhage [235-237], while others are relatively rare such as eclampsia [238]. The incidence of abortion varies widely between countries [239]. In sum, for a health facility to be able to report the performance of all the BEmONC interventions, the underlying obstetric complications need to occur, identified and handled at the health facility (which is what the indicator aims to measure) but this is also determined by health care organisation, the birth rate in the population and the epidemiological context. The thus indicator measures many aspects which it does not intend to measure, (Figure 6 coloured in blue) in addition to what it intends to measure (coloured in red).

The problem that the EmONC indicator is based on a defined population but not on the birth rate has also been discussed by Gabrysch et al [240]. The authors proposed to change the indicator definition from “availability of EmONC services per 500,000 population” to “availability of EMONC services per 20,000 expected births”, as the analysis proposed that this change increases the association of the indicator with maternal mortality.

However, although a change of the denominator to expected births would correct some of the caseload problem (number of births in catchment area), the most important—and in many settings, decisive—factor determining the level of the EmONC indicator is the number of pregnant women living in the facility catchment area which determine the total number of deliveries or pregnant women actually seen at a health facility in the defined time period of three months. The number of attended deliveries and pregnancies depend to a large extent on the density of health facilities, as well as the type of services they should provide according to national guidelines.

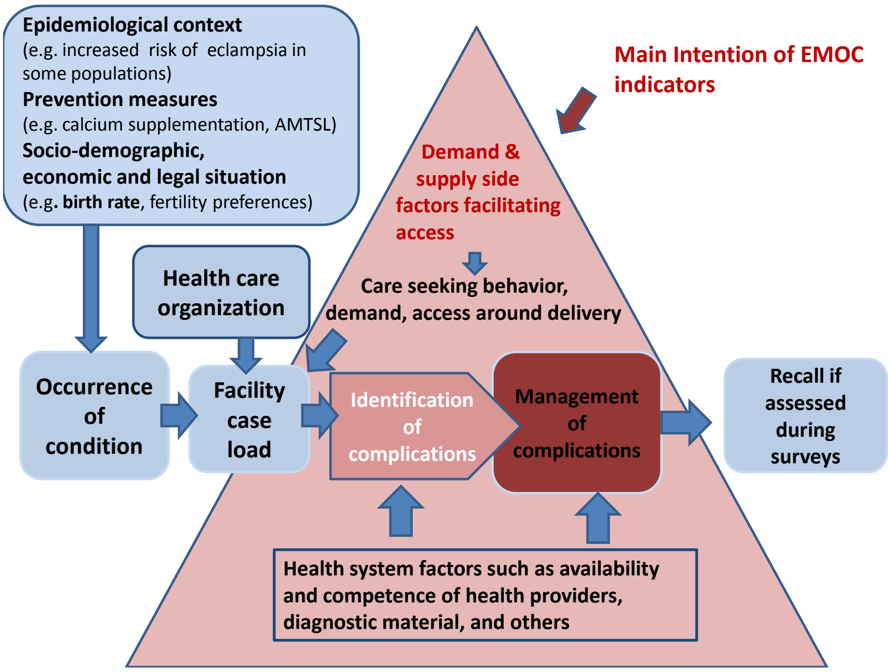

Figure 6: What the EmONC indicator aims to measure and what it measures

Many sub-Saharan African countries have decentralised their health care systems following the Alma Ata declaration and installed a dense network of primary health care facilities. Deliveries should be attended in all or most primary health care facilities. In these settings, the caseload in first-line health facilities is likely to be too small to see all seven complications over a period of three or six months as recommended in the EmONC guidelines [156]. Even if all first-line health facilities have midwives capable of performing all seven signal functions, and equipment and drugs are available, many health facilities would not qualify as EmONC facilities due to low caseload.

9. Measurement of Distance

Geographical information systems

Geographical information systems (GIS) are designed to capture, store, manipulate, analyse, manage, and present all types of geographical data. GIS programmes are able to merge and analyse data on geographical positioning and attributes using a unique identifier. Coordinate systems define how points relate to each other and to the earth's surface. Any point has X, Y, and Z (altitude) coordinates. X and Y can either be expressed as a latitude and longitude (in degrees), in minutes and seconds or in units that are specific to a large number of potential map projections [241].

Distance Measurements

Distance measures aim to provide an estimate of the geographical accessibility of services. Three options exist to measure distance: 1) Euclidean distance ("as the crow flies" or straight-line method); 2) distance along a path, road, trail or other transport network; or 3) travel time.

There has been some debate on which method to use. The Euclidean distance method is the simplest method. However, this does not take any obstacles such as major rivers or mountains into consideration. Nor does it measure the true distance travelled via paths and roads. Distance measurements via path and roads can overcome some of the constraints of simple Euclidean distance. However, this method demands accurate maps of paths and road networks.

It has been argued that travel time is more strongly associated with use of health care in high-income countries than Euclidean distance [242-244]. However, Schuurman indicated that, in Canada, in an area with a relatively equal access to a good road network and private or public transport, the difference between access measured using a travel time or Euclidean distance was small [245]. In Ethiopia, which is a very mountainous country, one study reported that there was no association between the Euclidean distance and child mortality, but an association between travel time and mortality, a finding supporting the superiority of estimating travel time rather than Euclidean distance in certain settings [246]. In rural areas in resource-poor settings, travel time will be difficult to establish, as transport is irregular and different modes of travel (by foot, bicycle or bus) might be used. It is thus questionable whether a reliable travel time measurement can even be established on the basis of the location where a person is living. Moreover travel time might vary hugely by time of the day and season. Travel time measures might rather demand individual reports on travel time.

Application of GIS in low-income settings

Consideration of distance and catchment areas for health services has been put forward long before modern GIS programmes were available [247]. National surveys such as household budget surveys have asked about approximate distance to services such as schools and health facilities and many studies have investigated into issues of geographical accessibility of delivery care [88]. The association between child mortality and accessibility of health services has also been reviewed. A recent systematic review and meta-analysis by Okwaraji and Edmond reported that children who lived farthest from a health facility had a 30% higher chance of dying compared to children living closer (OR 1.32, 95%CI 1.2 – 1.5) with stronger effects for the perinatal and neonatal periods compared to infant or under-five-year-old children [248].

The rising availability of global positioning system technology in the past few years has led to an increase in research using GIS-based distance methods to describe the effect of geographical accessibility in more detail. Some research groups have constructed travel time on the basis of GIS-application whereas others used the straight-line distance. A review looking at studies assessing the effect of access to health care on child mortality concluded that not only the method used (travel time or straight-line distance), but the density of health facilities, the distribution of causes of mortality, the terrain, and predominate travel mode might be important factors determining whether an association between distance and mortality can be observed [249].

Table 8: GIS-based studies assessing the effect of distance on uptake of care and maternal mortality

Publication and country	Setting and study type	Method	Finding
Institutional Delivery or Skilled Attendance			
Burkina Faso, household survey [90]	Two rural districts, 88,000 births. Approximately 50% of births take place within 30 km of a hospital and 5 km of a health centre, cross-sectional study	GIS-supported straight-line distance measurement between households and health facilities. Adjusted analysis	Adjusted OR 0.77 (95% CI 0.75 – 0.79) reduction of institutional delivery for every km within first 7.5 km of a health centre, thereafter adjusted OR 0.97 (95% CI .95 – 0.98). Adjusted OR 0.83 (95% CI 0.84-0.97) for every 10 km distance to a hospital
Zambia, linkages of DHS data and health facility census [250]	Rural Zambia, national study based on approximately 3500 births, cross-sectional study	GIS-supported straight-line distance measurement between households and health facilities. Adjusted analysis	Adjusted OR 0.63 (95% CI 0.48 – 0.81) reduction of institutional delivery for every unit increase in straight-line distance [log transformed]

Bangladesh [251]	Rural Bangladesh, demographic site	GIS-supported straight-distance measurement. Adjusted analysis	Partially adjusted OR of 0.22 (95% CI 0.2 – 0.3) and fully adjusted OR of 0.21 (95% CI 0.2 – 0.3) for facility-based delivery care comparing women living 3.1 km or farther from a facility to those <1 km of a health facility
Caesarean section			
Burkina Faso, Household [90]	(See above)	(See above)	Adjusted OR 0.9 (95% CI 0.85 – 0.96) for proportion of Caesarean section for every km within the first 7.5 km to a health centre, thereafter adjusted OR 1.0 (95% CI 0.95 – 1.04) Adjusted OR 0.9 (95% CI 0.84 – 0.97) for every 10km distance to a hospital
Maternal mortality			
Burkina Faso, Household [73]	(See above)	Crude estimates based on GIS-supported distance	MM-ratio 50% higher> 5 km from a health facility compared to less <5 km in one district but not the other [MM-ratio 429 (95% CI 333 – 525) >5km compared to 292 (95% CI 222 – 363) <5 km] Virtually no difference was seen in the other district [MM-ratio 506 (95% CI 453 – 584)<5 km compared to 537 (95% CI 425 – 648)>5 km]
Contraceptive use			
Malawi [252]	Linkage of DHS and health facility census	GIS-based straight-line distance. Adjusted estimates	No effect of distance on contraceptives use in adjusted analysis (different models were presented)

Although several studies identified examined the effect of distance on child mortality [248], only a few studies looked at the effect of distance on uptake of institutional deliveries and only one on maternal mortality (Table 8).

Uptake of care seems to be strongly affected by distance. In Burkina Faso it was reported that for every km of increased distance to a health facility, the odds of delivery in a facility reduced by one-fourth (adjusted OR 0.77, 95% CI 0.75 – 0.70) [90]. Gabrysch et al [253] also reported an association between distance and facility delivery in Zambia (adjusted OR 0.63, 95% CI 0.5 – 0.8, of institutional birth for every log unit (km) in distance from facility). In Bangladesh, a strong association between distance and facility-based delivery was reported (adjusted OR 0.21, 95% CI 0.2 – 0.3 of facility based delivery comparing distances of >3.1 km from a health facility to <1 km) [251].

In contrast, Bell et al. [73] reported an association of maternal mortality and distance to health facility in one of the study districts in Burkina Faso but not in the other. The MM-ratio was 50% higher more than 5 km from a health facility compared to less than 5 km from a health facility in one district (MM-ratio 429, 95% CI 333 – 525 within 5 km of a health facility compared to MM-ratio 292, 95% CI 222 – 363more than 5 km distance from a health facility). In the other district, there was no difference (MM-ratio 506, 95% CI 453 – 584 within 5 km of a health facility compared to 537, 95% CI 425 – 648 more than 5 km from a health facility).

Thus application of GIS to assess accessibility of delivery care and maternal mortality is limited.

10. Maternal Health in Tanzania

The Health System

Tanzania's population is today estimated at 46 million people; 42% are below the age of 15 years and 74% of the population lives in rural areas. The population growth rate is 2% annually, and the birthrate is 38 per 1000 population. The gross domestic product per capita is 1400 USD (purchasing power parity[9]), and annual economic growth has continuously been around 7% throughout the last 10 years. Agricultural goods, tourism and gold are the main sources of national income [254, 255].

Table 9: Key MDG indicators in Tanzania

	2005	2010
MDG 1		
% population under the basic need poverty line[10]	36% (2000/01)[256]	34% (2008/09) [256]
Prevalence of underweight children	22% [257]	16% [255]
MDG 2		
Net enrolment ratio in primary education		(% both sexes) 98%
Literacy rate of 15-24-year-olds	Male:75%, female: 64% [257]	Male: 83%, female: 77% [255]
MDG 3		
Ratio of girls-to-boys in school	Primary: 0.97, secondary 0.98, tertiary 0.43 [257]	Primary and secondary: 0.96[255]
MDG 4		
Under-five mortality	112 per 1000	81 per 1000
Infant mortality	68 per 1000 [257]	51 per 1000 [255]
MDG 5		
MM-ratio	578 per 100,000	454 per 100,000 [207]
Proportion of births by skilled attendant	46%	51% [207]
Contraceptive prevalence (any modern method, currently married women)	20% [257]	27% [255]
MDG 6		
HIV prevalence	Men 6.3%, women 7.7% (2003/04) [258]	Men 4.6%, women 6.6% (2007/2008) [259]
MDG 7		
Proportion of population with access to improved water source	47%	55% [255]
Population with access to improved sanitation	86% [257]	

[9] Purchasing power parity accounts for differences in purchasing power in countries
[10] Tanzania does not use the below 1 USD poverty line

The education system has made much progress, particularly in extending primary education to the population. Enrolment rates are very high, and 83% and 77% of 15-24-year-old men and women respectively can read. Much progress has also been seen in reduction of child mortality (Table 9).

Tanzania has established a district health system, incorporating the principles of primary health care in the national health policy already at the time of independence in 1961 [260]. The national health system also has a strong primary health care base. In the late 1980s, about 70% of the population was living within 5 km of a health facility [260, 261], which increased to 75%, and in 2007, 76% of households were within 6 km of a health facility [262, 263]. In 2006, a total of 211 hospitals (district, regional and other hospitals, excluding special and referral hospitals) served the population of mainland[11] Tanzania, which gives an approximate ratio of 1 hospital per 200,000 people, but urban/rural and regional differences are seen. First-line health facilities include 4679 dispensaries and 481 health centers, which gives a ratio of one first-line health facility for about 12,000 people [264].

Financing for health has improved and the overall per capita spending on health was reported to be 25 USD (average exchange rate) in 2009. About 60% of Tanzania's total expenditure on health comes from external sources [265]. Over 90% of the government's expenditure on health is tax-based, while social security contributions amount to less than 5% [266]. Tanzania has started several social insurance schemes over the past 15 years including the National Social Security Fund (NSSF), the Public Service Pension Fund (PSPF), and locally-managed community-based insurance schemes, which generate increasing funds for health [267].

User fees were first introduced in 1993 in hospitals and later to all health facilities. Under-five children, pregnant women, and family planning users are exempted from official user fees in the public sector. User fees during pregnancy and childbirth are paid in private for-profit and private non-profit (faith-based) health facilities, although service contracts between the public and faith-based health providers theoretically limit fees for exempted population groups. The latest DHS reported that 41% of women delivered in a public facility, 7.5% in a private non-profit (faith-based or voluntary) facility, and 1.6% in a private for-profit health facility [255].

The **human health resource** situation in Tanzania was described as very unsatisfactory by Kurowski et al [268, 269] and in Service Availability Mapping by the WHO [270] in the early 2000s. The WHO estimates that in Tanzania 0.1 physicians and 2.4 nurses and midwifery

[11] mainland describes Tanzania excluding Zanzibar

providers were available for 10,000 people, representing values much lower than the recommended benchmark of 23 health workers per 10,000 people [265]. Moreover, the distribution of more highly qualified staff cadres is skewed; doctors and better qualified nurses and midwifes tend to work in the larger cities and in hospitals. A study from rural southern Tanzania reported that only 75% of dispensaries had a prescriber (predominantly clinical officers or assistant clinical officers), and only 76% had nursing staff employed in 2004 [271].

Medical treatment is in Tanzania provided by medical doctors, assistant medical doctors and various shorter trained prescribing cadres, predominantly clinical officers and assistant clinical officers.

Medical doctors in Tanzania include physicians and a cadre unique to Tanzania the ‘Assistant Medical Officers’. Physicians undertake six years of university training at several private and public universities. The assistant medical officers, a cadre of “non-physician clinician,” which was introduced in the 1960s work first as clinical officers before they undergo two years additional non-university training, including three months of training in obstetrics to provide clinical services in several areas including obstetric operative care [272, 273].

Lower level prescribing cadres include the clinical officers which are the backbone of the Tanzanian health system. They receive three years of training in general medicine, including some training in obstetrics and pediatrics. Clinical officers are supposed to manage outpatient work in the first-line health facilities. In the past also assistant clinical officers were trained in a two-year training in general medicine similar to the clinical officers. However, this cadre is being phased out and replaced by clinical officers.

Nursing staff include a wide variety of cadres and titles, and curricula keep on changing. Midwifery is provided by registered and enrolled nurses who have had training in nursing and midwifery (two-year and three-year training respectively). These nurse-midwifery cadres are generally not entitled to prescribe drugs other than emergency and life-saving medication [274]. Mother and child health aides (MCHAs)—who are counted as auxiliary midwives—are a cadre with a two-year training in mother and child health care. MCHAs were the main providers of reproductive health in first-line health facilities in the 1990s [260], but are about to be phased out and replaced by registered and enrolled nurses. Many MCHA have received additional training in the past years and are today found in the category of enrolled nurses. Nursing assistants receive one-year training in nursing and are not counted as a skilled attendant.

Provision of drugs, medical products, vaccines and other essential medical items is deficient at all levels of the health care system. The SPA 2006 reported that less that 50% of health facilities had key tracer laboratory items (e.g. tests for anaemia or syphilis) and that only 25% of health centres and 10% of dispensaries had essential supplies for delivery care (see more on quality of skilled attendance below).

The distribution of drugs and equipment and the purchase of most essential items is mandated to the Medical Stores Department, a semiautonomous organisation under the Ministry of Health and Social Welfare[179]. The drug distribution system—called integrated logistics systems—also incorporates the distribution of drugs purchased by bilateral donors and global initiatives. Antiretroviral drugs, HIV tests, tuberculosis medication, artemesinin-based malaria drugs, vaccines, contraceptives, and a few other supplies are purchased and made available by donors.

In 2006, the drug management and distribution system to first-level health facilities changed from a “push system” to a “pull system” (an indent system). To date, health facilities are requested to order according to their needs via the office of the District Medical Officer, and the medical stores department delivers to the district medical office [179]. The monthly resource envelope for health centres amounts to 1,500 USD, and for dispensaries about 500 USD. Drugs and supplies purchased by vertical programs can be ordered outside these limits as global health initiatives or donors make them available. A study of the functioning of the system highlighted problems in timely procurement and forecasting at the central level [275]. Major problems in continuous provision of essential drugs have also been reported in mid-2010 for vertical programmes, particularly a lack of stock of contraceptive supplies, including condoms [276]. In addition, problems occur in the distribution from the district to the health facility level because of deficiencies in supervision practises- This is why a reform is ongoing to allow the medical stores department to deliver drugs and equipment directly to the facilities.

Health information data for planning and monitoring is available from several sources. Since 1991, five standard DHSs have been undertaken, the most recent in 2010. In addition, information on HIV is available from two AIDS indicator surveys (2003/04 and 2007/08) [277]. Mortality data are available from several demographic sites. The adult morbidity and mortality project including demographic sites in six districts ran from 1992 to 2002 [278]. Demographic sites today include the Ifakara, Rufiji, and Kigoma sites supported by the Ifakara Health Institute as part of the INDEPTH Network. In addition, much information on maternal and child health comes from the national health management information system called MTUHA and the service provision assessment surveys [277].

Governance and leadership in Tanzania is characterised by clear government support for improved health as expressed in the overall vision of “achieving a high quality livelihood for all Tanzanians” by 2025 and a national strategy for “Growth and Reduction of Poverty”, (MKUKUTA in Swahili) adopted in 2005 [255, 279].

Policy formulation and strategy development is the mandate of the Ministry of Health and is guided by the Tanzanian Assistance Strategy. This strategy was launched in 2002, promoting harmonisation and alignment in accordance with the Paris Declaration. Much progress has been made in the harmonization of strategies, but practices of some donors are in discordance as they continue to mainly provide vertical support [280].

Decentralisation and local management of health services has been a government policy since independence. Major implementation responsibility up to the end of 1990s relied on the regional structure, and 20 regional health management teams were created [260]. Tanzania has had several health sector reforms. The last reform, which is ongoing since 1994, is characterised by decentralisation to the district level, and also includes integration of vertical programmes and promotion of the private-public mix (Figure 7). Planning and implementation of maternal and reproductive health interventions is now done by council health management teams as an integral part of basic health services [281].

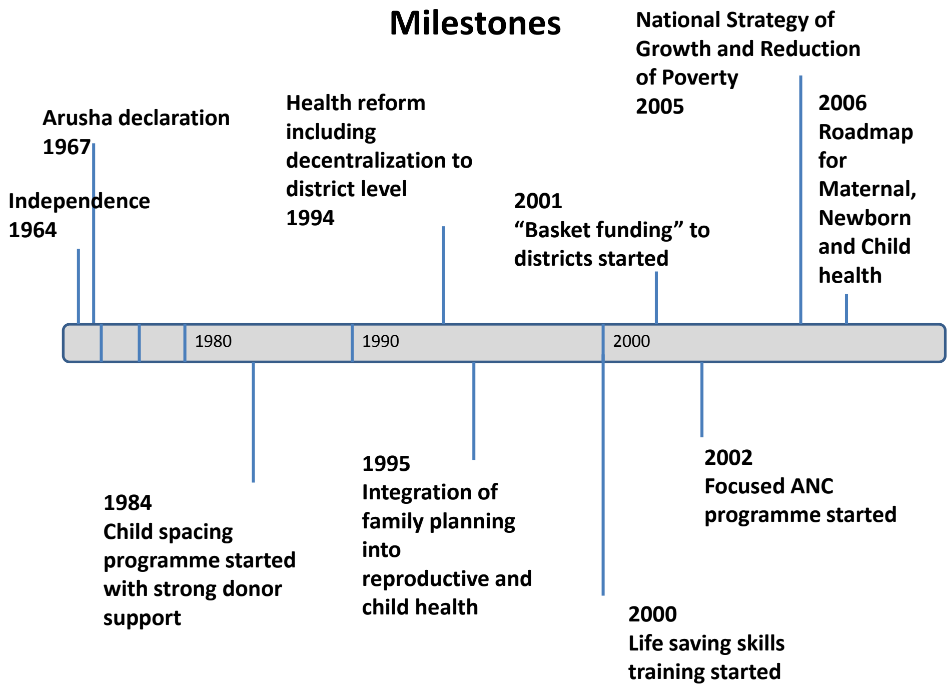

Figure 7: Milestones of the Tanzania health system and reproductive health

Decentralized planning and implementation of health care is supported by channeling funds directly to the districts through so called “basket funding”, which has been operating since 2001. Nine development partners contribute to the “basket” by providing non-earmarked funding of approximately 1 USD per capita (2010/2011) to the local government (district-level) to contribute to the financing of comprehensive council health plans [282, 283].

In addition, funds from cost sharing, community health funds, and other insurance schemes are managed at the district level, contributing to funds available to implement comprehensive district health plans.

Council health management teams are responsible for health services at community, dispensary, health centre, and district levels. The district medical officer, who is answerable to the local government authorities, heads the council health management teams. The district medical officer and the council health management teams are supervised by the regional medical officer and his or her team.

Inclusion of the community and civil society in health planning and implementation is supported through the establishment of several committees. These committees also support decentralisation efforts through a devolution process down to the village level. Health service agreements with private-non-profit providers are part of the health sector reform, but implementation is slow [255].

Service delivery is organised around a pyramidal structure with the community at the bottom. Village health workers, supported by the village government, should assist in the prioritization of interventions, health education, and basic public health interventions, but this system is only operational in parts of Tanzania.

The second level of the health care pyramid, the dispensary level, should provide a wide range of preventive and curative basic care, outlined in the essential health care packages. It includes vaccination, family planning, ANC, delivery care, PNC, prevention and treatment of sexually transmitted infections (STI), integrated management of childhood diseases, tuberculosis treatment, and others. There should be one dispensary for 5,000 people (or in every village), although the present ratio is closer to 1:12,000 [284]. An enrolled nurse and a clinical officer should be available in all dispensaries.

The third level of the health system is described as the health centres, which should be available for a population of 50,000 people, or one for every division, the administrative level below the district. Health centres should, in addition to what is available at dispensary level, offer laboratory services and inpatient care, including maternity services. The health centres should serve as the first referral level. District hospitals, or designated district hospitals (typically private-non-profit hospitals, which have an agreement with the government to serve as a district hospital), should offer inpatient and outpatient care, and surgical and obstetric operation services on a daily 24-hour service basis. The health care pyramid is terminated by regional and referral hospitals, which should offer advanced surgical and non-surgical care for complications. In addition, national and specialized hospitals provide care for selected diseases such as mental illnesses, tuberculosis, and cancer [285].

Levels of Maternal Mortality

Several studies point to a persistently high, but slowly reducing MM-ratio in Tanzania. According to the 1996, 2004 and 2010 DHSs, the MM-ratio estimations were 529, 578, and 454 per 100,000 livebirths respectively for the 10-year period prior to the surveys with wide confidence intervals (Figure 8) [286]. The estimates from the latest WHO publication and the IHME gave point estimates of 460 (95%CI 190-720) and 418 (95%CI 340-511) deaths per 100,000 livebirths respectively for the year 2010 and 2011 [1, 2]. Results from three demographic surveillance sites of the Adult Morbidity and Mortality Project reported estimates of 591 (95% CI 489 – 714) deaths per 100,000 livebirths for the 1993 – 1999 period in one urban district of Dar es Salaam, and 348 (95% CI 289 – 420) and 1099 (95% CI 964 – 1253) in the rural districts of Hai and Morogoro for the 1992 – 1999 period [70]. Data from a demographic site in the Rufiji district, a district neighbouring Lindi region, likely with a similar disease burden, reported a MM-ratio of 573 per 100,000 in 2000 [287].

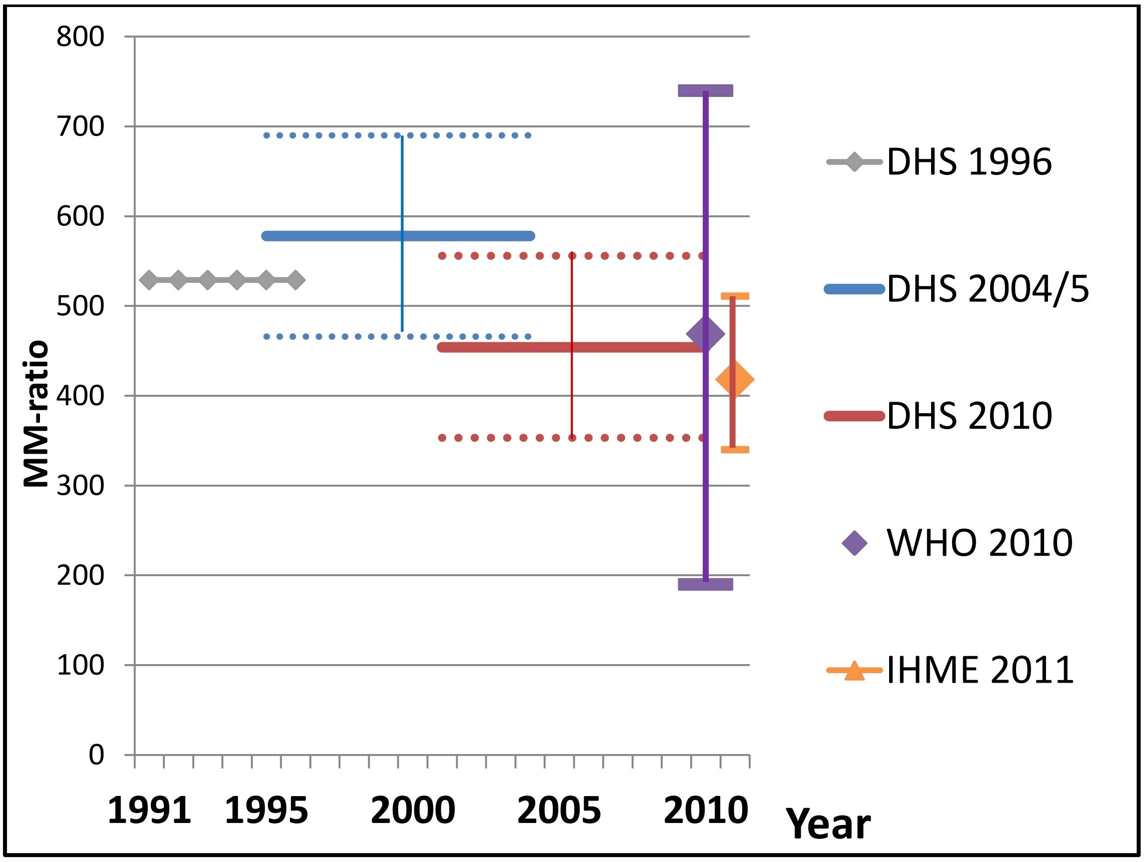

Figure 8: National MM-ratio estimates from Tanzania

Newborn mortality is estimated in the most recent DHS to be 30 and 26 per 1,000 livebirths for the five-to-nine and zero-to-four year periods preceding the survey respectively [255], thus also indicating a slight improvement.

Strategies to Reduce Maternal Mortality

Rural and preventive health care with a special focus on the most vulnerable, women, and children has been an important focus for health care delivery since the Arusha Declaration in 1967, which laid the foundation of the Tanzanian health system [260, 288]. In 1990 more than 3,300 rural health facilities were providing health care. Uptake of ANC was already 96% in the late 1980s. The first DHS in 1991/92 reported the percentage of health facility deliveries to be 52% [289]. Thus, Mother and Child Health services, today called reproductive and child health services, including vaccination and family planning, have long been a public health priority in Tanzania (see summary Table 10).

The most recent strategy to improve maternal and neonatal health expressed in "The Road Map Strategic Plan To Accelerate Reduction of Maternal, Newborn and Child Deaths in Tanzania 2008 – 2015" (also called ONE Plan) includes a wide range of activities from advocacy, to implementation, to community activities, to emergency obstetric care [290]. This strategy is a revised road map of an earlier version published in 2006 [291], which is supported by the WHO, UNICEF and UNFPA through the "Delivering as ONE" strategy, which is also supported by non-governmental organizations and development partners.

Family planning

Family planning was first introduced in 1959 when the Family Planning Association of Tanzania (UMATI in Swahili), an affiliate of the International Planned Parenthood Federation, opened the first urban family planning clinics. The first national program was launched in 1974 (the Integrated Mother and Child Health Care Strategy) and had limited success. Since 1984, a child spacing program was implemented with support from United Nations Population Fund with the goal of reaching a contraceptive prevalence of 25%. Contraceptive prevalence continued to be low at around 6% in the early 1990s, but increased by almost two percentage points per year between 1992 and 1999, much in response to effective and sustained donor support for training and provision of contraceptive supplies. The family planning programme was seen as one of the most successful in sub-Saharan Africa. In the early 2000s increases in uptake of contraceptives levelled off, probably as a result of integration, the decentralisation process, and shift of donor support to the HIV/AIDS programmes [276].

The integration of family planning into the broader concept of reproductive health is also reflected in the reorganisation of family planning within the Ministry of Health and Social Welfare. Since 1995 reproductive health, including family planning, has been implemented under the guidance and supervision of the Reproductive and Child Health Service Section, which answers to the Preventive Health Services of the Ministry of Health and Social Welfare [281].

Family planning has recently regained some momentum. Contraceptive prevalence (modern methods among married women) has risen from 20% to 27% between the 2004/05 and 2010 according to the most recent DHS [255].

Antenatal care

Antenatal care has a long tradition in Tanzania and attendance rates have been above 95% for the first visit since the late 1980s [289]. In the late 1990s investigations into the evidence of ANC reducing maternal morbidity and mortality [166, 167] and alternative operational models in ANC provision [292] led to changes in the internationally recommended ANC provision model. In parallel, several studies in southern Tanzania underlined that the risk approach in ANC failed to discriminate women at risk of developing obstetric complication [293]. Moreover, the women themselves had a partly different perception of danger signs than what biomedicine proposes, except for the first pregnancy, where biomedical and personal risk perception overlaps [294].

Several studies from Tanzania pointed to low quality of care in ANC in the early 2000s. Insufficient blood pressure measurement and screening for haemoglobin were reported [295, 296]. In response, the Ministry of Health and Social Welfare revised its national ANC policy and started to implement focused ANC with cascade training as early as 2002 [297]. The focused ANC module emphasised malaria and syphilis prevention and care as well as goal-oriented and women-centred care. Moreover, quality was put at the centre as opposed to quantity as before. Emphasis was placed on early detection of danger signs and referral as well birth preparedness and counselling for health facility delivery [298].

Several studies in recent years have reported continuously low ANC performance, particularly for syphilis screening, haemoglobin testing, and blood group/Rhesus factor determination [296, 299, 300]. Only 44% and 12% of health centres and dispensaries respectively have the capacity for syphilis screening [264]. Malaria prevention interventions are relatively well introduced. The latest DHS reports that 68% of women received preventive anti-malarial drugs, that about half of the women attending ANC received vouchers for insecticide treated bednets [255]. The overall community effectiveness of the malaria prevention programme lags behind its potential, particularly as the second dose of anti-malarials are often not given, and bed nets are not reaching all people in need [301, 302].

However, compared with the situation described by Gilson in the early 1990s where only 2.5% of the dispensaries surveyed had a standard package of ANC equipment/supplies available, the situation has greatly improved [260].
Much of the failure to provide key investigations and services is due to operational systematic failure to provide first-line facilities with necessary testing materials and drugs [299]. Missed opportunities are also reported for counselling and health education and intervention. Antenatal clients were only counselled about danger signs or had a birth plan outlined in about 50% of visits according to observational studies [299, 303]. The DHS estimated that 53% of women were informed about pregnancy complications [255]. Several studies have concluded that skilled attendance at birth in health facilities is not sufficiently promoted during antenatal care consultations in Tanzania [299, 300, 303, 304]. Women continue to believe that they can safely deliver at home when no problems were detected during antenatal care consultations [304]. There is a wide perception that first pregnancies should be delivered in a health facility [293].

Skilled attendance

Health facility delivery was reported to be as high as 70% in Tanzania in the 1980s when a dense network of primary health facilities were serving the population and 70% of the population lived within 5 km of a health facility [260].

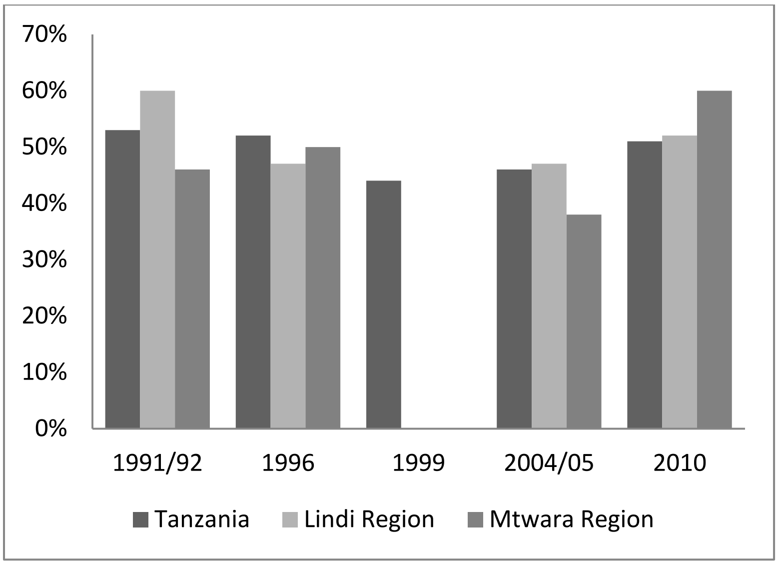

Figure 9: Health facility delivery according to five consecutive DHS in Tanzania

The first DHS done in 1991/92 reported an overall health facility delivery rate of 53% (Figure 9). The lowest proportion of skilled attendance was reported in the 1999 DHS. Since then, skilled attendance has been slowly increasing. The most recent DHS in 2010 reported a level of 51% [255, 257, 289].

During the 1990s, delivery care was based on a risk approach in ANC and training of traditional birth attendants. Clear referral guidelines were part of the ANC card using three types of referral: 1) immediate referral during ANC; 2) hospital delivery; and 3) emergency intrapartum referral. Women without risk factors were not explicitly advised where to deliver [305, 306]. Compliance with referral advice was limited. A study from southern Tanzania reported that compliance with referral advice was high only for primiparous women and women with previous Caesarean section. Distance to the hospital was the major determinant for hospital delivery [293].

Institutional delivery for all births has been promoted explicitly since 2002 [297]. The percentage of health facility deliveries and deliveries with a skilled attendant are virtually identical at 52% and 51% respectively according to the latest DHS [255]. Home births attended by trained health facility staff are not encouraged by the system. The most recent DHS reports that only 2.2% of deliveries with a skilled provider took place outside a health facility [255]. Most women deliver in public health facilities (41%) followed by faith-based facilities (7.5%), and private for-profit facilities (1.6%) [255]. The published DHS report does not indicate whether women deliver in dispensaries, health centres, or hospitals, but only whether the facility was a government, faith-based or private facility. The SPA from 2007 reported a median number of deliveries per month of 90, 20, and 6 in hospitals, health centres and dispensaries respectively [264]. A few smaller studies done in different parts of the country suggest that women prefer hospitals or mission health facilities for delivery. A study from western Tanzania reported that in a group of women who delivered in a health facility, 54% delivered in the nearest facility, 14% in a government hospital, and 26% in a mission facility. Six percent represented delivery in other government facilities or missing data [307]. A study from northern Tanzania, where a good network of district hospitals and a major referral hospital is situated, indicated that 28% of women who delivered in a health facility used first-line facilities, 28% delivered in the district hospital, and 44% delivered in the referral hospital [308]. A study using the unmet obstetric need approach in all hospitals of the Mtwara region indicated that 18% of all expected births were delivered in a hospital in 2001-2003 [309].

Table 10: Summary table on major interventions to improve maternal health

Interventions	Major findings
Family planning	Services are largely available in first-line heath facilities but poorly stocked contraceptives undermine the programme. Programme has recently regained momentum.
ANC	Focused ANC has been promoted since 2002. High coverage for first visit. Most women have two-to-three visits during pregnancy. Deficiencies in implementation of key services and interventions described in numerous studies.
Skilled attendance	Coverage of skilled attendant and institutional delivery is improving slightly. Many institutional deliveries take place in hospitals. Little is known about the quality of childbirth care in first-line health facilities. Observational studies done in hospitals suggest major deficiencies in quality of care (e.g. appropriate implementation of AMTSL was less than 10% in a sample of hospitals). Partographs were largely available, but not all parts were filled. Several studies reported that clinical practise was not carried out according to basic obstetric standards, even in tertiary hospitals.
Emergency obstetric care	More than 90% of hospitals provide Caesarean section services and blood transfusions, but major deficiencies are reported in use of assisted vaginal deliveries and the treatment and management of hypertensive disorders.
Referral	Referral from health centres to hospitals is theoretically available, but fuel shortages and requested contributions from patients are major barriers. The ANC card gives some guidance on referral, but more detailed intrapartum guidelines are missing.

Quality of skilled attendance

Information on structural quality (equipment and supplies) of obstetric care is available from the national SPA 2007. Less than 50% of health facilities were equipped with essential basic equipment for infection control such as running water or soap. Essential supplies for delivery care (e.g., scissor/blade, cord clamp, suction apparatus, eye ointment, and skin disinfectant) were only available in 41% of hospitals, 25% of health centres, and 10% of dispensaries. Key medicines and supplies for delivery care (oxytocics, suture materials, oral antibiotics, and other materials) were available in 59% of hospitals, 10% of health centres, and 3% of dispensaries. Overall availability of uterotonics (ergometrine or methergine) was 88%, 61%, and 70% in hospitals, health centres, and dispensaries, respectively [264].

Other information on quality of care during delivery is mostly available from studies auditing obstetric case notes or performing maternal death reviews in single health facilities, predominantly larger hospitals. A review of partographs in a study in four public hospitals in Dar es Salaam found monitoring of blood pressure documented in 53% and fetal monitoring in 94% of partographs assessed, although often not according to standards [310]. In an observational study in the Rufiji region, including 12 mostly complicated cases, the partograph was not used in any case [300]. However, Mbaruku et al, in a study auditing perinatal mortality in a regional hospital in western Tanzania, reported that partographs were filled in 99% of deliveries, 88% of them in a satisfactory manner [311].

Use of correct AMTSL is limited, even in hospitals. A study from a referral hospital in the Kagera region reported that oxytocic drugs were not given to 9% of patients, and another 14% only received the drug after the placenta was delivered. Management of postpartum haemorrhage did not include the best clinical practises such as bimanual compression [235]. A representative sample of 29 hospitals from several regions reported correct use of AMTSL in only 7% of 251 deliveries [312].

Severe deficiency in appropriate clinical decision making has been reported from a regional hospital in western Tanzania where 8 out of 18 cases of ruptured uterus occurred in the hospital, and two mothers died because a Caesarean section was performed in obstructed labour in the second phase with a dead child, although the appropriate intervention would have been an assisted vaginal delivery [311]. In Kagera regional hospital, major substandard care was reported in 74% of reviewed maternal deaths. Key obstetric procedures and interventions such as removal of retained placenta or antibiotic treatment were not done despite being indicated [313]. Indications for Caesarean sections are not always based on standard obstetric practises. Mbaruku et al reported that Caesarean sections for obstructed labour were done before the membranes were ruptured, although ruptured membranes are a precondition for the diagnosis [311]. Similarly, a study in two bigger hospitals in Tanzania indicated poor quality in diagnosis and questionable indications for emergency Caesarean section [314].

Emergency obstetric care

Overall Caesarean section rates have increased continuously during the past 15 years, with levels in rural and urban areas today of 3.2% and 9.6%, respectively [255, 257] (Figure 10).

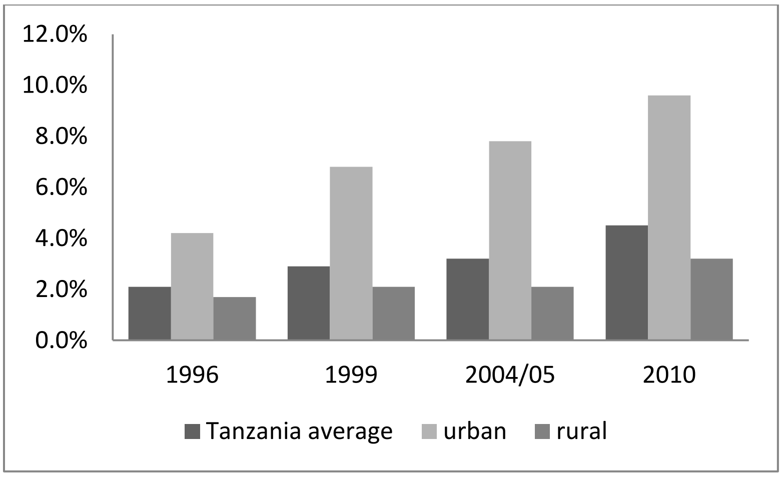

Figure 10: Birth by Caesarean section according to four consecutive DHS

Capacity for Caesarean sections and blood transfusions is available in most hospitals in Tanzania. The SPA 2007 reported that 96% and 99% of hospitals respectively offer Caesarean section and blood transfusions.

Vacuum extractors for assisted vaginal delivery, manual vacuum aspirators, and dilatation and curettage kits were available in 59%, 47%, and 42% of hospitals respectively. At the health centre level, the availability of equipment was much lower. Vacuum extractors, manual vacuum aspirators, and dilatation and curettage kits were available in only 19%, 17%, and 36% of health centres respectively [264].

There are a few studies on the availability of emergency obstetric care from the northern part of Tanzania and the Mwanza region. In six districts in the Moshi and Arusha regions, availability of basic and comprehensive emergency obstetric care services was 1.6 and 4.6 facilities per 500,000 members of the population. Large urban/rural differentials were reported [315]. In the Mwanza region, the need for comprehensive emergency obstetric care services was met, whereas availability of basic emergency obstetric care services was not reported [316]. Both studies reflect the relatively high density of hospitals in Tanzania. In contrast, health centres are rarely equipped to provide basic emergency obstetric care. The SPA 2007 reported that only 20% of hospitals in Tanzania qualified as comprehensive emergency obstetric care hospitals; less than 50% performed assisted vaginal delivery, and 57% gave parental anti-convulsants in the three-month period prior the survey [264].

Use of vacuum extraction for vaginal deliveries (forceps is discouraged in Tanzania) was low all over Tanzania. In a large referral hospital in northern Tanzania, operative vaginal deliveries were done for less than 2% of the deliveries, whereas the Caesarean section rate in the same hospital was 33% [317]. Similarly, in southern Tanzania the overall rate of assisted delivery was only 2% in four hospitals [309]. The proportion reported at the national University Hospital, Muhimbili, was 2% [318].

Sporadic training in emergency obstetric care started in the early 2000s after the first draft of a training manual on life-saving skills was published [319]. The manuals have since been revised with support of the Johns Hopkins Program for International Education in Gynecology and Obstetrics (JHPIEGO). Training has increased lately with support of several donors, particularly JHPIEGO.

The referral system

Key information on referral transport systems is available from the SPA Survey 2006. About 50% and 45% of hospitals and health centres reported to own an ambulance or another facility-based vehicle, 34% and 42% respectively call a vehicle, stationed at another place and 18% and 24% hire a vehicle in case of need [264].

A study in Mtwara, in rural southern Tanzania, describes the referral system, which is also found in many other places: a designated ambulance is placed at the district headquarters and all health centres and selected dispensaries are connected with radio call systems for communication in case of emergency [320]. Although the provision of the ambulance service should be for free in case of emergency, in reality, clients are often requested to pay for fuel, which can amount to costs as high as 45,000 Tanzanian shilling (equivalent to 25 USD)[321, 322].

The antenatal card describes referral standards in Tanzania [323]. Women with selected socio-demographic or historical obstetrical risk factors should present during pregnancy for assessment or delivery at the hospital (see previous section on antenatal care). In addition, complications in the recent pregnancy such as high blood pressure or intrauterine fetal death should lead to immediate referral to a hospital [322]. Thus, the official referral strategy gives no major role to health centers, although these are better equipped than dispensaries and might be able to manage selected complications.

Community emergency transport systems using bicycle stretchers or tricycles have been piloted in some parts of Tanzania, and sustainability over five years was achieved in half of the villages according to one study in northwestern Tanzania [324].

Determinants of skilled attendance and health facility delivery

According to the latest DHS, health facility delivery in Tanzania is highest in the age group below 20 (56% <20 years versus 45% 35-49-year-olds), for the first birth (67% versus 40% for birth order six or more), in urban areas (82% versus 42% in rural areas), in women with secondary education or higher (85% versus 34% in women with no education), and in the highest wealth quintiles (90% versus 33% in lowest wealth quintiles) [255] (Table 11).

However, this pattern is not confirmed in all studies in Tanzania. Rockers and colleagues reported that neither wealth status nor schooling had an influence on hospital delivery in a rural population in western Tanzania. The lack of association is probable because the women in their predominantly rural study population were relatively homogenous in terms of socio-demographic status and ethnicity [325]. In southern Tanzania, Mpembeni et al [320] reported that socioeconomic status did not significantly predict health facility delivery, but that education did. In a study in the Morogoro region, education was marginally significant, and selected household assets such as an iron roof significantly predicted uptake of health facility delivery [321].

Uptake of ANC and the number of ANC visits are reported to be determinants of uptake of delivery care in the latest DHS [255]. The importance of ANC for uptake of skilled attendance is also underlined by Rockers et al [325]. This study reported that women who received ANC from a health centre or mission facility were at three times greater odds of delivering in a health facility, even after controlling for distance and socio-demographic indicators. The authors argue that the higher quality of care in health facilities potentially explains the association.

Larger distance to health facilities is described consistently as a major barrier to uptake of care. A study investigating determinants of uptake of facility care in southern Tanzania reported that women were four times more likely to deliver in a health facility if the distance was five or fewer kilometres from their home compared to six or more [320]. In western Tanzania, uptake of health facility delivery was reduced to one third if the mother did not live in a village with a health facility [325]. A study in the Morogoro region reported that a travel time of more than

60 minutes to the nearest health facility reduced uptake of health facility delivery by two thirds [321].

Discussion between partners on where to deliver as well as agreement that health workers have appropriate skills were also reported as factors leading to increased use of health facility delivery [320]. In southern Tanzania, health facility delivery was higher in households headed by a woman [326]. Support by the nearest family members, the spouse or parents were mentioned in qualitative research as major facilitators of health facility delivery [326].

Lack of referral systems and particularly, ambulances for emergency transport is also often highlighted as a barrier to the uptake of care. Mbaruku et al [311] described that a second delay—delay introduced due to transport problems to the referral facility—occurred in 22% of cases where a perinatal death was seen. In the Morogoro region, referral costs were mentioned by relatively poor women as a barrier in a qualitative study [321].

Costs for delivery and transport are also mentioned in qualitative studies as major barriers to health facility delivery [321, 322]. Provider fees for delivery in mission facilities were estimated at around 5 USD whereas health providers in government facilities expected a “thank you” of approximately 2 or 3 USD, which constituted an “unofficial” provider cost. Thus, overall costs for delivery care in private and public facilities amounts to 5– 6 USD, and transport costs contribute to a large part of these costs [327, 328]. In addition to transportation costs, women are expected to buy a number of items such as gloves, soap, syringes, cotton wool and others[321]. Additional funds for transport for delivery was a major cost, particularly in the event of emergency transport [326].

Pembe and colleagues raised the issue of different perceptions of biomedical risk factors as reasons for not delivering in a health facility. In particular, women with a demographic risk factor such as having had five or more previous deliveries, or being of younger or older age do not perceive themselves at higher risk [322]. Similarly, a study in the 1990s in the Mtwara region point to differences in risk perception, with the exception of first pregnancy and previous Caesarean section [294].

Ethnicity is not commonly a strong predictor for uptake of health care in Tanzania, but certain tribes, particularly nomadic groups in northern Tanzania, have very low facility delivery rates [329]. In southern Tanzania, a minority group of Yao have higher facility delivery rates, even after adjustment for wealth or education [326].

Table 11: Summary of determinants of health facility delivery in Tanzania

Determinant	Finding
Age +	Decrease in uptake in older age. Highest use in young women < 20, and in the age-group 20-25 years
Parity ++	Around 50% higher for first birth
Socioeconomic status +/-	Higher uptake, particularly in highest wealth group, but wealth status has not been reported as a determinant in all studies
Education +/-	Higher uptake, particularly in women with secondary and tertiary education, but education has not always been reported as determinant
Uptake of ANC +	Has been reported as a determinant, particularly if ANC was received from a health centre or mission facility
Distance +	Longer distances to health facilities (>5 km) reduce uptake of care
Gender / family +	Partner agreement on the importance of delivery care improves uptake. One study described higher uptake if household was female headed
Costs ++	Described as major barrier in many qualitative studies
Ethnicity +/-	Variable association
Perceived quality of care ++	Described as major determinant; women prefer to deliver in hospitals and mission health facilities

Other factors influencing the uptake of facility care are perceived quality of care and staff attitudes. A study exploring factors influencing the place of delivery among rural women in western Tanzania reported that women clearly prefer improved quality compared to lower costs or support for transport. According to policy simulation modelling, home deliveries would be reduced to 12% if drugs and equipment would be improved in dispensaries and if provider attitudes would improve in all facilities. Choices for improvement given included assistance for transport, delivery costs, availability of drugs and equipment, and provider attitude [330]. A qualitative study in southern Tanzania supported that quality of care, particularly impolite staff attitudes against poor women, constituted a major concern and barrier to uptake of care [326].

Abortion and abortion care

Induced abortion is illegal in Tanzania except to save the mother’s life [331]. Punishment is seven years of imprisonment for a woman undergoing abortion and 14 years for the abortionist. Formal prosecution or imprisonment are rare, but women are generally stigmatised and ostracized [332]. Several plants are used to induce abortion [333]. High dosages of chloroquine or washing powder are also used [332].

Abortion-related complications are listed in most places among the top ten reasons of admission to a hospital. More than 50% of abortion complications managed at the hospital level might be due to induced abortion. Data from three demographic sites where data on maternal mortality were collected between 1992 and 1999 suggest that between 6% (Morogoro), 8% (Dar es Salaam), and 23% (Hai district) of maternal deaths are due to induced abortion [70].

Rasch and Kipingili [334] reported that women with less education tend to get help for abortion from traditional healers or family members and friends; they used mostly traditional herbs. In contrast, secondary school leavers are more likely to go to a midwife, nurse, or doctor who performs a manual vacuum aspiration (MVA) or a dilatation and curettage (D&C). Surprisingly, complication rates were higher among women with secondary school education in this study.

Post abortion care and manual vacuum aspiration have been introduced in health facilities since the early 2000s. MVA and D&C material is available in 47% and 42% of hospitals respectively. In 2006, 31% of health centres and 77% of hospitals reported that they removed products of abortion in the three months prior the survey [264].

11. Rationale of the Study

A review of the body of evidence surrounding determinants of maternal mortality indicated that few population-based studies are available that describe socio-economic factors influencing maternal mortality. Evidence that education and wealth have an influence on survival is limited to a few studies, probably because most data on maternal mortality are derived from studies using the sisterhood method, which cannot establish individual education or wealth levels and have to approximate poverty levels based on the respondents' socioeconomic status [335]. Many studies are constraint by a limited sample size (see also Table 73). Further, the evidence that distance to care—and thus accessibility to skilled attendance and emergency obstetric care—affects maternal mortality is limited. Moreover, the section on assessment of the quality of care supports the need to have better measurements of the quality of essential childbirth care to complement the "skilled attendant indicator". Thus, in view of this limited evidence on factors contributing to high mortality as outlined in the background section, this study aims to describe the epidemiology of maternal mortality in a rural and disadvantaged area in southern Tanzania. The study includes an analysis of socio-demographic factors affecting uptake of care and maternal mortality as well as a comprehensive analysis of accessibility and quality of maternal care based on 507 pregnancy-related deaths. The study had thus a sample size to be able to show differentials in sub-groups – a rare opportunity.

Chapter 2: Methods

The methods section gives a short description of the study area, the data collection methods, the variables used and the development of the index of maternal health. The conceptual framework and statistical methods used for the analysis are described. The methods section further has a section on data quality, which includes cross-checking of selected information from the census 2007 and the health facility census 2009.

1. The Study Area: Lindi and Mtwara Regions

The study was carried out in Lindi and Mtwara regions in southern Tanzania (Figure 11). Key indicators for health are given in Table 12. The two regions are administratively divided into 11 districts. Five of these districts (Tandahimba, Newala, Nachingwea, Ruangwa and Lindi Rural) were included in the study. The five districts were further divided into a total of 24 divisions and 114 wards in 2007. According to the national census 2002, the five districts had a total population of 890,939 people[336].

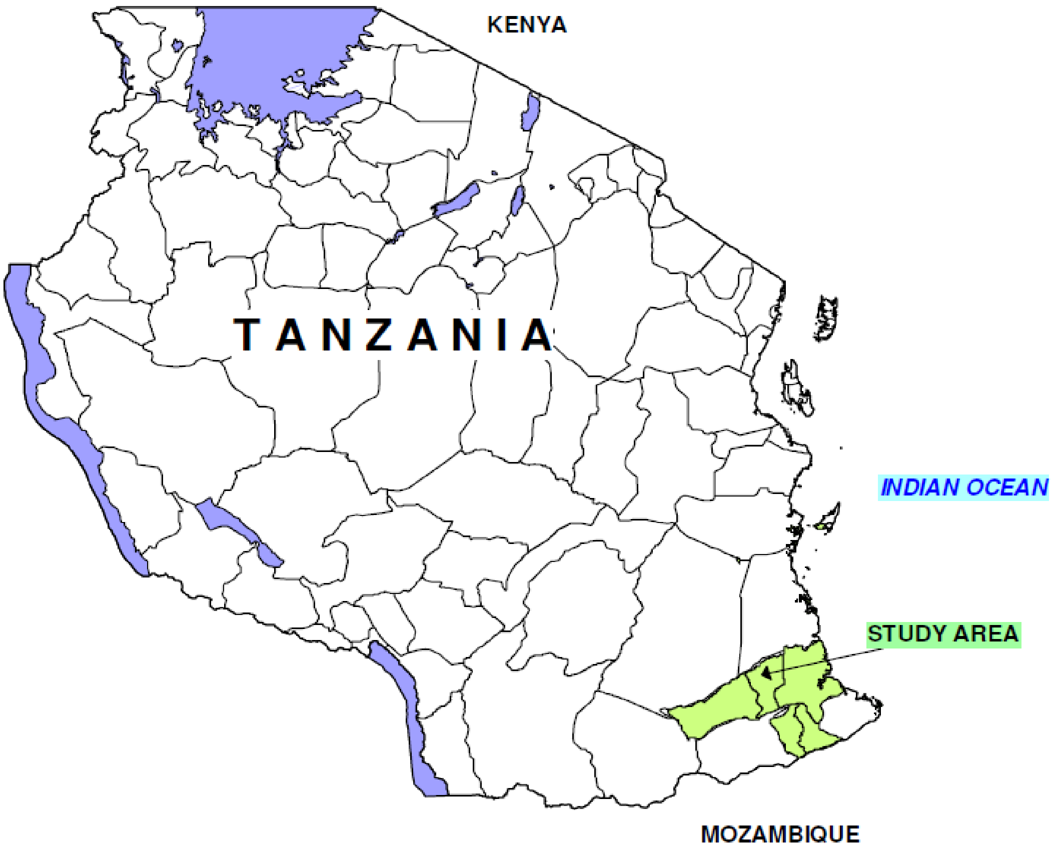

Figure 11: The study area in Tanzania

Table 12: Key health service indicators for Lindi and Mtwara regions

	Lindi	**Mtwara**	**Tanzania mainland**
Districts	6 districts (3 included)	5 districts (2 included)	21 regions and 132 district councils
Surface Area	66,046 km^2 Lindi rural: 6,513 km^2 Nachingwea: 5,890 km^2 Ruangwa: 2,878 km^2	16,707 km^2 Newala: 2,031 km^2 Tandahimba: 2,005 km^2	885,800 km^2
Density (population per km^2)	12*/km^2	68/km^2	47/km^2
Number of Hospitals	8 hospitals (4 located within the 3 study districts)	6 hospitals (2 located within the2 study districts)	211 (2006)
Number of Health Centers	34 (13 located within the study area)		481 (2006)
Number of Dispensaries[337]	329 (140 located within the study area)		4679 (2006)
Ratio physicians to population (incl Assistant Medical Officers) [338]	0.4:10,000	0.4:10,000	0.7:10,000
Ratio nurses and midwifes to population[338]	3.3:10,000	2.9:10,000	3.9:10,000
Antenatal care coverage (at least one visit) ^	99%	99%	96%
Institutional delivery ^	52%	59%	50%
Use of family planning (married women, modern methods) ^	39%	37%	27%
Unmet need for family planning (married women) ^	24%	24%	24%
HIV-prevalence (15– 24 years old)[259]	Females: 4%, Males: 1.7%	Females: 2.7%, Males: 1.1%	Females: 3.6%, Males: 1.1%

^DHS 2010 [255] *Lindi region includes the Selous game reserve, thus a large part is unpopulated

Socio-cultural and economic characteristics

Both Lindi and Mtwara regions border the Indian Ocean; Mtwara region also borders Mozambique. Most of the area is characterised by a hilly landscape and low-lying plains. Parts of Tandahimba and Newala districts are on the Makonde Plateau, which reaches 900 m above sea level. Whereas the population density in Mtwara region is relatively high at 68/km^2, Lindi region is very sparsely populated (overall density 12/km^2), to a large extent because it includes the uninhabited Selous Game reserve.

Both regions have small urban populations. About 16% and 20% of the population live in urban areas in Lindi and Mtwara, respectively. Neither of the regional capitals, Lindi and Mtwara towns, are part of the study area. Only a single ward in the study area was categorised as a predominantly urban ward (Nambambo, Nachingwea Town) according to the 2002 census. A total of 94 (82%) of the wards included in the study area have an entirely rural population. A further 16 of the 114 wards have a mixed urban and rural population according to the census categories.

Lindi and Mtwara have long been a neglected part of Tanzania. The regions have been connected to Dar-es-Salaam by an all-year road only since 2007. Apart from the truck road to Dar-es-Salaam, most roads are unpaved and often in a bad state. Many roads are impassable during the main rainy season from March-to-May. Electricity is only available in the district towns and in a few villages along the national grid power lines spanning from Lindi town to Mtwara town.

Most families live on subsistence farming, or for those near the coastline, from fishing. Some income—although unreliable and volatile throughout the years—is generated from selling cashew nuts, particularly in Mtwara region (Tandahimba and Newala districts)[339]. Groundnuts and sesame are other main cash crops. An international harbour in Mtwara Town is facilitating export, but it is only very recently that export has grown [340].The main food crops are maize, cassava, sorghum and rice. Some families own livestock. Most people live in mud-walled or sun-dried brick houses. Iron roofs are increasingly available but thatched-roof houses are still common. Access to water is mostly from protected or unprotected public wells.

Both regions are among the least industrially developed in Tanzania. The 2008 national report, "Industrial Production and Performance" reported that only six industries were established in the two regions, with only 201 people and 272 people being employed in the industrial sector in Lindi and Mtwara, respectively [341]. The situation might change in the near future, as a new national gas exploration project in Mtwara has been established, bringing in many new businesses. A recent business report stated that in Mtwara region, the overall number of business establishments will increase in the second half of the 2010s [342].

The main ethnic groups in Lindi and Mtwara regions are the Makonde, Yao, Makua and Mwera, which all share some cultural traits and are part of a wider belt of matrilineal people in Eastern and Central Africa. In these cultures, men and women have equal rights to ownership of land, although it is difficult for women to keep control over their land after being widowed [88].Most people speak their local language, but Swahili is widely spoken. The official language in primary school is Swahili, whereas in secondary schools and at higher levels of education, English is used.

The education system is based on seven years of primary school, followed by four years of secondary education to achieve an ordinary secondary certificate. An additional two years of study are required to achieve an advanced secondary education, which qualifies students for university enrolment.

Enrolment in primary schools is today almost universal, and 83% of men and 77% of women aged 15– 24 can read [255].

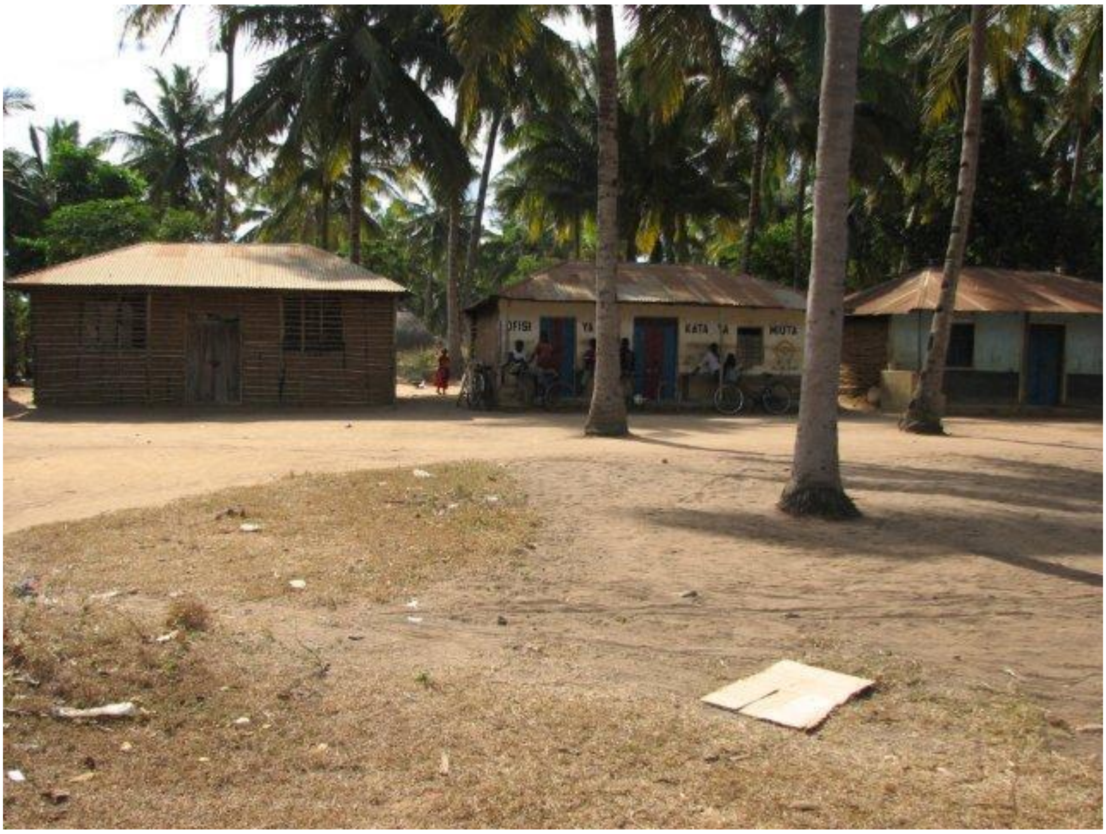

Figure 12: Typical village centre on the Makonde Plateau

Figure 13: Cashew nut plantations

Figure 14: Fisher men at the coast line

2. Description of Data Collection Methods

The Census 2007

The population-based data used in this analysis was collected through a census of all households in five districts of Lindi and Mtwara regions, which took place between 25 June and 30 October 2007. In households in which a pregnancy-related death had been reported, verbal autopsy interviews were conducted between 7th August and 29thNovember 2007.

The three primary aims of the census were: (i) to estimate the effect of a strategy of intermittent preventive treatment in infants aged 2– 22 months; (ii) to estimate newborn mortality; and (iii) to estimate the coverage of essential elements of antenatal, intrapartum and immediate postnatal care. Pregnancy-related mortality was added as an additional primary study aim partly in response to requests from regional health authorities and because the questions to investigate maternal mortality could be included without major additional costs.

The census was done as part of a baseline study for newborn survival (NCT 1022788) and follow-up of a study of Intermittent Preventive Treatment (IPT) for malaria in infants (NCT 00152204, http://www.ipti-malaria.org/) aged 2– 11 months, the results from which have been recently published [343].

Data collection tools

The questionnaire was module-based and consisted of a (i) household module addressed to the head of household including assessment of any deaths in the household since January 2004, and a (ii) birth history module addressed to all women of reproductive age (see questionnaire in annex). The questionnaire modules were elaborated based on well-established sequences of questions as used in the DHS, standard Multiple Indicator Cluster Surveys and Malaria Indicator Surveys. The birth history model was addressed to all women of reproductive age (13– 49 years) and had three sub-modules (Figure 15) (see more below). All questionnaires were in Swahili.

The household module and the birth history modules were recorded using Personal Digital Assistants (PDAs), which had been employed successfully in an earlier study in the same area [344]. The verbal autopsy questionnaires were paper-based.

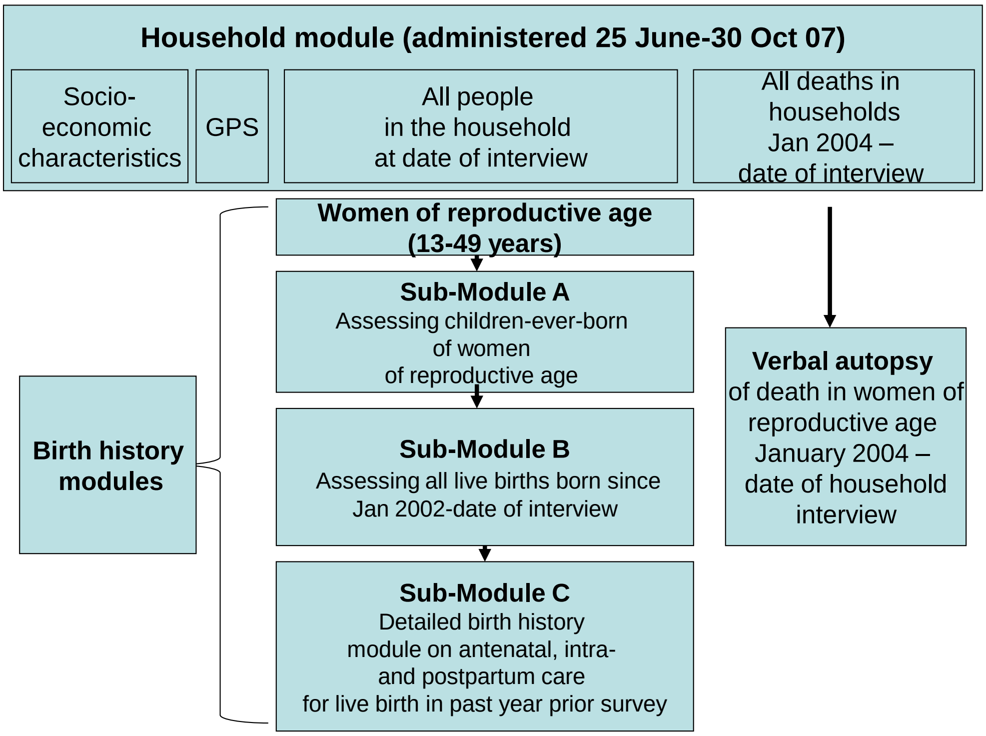

Figure 15: Modules used in the census 2007

The household module

The household module included 1) socioeconomic data from the household 2) information on all household members 3) deaths in the household 4) and geographical positioning of household. Socioeconomic information included the ethnic group, sex of the head of household, and proxy markers of household socioeconomic status, including ownership of assets and housing characteristics. Assets included were a radio, bicycle, mobile phone, bednets, animals and poultry. It was also asked whether the house had a traditional or a corrugated iron roof, was rented or owned, had electricity, and which types of cooking materials were used.

Members of the household were defined as all of the people in a household who live and eat regularly together. Socio-demographic information of all members of the households was collected, including their date of birth, sex, years of education, and their main and secondary occupations. An events calendar based on key events and milestones in the history of Tanzania was used by the interviewers to assist in obtaining date of birth information. Information on main and secondary occupations was done with a categorical variable with the responses, “farmer”, “employed”, “other activities to generate income”, “housewife” or “studying”.

Information was also collected for any death that occurred in the household in the three years prior to the census (January 2004 – to date of interview) including information on age and sex of the deceased person. When the deceased was a woman in reproductive age, it was further asked whether she was pregnant, delivering, or within two-months postpartum at the time of death.

The geographical positioning of each household was recorded. However, the recording was done separately a day before the main data collection. A mapper (see more in the following section regarding conduct of the census) visited all sub-villages a day before the household and birth history interviews were conducted. The mapper took geographical positions using a geographical positioning device (type Garmin 12 or eRrex) and drew a map of the sub-village including the household and sub-village identifiers for each household. The longitude and latitude of the household were downloaded and stored with other respective sub-village and household identifiers.

The birth history module

The birth history sub-module A was administered to all women of reproductive age and included questions on children ever born and whether they were still alive. The sub-module B was administered to women of reproductive age who reported a livebirth during the past 5 years (January 2002– to date of interview). Questions included were on dates of birth, sex, whether the children were singleton or twins, and whether the child was still alive or it had died, and the date of death if applicable. Data on stillbirths were not collected.

For women who had a livebirth in the year prior to the study, sub-module C was used to collect information on antenatal, intrapartum and immediate postpartum care. Information collected included which investigations were carried out during ANC (measurement of blood pressure, intermittent preventative treatment for malaria, and others), place of delivery, from whom a delivering mother received assistance, whether a Caesarean section was done, and whether the women had experienced complications (e.g. delivery of the placenta). The questionnaire also included questions on care of the newborn in the immediate postpartum period, such as initiation of breastfeeding, cord care and bathing practices.

Verbal autopsy of pregnancy-related deaths of women of reproductive age

Verbal autopsy interviews were done for deaths of women of reproductive age which were reported to be pregnancy-related. A standardized paper based questionnaire including an open narrative component, as proposed by the INDEPTH Network[12], was used (see questionnaire in annex p 294).

The verbal autopsies were conducted between 2nd July and 29 November 2007. Households which reported a pregnancy-related death of a woman in reproductive age during the main household census were visited again. The identification of the household was facilitated by the GIS coordinates taken during the census. The verbal autopsies were administered by a team of four interviewers which had been trained for two weeks by an experienced verbal autopsy coder. The training included interview techniques and pilot interviews. All questionnaires were photocopied and send to two physicians experienced in coding verbal autopsies. These two physicians independently assigned a cause of death. If the two physicians agreed, the cause of death was accepted as final. If the two physicians could not agree on a cause of death, a third physician was asked to give an independent opinion. If all three physicians could not agree, the cause of deaths was defined as "no agreement". A short list of the International Classification of Diseases was used to categorise the deaths (see annex p 294) [19].

Conduct of the census 2007

In the **preparation phase**, a series of sensitization meetings were held in Lindi and Mtwara regions in March and April 2007 to inform the political and administrative leaders such as ward councillors, ward executive officers and divisional secretaries about the aims of the study. These meetings also aimed to seek assistance from these leaders in updating the list of sub-villages and the number of households in each sub-village and also in recruiting interviewer candidates from their local areas. Thus, the household listing for the census was based on updated list from local administrative leaders.

The developed study tools were programmed into PDAs. Pre-testing and validation of study instruments was done. Two rounds of pre-piloting were conducted in Mtwara Rural district in order to assess the study tools, develop the standard operating procedures for household listing, mapping and interviewing and to prepare for the main training of the study team.

Training of the study team first included a seven-day training of 14 facilitators, followed by a three-week training and evaluation course of over 200 field staff. The interviewers were mostly residents from the five districts within the study area and had secondary school education. Training included a review of standard operating procedures, interviewer responsibilities, data management, giving information to households, obtaining written

[12](http://www.indepth-network.org/index.php?option=com_wrapper&Itemid=822)

consent and field practice with the study tool. To prepare them to be mappers and supervisors, a few of the trained field staff members received additional training in the listing and mapping of households, management and quality control issues.

Twenty-two teams conducted the **fieldwork**, each consisting of a supervisor, a mapper and seven interviewers. The teams worked in parallel, organized into four platoons, each supervised by a senior experienced field supervisor. The daily work of the platoons was based on a master plan, which was prepared from data available from the national census 2002 and the updated sub-village lists and household numbers.

A day before the main interviews were done, a mapper visited the sub-village. He informed the sub-village leaders about the upcoming interviews, gave information on the aims of the study with help of prepared information materials, drew a map of all households in the sub-village by taking the geographical positioning of each household and left an information sheet with each household. On the following day, the interviewers interviewed heads of households and women of reproductive age after seeking written informed consent.

Quality assurance included: daily random repeats of parts of four interviews with discussion of discrepancies within the team; random accompaniment of one interview by the supervisor; cross-checking of mapping, daily summary sheets and interviews conducted; revisiting of households where no members were found; and preparation of daily field reports.

Data management consisted of range, logical and internal consistency checks programmed into the PDA tool. Skip patterns were used in data entry. At the end of each day, a manual summary was prepared, which was compared with the electronic summary. Any discrepancy identified was recorded on a data error sheet and in the supervisors' notebooks. These documents were used to guide the cleaning of the data in Microsoft Access.

The Health Facility Census 2009

The health facility information used for this study was collected during a health facility census undertaken within the framework of the ongoing Improving Newborn Survival in Southern Tanzania (INSIST) randomized-controlled trial (clinical trial number NCT01022788) and aimed at generating baseline information on the structure and function of the health system in the field of maternal and newborn care in five districts in southern Tanzania.

A modular, checklist-type questionnaire was adapted from publicly available tools such as the Safe Motherhood Needs Assessment and the monitoring tool for emergency obstetric care (see questionnaire p 316 in annex) [156, 345]. The first section, directed to the head of the health facility, assessed services routinely offered, staff employed and training received. The second section on equipment and supplies included an assessment by the study team of the functioning of facility equipment. The third section reviewed health facility records and abstracted information on workload. The fourth section was directed to all staff working in the reproductive health clinic and assessed implementation of nine essential interventions based on the WHO recommendation of essential routine delivery care [346]. This section used a five alternative answer options ranging from “always implemented” to “never done”. Emergency obstetric care functions were assessed using standard questions on whether signal function were performed [156]. The questionnaire was administered in Swahili and was the same for all health facilities.

Data were collected in March 2009 by trained interviewers. Pairs of interviewers visited each facility without prior notice. Revisits were not undertaken if the facility was closed. Data quality assurance included daily reviews of collected data by a supervisor with regular feedback and a repetition on a subset of questions in selected health facilities.

PDAs were used for data collection. A modular questionnaire was developed using Pendragon Forms 4.0 software. Logical checks and skip patterns were performed. Information was downloaded daily onto laptop computers and backups were made. Daily summary reports were produced to ensure completeness of data collection.

3. Data Management and Data Preparation

Household Census Data

Household information, including data on each household member and the birth history sub-modules A and B, had already been cleaned by the ITPi project team when the data set was received. Major data cleaning and manipulation was thus limited to the detailed birth histories (sub-module C) and the geographical information data (see p 111)

The checking of the module C of the birth history (antenatal, intrapartum and postpartum care) found little inconsistent information. Inconsistencies found were, for example, that a positive answer was given for “having received antenatal care” but if asked about the number of visits “null” visits were recorded. In cases like this, the first answer in the questionnaire, in this case “having received any ANC” was treated as the correct answer and mismatched information was set as missing.

Inconsistency was observed for Caesarean section. The expression used in Swahili for Caesarean section is ambiguous’[13]and it is likely that some episiotomies are included in the total numbers. In our data set, 99 out of the 1008 (9.8%) reported Caesarean sections were among mothers who reported not having delivered in a hospital. None of the first-line health facilities in the two regions where the study was carried out were equipped or had the staff to do a Caesarean section in 2007. Thus, Caesarean sections indicated as being done in first-line facilities or at home were recorded as missing, in line with recommendations found in the literature [347]. Four Caesarean sections in mothers who reported to have delivered at “another place” were left in the data set, as these may describe private maternity institutions somewhere else in the country.

Another variable for which inconsistencies were observed was the question on assistance during delivery. Women were asked about the person who assisted during their last delivery allowing multiple answers for the people present. It is likely that women have difficulties distinguishing the profession and training level of health workers. The expression “Mama Mkunga” which translates to midwife is likely to be used also for MCHA, who are auxiliary midwifes or nurse assistants. The analysis of uptake of care thus did not use the indicator skilled attendant, but only birth in a health facility, which was thought to be less biased by a woman’s ability to distinguish provider categories.

[13] The Swahili expression for Caesarean section means literally translated ‘by the way of operation’

Preparation of the analysis of pregnancy-related mortality

Information on pregnancy-related deaths was available from two sources: 1) the household module of the census; and 2) from the verbal autopsy questionnaire. The analysis of pregnancy-related mortality used primarily the reports at household level (head of household reporting that the deaths occurred in pregnancy, while delivering or two months postpartum) but not the confirmed "maternal deaths" as available from the verbal autopsy. This decision was made because verbal autopsies were missing for 14% of reported pregnancy-related deaths (see p 145) and the distinction between indirect (maternal) and a coincidental (non-maternal) cause of death using verbal autopsies is uncertain. Sub-group analysis for confirmed direct and indirect maternal deaths is presented.

Three full years of ascertainment of deaths and livebirths were used. Thus, deaths recorded in the period from January to May 2004 were excluded, firstly to have three full years (1st June 2004 to 31st May 2007) for data analysis, and secondly, to reduce the edge effect of incomplete documentation[14] around the recording limits.

Geographical Information Data

The cleaning of the geographical information data was a major part of the data preparation. The initial investigation disclosed that the GIS information and household identifiers had inconsistencies. To analyse and correct the observed inconsistencies, systematic investigations into all GIS coordinates became necessary. Moreover, the geographical data were incomplete, most likely due to problems downloading GIS coordinates to the laptops every day during the fieldwork.

The GIS data cleaning and consistency checking was based on information from the household file, which included sub-village and a household identification numbers and included information on the respective ward, division and district to which each household belonged. The GIS file included information on longitude and latitude together with the sub-village and household numbers.

The GIS file was merged with the household file using the household numbers and sub-village identifiers. 184,945 records had information from both data files, and household information and GIS information could be merged. There were 62,521 records with household information

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[14] The edge effect describes the phenomenon of lower recording of vital event around the recoding limits, which might partly be due to event displacement to reduce the work load during interviews

but no GIS information. The GIS file had 14,235 records with coordinates, but no corresponding household information (Figure 16).

All the records with both household and GIS information (184,945 records in 2,362 sub-villages) were checked to investigate consistency by displaying them in Arc-GIS (version 9.2; ESRI, Redlands, CA, USA) and using a map of ward boundaries from the National 2002 Tanzania Census for comparison [348]. The aim was to examine whether the position of a specific household coincided geographically with the ward indicated in its sub-village identifier code. Four major problems were identified: 1) GIS coordinates and sub-village identifiers did not correspond to each other (problem 1,"***mismatch of sub-village identifier and GIS coordinates***"); 2) some households had more than one pair of GIS coordinates (problem 2, "***doubles and triples***"); 3) some households within a sub-village with GIS coordinates were located far outside the sub-village/ward (problem 3, ***"outliers"***); and finally 4) there were missing household GIS coordinates (259 sub-villages without any GIS coordinates) (Problem 4, ***"missing GIS information***") (see Figure 16).

Algorithms were developed to systematically deal with the four problems and inconsistencies found when examining the GIS data. A variable for the quality of the data with five categories was added to the GIS data set to tag the GIS data by the cleaning and manipulation procedure.

The decisions taken for the four major problems described above were as follows:

1. **Mismatch of sub-village identifiers and GIS coordinates**

This problem was caused by a transcription error when downloading and storing the GIS data. The GIS information was taken by a mapper, who visited the sub-village one day before the household interviewers came to complete the interviews. The mapper recorded the position of each household and prepared detailed maps of each sub-village. The GIS data were uploaded every evening onto a laptop and the file should have been given a respective sub-village identification number. However, some of the GIS data were allocated to the wrong sub-village identification number.

These incorrect GIS coordinates were deleted unless they could be used for other sub-villages. To decide whether the GIS data could be used for other villages, additional investigations were made. These included the consultation of a study preparation document in which all sub-villages were listed with names, the number of households, and the date they were visited. By using the GIS visualisation, the number of households expected in the sub-village—according to the national 2002 census—and the date the sub-village was visited, GIS data from some sub-villages with coordinates allocated to the wrong ward were reassigned to sub-villages where GIS household information was missing. A cautious stand was taken and only 3,348 coordinates were reassigned (see also Table 23 and Table 74 in annex).

2. Doubles and Triples

In the GIS data set, a total of 3,781 households had two or three coordinate pairs (doubles and triples). These were deleted at random if they were lying only 100 m apart from each other, as this cut-off was perceived as a measurement irregularity. All other doubles and triples (3,697) were examined. To decide which of the coordinates most likely belonged to the respective sub-village, a median of all of the coordinates that had no doubles within the sub-village was computed, the coordinates closest to the median were selected.

3. Outliers

This problem was typically observed for the first or the first few coordinate pairs of a sub-village, probably due to coordinates being taken before the geographical positioning had properly located the current position. These coordinates were replaced by the median of the next five household coordinates belonging to the same sub-village.

4. Missing sub-village coordinates

Out of the 2,621 sub-villages in the census area, 259 sub-villages had no coordinates before the cleaning and re-assignment (10%). The re-assignment of wrong and doubles or triples coordinates to households with missing coordinates was only possible for a few sub-villages due to the cautious stand that was taken. In only a few cases, the list of sub-villages, the date of visiting the sub-village and the projected location provided a clear indication of which sub-village the additional coordinates belonged to. More often, the additional coordinates were the same or very similar to those from sub-villages where no inconsistencies were found. In total, 272 sub-villages had no coordinates after the cleaning and re-assignment procedure (see steps to reduce missing data Figure 16).

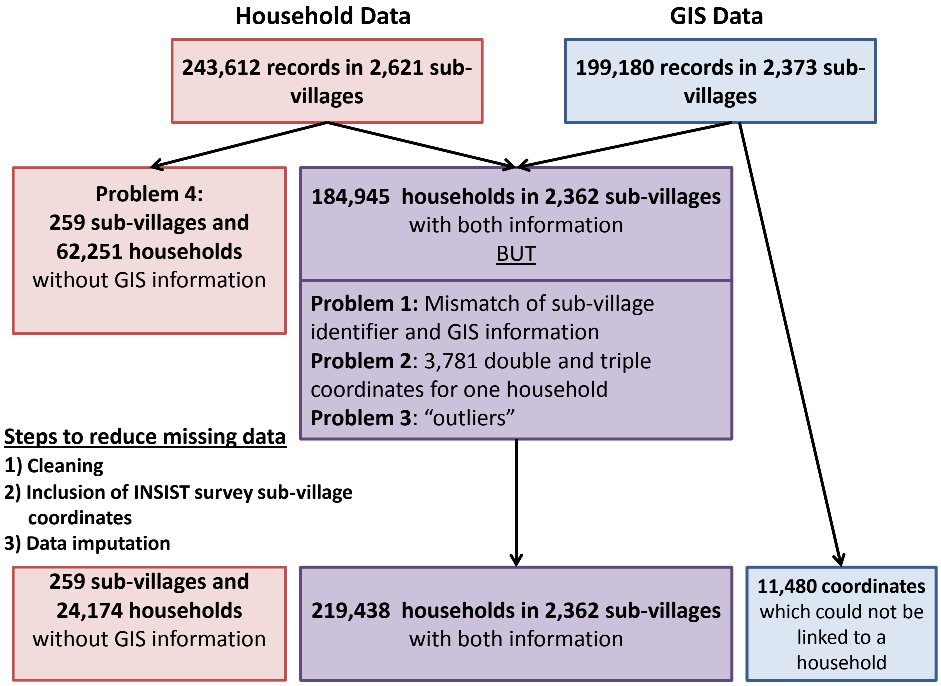


Figure 16: Flowchart describing cleaning and manipulation of the GIS data

Inclusion of coordinates from an INSIST 2011 sample survey

During an INSIST sample survey carried out in 2011, central sub-village GIS coordinates were taken. A total of 13 sub-village central coordinates could be used to fill missing data for sub-villages. These sub-village coordinates did not represent the actual coordinates of a single household.

Computation of missing GIS coordinates for single household when coordinates from neighbouring households were available

The final step was to fill coordinates from single households where other coordinates from neighbouring households within the same sub-villages were available. This was done by computing the median of available coordinates within a sub-village and filling missing coordinates with these median coordinates. Using this approach, a large number of missing GIS coordinates were imputed (36,214 or 15% of all coordinates in the data set).

Final GIS data set

In the final GIS data file, 24,174 (10%) out of 243,612 identified households had no GIS coordinates (Figure 16). The assessment of the cleaning and replacement procedure is presented in the section on Data Quality (see Table 23).

The households without GIS data were included in all analysis except for the assessment of the effect of distance. A row specifying effect estimates in the group of women from households without any GIS data has been added in tables analysing the effect of distance.

Health Facility Census 2009 Data

The health facility census information was carefully checked with regards to consistency and the likelihood of the reported responses in view of previous knowledge of the resource situation. This previous knowledge of health facilities of the region came from having visited many facilities in the period 2001-2003. In addition information was counterchecked using administrative records and discussion with regional administrative health staff during a visit to Lindi and Mtwara regions in March 2011.

Data manipulation included correction of the level of health facility (dispensary, health centre and hospital) and designation (private, public, private not-for-profit/mission facility). In addition, a few incorrect responses to availability of health staff were corrected. For example, according to the un-cleaned data set, two dispensaries were headed by a medical officer. However, cross-checking with the regional administrative staff confirmed that no health centre and dispensary in the region ever had any medical officer employed.

Travel to Lindi and Mtwara region in 2011 also made it possible to verify other unexpected findings such as the lack of blood pressure machines, even at the hospital level. The staff in the maternity ward in Newala confirmed that during the time of the survey, they had difficulties with blood pressure machines because the supplies received from the Medical Stores Department were of low quality and new machines broke within three weeks.

The availability of Caesarean section, vacuum extraction and MVA for removal of retained products of abortion were also verified and corrected if they were inconsistent with information from administrative records.

4. Outcome and Exposure Variables: Construction and Categorization

Outcome Variables

Pregnancy-related mortality

Pregnancy-related mortality was the main outcome for this study. Pregnancy-related mortality was defined as a death of a female household member aged 13– 49 where the head of the household reported that she had been pregnant, died in childbirth or within two months after delivery or termination of pregnancy.

Verbal autopsies were done to conform the pregnancy-related deaths and to establish a cause of deaths diagnosis. However, for 69 pregnancy-related deaths, the cause of death diagnosis was missing (Figure 30). For a further 30% of cases, the cause of death remained unresolved. Information from the verbal autopsies is analysed and presented in the results section. A sub-analysis for the effect of socio-demographic factors distance on mortality is presented also for a sub-group of 'maternal deaths' which are all pregnancy-related deaths but excluding the deaths where the verbal autopsy did not confirm that the mothers died during pregnancy or postpartum. Also some analysis is given for confirmed direct and indirect maternal deaths.

Pregnancy-related mortality was calculated based on the deaths recorded as "pregnancy-related" and the livebirths recorded during the birth history interviews (sub-module B) administered to all women of reproductive age (13– 49 years) and expressed as deaths per 100,000 livebirths. Thus, whereas deaths were recorded at the household level by asking the head of household if any deaths had occurred, livebirths were recorded as part of the births histories.

The maternal mortality ratio was constructed by dividing the pregnancy-related deaths by the number of reported livebirths in the same period expressed per 100,000 livebirth, and adjusted for missing birth histories. The adjustment factor was based on the age-adjusted birth rate observed in women of reproductive age during the period which was applied to the number of missing birth histories.

Variables of uptake of care

The variable **four or more antenatal care visits** was constructed using the question of how many times the women had gone for ANC. Information was collected on total numbers of visits. A binary variable was constructed.

Delivery in a Hospital/Delivery in First-Line Facilities: The place of delivery was assessed using a variable with five categories. Two binary variables were computed, each giving the value 1 for women who delivered in hospitals and first-line facilities (health centres/dispensaries), respectively and the value 0 to all other births. There was no missing information, but one "don't know" answer was coded as missing. Thus, the analysis distinguished delivery in a hospital and delivery in a first-line facility instead of combining both for a measurement of institutional birth. Uptake of hospital/first-line facility delivery and not skilled attendance was used as the main outcome variable for two reasons. Firstly, some response bias was assumed in regard to women's responses to the question of who was present at the time of delivery. Secondly, as the analysis focused on the influence of distance to a health facility, delivery in a hospital and delivery in a first-line facility was the main interest.

Birth by Caesarean section was assessed using a three answer option: yes, no, don't know. Three answers were missing. The answer options were re-coded into a binary variable after cleaning of the information on Caesarean sections as described earlier. Data cleaning resulted in 98 (0.4%) missing data points.

Postnatal care was assessed asking mothers about a check up done postpartum and a binary variable was constructed.

Exposure Variables

Administrative Information/Location

All households could be linked to the five districts, 24 divisions, 114 wards, and 2621 sub-villages. There was no missing information concerning the administrative location of any household. The variables district, division and wards were used in the analysis. In addition, a variable "region" was created to combine the three districts from Lindi region (Lindi Rural, Ruangwa and Nachingwea districts) and the two districts from Mtwara region (Newala and Tandahimba districts).

Ethnic group was assessed using a ten-category question including the most common ethnic groups (nine options) and the option "other". A new categorical variable was constructed to reduce the ten categories to five. The first category represents the predominant ethnic group, the Makonde. Three more represented the second, third and fourth most common group, with the smaller ethnic groups combined into a fifth category.

For the descriptive analysis of predictors of “four of more ANC visits” and “postnatal care”, the ethnic groups were further reduced to two groups comprised of the three most dominant ethnic groups (Makonde, Mwera and Makuwa), and the minority ethnic groups Yao and others.

Household wealth was assessed using a household asset score. Principle component analysis was used to reduce ten asset indicators of household-owned consumer durables such as a bicycle, a radio, animals or poultry, indicators of housing characteristics like roofing materials and cooking materials and income other than farming into one single score (see Table 27). This reduction allowed for the construction of five wealth quintiles. The score used weighted sums of the household assets [104, 349, 350]. The asset score used the same indicators as employed for other studies in the same area [343]. The distribution of ownership of the assets within the five wealth quintiles is shown in Table 27.

The wealth quintiles were used as an individual level variable [335] which is widely accepted [73, 351]. For the descriptive analysis of predictors of “four or more ANC visits” and “PNC” wealth quintiles were grouped into two groups comprised of the three poorest quintiles and the two least poor quintiles to keep information for presentation purposes limited.

The **sex of the head of household** was also assessed at household level with a categorical variable (male/female). This variable was included because another study in the same area had indicated that women living in a female compared to male headed household were more likely to deliver in a health facility [326].

Education of mother was assessed as part of the household module in full years. For the analysis of the birth histories for predictors of uptake of care, a categorical variable was constructed in line with categories used in the DHS in Tanzania [255] using 0 years = no education, 1– 6 years = primary education incomplete, 7-12 years = primary education complete and 13 or more years = secondary or higher education.

The assessment of the education level for mothers who died was done as part of the verbal autopsy questionnaire. The interviewee was asked about the total number of years the woman had spent in school and in a second question about the highest education level of the deceased. Answers were only available for women for whom a verbal autopsy questionnaire was available (see Methods section p 145).

There were more missing answers on the question of total years of schooling than for the question of highest education level within the verbal autopsies. Cross-tabulation of the two variables revealed that missing answers for the question on “years of schooling” all fell in the category “no education” as assessed on the question of “highest education level”. The missing answers for “years of schooling” were thus recoded to “no schooling” to reduce the proportion of missing information for this variable.

In the analysis of pregnancy-related mortality the education of the head of household was used and categorisation was the same as for education of the mother.

Occupation was assessed in the census by using a four-answer question including “farming”, “being employed”, “being a housewife” and “others”. This variable was used with all four options for the analysis for predictors of uptake of care.

The verbal autopsy questionnaire also used a four-answer option, but categories were different and included “farming”, “engaged in any businesses”, “employed” and “others” (see also Methods section p 145). To make the two methods of assessment broadly comparable, a variable with only two answer options was constructed including “farmers” and “others”.

Age of mother for the analysis of uptake of care (uptake of hospital delivery, delivery in first-line facility and birth by Caesarean section) was derived by calculating the age at census using the variables “date of birth” of the mother and “date of study”. This technique overestimates the mother’s age at birth on average by six months. No differential bias was introduced, as the construction of the mother’s age variable was the same for all participants included in the analysis.

For the analysis of the effect of age on pregnancy-related mortality, the age of mothers at delivery was constructed using the date of birth of the mother and the date of birth of the children. Thus age was available as a continuous variable.

For mothers who died, age was assessed by asking the head of household about how old the deceased was when she died. Age was recorded in full years. In addition, the verbal autopsy questionnaire included the documentation of age at death.

For the final analysis of pregnancy-related mortality, the information obtained during the census survey was used because the answers were available for all deaths and not only for deaths for which a verbal autopsy was done.

Age categories were constructed using the age groups: 13 and 14, 15 and 16, 17– 19, 20– 24, 25– 29, 30– 34, 35– 39, 40– 44 and 45– 49 for the analysis of uptake of care as well as pregnancy-related mortality. These categories were chosen for two reasons. First, in most publications, including DHSs, five-year groupings such as 20– 25, 25– 29, etc. are constructed. Thus the age groups 20+ were in line with the common groupings.

Age grouping for women aged 19 and younger poses problems. In many publications, all births in women below 20 are combined in one age group. This common categorization obscures the much higher risk in women below 15 years [352, 353]. Thus, the age-groups 13 and 14, 15 and 16 and 17– 19 were used to deal with the increased risk in young age, but as a result, the confidence interval was wide in the group 13– 14 years. For the descriptive analysis of four or more ANC visits and PNC only four categories were used (13– 16, 17– 19, 20– 34 and 35– 49 years).

Parity in its recommended definition of the total births, live and stillbirths could not be calculated because no ascertainment of stillbirths was included in the birth history module. Thus, parity in this study is defined as the total number of all livebirths, omitting stillbirths. In our analysis, this variable was only used for the assessment of predictors of uptake of care. No information on parity was available from the verbal autopsy questionnaires.

The variable **period** was used for the analysis of pregnancy-related mortality and described a full year of livebirths and deaths.

Summary estimates for uptake of care

The bivariate analysis of predictors of uptake of care and pregnancy related-mortality included a summary estimate of overall uptake of ANC, skilled attendance, hospital delivery, delivery in first-line facilities and Caesarean section in each ward. These ward-level summary variables were calculated to describe the overall attitude towards usage of maternity care in the 114 wards included in the study area. The ward level was used because people within a ward were assumed to share certain characteristics, such as the same health facilities, overall accessibility to care (distance, road network and transport) and similar socioeconomic and ethnic characteristics.

To construct these summary variables, dichotomized individual-level responses towards use of four or more ANC visits, delivery in a hospital or first-line facility, and birth by Caesarean section were calculated for each ward. The ward variables were then broken down into quintiles where the lowest quintile (20% of wards with lowest uptake) was used as a reference.

Measurement of distance

For the analysis of distance to a health facility, the straight-line distance based on GIS coordinates was used. Ideally, one would use more sophisticated measures which better approximate the true distance using road and surface characteristics or actual travel time to estimate the geographical accessibility. However, even more sophisticated geographical methods would not be able to account for several other factors affecting geographical access and travel time in this study area. Travel time heavily depends on the time of the day. In some areas, women will not travel at night because they fear wild animals, particularly lions. In many places, public transport is—if at all—only available once a day. In some places, a trunk road or a privately owned motorcycle might assist in providing transport; in other places, no such motorized transport is available. Thus, distance, whether using the straight-line distance or more sophisticated approximation of distance via roads, will inevitably miss many factors affecting geographical accessibility. In addition, the straight-line distance is often assumed to be a good approximation of distance in rural areas where walking using small paths but not roads is most common. Bicycles are increasingly becoming available in the study area, but the assumption that paths rather than roads are largely used might still hold true, particularly for access to first-line facilities.

Owing to the inevitable shortcomings of any distance or travel time calculation, no further attempts were made to calculate distance via roads or presumed average travel time for this study.

Distance to health facilities was calculated in meters, but transformed into km for presentation. An error in the distance measurement of up to 100 meters is assumed in areas not covered by a dense network of satellites such as in rural Africa.

Distance was calculated separately for distance to a hospital and distance to first-line facilities. Further, distance to a first-line facility was divided into distance to health centres and dispensaries. For the analysis of the effect of quality categories on uptake of care, distance to facilities was also calculated and categorized by the index of maternal care and for comparison facilities categorized by having a midwife and transport available (see p 123).

Categories used to describe the effect of distance on uptake of care were chosen after first examination of the crude pattern using Lowess curves and after tabulation using small distance categories for all outcome variables. For the final analysis, distance categories broadly comparable with other publication were used [90, 250] but adapted to the distance pattern observed in this study. This pattern is characterized by the mean distance to a hospital and first-line health facilities, and the proportion of births in respective categories. The distance categories chosen included six steps (<5 km, 5– 10 km, 10– 20 km, 20– 30 km, 30– 40 km and >40 km) for uptake of care at the hospital.

For the analysis of pregnancy-related mortality 5km steps were used because these better described the differences in mortality by distance. The initial examination indicated an increase in mortality in places being more than 25 km far from the hospital.

For the analysis of uptake of delivery in first-line facilities (health centres and dispensaries), five categories were used (<1 km, 1– 2.5 km, 2.5– 5 km, 5– 7.5 km and >7.5 km).

5. The Index of Maternal Care at First-line Health Facilities

To counter the shortcomings of the EmONC approach to identify differences in quality of care in health facilities with low caseload and the absence of a clear indicator set to measure quality of skilled attendance, an index of maternal care at first-line facilities was constructed for use in this study. The index of maternal care was conceptualised before the new essential list published by WHO and others [224] and before the "essential childbirth care" concept of the LiST tool [223] was published in 2011. However, the index is compatible with what was suggested by these publications.

The primary idea behind the index of maternal care at first-line health facilities was to summarise indicators for several components of antenatal and peripartum childbirth care into one single score. The index did not aim to address quality in a comprehensive manner as outlined in the chapter on quality of care (p 58) but rather summarized coverage levels of essential interventions for routine and emergency obstetric care [354]. The single index was used to define quality categories of maternal care and then to assess the effect of distance to first-line facilities providing a certain quality of maternal care on uptake of delivery in first-line facilities. Further, the effect of quality of care on pregnancy-related mortality was assessed.

The index is based on "quality", defined by availability and provision of services and interventions and aims to categorise first-line health facilities based on this "quality". The index does not include user-perceived quality. In this respect, it is similar to the EmONC classification [156].

The rationale for constructing the index was threefold. First, a simple categorization into health centres and dispensaries was thought to be insufficient to define the level of quality of obstetric care; some dispensaries in the area were known to provide good care similar to health centres, whereas some health centres were providing care below their potential. Second, it was anticipated that the better established categorization of health facilities into facilities providing BEmONC or not, as used in a similar study [250], would not be appropriate in this rural setting because of the low caseload in dispensaries and health centres. Several previous EmONC studies have indicated that BEmONC facilities are very rare in Tanzania [264, 316]. Thirdly, the EmONC approach is focused on assessment of care for complications and thus gives no indication of quality of essential childbirth care. In light of the importance of measures of essential childbirth care such as implementation of AMTSL [234], this exclusion was seen as a major deficiency of the EmONC approach. Therefore, an alternative categorization including essential childbirth care elements was judged to be necessary.

The construction of the index was guided by the distribution of causes of maternal mortality [6, 355] (see Figure 17) and WHO publications and textbooks defining essential interventions to reduce maternal mortality [224, 356]. Thus, the index is based on evidence based interventions, and as such, it includes a range of different approaches and interventions needed for reduction of maternal deaths, spanning from antenatal to peripartum care as well as from preventive to curative measures (Figure 17).

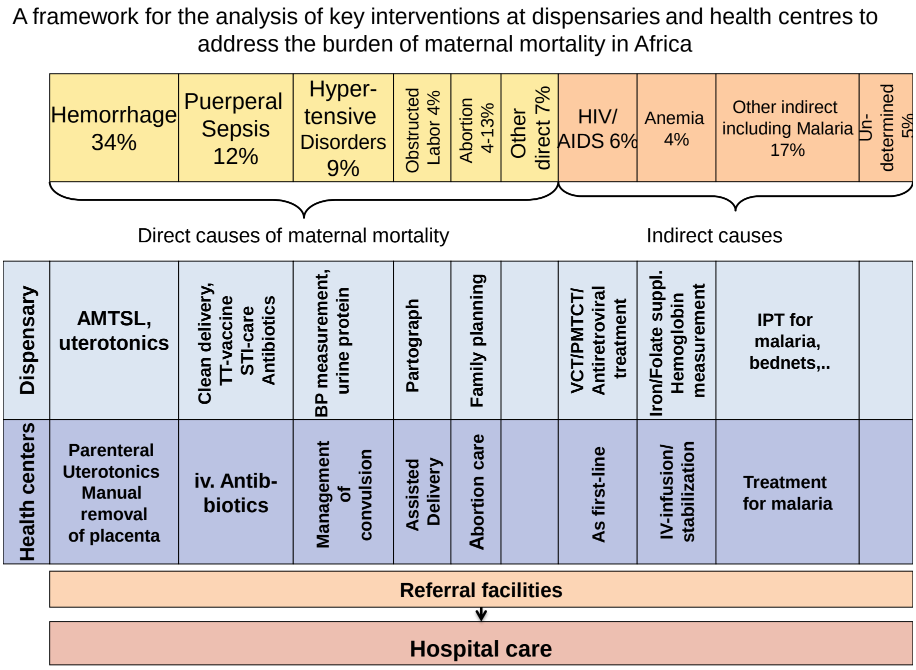


Figure 17: Preventive and curative interventions to address main causes of maternal mortality

Development of the indicator

The selection of interventions for which indicators were chosen was based on four criteria. They should: 1) be based on interventions directed at all main causes of maternal mortality (direct and indirect); 2) range from ANC to essential childbirth care and management of obstetric emergencies; 3) cover both preventive and curative interventions; and 4) include interventions that could be made available at the first level of care (the dispensary level in Tanzania), and a few which demand higher, intermediate-level care (the health centre in Tanzania). In addition, cross cutting elements such as availability and functioning of a referral system were included.

To develop the indicator, first the framework shown in the figure below (Figure 17) was developed and a list of interventions at the primary and intermediate levels of care based on the criteria outlined above was drafted. The indicator list was based on the information available from the facility census of March 2009 (see Methods section p 108).

There are four types of interventions where indicators were included: those delivered as part of ANC (***ANC indicators***); as part of essential childbirth care and care during pregnancy ***(essential childbirth indicators***); those representing emergency obstetric interventions (***EmONC indicators***); and others which are cross-cutting indicators such as opening hours and referral capacity (***cross-cutting indicators***).

Indicators for interventions aiming to prevent all the main causes of maternal mortality were selected. For example, three interventions included are directed at reducing morbidity and mortality from haemorrhage, such as injection of uterotonics, uterus massage and controlled cord traction, all essential parts of AMTSL [234] and part of the essential childbirth care package. Manual removal of placenta reflects care for haemorrhage, which is part of the EmONC concept. Indicators directed at preventing or treating haemorrhage, the most common obstetric complication, received four points out of a total of 26 (Table 13).

Three indicators were identified presenting three key interventions to prevent or treat puerperal sepsis: tetanus vaccination; infection prevention measures during childbirth; and parental antibiotics for puerperal sepsis. The last indicator is, again, part of the seven EmONC signal functions. The other indicators represent interventions that are delivered during ANC (tetanus vaccination) or are part of essential childbirth care (infection prevention).

To roughly balance between the chosen intervention and its importance in preventing maternal death, weighting was applied. Preventive interventions during ANC are judged in general to have less effect on mortality reduction [165], thus they were given half weight. Basic childbirth care was given single weight, and indicators classically described as EmONC signal functions [156] were given double weight, as evidence is available that they are important to prevent maternal deaths [157]. Indicators of referral and availability of delivery care were given single weight. Other weighting systems were also used and compared to the results (see section Explorative Examination and Internal Validation, p 129) for some sensitivity analysis.

As the effect of single interventions on maternal mortality is not precisely known, but rather rough estimations of the effect of packages of intervention [357, 358]—or as in the case for AMTSL only for intermediate outcomes such as prevention of haemorrhage [234]—no further attempt was made to balance further between the different interventions.

Table 13: Final indicator list including weighting for the index of maternal care

Direct causes	Intervention	Indicator	Points
Haemorrhage ***3 criteria***: 2 essential childbirth 1 EmONC	-Oxytocin/Ergometrine as part of AMTSL - Uterus massage and controlled cord traction -Manual removal of placenta	- Consistent uterotonic administration and availability at day of visit - Consistent performance - Performed at least once during the past six months	1 point 1 point 2 points =**4 points**
Puerperal sepsis ***3 criteria*** 1 ANC 1 essential childbirth 1 EmONC	- Tetanus vaccination - Infection - Parenteral antibiotics	-Routinely offered during ANC -Consistent application and gloves available at day of visit -Performed at least once during the past six months	½ point 1 point 2 points =**3.5 points**
Obstructed labour ***2 criteria:*** 1essential childbirth 1 EmONC	- Partograph - Assisted vaginal delivery	-Consistent use + partographs available at day of visit - Performed at least once during past six months	1 point 2 points =**3 points**
Hypertensive disorders ***3 criteria***: 1 ANC 1 essential childbirth 1 EmONC	- Blood pressure(ANC) - Regular check of blood pressure (delivery) -Parenteral anticonvulsants/sedatives	- Routinely offered during ANC-Routinely done and blood pressure machine functioning - Performed at least once during the past six months	½ point 1 point 2 points =**3.5 points**
Abortion ***2 criteria***: 1 ANC 1 EmONC.	- Family planning - Key contraceptives oral, injectables and condoms -Removal of retained products (MVA or D&C) at	- Routinely offered during ANC - Contraceptives and male condoms available at day of visit - Performed at least once in the past six months	½ point ½ point 2 points =**2.5 points**
Indirect causes			
Malaria ***3 criteria*** 2 ANC 1 basic care	- Bed net promotion/ vouchers - IPT during pregnancy - Treatment for malaria	-Routinely offered during ANC -Routinely offered during ANC - Availability of intravenous quinine or oral coartem	½ point ½ point 1 point =**2 points**
HIV/AIDS ***3 criteria*** 3 ANC	- STI treatment - VCT/PMTCT[15] - Syphilis testing	- Routinely offered during ANC - Routinely offered during ANC - Routinely offered during ANC	½ point ½ point ½ point =**1.5 points**
Anaemia ***3 criteria*** 2 ANC 1 essential childbirth	- Assessment of haemoglobin - Iron and folic acid -Fluids and infusion sets for replacement fluid	- Routinely offered during ANC - Routinely offered during ANC - Available at day of visit	½ point ½ point 1 point =**2 points**
Cross-cutting issues / Referral facilities ***4 criteria***	- Delivery care 24/7 - Telephone/radio transmitter - Means of transport for emergency referral - Referral	-Availability -Availability -Availability - Organised at least once during past six months	1 point 1 point 1 point 1 point =**4 points**
Summary: **26 criteria , 26 points**			**26 points**

[15] VCT/PMTCT Voluntary counseling and testing / Prevention of Mother-To-Child Transmission

The proposed list of indicators and the scoring system together with a rationale for the index and the aim of the overall study was sent to ten specialists in maternal health (one at Karolinska Institutet, Sweden, three at the London School of Hygiene and Tropical Medicine, UK, two at the University of Heidelberg, Germany and three at the Institute of Tropical Medicine in Antwerp, Belgium and one from the Safe Motherhood and Newborn Health Committee of FIGO.) Responses were received from Antwerp, London, and Heidelberg, which led to the inclusion of three additional indicators: 1) care for sexually transmitted infections; 2) readiness for replacement fluid; and 3) readiness for malaria treatment.

Thus, the final index employed in this study included 26 indicators: 1) 10 indicators for ANC; 2) seven indicators of essential childbirth care including readiness to treat anaemia and malaria; 3) five indicators of emergency obstetric care; and 4) four cross cutting indicators (Table 13).

Internal cross-validation of the scoring

After the computation of the points from the 26 indicators and the proposed weighting to have an overall score per facility, an analysis was done to investigate:

1) Whether overall scores of facilities differed in relation to the level of care (hospital, health centre and dispensary)

2) How the different indicator domains (ANC, essential childbirth care, EmONC and cross-cutting issues) contributed to the overall score

3) How the scoring would change if different weighting between indicator domains was applied, or if indicator domains were excluded using Bland-Altman plots [359]

4) How the overall scores related to the number of deliveries reported to have taken place in the facilities in the year prior to the assessment (year 2008)

An analysis by ownership of health facility (private, mission, public facility) was also done but results were constrained by the fact that only one health centre and four dispensaries were owned by a mission and only one dispensary was a private run facility.

To examine how the scoring would change if different weightings were applied, or if indicator domains were excluded, two more scores were constructed. The scoring model 2 excluded the ANC indicators domain and gave single weight to all indicators from all the domains of "essential childbirth care", "EmONC" and "cross-cutting issues". The scoring model 3 included the ANC indicator domain, but excluded the "EmONC indicators".

This sensitivity analysis led to the decision to proceed with the original scoring model format (Scoring model 1) for the further analysis. Firstly, the score was developed based on clinical rationale. Following this rationale ,the exclusion or downsizing of the EmONC indicators was not considered appropriate against the background of the evidence supporting EmONC [157]. Secondly, although the evidence for the effect of ANC on maternal mortality is weak [165], experts underline the importance of detection of pre-eclampsia [357] malaria prophylaxis, tetanus immunization or iron and folate supplementation [224], therefore, exclusion of ANC would not be appropriate. Thirdly, the scoring model 1 and 2 better distinguished between the levels of care, which was considered an important feature. Hospitals and health centres have more options to deal with complications and are better staffed, which should be reflected in the overall score, hence why Score 3 was not considered further. Finally, the correlation between the scoring model 1 and 2, assessed by Bland-Altman plots, was high, which is why it was considered appropriate to proceed for the final analysis with the most comprehensive scoring choice: Scoring model 1.

Final categorization of first-line health facility

The final allocation of first-line health facilities to quality categories was done by using equal steps of scores attained. Four categories were constructed. The lowest category “very poor care” was assigned to health facilities having four or fewer points. The next category called “poor care” was allocated to facilities having had a score of 4.5– 8. The category “basic care” included facilities with scores of 8.5– 12. Finally, the category “advanced basic care” was given to health facilities with 12 or more scoring points. These categorisations were assessed in relation to level of care (dispensaries and health centres) to get an understanding of how different the index and “level of care” were when categorising facilities into those providing better or worse care. Further cross-tabulation of the categorization with the availability of transport and midwifery staff was done to enhance the understanding of factors leading to higher or lower quality categories.

Explorative Examination and Internal Cross-Validation of the Index of Maternal Care

The index of maternal care was based on points (scores), which were given for each of the 26 key interventions implemented, resulting in an overall score per health facility. The highest score that could be attained was 26. The box-plots show the scores computed using the 26 indicators and the scoring model 1 computation described above. The scores had an approximately Normal distribution, with some skew towards lower scores for health centres.

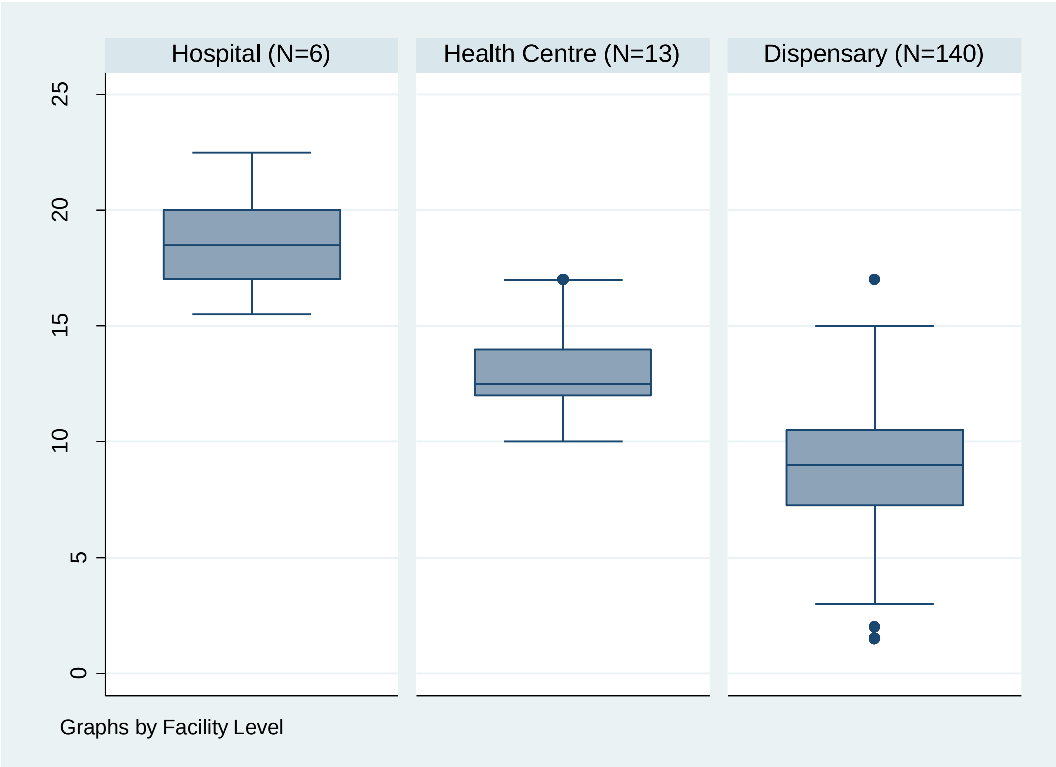


Figure 18: Scores attained at the different levels of care using scoring model 1

A few dispensaries had scores similar to health centres, which reflects that a few dispensaries act as health centres, although official upgrading is still due (Table 14). To assess whether different weighing options or exclusion of indicator domains would affect the categorization of health facilities, the scoring systems, “Scoring model 2” and “Scoring model 3” as described previously, were also computed.

Table 14 gives an overview of median scores and interquartile ranges attained by health facilities. The contribution of the four main indicator domains is also described. The indicators of the essential childbirth care domain as well as ANC had the strongest discriminatory effects between hospitals, health centres and dispensaries. The EmONC indicators predominantly differentiated between hospitals and health centres, whereas the difference between health centres and dispensaries was small. The crosscutting/referral indicators gave a similar picture for hospitals and health centres, whereas the scores attained by dispensaries were lower.

Table 14: Total scores attained by indicator domain and using different scoring models

	Median Score and Interquartile range (IQR)		
	Hospitals (n=6)	Health Centres (n=13)	Dispensaries (n=140)
Indicator domains			
ANC (Maximum 10 points)	Median 9 IQR 8– 9	Median 8 IQR 6– 8	Median 6 IQR 5– 7
Essential childbirth and pregnancy care (Maximum 7 points)	Median 7 IQR 6– 7	Median 6 IQR 5– 6	Median 4 IQR 3– 5
Emergency obstetric care (Maximum 5 points)	Median 2.5 IQR 2– 3	Median 0 IQR 0– 1	Median 0 IQR 0– 0
Cross-cutting issues (Maximum 4 points)	Median 3 IQR 2– 3	Median 3 IQR 2– 3	Median 2 IQR 1– 2
Scores			
Scoring model 1 (used for the Index) Summary including 10 indicators for ANC x ½ = 5 points, 7 points for delivery and basic care and 10 points for basic emergency obstetric care interventions (Maximum 26 points)	Median 18.5 IQR 17– 20	Median 12.5 IQR 12– 14	Median 9 IQR 7.3– 10.5
Scoring model 2 (alternative scoring: summary points excluding ANC and giving no double weight to basic emergency obstetric care interventions) (Maximum 16 points)	Median 12 IQR 10– 13	Median 9 IQR 8– 9	Median 6 IQR 5– 7
Scoring model 3 (alternative scoring: summary points including 5 points for ANC , 7 for delivery and basic care and 4 cross-cutting but excluding basic emergency obstetric care interventions (Maximum 16 points)	Median 13.8 IQR 13– 14	Median 12 IQR 10– 13	Median 8.5 IQR 7– 10

Box-plots were used to examine visually the discriminatory effect of the three scores by the different levels of care. Excluding ANC indicators and downsizing the weight of EmONC seems to obscure the higher potential impact health centres could have by being better staffed and having more options in detecting and treating complications (Scoring model 2, Figure 19). **Fehler! Verweisquelle konnte nicht gefunden werden.** shows the scores at the different level of care when EmONC indicators were excluded (Scoring model 3). Excluding EmONC indicators seems to make the health facilities at the different levels more similar to each other, thus some of the discriminatory effect between levels of care seems to be lost.

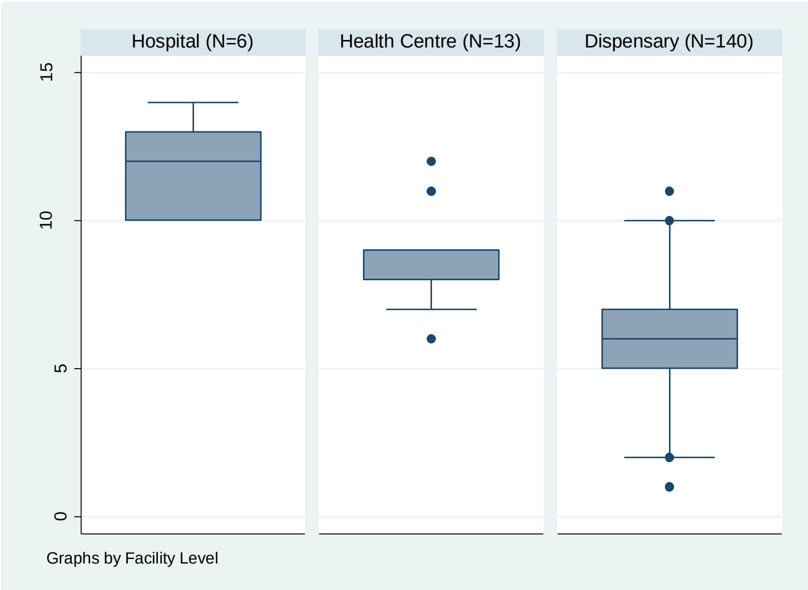


Figure 19: Scores attained by facility level using scoring model 2
(Excluding ANC, and normal weight for EmONC)

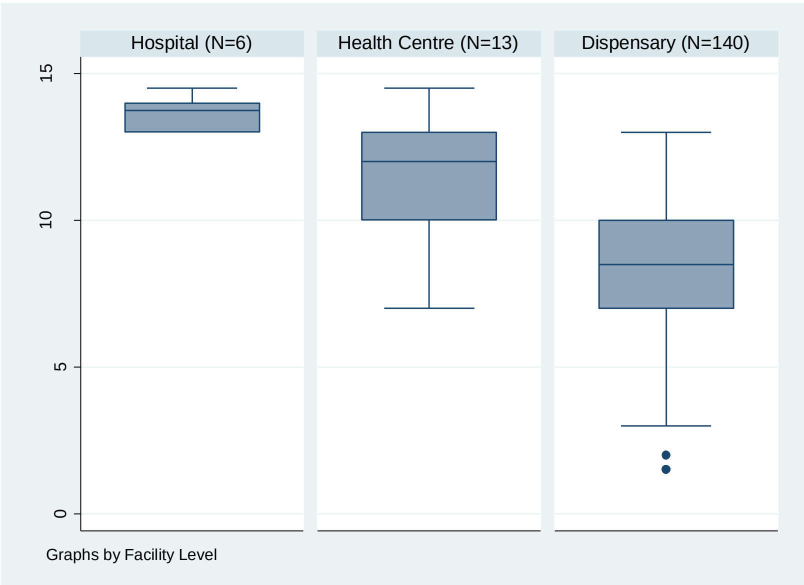


Figure 20: Scores attained by facility level using scoring model 3
(Excluding EmONC indicators)

To further analyse the differences between the scores, Bland-Altman plots were drawn. Bland-Altman plots visually show the differences between measurements.

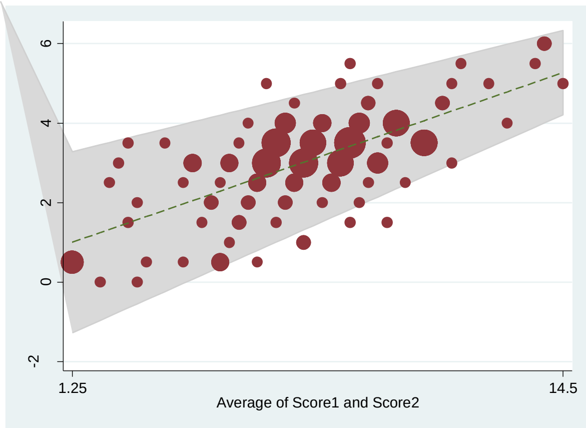


Figure 21: Bland-Altman plot comparing scoring model 1 and 2

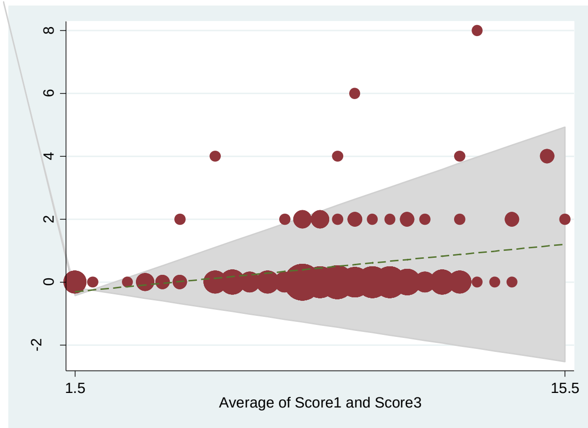


Figure 22: Bland-Altman plot comparing scoring model 1 and 3

(both for 153 first-line facilities)

The Bland-Altman plots [359] comparing scoring models 1 and 2 suggest that most of the differences between the two scores lies within two standard deviations (Figure 21). The differences between scoring model 1 and 2 increased (dotted line), reflecting the fact that the total scores attainable differ between the two scoring systems (total score of 26 points and 16 points, respectively). Most differences were within two standard deviations (grey zone) suggesting that the two scores could be used interchangeably.

A very different pattern is observed when comparing scoring models 1 and 3 (Figure 22). The exclusion of the EmONC indicator domain increased the differences for better scores for better-rated facilities. This increase is expected because facilities with lower overall scores are assumed to be less able to manage obstetric complications, and thus the EmONC domain will contribute few or no points.

Comparison between overall scores and total number of deliveries in 2008

One assumption when constructing the indicator was that higher quality would lead to higher uptake of care. Therefore it was also assessed whether any of the scoring models had a higher correlation with the total number of deliveries per health facilities. The results are shown in figures below (Figure 23, Figure 24, and Figure 25).

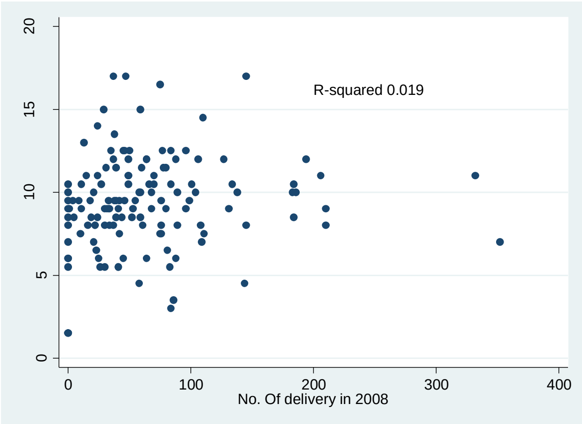


Figure 23: Correlation between scores (model 1) and deliveries in 2008 per facility

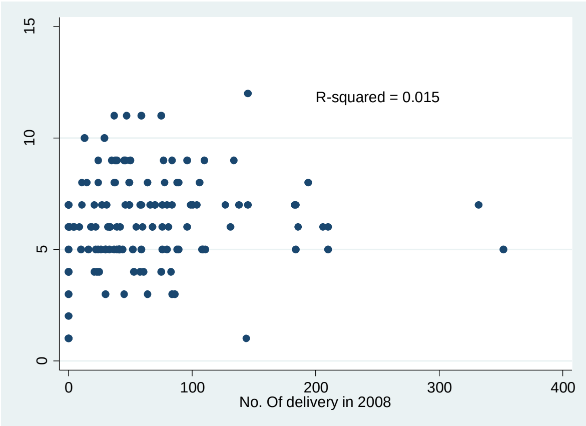


Figure 24: Correlation between scores (model 2) and deliveries in 2008 per facility

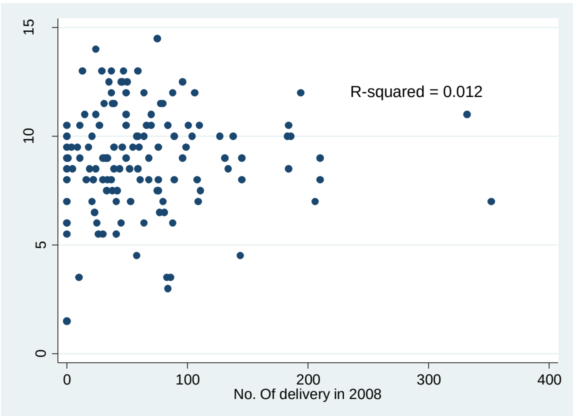


Figure 25: Correlation between scores (model 3) and deliveries in 2008 per facility

Excluding hospitals, all three scores indicated little evidence of a correlation between the scores attained and the total number of deliveries in the health facilities in 2008. The correlation coefficient (r^2) ranged from 0.019 to 0.012. This result was unexpected as it was thought that higher technical quality as defined in higher coverage levels of essential interventions would lead to higher workload. Table 15 examines whether any of the indicator domains (ANC, essential childbirth care, EmONC or cross-cutting indicators) were different between facilities with a higher or lower workload. A total number of 120 deliveries in 2008 were chosen as the cut-off, because the 34 facilities with a higher caseload than 120 deliveries represented approximately 25% of the total facilities (excluding the hospitals).

Table 15: Total scores per indicator domain by caseload in facilities in 2008

	Facilities with		
	< 120 deliveries in 2008 (119 facilities)	> 120 deliveries in 2008 (34 facilities)	p-value for difference between categories(Chi-squared test)
Indicator domain	Median points (Interquartile range IQR)	Median points (Interquartile range IQR)	
ANC	6 (IQR 5– 7)	6 (4– 7)	0.247
Essential childbirth care	4 (IQR 3– 5)	3 (2– 5)	0.053
EmONC	0 (IQR 0– 0)	0 (IQR 0– 0)	0.426
Cross-cutting issues	2 (1– 2)	2 (1– 3)	0.266
	% in category	% in category	
Transport available	18%	38%	0.011
Midwife available	56%	58%	0.794

Table 15 indicates that there is no difference between facilities with fewer or more than 120 deliveries regarding any of the indicator domains. The median points did not differ except for essential childbirth care, where facilities with less than 120 deliveries attained a median of 4 points and facilities with more than 120 deliveries attained a median of 3 points. Facilities with more than 120 deliveries reported the availability of transport in 38% of facilities whereas the proportion was lower (18%) if the facility had fewer than 120 deliveries.

Assessment of the categorization

The health facilities were grouped in four categories based on equal steps of scores attained (see Methods p 128). To assess the final categorisation, cross-tabulation of the index against 1) the level of care (dispensaries and health centres) and 2) availability of transport and midwifery staff was done. Table 16 describes how the category of the index compares to the standard categorization of dispensaries and health centres.

The index of maternal care categorized half of the health centres as providing advanced basic care (seven health centres, 54%). The other health centres were rated as providing basic care (six health centres, 46%). 11 dispensaries (8%) were categorized as providing advanced basic care, 76 dispensaries (46%) as providing basic care, 30 dispensaries (30%) as providing poor care and five dispensaries (4%) as providing very poor care.

Table 16: Cross-tabulation of facilities categorized by the Index of maternal care and level of care

	Very poor care 4 facilities N (%)	Poor Care 39 facilities N (%)	Basic care 82 facilities N (%)	Advanced basic care 18 facilities N (%)
Dispensaries*	5 (4%)	39 (30%)	76(58%)	11 (8%)
Health centres	0	0	6 (46%)	7 (54%)

*Excluding 9 dispensaries without delivery care

The computed categories of the index were also cross-tabulated with the availability of transport and midwifery staff (Table 17). Almost three-quarters (72%) of facilities categorised as providing “advanced basic care” and “basic care” had any staff with midwifery skills compared to two-thirds, that were categorised as providing “poor care” or “very poor care”. Availability of transport was higher in better-rated facilities compared to lower-rated facilities.

Table 17: Cross-tabulation of facilities categorized by the Index of maternal care by availability of transport and midwifery staff

Facilities with *	Very poor care 4 facilities N (%)	Poor Care 39 facilities N (%)	Basic care 82 facilities N (%)	Advanced basic care 18 facilities N (%)
Transport available & working~	1 (25%)	3 (8%)	21 (26%)	9 (50%)
Registered or enrolled nurse midwife	3 (60%)	19 (49%)	49 (60%)	13 (72%)
Any staff with midwifery skills$	3 (60%)	26 (67%)	59 (72%)	13 (72%)

* Excluding nine dispensaries without delivery care
~Either based on hospitals or health facilities; information for one health facility is missing
$ Registered or enrolled nurse midwife or MCHA

Assessment of ownership of facility

The comparison of scores attained using the scoring system 1 indicated that the five mission facilities (one health centre and four dispensaries) achieved higher mean scores than the government facilities (mission facility mean score 12.6 [range 8-17] versus government facility mean score 9.0 [range 1.5-17]. The only private run facility received a score of 3.5 points.

6. Conceptual Framework Used for the Analysis

Different frameworks have been used to analyse determinants of uptake of care and maternal mortality. One of the most famous is the three delays models, “too far to walk” [107]. Other frameworks used are “the long road to death”, which examines the medical causes of deaths, insufficient medical care, immediate factors and distant determinants [360]. A framework by McCarthy and Maine distinguishes between distant and intermediate determinants [361]. Gabrysch and Campbell proposed a framework based on the three delays framework, but separated preventive and emergency care-seeking [88].

For the analysis presented in this thesis, a hierarchical organised framework is used to describe the influence of individual, household and contextual factors on the uptake of maternal care and pregnancy-related mortality (Figure 26). The factors included are based on the variables available from the population census and health facility data.

The key question examined is how accessibility—defined as the straight-line distance to health facilities—influences uptake of care (delivery at first-line facilities, delivery in a hospital and birth by Caesarean section) and pregnancy-related mortality.

The analysis included factors at: 1) the individual level, such as education and occupation as well as age and parity; 2) the household level, such as the ethnic group and wealth quintile, which are treated as individual variables; and 3) contextual factors, such as the overall uptake of maternal care in the wards and the classification of the ward. These factors are known to be important for uptake of care and pregnancy-related mortality [14, 88].

The analysis distinguished between delivery in a hospital and delivery in first-line facilities (dispensaries and health centres). Thus, the analysis did not assess “institutional delivery”, but separately assessed how distance and socio-demographic factors influenced delivery in a hospital and delivery in a first-line facility. The analysis of association between distance and hospital delivery used the **distance to a hospital**. The analysis of factors contributing to uptake of delivery care in first-line facilities examined the **distance to first-line facilities**. Distance to first-line facilities was further assessed for distance to certain quality levels of first-line facilities. For this analysis, the health facilities were categorized by 1) levels of care (dispensaries and health centres), 2) distance to quality levels using the categorization from the index of maternal care and 3) first-line facilities reporting to have a midwife and transport facilities (see Method section p 123). The distance between the mother’s home and the different facility was calculated for each of the categories.

The contextual factors ward classification or uptake of maternal care services (four or more ANC visits, delivery in hospital or first-line facility, birth by Caesarean section) were only used in a bivariate analysis. The rationale behind this decision is that contextual factors include spatial characteristics. For example, urban or mixed wards are likely to have shorter distances to hospital care. Including such cluster variables in a multivariate analysis would confound the effect of distance on uptake of care.

For the analysis of pregnancy-related mortality, the summary estimate of uptake of care will be used as a proxy for the likelihood of uptake of delivery services. Complications during childbirth lead to both higher care-seeking and higher mortality. Therefore, individual care-seeking cannot be included in an analysis of determinants of pregnancy-related mortality, as it is on the pathway [147].

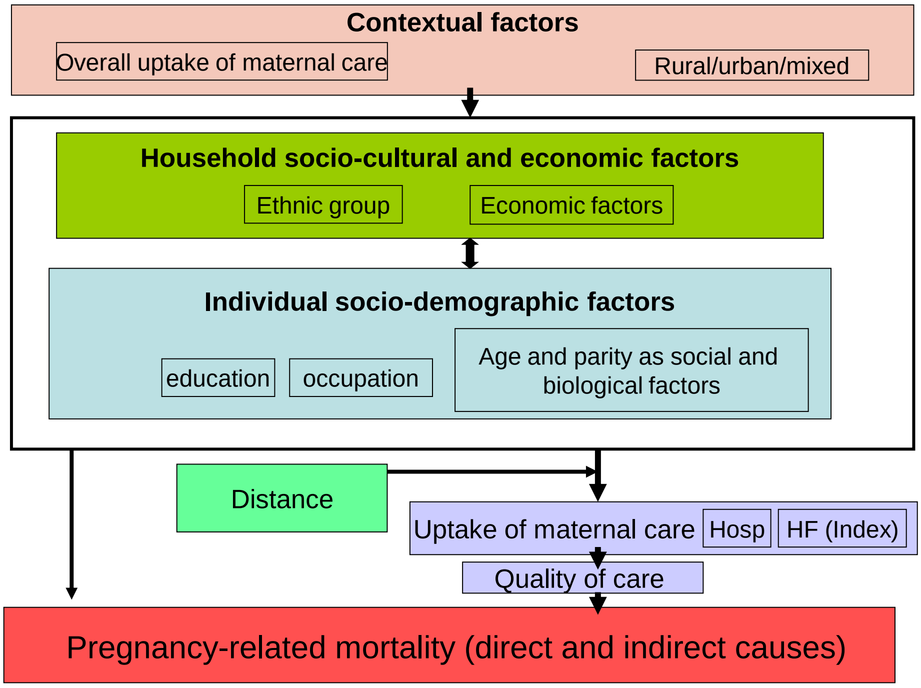


Figure 26: Conceptual framework for the analysis of pregnancy-related mortality

7. Statistical Methods

All statistical analysis was performed using Stata 12 (College Station, Texas, USA). In addition, mapping was used to describe uptake and present data. ArcGis 9(version 9.2, ESRI, Redlands, CA, USA) was used for all maps.

The distance between the mother's household and first-line facilities and hospitals was calculated using the "nearstat" command provided in Stata 12. To be able to use this command, the GIS coordinates, originally in latitude and longitude, were transformed to Universal Transverse Mercator, zone 37s [16].

For the calculation of distance to a hospital, not only the hospitals within the study area were included, but also two hospitals in other districts, the Lindi Regional Hospital and Ndanda Mission Hospital. These hospitals serve mothers from the study area [163] as they are within a close distance and present the nearest hospital for a large part of the population (Figure 36).

Bivariate analysis of uptake of care and pregnancy-related mortality

Two effect measures were used for the bivariate analysis, prevalence ratios and odds ratios. The bivariate analysis of uptake of care used prevalence ratios to describe differences between the categories. The rationale for the use of the prevalence ratio which presents the relative risk between categories was that odds ratio when calculated for common events such as uptake of institutional delivery - although the appropriate measure for the analysis of cross-sectional studies such as this one - are difficult to interpret, particularly for non-specialists [362]. Prevalence ratio estimates using the GLM command use logistic models with random effects. To estimate confidence intervals, a Poisson distribution with robust variance was used. (xi: glm [outcome] [exposure], fam (poisson) link (log) nolog eform). A limitation of the prevalence ratio is that estimates have larger confidence intervals [362, 363]. However, confidence intervals were very narrow in our study because of the large number of participants included in the census, why this limitation was of little relevance.

The analysis of pregnancy-related mortality used odds ratios. Pregnancy-related mortality is a rare event so that risk ratios and odds ratios are very similar.

[16] The **Universal Transverse Mercator** geographic coordinate system uses a 2-dimensional Cartesian coordinate system to give locations on the surface of the Earth. It is a horizontal position representation which flattens out the natural bending of the Earth surface.

The analysis of institutional birth was split into uptake of hospital delivery and uptake of care at first-line facilities (dispensaries and health centres). The analysis of predictors of uptake of care included the tabulation of the proportions of uptake of care for three main outcome measurements:

1) Delivery in a hospital
2) Delivery in a first-line facility (dispensary and health centres)
3) Birth by Caesarean section

In addition, some descriptive analysis is presented for the uptake variables four or more ANC visits and PNC, yet in less detail. A stratified analysis is presented for major socio-economic and demographic variables, distance to health facilities and ward-level cluster estimates.

Frequency distributions and effect estimates were tabulated. For convenience of presentation, continuous variables were categorized. Baseline categories were chosen as they represent the natural baseline and were not too small (less than 8%) of the included events. For age and education, we accepted categories with only a few births. Age below 20 years is typically grouped into one or two groups, which obscure the differences in uptake of care and mortality in the very young ages. As this study included a large number of participants and represented a census of all people, we took the possibility to also present differences in very small groups.

Chi-squared tests and tests for trends were used to examine differences between categories or any indication of trend within ordered categorical variables such as wealth quintiles and levels of education.

For the presentation of availability of services and equipment, the percentages were rounded to full numbers because decimal places were considered to have little public health relevance. Results were also rounded to full numbers for the presentation of uptake of care outcome measures (four or more ANC visits, birth in hospital or first-line facilities and PNC) except for the presentation of the proportion of births by of Caesarean section, because for this outcome, measurement differences seen within one decimal place were considered relevant.

Effect estimates such as the relative risk (prevalence ratio) or the odds ratio were presented with two decimal places as per convention. P-values were shown with three decimal places.

A row for missing data was added for education, occupation and distance in the analysis of uptake of care and also for wealth quintiles in the analysis of pregnancy-related mortality, as they contained more than 1% missing data.

Multivariate analysis and model building

The investigation into confounding and interaction in final models used multilevel logistic regression (xtmelogit command), specifying two levels, the sub-village and the ward level. As explained previously, the bivariate analysis of 'uptake of care' used prevalence ratios.

The census data had a hierarchical structure, as births and deaths are clustered at that individual level (one mother could have several livebirths, although can only die once), at household level (more than one mother in a household), sub-villages level (several household with livebirths per sub-village) and finally the administrative of wards, which consists of several sub-villages.

Examination into clustering of events indicated that both data sets used assessment of uptake of care of mothers with a livebirth in the year prior to the census (22,243 livebirths) and assessment of pregnancy-related mortality (64,089 livebirths),therefore, clustering at the sub-village and ward levels needed to be considered (Table 18).

Table 18: Examination into clustering of livebirths in the data

Levels	Analysis of uptake of care 22,243 livebirths		Analysis of pregnancy related mortality (64,089 livebirths)	
	Number of clusters	Mean number of observations /maximum in cluster	Number of clusters	Mean number of observations /maximum in cluster
Mother	22,243	1 / 1	61,150	1 / 2
Household	19,768	1 / 4	61,134	1 /6
Sub-village	2,321	9/59	2,614	25/173
Ward	114	176/419	114	567/1472

The intracluster correlation coefficient ranged for the different outcome measurements of uptake of care (hospital delivery, birth by Caesarean section and delivery in first-line facility) between 20-30% at sub-village and 10-20% at ward level. In the data set used for the analysis of pregnancy-related mortality an intracluster correlation coefficient of 10% for sub-village and 3% for ward level was calculated.

Including the main explanatory variable, the distance to hospital, the log-likelihood ratio test assessing the effect of uptake of hospital care, birth by Caesarean section and delivery in first-line facilities comparing multilevel logistic regression and conventional logistic regression was highly significant for inclusion of the sub-village and ward level ($p<0.001$).

All potential confounders that were associated with delivery in a hospital, delivery in a first-line facility and birth by Caesarean section were assessed for any association with distance at least at a 95% level ($p<0.05$). The variables that caused a change of the logOR on the effect of distance on uptake of care or pregnancy-related mortality of at least 10% were considered as confounders. This confounder analysis was done using multilevel logistic regression with random effects for sub-village and wards level. For identified confounders, effect modification between distance and identified confounders was assessed by performing interaction tests. For this analysis, the variables were collapsed in two (wealth, education and occupation) or three (parity) categories in order to increase the power of the interaction tests. A log-likelihood ratio test was used to compare a model including an interaction parameter with a model excluding an interaction parameter.

The final model included all predictors which were confounding at least one of the uptake outcomes. In addition a stepwise approach was used to assess whether other variables were significantly improving the model. Wald tests were used to assess the overall significance of the variable in the model.

Health facility information

For the analysis of availability of services and equipment at dispensaries, health centres and hospitals, frequency distributions for interventions and services available were tabulated. Chi-squared tests were carried out to assess the association between availability of services and levels of care (dispensary, health centre and hospital).

In addition a summary measure of essential childbirth care was defined. This essential childbirth package included AMTSL, partograph use including fetal monitoring, infection prevention, breastfeeding promotion, thermal care and prevention of ophthalmia neonatorum. These interventions were included, as they are components of essential child care as per WHO publications [346, 364]. A weighted analysis was performed to reflect the distribution of care-seeking by mothers (share of deliveries in hospitals, health centres and dispensaries) to calculate the proportion of mothers having received essential childbirth care. This measurement was applied to the proportion of institutional deliveries –41%reported for the 2007 study of the area [365]— to compute a population figure for women having received “essential childbirth care”.

Health facility information was used to construct the index of maternal care as described previously.

8. Ethical Considerations

The study was done as part of a baseline study for newborn survival (LSHTM ethics number 5316) and follow-up of a study of Intermittent Preventive Treatment for malaria in infants aged 2-11 months (LSHTM ethics number 1088). Ethical clearance for the intervention studies was also obtained from the local and institutional review boards from Ifakara Health Institute through the Commission for Science and Technology, and the Ethics Commission of the Cantons of Basel-Stadt and Basel-Land, Switzerland.

In addition, personal ethical clearance for the analysis of this study was obtained from LSHTM (secondary data analysis, ethics number 5754) and from Ifakara Health Institute through the Commission for Science and Technology in Tanzania (IHI/IRB No 18-2010).

The population was informed about the survey one day prior the conduct of interviews by a sensitizer who used information sheets in the local language. Written consent to participate was obtained from the household head and orally from women answering the questions about their pregnancies. Permission was sought from the head of the health facility for the health facility census.

9. Description of the Census Population and Data Quality

Census 2007 Data

The following section gives an overview of the census population and quality issues in the modules used for the analysis with regard to completeness and internal coherence. As such, this section presents results and compares information from the three different sources, the census, the verbal autopsies and the health facility census.

The census identified 243,612 households based on the household listing available from administrative leader. In 6.5% of identified households, no person was present (15,823 households) and in 0.7% (1,809), the head of household refused to participate. Thus, in 93% (225,980) of households an interview with the head of the household was done (Figure 27). A total of 818,583 people were identified in the 225,980 households in 2007.

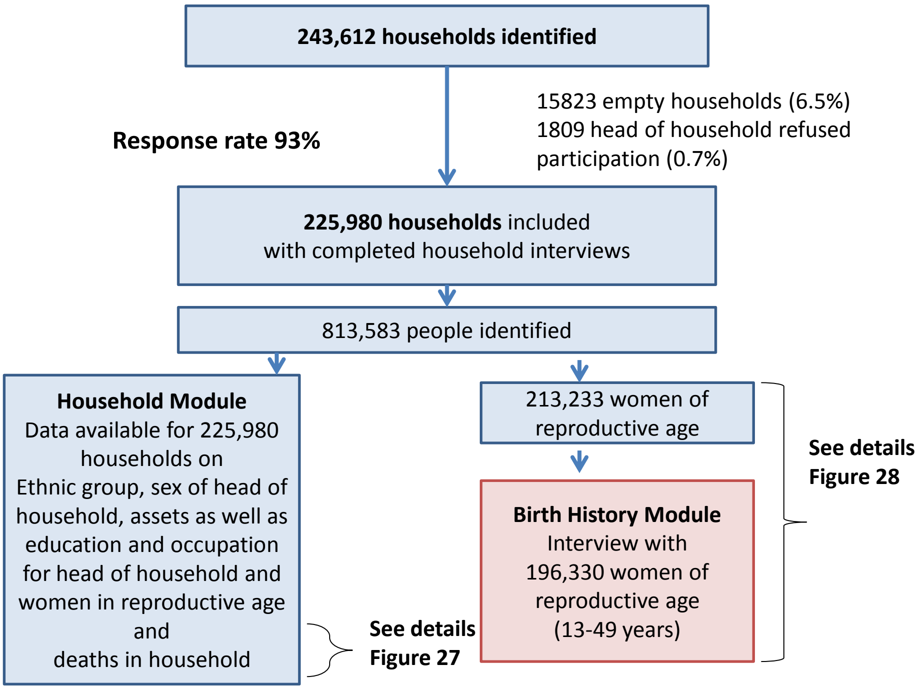


Figure 27: Flowchart describing available information from the census

At the household level, the information for administrative location (district, division, ward, sub-village) ethnic group, and whether the household was male or female headed were collected. This information was complete for all households except for sex of the head of household where 11 (0.05%) and 29 answers (0.04%) were missing in the data set used to analyse uptake of care and pregnancy-related mortality (Table 22). GIS data were available for 203,530 households.

The assets and housing characteristics used for the construction of the wealth index were also collected at household level. There were ten components included in the asset index (see Table 27). Information was missing only for the variable "income other than farming" (overall 2.9% missing, 6601 households). Because of the missing income information, a wealth index could not be constructed for these households. The proportion of missing wealth information differed between the data sets used for the analysis of uptake of care and of pregnancy-related mortality (Table 22).

Household members were identified by asking the head of households about all members of the household and their dates of birth. Answers to the variable "date of birth" were not available for 908 (0.1%) people (411 female and 496 male household members). These members were excluded from the analysis as a woman of reproductive age was defined by her age. In result, there was no missing age information in the data sets used for analysis.

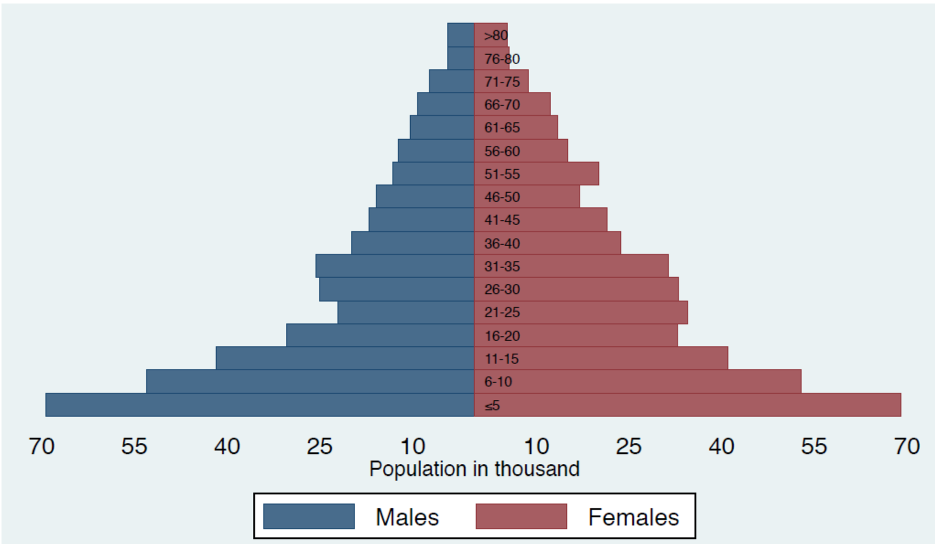


Figure 28: Age distribution of the census population

The age distribution of all the household members identified in the census is shown in Figure 28. The expected pyramidal distribution was obtained.

Information on the education status of household members was also attained at the household level. Information on education was missing for 1,516 (0.7%) women of reproductive age (13-49 years). Completeness of information was 99.6% and 99.5% respectively for education assessed for mothers who had a livebirth since 2004 (the population included in the analysis of pregnancy-related mortality) and for mothers with a livebirth in the year prior the study (the population included in the analysis of the birth histories) (Table 22).

Information on mortality

Information on pregnancy-related deaths was obtained by asking the head of household about any deaths that had occurred since January 2004. A total of 25,283 deaths were recorded in the period from 2004 up to the day of the survey. Out of these 25,283 deaths, 7,119 were in the age group 13– 49 (3,879 women and 3,240 men). A total of 213,233 women and only 179,157 men aged 13– 49 years were identified in the 225,980 households included in the study. Therefore, 52 female deaths and 52 male deaths per 10,000 members of the population per year, respectively, in the age group 13– 49 years were reported to have died.

Figure 29 shows the age distribution of pregnancy-related and non-pregnancy-related deaths among women of reproductive age according to reports from the heads of households. The distribution of age at death in pregnancy-related deaths shows a much higher proportion in women around 20 years (18– 23).

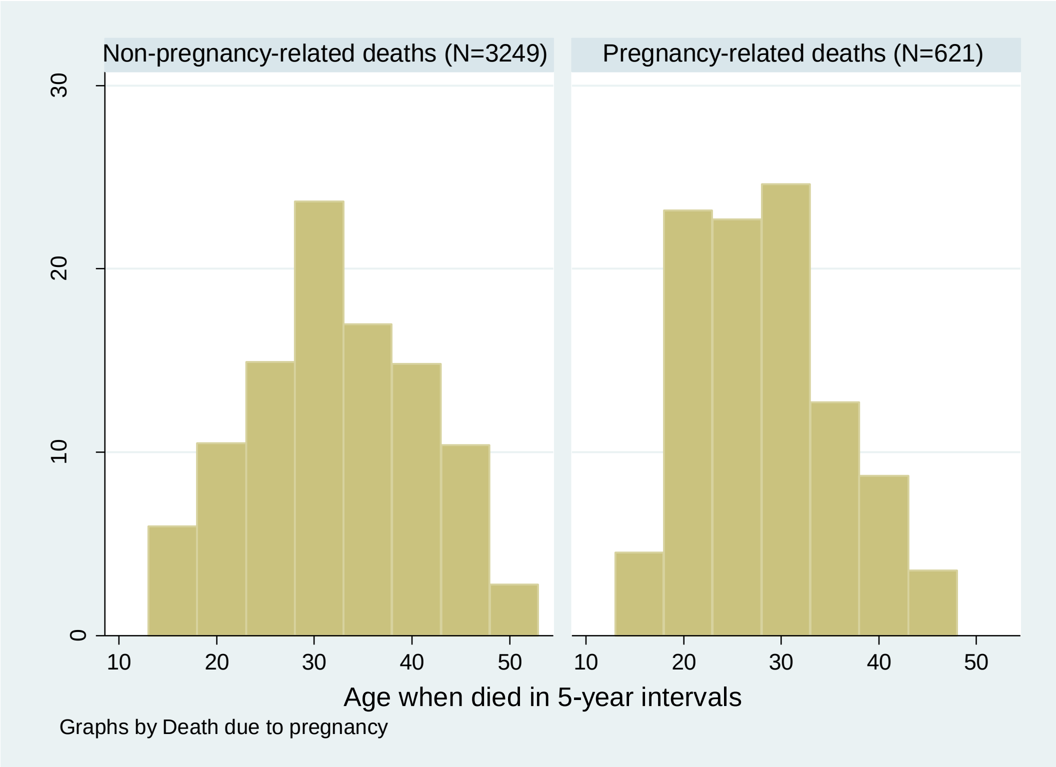


Figure 29: Distribution of deaths in women aged 13-49 years by pregnancy status

A total of 621 deaths among women aged 13– 49 recorded in the deaths file were recorded as pregnancy-related deaths. Four deaths could not be included as they were to mothers of 12 years of age, and thus outside the defined age from which livebirths were obtained.

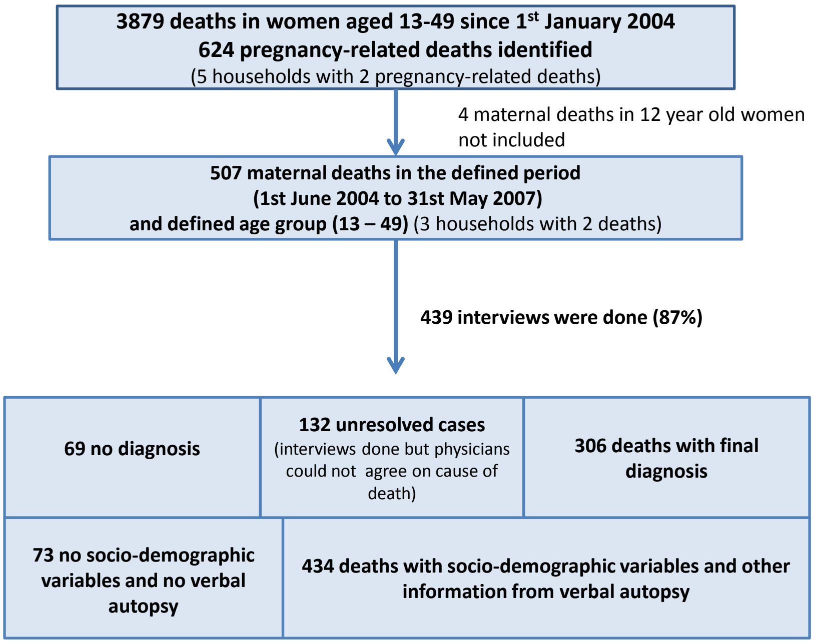


Figure 30: Flowchart describing availability of information on pregnancy-related deaths

The 621 pregnancy-related deaths represent 16% of all deaths among women of reproductive age. Another nine deaths (0.2%) were recorded as unclear with respect to whether they were pregnancy-related or not. These were not included in the analysis.

A total of 507 pregnancy-related deaths were kept in the age group 13 – 49 years and the defined time period (1^{st} of June 2004 to 31^{st} May 2007) (see Methods section p 111).

For 439 (87%) of these 507 pregnancy-related deaths, a verbal autopsy interview was completed (Figure 30). For 42 deaths, there was no indication why no verbal autopsy was done. For 14 deaths, the interviewers recorded that the household was found empty and in 11 deaths, they recorded repetition. One head of household refused to participate.

Thus, for 69 (14%) pregnancy-related deaths, no diagnosis was available, and for 73 (14%) of pregnancy-related deaths no socio-demographic variables and other verbal autopsy information were available.

There is no indication that households with a pregnancy-related death for which verbal autopsies were done differed from households where the verbal autopsy was missing (Table 19). The socio-demographic characteristics of households with and without completed verbal autopsy were similar.

Table 19: Missing verbal autopsy questionnaires by socio-demographic characteristics

Comparison of pregnancy-related deaths with and without out verbal autopsy

	%	Number missing	p-value		%	Number Missing	p-value
District			0.941	**Maternal age**			0.539
Lindi Rural	**13**	22		<20	**18**	13	
Nachingwea	**15**	15		20-29	**14**	30	
Ruangwa	**16**	10		30-39	**15**	26	
Newala	**13**	11		40-49	**9**	9	
Tandahimba	**15**	15					
Wealth quintiles			0.793	**Household head sex**			0.025
Most poor	**12**	10		Male	**12**	47	
Very poor	**16**	14		Female	**21**	26	
Poor	**14**	14					
Less poor	**14**	14					
Least poor	**19**	16					
Ethnic group			0.949	**Period**			0.305
Makonde	**14**	35		June 04 – May 05	**18**	27	
Makuwa	**16**	4		June 05 – May 06	**13**	21	
Yao	**19**	5		June 06 – May 07	**13**	25	
Mwera	**14**	24					
Others	**17**	5					

The age of the deceased women was collected both during the census and during the verbal autopsies. For 431 pregnancy-related deaths, information from both sources was available. High consistency is seen. According to the census survey, the mean age of mothers who died was 28.0 (95% CI 27.3– 28.7) and 28.2 (95% CI 27.5– 29.0) according to verbal autopsies. The t-test for differences in means suggested that there was no difference between the two age measurements (p=0.138).

Apart from the missing information on occupation due to missing verbal autopsies differences in the question and answer categories were further problems as answer categories differed.

To make the two ways of assessing occupation comparable between women with a livebirth and women who died, both original variables were collapsed into a variable with two categories using “farming” and “others”.

Table 20: Occupation of mothers with a livebirth or who died

	64,098 livebirths %	434 mothers who died* %
Farming	95%	95%
Housewife	2%	NA
Employed	0.5%	0%
Engaged in any business	NA	1%
Others	1%	3%
Missing	1%	1%

*73 missing verbal autopsies

The birth history module

Out of the 818,583 people in the households, 213,233 were women of reproductive age (13–49 years old). As women of reproductive age were defined by their age, only female household members for whom age was available were included. This excluded 411 female members whose age was unknown.

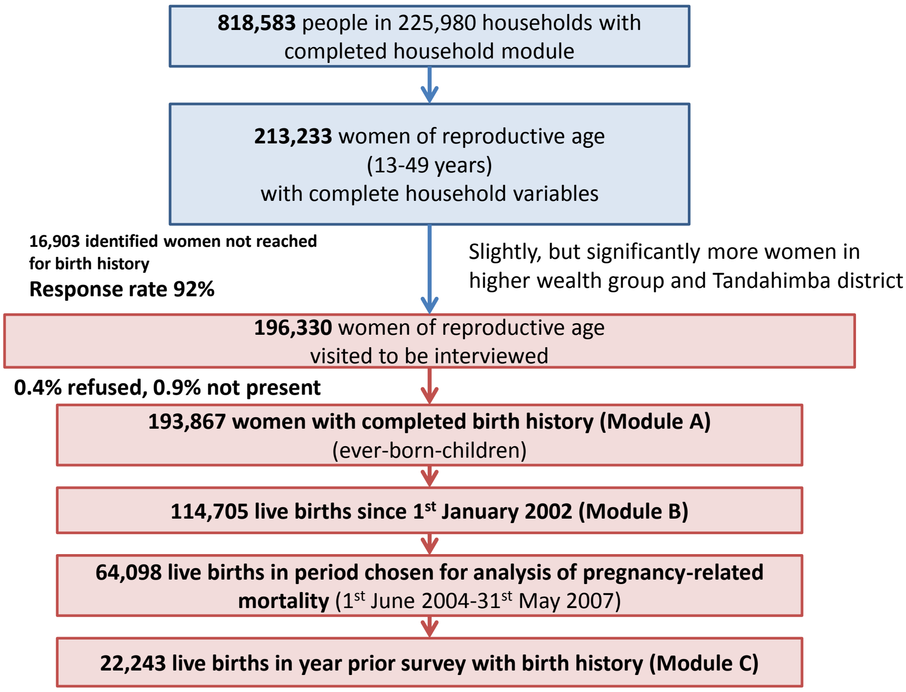


Figure 31: Flowchart describing available information from birth histories

A birth history interview was available for 193,867 women of reproductive age. For 8% (16,903) of the women identified, no indication was available as to why they were not interviewed, 0.4% refused to participate (768 women) and 0.9% (1714 women) were noted as not present in households by interviewers (see Figure 31). For 19,396 women (9.1%) of women no birth history was available.

The analysis of socio-demographic and economic factors in relation to missing births indicated that there were statistically significant differences between women interviewed compared to women not interviewed. The proportion of women missed was higher than 10% in only two strata: the district of Tandahimba and in the group of women with formal employment.

A total of 9.9% (5,063 women) from a least poor household compared to 7.4% (2.211 women) from a most poor household were not interviewed. About 11% (167) women being employed compared to 5.9% being housewife were not interviewed. All differences between categories were highly significant (p<0.001) although the differences were not exceeding four percentage points below and above 9.1% in any sub-group (Table 21).

Table 21: Missing birth histories by socio-demographic characteristics

19,396 missing birth histories out of 213,233 women in reproductive age							
	Number missing	%	p-value		Number missing	%	p-value
District			<0.001	**Maternal age**			<0.001
Lindi Rural	4,651	**9.5**		<20	3,684	**7.6**	
Nachingwea	3,108	**8.0**		20– 29	6,546	**9.8**	
Ruangwa	2,484	**8.4**		30– 39	5,385	**9.3**	
Newala	3,870	**8.7**		40– 49	3,781	**9.4**	
Tandahimba	5,283	**10.4**					
Wealth quintiles			<0.001	**Education**			<0.001
Most poor	2,211	**7.4**		No education	4,410	**8.8**	
Very poor	2,952	**8.4**		Some primary	3,561	**7.4**	
Poor	3,796	**9.0**		Primary	9,840	**9.5**	
Less poor	4,300	**9.4**		Secondary +	863	**8.9**	
Least poor	5,063	**9.9**					
Ethnic group			<0.001	**Work**			<0.001
Makonde	11,235	**9.4**		Farming	15,913	**9.5**	
Mwera	5,469	**8.6**		Housewife	275	**7.3**	
Makuwa	902	**8.6**		Employed	201	**13.2**	
Yao	669	**8.6**		Others	318	**10.0**	
Others	1,121	**9.3**					

Detailed birth histories for children born after January 2002

Detailed birth histories (birth history module Figure 15), were collected for all children of women in reproductive age born from the January 1st 2002 up to the date of household survey. A total of 114,705 livebirths were documented.

There were 114,705 births recorded in the birth histories. Dates of birth were evenly distributed, suggesting that birthdates of children were accurately remembered and recorded by the interviewers.

Figure 32 gives the distribution of livebirths recorded after January 2002. The observed pattern of percentage of births by date of birth gives the impression that more births were recorded in time periods closer to the census. This suggests that some births might be missed in the earlier recording periods (year 2002– 2003), raising the suspicion of a recall bias (mother might recall livebirths in farther time periods less well) and interviewer error (omitting recording of births near the recording limits or replacement to earlier periods to reduce work load).

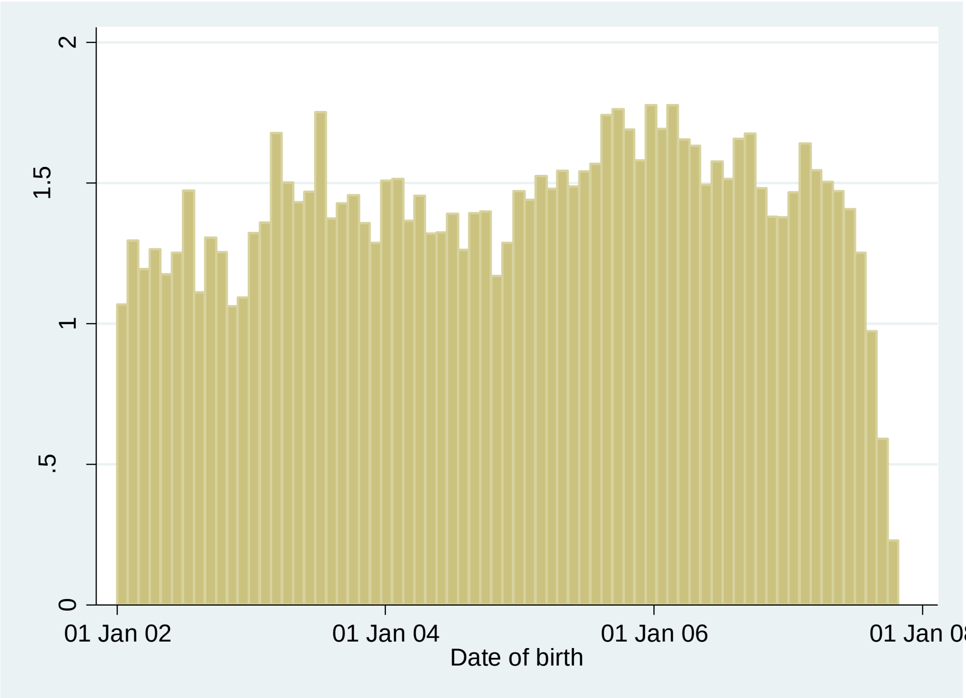


Figure 32: Date of birth of 114,705 children born after 1st January 2002

The study on pregnancy-related mortality only included births from June 2004 to May 2007. Thus, the probable omission of births in 2002 and 2003 are not of concern for the analysis of pregnancy-related mortality. The graph supports the common quality assurance mechanism of recording births and deaths for a period longer than foreseen for the main analysis to reduce recall and interviewer bias.

The completeness of explanatory variables in the different data sets is summarised below (Table 22).

Table 22: Completeness of explanatory variables in different data sets

Explanatory variables	Completeness in birth history file (last year prior the study)	Birth file (64,098 livebirths within 1st June 2004 to 31May2007)	Maternal deaths (507 within 1st June 2004 to 31May2007)
Variables assessed asking the head of household			
Administrative area Sub-village, ward, division, district	None missing	None missing	None missing
Wealth quintiles	886/22243 (4%)	2,417 (4%)	37 (7%)
Ethnic group in categories with 10 and categories with 5, and 2	None missing	None missing	None missing
Sex of head of household	11/22243 (0.05)	29 (0.04%)	1 (0.2%)
Age Continuous (at date of study) and age categories	None missing	Not used	Not used
Age Continuous, constructed from date of birth of mother and date of birth of child, and obtained as full years for mothers who died	Not used	None missing	None missing
Variables obtained from head of household for livebirths and from verbal autopsy for deceased			
Work 4 categories and binary variable	389/22242 (2%)	725 (1%)	73 (15%)
Education continuous variable and education categories in line with categories used in DHS in Tanzania	99/22243 (0.5%)	227 (0.4%)	74 (15%)
Variables obtained from birth histories			
Parity continuous variable of number of livebirths as proxy for parity	3/22243 (0.01%)	Not used	Not used
Other variables			
Period categorized in three periods, each one year	NA	None missing	None missing

Geographical Data

The final data set used for the distance calculation included 203,530 single coordinates that could be merged with households included in the study[17]. For 22,450 (10%), household GIS data were missing. In particular, GIS data were missing in Newala district (9,183 coordinates, 19%) whereas all other district had proportions of missing GIS information ranging between 6% in Ruangwa and 9% in Nachingwea (Table 23).

Table 23: GIS information by cleaning manipulations and imputation of GIS-household coordinates and by districts

	Original data N=160,883	Corrected doubles/triples and outliers N=3,914	Reassignment data based on visualization N=3,348	Substitution by sub-village centres from INSIST survey N=2,385	Substitution by sub-village median N=33,000	Missing coordin-ates 22,450/ 225,980
District	% in each category					
Lindi Rural	80	1	1	0	9	8
Nachingwea	73	1	3	1	13	9
Ruangwa	72	2	1	0	19	6
Newala	63	1	2	2	13	19
Tandahimba	68	3	1	1	21	7
Total	71	2	2	1	15	10

The data manipulation, cleaning and imputation of missing coordinates yield different distance estimates, which was not surprising as there were pockets of missing GIS information in certain wards. Households with corrected and manipulated GIS coordinates were in shorter distance to a hospital. The mean distance to a hospital was 19 km based on original GIS data and 16 km for manipulated and imputed GIS data. For distance to a dispensary the manipulation (corrected and imputed coordinates) led to an increase in distances. The mean distance to a dispensary providing delivery care was 3.9 km based on original GIS data and 4.4 km for manipulated and imputed GIS data (Table 24).

[17] Number differs from description before (Figure 16) because not 243,612 households but 225,980 households were included in the final analysis (Figure 277)

Table 24: Distance to facilities by cleaning manipulations and imputation of GIS coordinates

		Mean distance to (Km)		
	Number of coordinates	Dispensary with delivery care	Health centre	Hospital
Original data	**160,883**	3.9	17	19
Corrected doubles/ triples and outliers	**3,914**	4.4	15	19
Reassignment data based on visualization	**3,348**	3.9	21	17
Substitution by sub-village centres from INSIST survey	**2,385**	2.6	16	17
Substitution by sub-village median	**33,00**	4.4	16	16
t-test for difference between original data and cleaned /imputed data		3.9 versus 4.3 2-sided t-test p<0.001	17 versus 16 2-sided t-test p<0.001	19 versus 16 2-sided t-test p<0.001

The mapping of the percentage of missing coordinates (Figure 33) also indicates that households with missing information were largely concentrated in a few wards. The vast majority of wards had less than 10% of geographical information missing.

The distribution of the proportions of original data, cleaned and imputed data and missing data did not differ greatly between the districts by wealth quintile, education level or occupation, but the differences were significant (p<0.001) (see Table 74 in annex). In the data set including the 22,243 women with a livebirth in the year prior to the survey, 15,977 households had original coordinates, 4,043 households had cleaned or imputed data and 2,223 households had no coordinates available. The distribution of availability, imputed and missing data were different between districts. The proportion of missing data was lower in Ruangwa and Tandahimba districts (6% each) and higher in Newala (20%). No difference in the distribution of original, imputed or missing data was observed with age and parity between the districts.

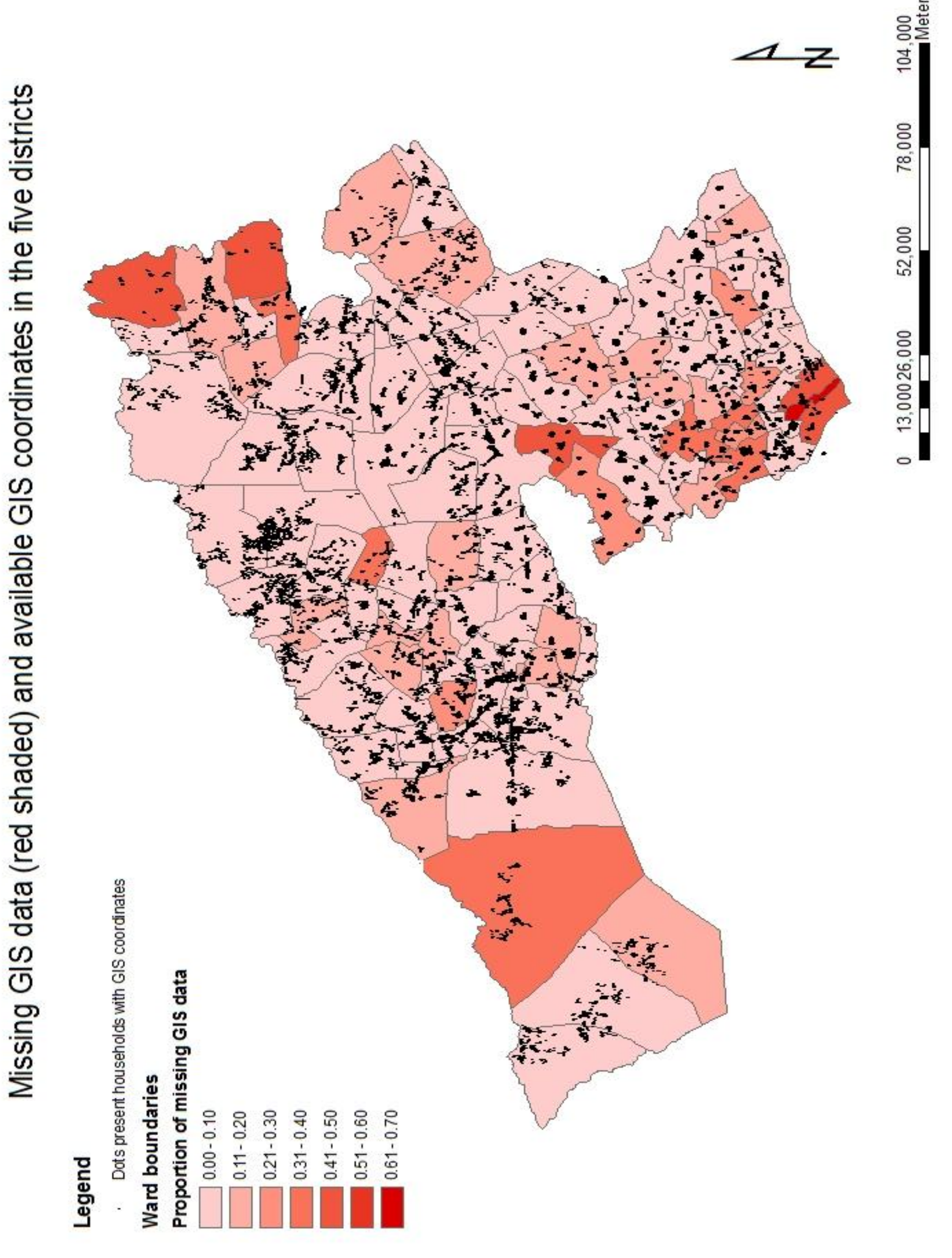


Figure 33: Missing GIS information by ward

Chapter 3: Results

The first results section describes the study population, including geographical accessibility to health facilities. The second section outlines how the quality of maternal care provided in a health facility is described based on the data available from the health facility census. The third section includes a description of the determinants of uptake of care with a more detailed analysis of uptake of facility delivery and birth by Caesarean section, with a particular emphasis on distance to health care. The fourth section presents the results from the analysis of pregnancy-related mortality and its determinants. The last section summarizes the results on uptake of care and pregnancy-related mortality.

1. Characteristics of the Study Population

Socio-Demographic Characteristics

The **study area** had a predominantly rural population. The population lived scattered in 2,621 sub-villages, and 114 wards. A total of 225,980 households were included in the analysis. Each household had a mean of 3.6 members. Most households were headed by men (71%, 160,152 households), and more than a quarter (29%, 65,539 households) by women.

In Lindi Region, 53,030 households (23%) were in Lindi Rural, 40,841(18%) in Nachingwea and 32,894 (15%) in Ruangwa district. In Mtwara Region 48,179 households (21%) were in Newala and 51,036 households (23%) in Tandahimba district.

The predominant **ethnic** groups were Makonde (55%), Mwera (31%), Makuwa (5%), Yao (4%) and a few smaller ethnic groups (see Table 25).

Table 25: Ethnic group of households

Ethnic group	Number	%
Makonde	124,095	**55**
Mwera	70,384	**31**
Makuwa	11,210	**5**
Yao	8,360	**4**
Ndonde	3,320	**1**
Ngido	2,550	**1**
Ngoni	1,858	**1**
Nyasa	379	**0**
Matumbi	372	**0**
Others	3,452	**2**
Total	225,980	**100**

Ownership of assets is listed in Table 26. Half of the households in the study area reported to own a bicycle, a radio and chicken in 2007. Those who owned chickens had a mean of eight chickens (median 5; IQR 3 -10). Possession of betnets was estimated at 65% (146,933) of all households. Bednet ownership ranged from 43% in the lowest wealth quintile to 85% in the highest wealth quintile. Of those households that owned bednets, the mean number was 1.8 nets (median 2; IQR 1-2).

Table 26: Asset ownership of households

Asset	Number	%
Bednet	146,933	**65**
Poultry	121,002	**54**
Radio	93,386	**41**
Bicycle	92,641	**41**
Tin roof	63,569	**28**
Livestock	30,396	**14**
Phone	18,755	**8**
Rented house	15,057	**7**
Charcoal for cooking	9,460	**4**
Mains electricity	4,598	**2**
Total	225,980	**100**

Eight percent (18,755) of the households owned a phone in 2007; ownership was 41% and 1% for the least poor and less poor wealth quintiles, respectively (Table 27). Bicycles were owned by 75% of household categorised as being in the highest wealth quintile but 0% of households in the poorest quintile. Very few households reported being connected to electricity (4,598 households, 2%) whereas improved roofing (tin instead of thatched based roofing) was reported in 28% (63,569) of all households.

Table 27: Household assets and housing by scores and quintiles

Socio-economic status quintile	Households No	Households %	Mean SES score	Rent the house they occupy	Bicycle	Radio	Phone	Income other than farming	Use of charcoal for cooking	Animals	Poultry	Mains electricity	Tin roof
	Household Asset: percentage of household with respective 'asset'												
Most poor	42,746	20	-1.264	0%	0%	0%	0%	0%	0%	0%	10%	0%	0%
Very poor	38,240	18	-1,018	0%	34%	0%	0%	0%	0%	15%	78%	0%	0%
Poor	46,775	22	-0.465	0%	27%	53%	0%	9%	0%	12%	49%	0%	26%
Less poor	43,308	20	0.146	8%	71%	68%	1%	17%	0%	20%	70%	0%	37%
Least poor	43,086	20	2.516	25%	75%	81%	41%	60%	22%	22%	60%	5%	73%

Most women had completed primary **education** (53%, 112988 women) but 24% (50,070) of women had no education. Only 614 (0.3%) of women of reproductive age in this rural area had completed secondary or higher education (Table 28).

Table 28: Highest education attained of women of reproductive age

Education	Number	%
no education	50,070	**24**
Some primary education	48,045	**23**
Completed primary education	112,988	**53**
Secondary or higher	614	**0.3**
Missing	1,516	**0.7**
Total	213,233	**100**

Information on the **main occupation** was missing for 36,379 women (17%) of reproductive age[18]. The majority (168,383 women) were farmers representing 79% of women of reproductive age in the study population. Less than 5% (8,472) of women in this study population were employed, were housewives or had any other occupation (Table 29). Three percent (5,015) of women, who were predominantly farmers, said that they also had another occupation.

Table 29: Occupation of women of reproductive age

Occupation	Number	%
Farmer	168,382	**79**
Housewife	3,786	**2**
Employed	1,518	**1**
Others	3,168	**1**
Missing	36,379	**17**
Total	213,233	**100**

[18] The proportion of missing data was lower at only 1% in the sub-group of women in reproductive age with a completed detailed birth history probably because missing information attained at household level could be added during the birth history interview with women in reproductive age - see Table 22.

The mean **age of women of reproductive age** in this survey was 29 years (median 28, IQR range 20-37 years). The age distribution is tabulated in Table 30. Complete information on the number of children ever born was available for 193,867 women.

Table 30: Age distribution of women of reproductive age

Age	No	%
13-19 years	48,342	**23**
20-29 years	66,775	**31**
30-39 years	57,852	**27**
40-49 years	40,264	**19**
Total	213,233	**100**

Around a quarter of women (49,466) had had no livebirths ever (Table 31). Most of these women (76%, 37,427 women) were younger than 20 years. 83% of women below 20 and 2,064 (6%) of women aged 40-49 years had never had a livebirth.

Of women who ever had a livebirth, the mean number was 3.2 livebirths (median 3, IQR 2-4). 14% of women (19,511) had six or more livebirths (Table 31).

Table 31: Number of livebirths of women of reproductive age

Livebirths	No	%
No livebirth ever	49,466	**26**
1	34,043	**18**
2 to 3	59,520	**31**
4 to 5	31,297	**16**
6 or more	19,511	**14**
Total	193,837	**100**

*answers missing because of missing birth histories (see Figure 31)

Distance to Health Facilities

A network of health facilities serves the population in the districts. There were a total of 163 facilities, of which six were hospitals, 13 were health centres, and 144 were dispensaries. Lindi Rural, Ruangwa, Tandahimba and Newala have each one hospital and Nachingwea had two hospitals, one public district hospital and one church/mission-owned hospital. In addition, the map below also includes two hospitals that are situated outside the study area, Ndanda Mission Hospital (between Ruangwa and Newala district), and Lindi Regional Hospital in Lindi town (surrounded by Lindi Rural district). They have also been included in the analysis of distance to a hospital, as many patients in the study population seek care in these facilities (see Method section p 121)

The mean distance to any facility providing delivery care within the study area was 3 km. A total of 50% of all households were within 2.5 km, 75% of households were within 4.6 km and 95% of household were within 7.6 km of any health facility with delivery care (Figure 35 and Table 32). The distances were larger in the three districts in Lindi region than those in Mtwara region. In Lindi Rural, Nachingwea and Ruangwa, 95% of the population were within 7.9 km, 10.1 km and 7.8 km respectively of a facility providing delivery care.

Table 32: Distance to health facilities providing delivery care by districts

Distance in km*	Lindi Rural	Naching -wea	Ruang wa	Newala	Tanda-himba	Overall
Any health facility (dispensary, health centre or hospital) with delivery care						
Mean distance	3.0	3.7	3.1	2.8	2.4	3.0
50% of households lie within	2.2	3.1	2.6	2.7	1.7	2.5
75% of households lie within	4.8	5.4	4.7	4.2	4.3	4.6
95% of households lie within	7.9	10.1	7.8	5.7	5.5	7.6
Hospital						
Mean distance	24	15	16	18	16	18
50% of households lie within	24	11	15	18	17	17
75% of households lie within	31	16	20	26	21	24
95% of households lie within	42	73	29	32	27	35

*203,530 households with GIS information

The mean distance to any hospital (mission or public hospital) was 18 km in the five districts. The figure also included the two hospitals outside the study area that were included in the analysis of distance to hospital (Figure 34).

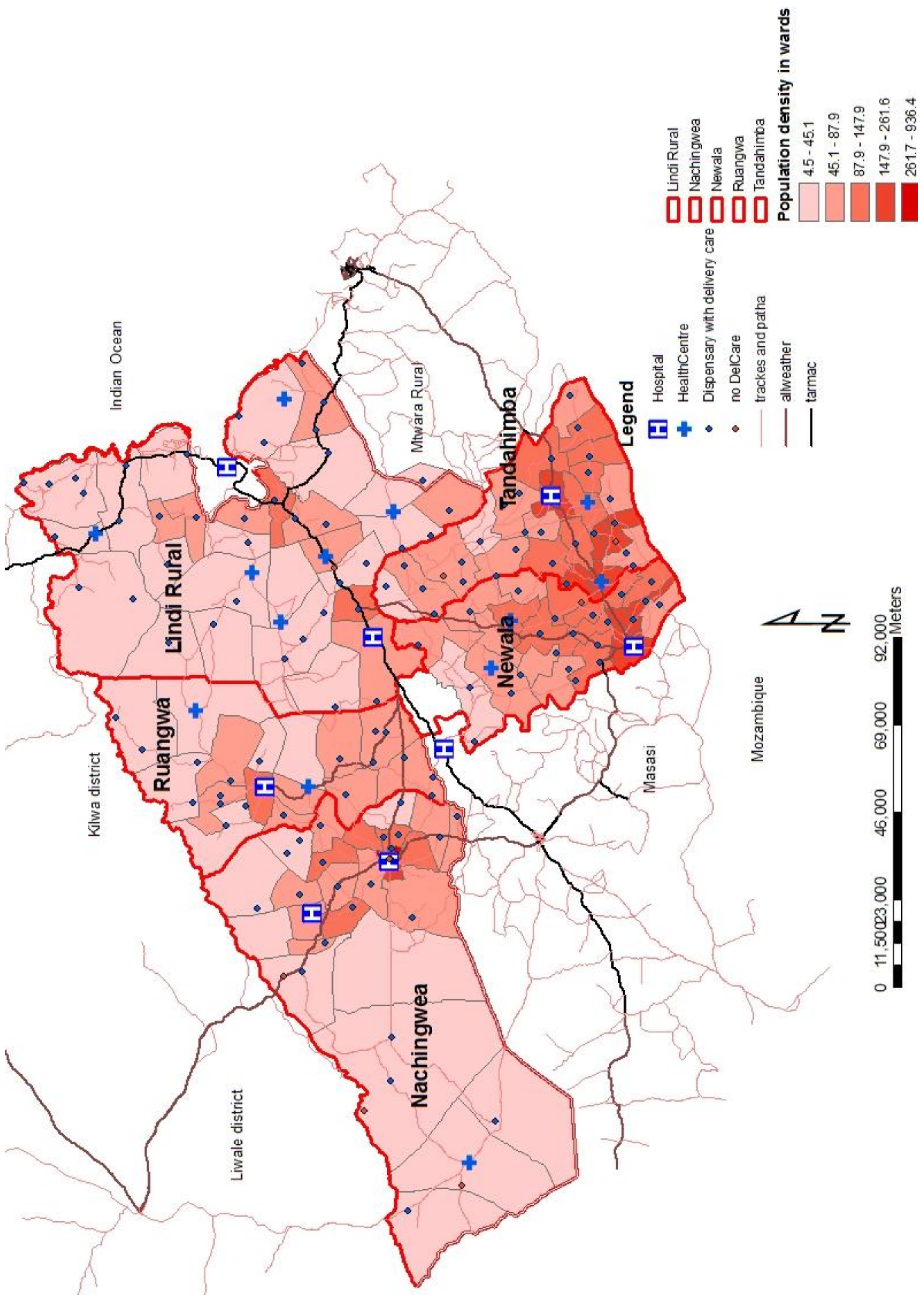


Figure 34: The study area with the health facilities within the five districts shown

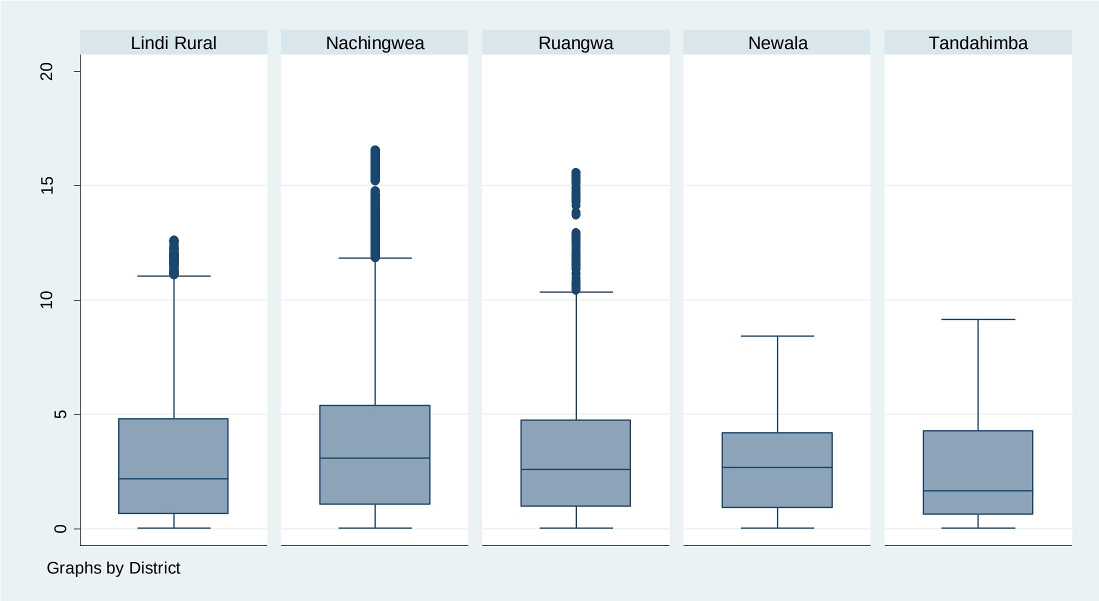


Figure 35: Box plots describing the distance to any health facility providing delivery care
(Boxes represent the data within the interquartile range (IQR) from the 25th to 75th percentile. The lines represent the range of the data minus outliers that are data points that lay more than 1.5 fold above or below the IQR).

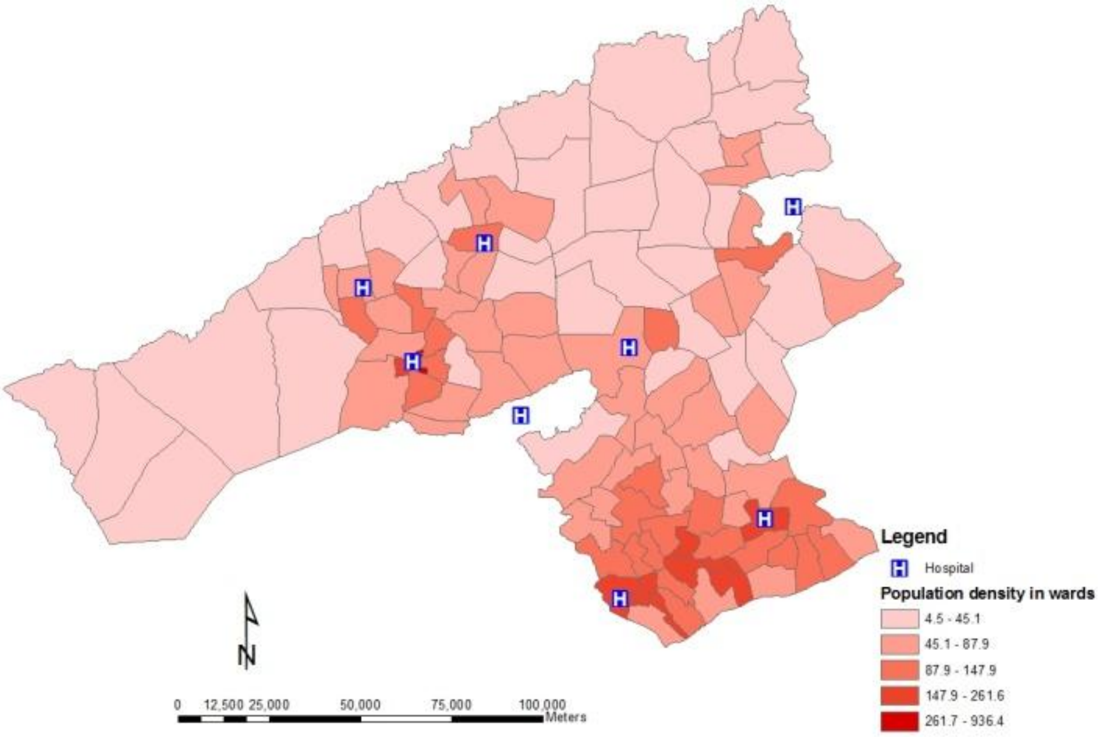


Figure 36: Density of the population and hospital location

The hospitals were situated in the more densely populated areas (see Figure 36). The mean distance to a hospital was larger in Lindi Rural district (24 km) compared to the four other districts (Nachingwea 15 km, Ruangwa 16km, Newala 18 km and Tandahimba 16 km). In

Nachingwea district, more households were located far from any hospital; although 75% of the population live within 16 km of a hospital, 95% live within 73 km.

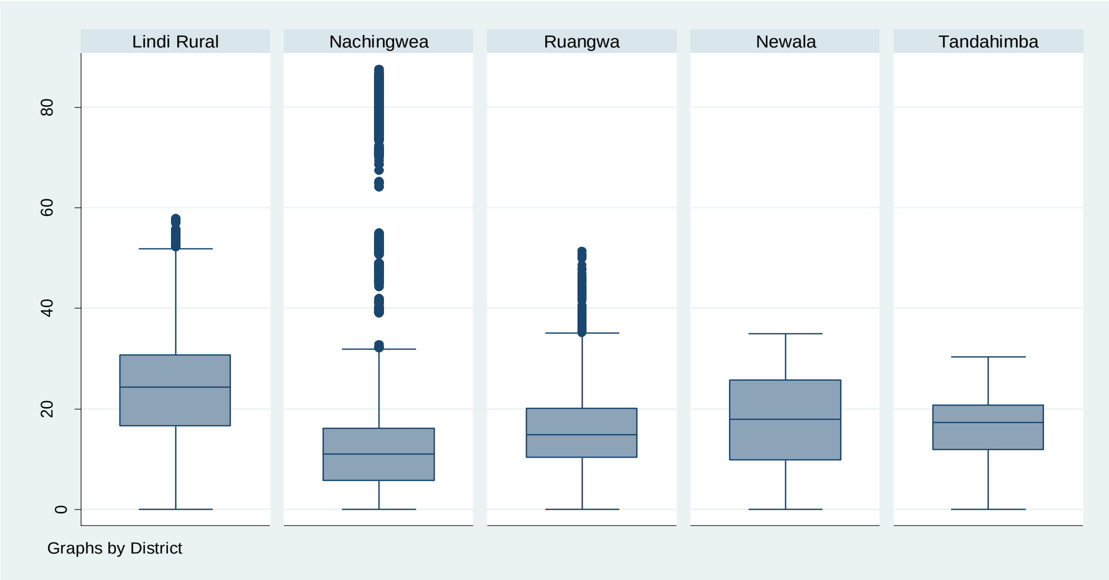


Figure 37: Box plots showing the distance to any hospital

The mean distance to a health centre was 16.6 km and 50%, 75% and 95% of the population were living within 15 km, 22 km and 37 km of a health centre respectively (data not shown).

1. Quality of Care Provided in Health Facilities

Data on quality of care was available for 159 health facilities in the five districts. Data could not be obtained from three facilities due to unavailability of staff. One private-for-profit health centre was excluded because it did not provide any care to mothers and children. Health facilities with information included six hospitals, 13 health centres and 140 dispensaries. Two hospitals, one health centre and three dispensaries were private-non-profit (mission) facilities, one was private-for-profit and all others were public facilities.

Human Resources

The staffing level and qualification of the health worker heading the first-line facility are shown in Figure 38 and Figure 39. The staffing information for the six hospitals was not available.

A median of six (IQR 5– 7) and 2.5 (IQR 2– 3) health workers were employed at health centres and dispensaries, respectively. A few health centres and dispensaries had more health workers. This included one health centre in Newala, two military (parastatal) facilities, one private dispensary in Nachingwea and one mission dispensary in Tandahimba.

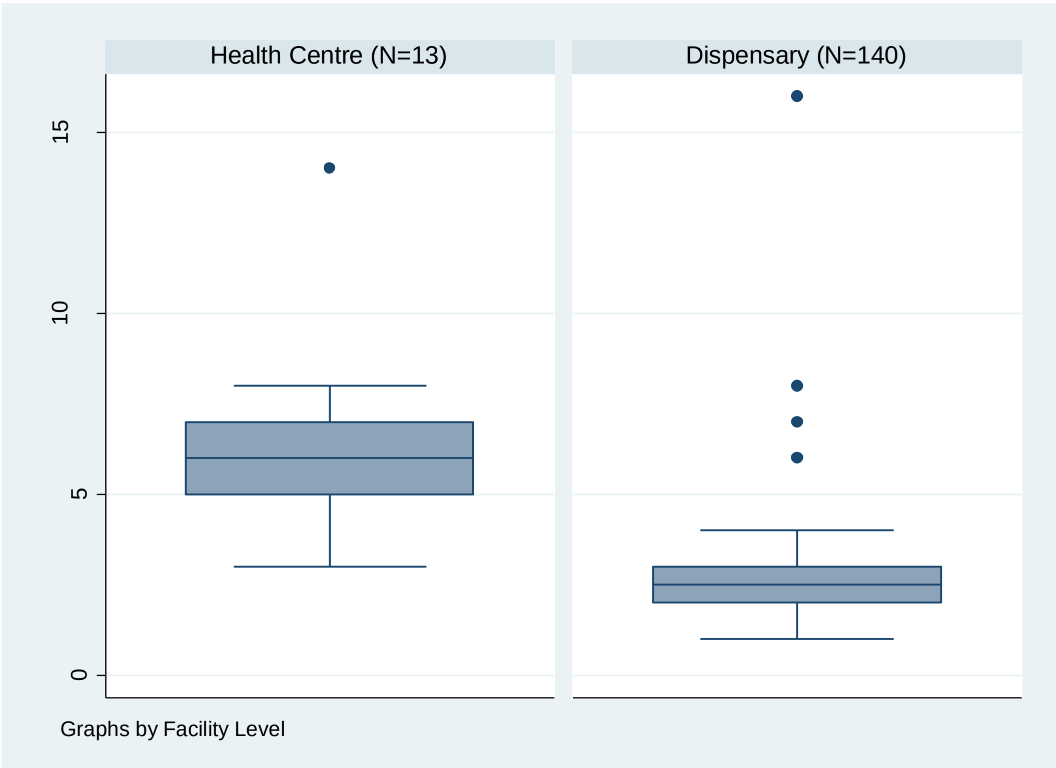


Figure 38: Box plot describing the number of health providers by level of care
(health centres and dispensaries)

Health centres were better staffed not only in terms of numbers but also qualification (Table 33).

Table 33: Availability of staff by health centre and dispensary
(at least one staff member of the respective category)

	Health centre		Dispensaries	
	N=13	%	N=140	%
Assistant medical officer	2	**15**	0	**0**
Clinical officer	11	**85**	76	**54**
Assistant clinical officer	3	**23**	15	**11**
Registered nurse	4	**31**	16	**11**
Enrolled nurse	10	**77**	62	**44**
Mother and Child Health Aid (MCHA)	1	**8**	22	**16**
Nurse assistant	8	**62**	89	**64**

All health centres but only 62% of the dispensaries had a clinician (assistant medical officer, clinical officer or assistant clinical officer) employed (Table 33). Four out of the 13 health centres (23%) in the study area had a registered nurse and 10 heath centres (77%) an enrolled nurse employed. Two health centres had at the time of study no midwifery staff (registered nurse or enrolled nurse).
The staffing level for midwifery staff in dispensaries was even lower. Only 16 out of the 140 dispensaries surveyed (11%) had a registered nurse and 62 (44%) an enrolled nurse (Table 33). Some of the facilities had both nursing staff categories but 46% had neither a registered nor an enrolled nurse. Out of the 64 dispensaries without any nurse-midwife, 18 dispensaries (13%) had at least an auxiliary midwife (MCHA), but 46 (33%) only had a nurse assistant, a cadre not considered as skilled attendant. In sum, 85% of health centres and 67% of dispensaries had recognized midwifery staff employed.

Figure 39 indicates the staff categories in charge of health centres and dispensaries (highest available staff category in facilities). An assistant medical officer was in-charge of two (15%) health centres, all others were headed by a clinical officer. Seventy six (54%) dispensaries were headed by clinical officers, 10 (7%) by a registered nurse and11 (8%) by an assistant clinical officer. In 18 dispensaries (13%), auxiliary personnel (MCHAs or nurse assistants) were in-charge of the dispensary.

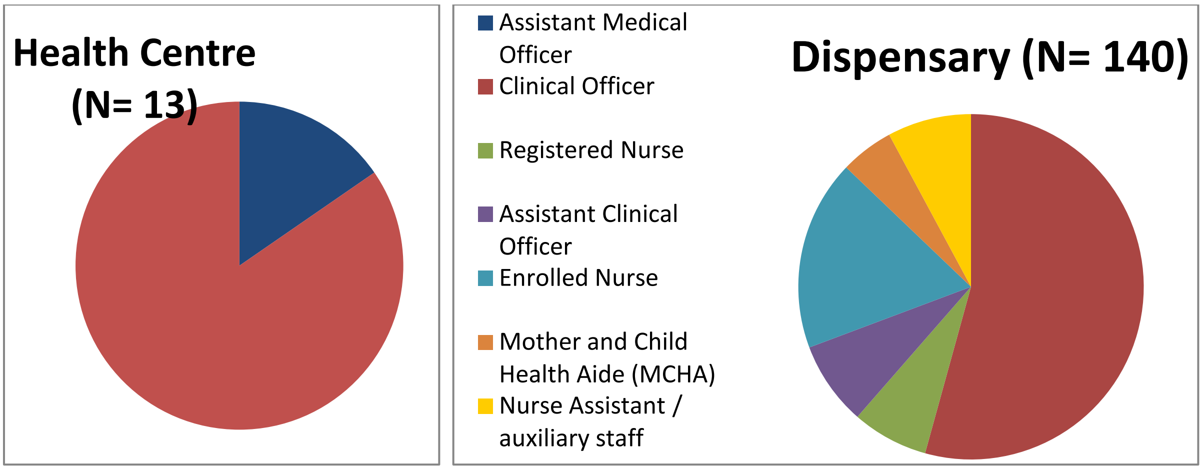


Figure 39: Staff categories in-charge of health centres and dispensaries

Training in maternal and newborn care

Overall, 309 out of the 470 (66%) health workers employed at the health centres and dispensaries had received any in-service training in the past year prior to the survey, predominantly in Prevention of Mother to Child Transmission (PMTCT). A total of 13% and 12% of staff at health centres and dispensaries, respectively reported training in Safe Motherhood/EmONC, whereas training in essential newborn care and focused ANC was less frequent (Table 34).

Table 34: Training in maternal and newborn care in health centres and dispensaries in the year prior the survey

	Staff at health centre		Staff at dispensaries	
	N=81	%	N=389	%
PMTCT	26	**32**	127	**33**
Focused ANC	6	**7**	51	**13**
Safe Motherhood training/EmONC	10	**13**	47	**12**
Family planning	14	**17**	38	**10**
Essential Newborn Care	7	**9**	13	**3**

Antenatal Care

Antenatal and delivery care was offered in all six hospitals, in all 13 health centres and in 135 out of 140 (96%) dispensaries. Data on workload was not available for one health centre and 13 dispensaries. The hospitals, health centres and dispensaries with information on workload reported a median of 878 (IQR 491– 910), 251 (IQR 200– 350) and 125 (IQR 75– 225) pregnant women respectively for their first ANC visit in 2008 (Figure 40). Assuming a similar workload for the facilities for which information was missing, 15% (4,450), 12% (3,614) and 72% (20,995) of first ANC visits took place at the hospital, health centre and dispensary, respectively.

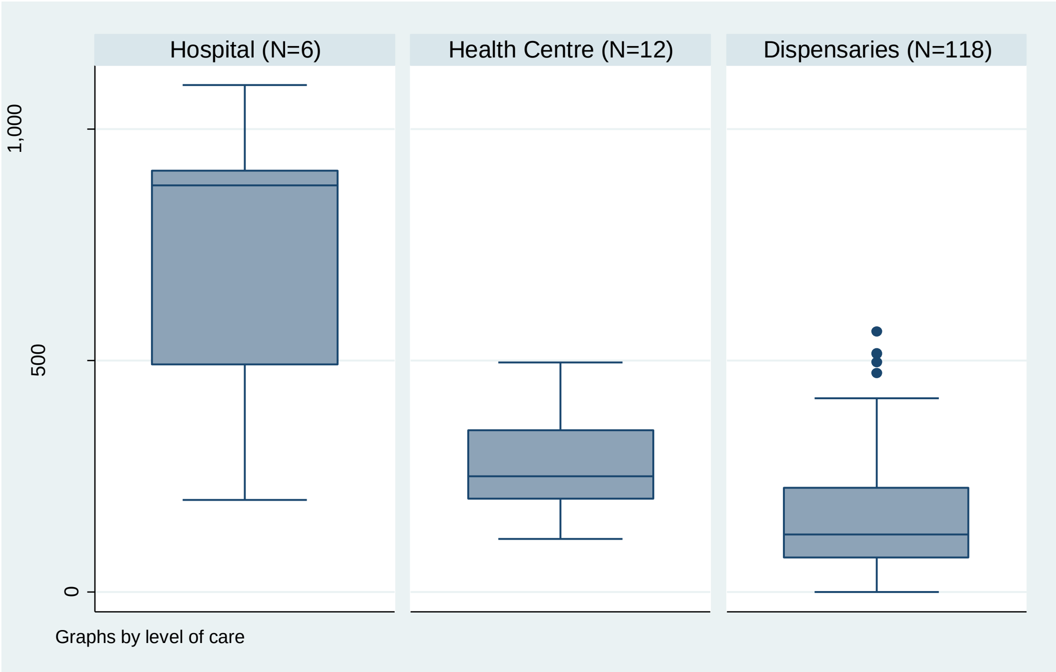


Figure 40: Box plots showing the median number of women seen for antenatal care by level of care (First ANC visit, total for year 2008)

Tetanus vaccination, counseling for family planning, bednets and birth preparation services were almost universally available (Table 35). Less well-established services included screening for pre-eclampsia and haemoglobin. Blood pressure measurement was not routine in one hospital, one health centre and 33 (28%) dispensaries. Urine protein testing for pre-eclampsia diagnosis was only performed in six (55%) health centres and five (4%) dispensaries. PMTCT was offered in 94 (79%) dispensaries, whereas syphilis screening was only available in 51 (43%) dispensaries.

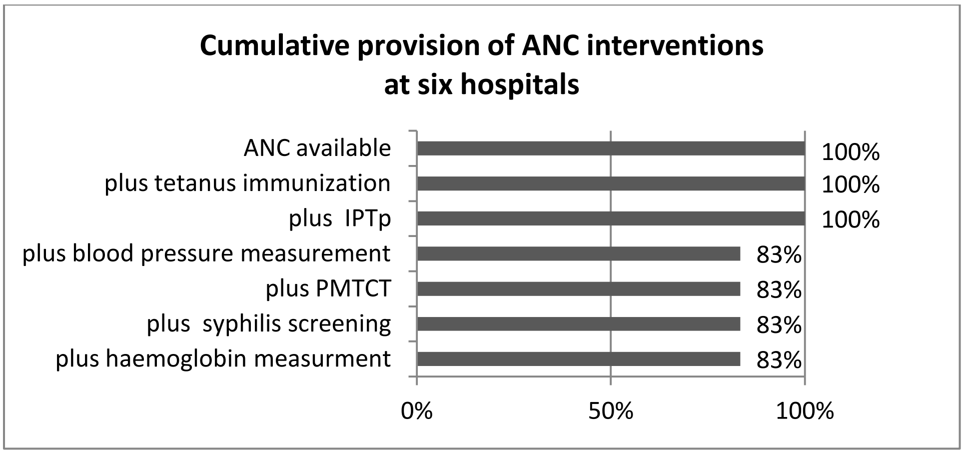
Major differences between the availability of key interventions were seen between the five districts for measuring haemoglobin and syphilis testing. In one district in Mtwara region (Newala district) haemoglobin testing was available in 16 facilities (64%) whereas in the other districts the level ranged from 5% (Ruangwa, one facility) to 30% (Nachingwea, eight facilities). The availability of syphilis testing ranged from 13% (four facilities) in Tandahimba to 90% (27 facilities) in Lindi Rural (data not shown).

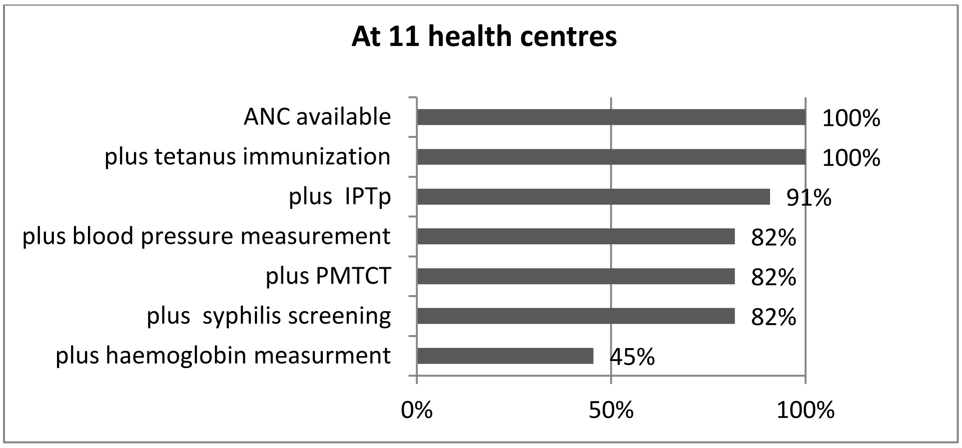
Table 35: Availability of antenatal care and essential supplies by level of care
(Reports by head of reproductive health unit)

	Hospital %	Health centre %	Dis-pensary %	Chi-squared p-value^
Interventions and services offered during antenatal care				
	N=6	N=11	N=119	
Screening and preventive intervention				
Tetanus vaccination offered	100	100	97	0.755
IPTp offered	100	91	94	0.748
Blood pressure measurement offered	83	91	72	0.350
Urine protein test offered	100	55	4	<0.001
Haemoglobin test offered	100	55	19	<0.001
PMTCT offered	100	100	79	0.112
Syphilis testing offered	100	100	43	<0.001
Counseling				
Family planning counseling	83	100	98	0.045
Bed net /voucher promotion	100	100	94	0.590
Birth preparation counseling	100	100	99	0.931
Danger sign counseling	100	100	100	-
Available supplies				
	N=6	N=13	N=129	
Sulphadoxine-Pyrimethamine (for IPTp)	100	92	86	0.507
HIV tests	100	92	82	0.350
Syphilis tests	67	85	43	0.008

^between levels of care

When calculating the cumulative provision of care (Figure 41), 83% (five out of six) hospitals, 45% (five out of 11) health centres and only 6% (seven out of 119) of dispensaries provided a package of essential elements of quality ANC including tetanus immunization, IPTp, blood pressure measurement, PMTCT, syphilis and haemoglobin testing (Figure 41). Although the number of higher level facilities included in the facility census being small was why no firm conclusion could be drawn, the attrition pattern was strongest for dispensary but less for hospitals and health centres. Figure 41 and Table 35 also indicates that a few interventions are not well implemented even at higher level facilities. These are screening for pre-eclampsia/eclampsia and syphilis screening. Particularly blood pressure measurement, syphilis screening and haemoglobin measurement were not well established at the dispensary level.





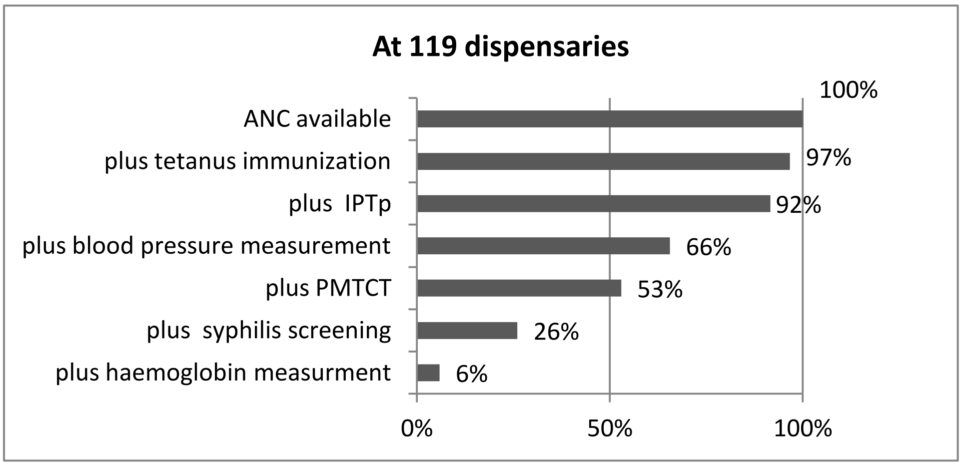


Figure 41: Cumulative provision of ANC by level of care

Delivery Care including Emergency Obstetric Care

A total of 148 out of 159 health facilities (93%) offered delivery care. One hundred percent of the hospitals and health centres have a separate room for delivery care, but in five out of the 128 dispensaries such a room was missing. For 136 facilities providing delivery care, information was available on workload. The six hospitals attended a median of 1137 births (IQR 689– 1163), the health centres a median of 92 births (IQR 57– 140) and the dispensaries a median of 48 births (IQR 26-81) in the year 2008 (Figure 42). Thus, the median caseload of deliveries per month was 95 in hospitals, eight in health centres and four in dispensaries (Figure 42). Assuming a similar workload for facilities without information, 37% (5,579), 9% (1,319) and 54% (8,118) of institutional births reported by facilities were in hospitals, health centres and dispensaries, respectively[19].

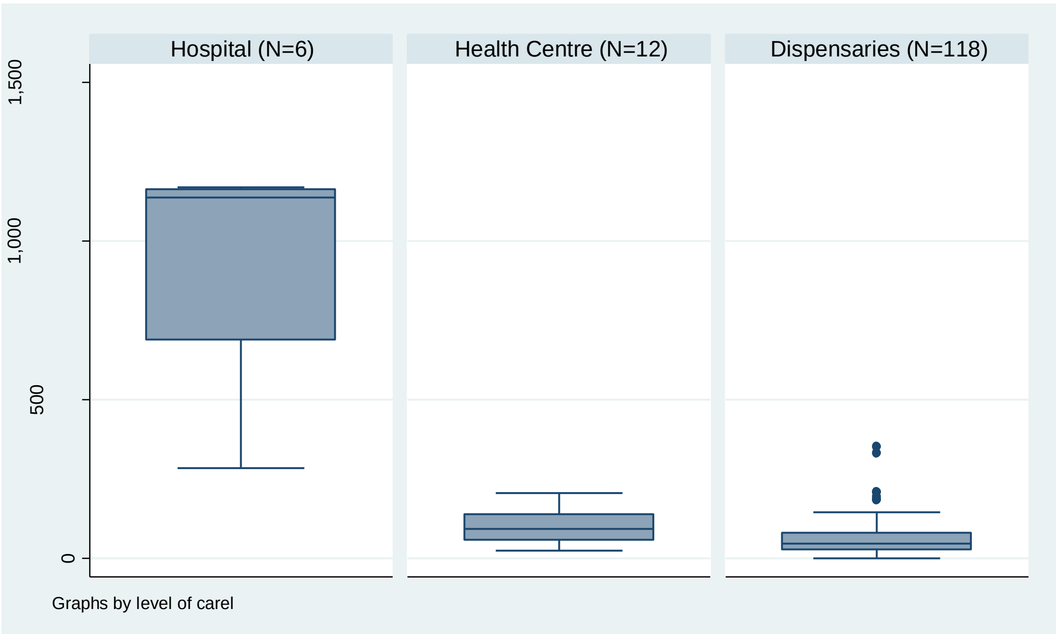


Figure 42: Box plots showing the median number of deliveries by level of care
(total for 12 months in the year 2008)

Injection of uterotonics, cord traction and uterus massage as part of AMTSL were implemented in all hospitals, two-thirds of health centres, and a little over half of the dispensaries. Uterotonics were available in all in hospitals and health centres but only in 90 dispensaries (69%) (Table 36).

All hospitals, 11 (85%) health centres and 83 (63%) dispensaries stated that they always monitor labour with help of a partograph (Table 36). However, two hospitals (33%), four health

[19] For population based information on place of delivery see Table 40: Uptake of delivery care

centres (31%) and 47 dispensaries (36%) reported that they do not monitor blood pressure regularly as part of delivery care. Functioning blood pressure meters were available in five (83%), 13 (100%) and 72 (55%) of hospitals, health centres and dispensaries respectively.

Application of eye ointment for the prevention of ophthalmia neonatorum was routinely done at five hospitals (83%) and 10 health centres (92%), but only 50% of the dispensaries.

Table 36: Provision of essential delivery care and availability of essential supplies and equipment by level of care

	Hospital %	**Health centre** %	**Dis-pensary** %	Chi-squared p-value^
Essential delivery and newborn care				
	N=6	N=13	N=131	
Injectable uterotonics as part of AMTSL always injected	100	77	57	0.045
Cord traction/massage as part of AMTSL always done	100	69	59	0.106
Partograph always used	100	85	63	0.063
Fetal heart beat always recorded	100	100	82	0.139
Blood pressure always measured	67	69	64	0.930
Infection prevention measures always used	100	92	94	0.798
Encouragement of breastfeeding always done	100	100	95	0.587
Wrapping/drying of baby always done	100	100	95	0.636
Application of eye ointment always done	83	92	50	0.006
Available equipment and supplies				
	N=6	N=13	N=129	
Uterotonics	100	100	69	0.017
Functioning blood pressure apparatus	83	100	55	0.003
Functioning means of sterilisation	83	100	88	0.381

^Differences for level of care

Except for injection of uterotonics and application of eye ointment of ophthalmia neonatorum, no statistically significant difference was seen for interventions implemented during delivery care at the different levels of care. The only intervention that showed a difference with regard to district was the application of eye ointment (data not shown in table). In the three districts in Lindi region, the coverage rates were much higher (Lindi rural 74%, Nachingwea 60%, Ruangwa 86%) than in Mtwara region (Newala 17%, Tandahimba 37%).

Only three hospitals (50%), five health centres (38%) and seven dispensaries (5%) could be rated as providing a minimum package of “essential childbirth care” using eight selected essential interventions for mothers and newborn during delivery (AMTSL, partograph use, blood pressure measurement, fetal monitoring, infection prevention, encouraging breastfeeding, thermal care of the newborn and prevention of ophthalmia neonatorum)

(Figure 43). The cumulative provision of care at the three levels indicated again that the pattern of attrition differed between the level of care.

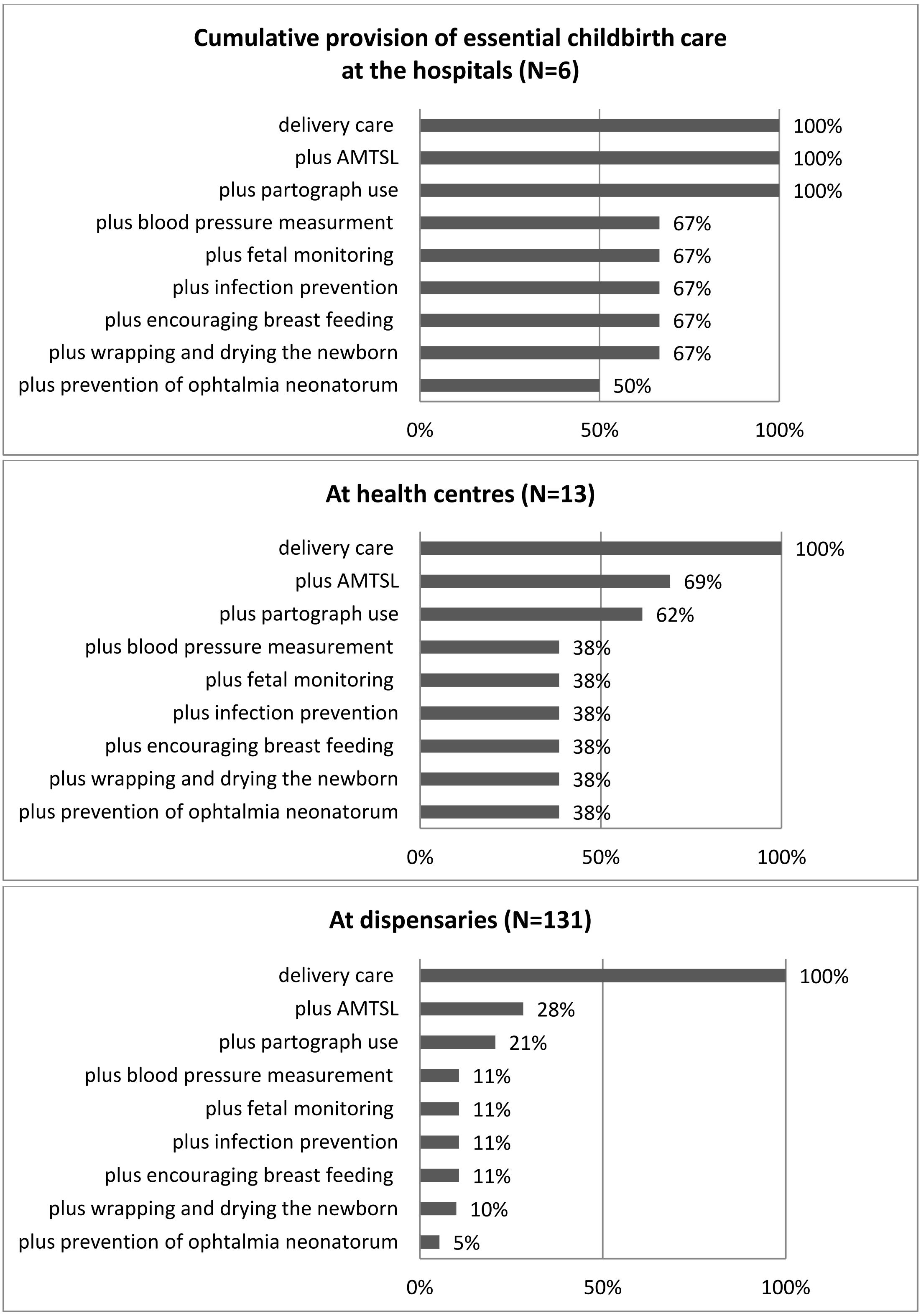


Figure 43: Cumulative provision of essential childbirth care interventions by level of care

But also problems common to all three levels of care were observed. Two out of the six hospitals included were not able to provide blood pressure monitoring during labor and prevention of ophthalmia neonatorum was also not available at all facilities (Figure 43). At health centre and dispensary level consistent provision of AMTSL was not available in a larger proportion of facilities, and partographs were also not always used.

A weighted analysis based on the number and distribution of deliveries reported by facilities in 2008 (37%, 9% and 54% in hospital, health centre and dispensaries respectively) suggested that only 25% of institutional births in the five districts received essential childbirth care including all these eight interventions. Multiplying this figure by the local population-based institutional delivery rate of 41% [365], the proportion of all births that received essential childbirth care was just 10%.

Table 37: Major obstetric complications, emergency obstetric interventions and equipment by level of care

(Proportion of facilities reporting having seen the complication, or having performed the intervention at least once during the last past 6 months prior the survey)

	Hospital	**Health Centres**	**Dis-pensaries**	**Chi-squared p-value^**
	% (N=6)	% (N=13)	% (N=131)	
Major obstetric complications				
Postpartum haemorrhage	50	31	21	0.436
Obstructed labour	83	77	28	<0.001
Puerperal Sepsis#	17	23	2	<0.001
Eclampsia	50	0	3	<0.001
Complications from incomplete / unsafe abortion	67	39	13	0.002
Signal functions				
Manual removal of the placenta	50	23	11	0.058
Assisted delivery	17	15	4	<0.001
Parenteral sedatives given	33	0	1	<0.001
Parenteral antibiotics for puerperal sepsis#	100	8	5	<0.001
Removal of retained abortion residuals	50	31	1	<0.001
Newborn resuscitation	83	15	17	0.002
Equipment and supplies (functioning and available at day of visit)				
Vacuum extractor (assisted delivery)	67	15	2	<0.001
Magnesium sulphate	83	62	57	0.413
iv. Antibiotics (intravenous ampicillin, intravenous and oral metronidazole and intravenous gentamycin)$	100	23	8	<0.001
Amoxicillin/ampicillinand metronidazole, both orally*	50	7	3	<0.001
Manual Vacuum Aspiration (MVA)	100	46	0	<0.001
Newborn ambu bag	100	69	31	<0.001

^ p-value for difference between level of care
# Inconsistent reporting
$ WHO recommendation
*Standard for moderate to severe puerperal sepsis in Tanzania

No hospital or first-line health facility reported having seen all the five major obstetric complications during the six months prior to the survey (

Table 37). The most common complications were postpartum haemorrhage and obstructed labour. The most frequent obstetric interventions were manual removal of the placenta and neonatal resuscitation. Fourteen (11%) health centres and 22 (17%) dispensaries reported having performed these two interventions at least once during the past six months. Assisted delivery (vacuum extraction) was rare, reported by only one hospital and two health centres. No hospital or health centre in the study area qualified as an EmONC-facility because none of the hospitals and health centre reported having performed all key functions within the last six months.

2. Uptake of Maternal Care with Emphasis on the Effect of Distance

Overall Uptake of Care

Antenatal care

Almost all women (22,048; 99%) in the five districts came for an ANC at least once during pregnancy.

Table 38: Uptake of antenatal care

22,243 women with a livebirth		
	N	**%**
Antenatal care(22,243 answers*)		
Uptake of Antenatal care	22,048	99
Month of first ANC visit (22,041 answers)		
< 4 months	4,480	20
4 5 month	13,310	60
6 – 7 months	4,048	18
8 – 9 months	203	1
Total number of ANC visits (21,959 answers, 89 missing out of women with ANC)		
1 ANC visit	514	2
2 and 3 ANC visits	12,363	56
Four or more ANC visits	9082	41

*10 did not know

Sixty percent of women (13,310) started ANC in the second trimester while only 20% (4,480) of women came during the first trimester to attend antenatal care the first time as recommended. Most women (12,363, 56%) had two-to-three visits, and 41% (9,082) completed the recommended four visits during pregnancy (Table 38).

There was no major difference in relation to reported interventions received between women who came two-to-three times for ANC compared to women who attended the recommended four times or more. The difference in women's reports of received services and interventions between women coming two-to-three times and the recommended four times did not exceed five percentage points for any intervention (Table 77 in annex).

There was little variation of uptake of four or more ANC visits in relation to ethnic group, wealth, occupation, age or parity. Uptake of four or more ANC visits was slightly higher in Lindi region than Mtwara region (5,660, 44% compared to 3,422, 38% (Table 39). Women from the ethnic minority groups including Yao had a slightly higher uptake than the majority groups Makonde, Mwera and Makuwa (1,967, 44% compared to 8,015, 38%).

Table 39: Uptake of antenatal care by socio-demographic factors

	Four or more ANC visits (21,959 responses)		Prevalence ratio between categories (95% CI)
Region	No	%	
Lindi	5,660	**44**	1 (reference)
Mtwara	3,422	**38**	0.86 (0.82-0.90)
Ethnic group			
Makonde, Mwera, Makuwa	8, 015	**41**	1 (reference)
Yao and minority groups	1,067	**44**	1.06 (1.00-1.13)
Wealth quintiles (assets)			
Three most poor groups	4,702	**40**	1 (reference)
Two least poor groups	4,028	**43**	1.08 (1.04-1.13)
Missing (4%)	352	**40**	1.00 (0.90-1.12)
Maternal education			
No education	2,702	**43**	1 (reference)
Some primary	1,333	**41**	0.96 (0.90-1.03)
Completed primary +	5,014	**41**	0.95 (0.91-1.00)
Occupation			
Farming	8,515	**41**	1 (reference)
Others	409	**47**	1.13 (1.02-1.25)
Missing (4%)	158	**42**	1.02 (0.87-1.19)
Maternal Age			
13-16	130	**36**	0.86 (0.72-1.02)
17-19	1,068	**38**	0.92 (0.86-0.98)
20-34	6,077	**42**	1 (reference)
40-49	1,807	**43**	1.03 (0.98-1.08)
Parity (only livebirths)			
1stbirth	2,090	**41**	1 (reference)
2nd& 5th	5,954	**42**	1.02 (0.97-1.07)
6 and more	1,038	**42**	1.03 (0.96-1.11)
Sex of head of household			
Female	1,861	**40**	1 (reference)
Male	7,215	**42**	1.05 (1.00-1.10)
Overall	9,082	**41**	

Women of the two least poor wealth quintile groups had only an 8% (RR 1.08, 95%CI 1.04– 1.13) higher uptake compared to women of the three poorest wealth groups. Women engaged in employment or being housewives were 13% more likely to have completed four ANC visits compared to women who reported being farmers (RR 1.13, 95% CI 1.02– 1.25).

Parity had very little influence on uptake of four or more ANC visits (41%, 42% and 42% in mothers having their first birth, second-to-fifth birth, or sixth or higher livebirth. The sex of the household head also had little influence on uptake of four or more ANC visits.

Intrapartum care

Overall 41% of women delivered in a health facility, most of these women (29%) went for childbirth care to a hospital, while 2% reported they delivered in a health centre and 9% in a dispensary (Table 40).

Table 40: Uptake of delivery care

	22,243 women with births in the year prior the survey	
	N	**%**
Place of delivery (22,243 answers)		
Hospital	6,475	29
Health centre	472	2
Dispensary	2,099	9
Total delivery in health facility	9,046	41
At home	12,624	57
Other household	298	1
Other place	274	1
Total other place	13,196	59
Don’t know	1	0
Birth assistants^(22,240 answers)		
Clinician/doctor	1,951	9
Nurse or midwife	8,765	39
Female relative or friend	8,681	39
Traditional Birth Attendant	6,824	31
No one	630	3
Skilled attendance	10,038	45

^ More than one answer allowed

Women delivering at home most commonly delivered with a relative or friend (8,681 women, 39%), followed by a traditional birth attendant (6,824 women, 31%) while health facility deliveries were most commonly attended by a nurse or midwife (8,765 women, 39%).

Induction or augmentation of labour was reported in 13% (2,865 livebirths) of all deliveries (Table 41). Women who delivered in a health facility reported use of augmentation by oxytocics in 10% (918) of deliveries. Three percent of women (291 births) who delivered in a facility reported the use of traditional methods (oral or vaginal application) to speed up labour. At home, traditional methods for augmentation of labour were used in almost 8% (991 births) of the deliveries.

Table 41: Augmentation of labour by place of delivery

Augmentation of labour	Health facility N=9,044		Home/other place N=13,192		Total N=22,236	
		%		**%**	N	**%**
No augmentation	7,484	**83**	11,887	**90**	19,371	**87**
Traditional medicine (oral application)	117	**1**	264	**2**	381	**2**
Traditional medicine (vaginal application)	174	**2**	727	**6**	901	**4**
Oxytocics	918	**10**	23	**0.2**	941	**4**
Others	351	**4**	291	**2**	642	**4**

Excluding women with a birth by Caesarean section (because these women are not likely to know the timing of the birth of the placenta), women's reports suggested that in 70% (14,843) of all births the placenta was delivered immediately after the delivery of the baby (Table 42). Retained placenta (placenta was not delivered within half an hour) was reported for 14% (1,103 births) of health facility births and 17% (2,226 births) of births that took place at home or another place. Six percent (1,253 births) of women could not give an answer to the timing of the delivery of the placenta.

Table 42: Timing of delivery of placenta by place of delivery
(Excluding birth by Caesarean section)

Timing of delivery of placenta	Health facility N=8,135		Home or other place N=13,191		Total N=22,233	
	N	**%**		**%**	N	**%**
Immediately after birth	5,967	**73**	8,876	**67**	14,843	**70**
Within half an hour	513	**6**	1,382	**11**	1,895	**9**
Did not come within half an hour	1,103	**14**	2,226	**17**	3,329	**15**
Don't know	552	**7**	701	**5**	1,253	**6**

Postnatal care

Relatively few women (22%, 4,799) sought postpartum care (Table 43). A total of 4,279 out of these 4,799 women (89%) went to a health facility for check-up, and 414 (11%) to a house in the community and six women (0.1%) reported they went to another place. Most postnatal care (PNC) visits were done by a nurse midwife (2,479births, 52%), or by a clinician (2,074births, 43%). A minority of women reported that the PNC visit was with a traditional birth attendant (246 births, 5%). There was very little variation in the uptake of PNC in relation to the region, ethnic group or education.

Table 43: Postnatal care by socio-demographic factors

	Postnatal care (22,223 answers)		**Prevalence ratio between categories** (95% CI)
	N	%	
Region			
Lindi	2,742	21	1 (reference)
Mtwara	2,057	23	1.08 (1.02-1.14)
Ethnic group			
Makonde, Mwera, Makuwa	4,257	22	1 (reference)
Yao and minority groups	542	22	1.02 (0.93-1.11)
Wealth quintiles (assets)			
Three most poor groups	2,252	19	1 (reference)
Two least poor groups	2,371	25	1.33 (1.26-1.41)
Missing (4%)	176	20	1.05 (0.90-1.23)
Maternal education			
No education	1,133	18	1 (reference)
Some primary	668	20	1.15 (1.05-1.27)
Completed primary +	2,981	24	1.36 (1.27-1.46)
Occupation			
Farming	4,317	21	1 (reference)
Others	363	41	1.97 (1.77-2.19)
Missing (2%)	119	31	1.49 (1.24-1.79)
Maternal Age			
13-16	100	27	1.27 (1.04-1.55)
17-19	653	23	1.09 (1.00-1.19)
20-34	3,143	21	1 (reference)
35-49	903	21	0.99 (0.92-1.07)
Parity (only livebirths)			
1^{st} birth	1,432	28	1 (reference)
2^{nd} & 5^{th}	2,926	20	0.73 (0.69-0.78)
6 and more	441	18	0.64 (0.58-0.71)
Sex of head of household			
Male	1,025	22	1 (reference)
Female	3,772	22	1.00 (0.93-1.07)
Overall	4,799	22	

Women in the three lowest wealth groups had a lower uptake of PNC (19% versus 25% than the highest two wealth groups, RR 1.33, 95% CI 1.26–1.41). Women with occupations other than farming were twice as likely to go for PNC then women who were farmers (RR 1.97, 95% CI 1.77–2.19).

Women having their first livebirth had a higher use of PNC (28%, 1,432 births) compared to women having had two-to-five (20%, 2,926 births) or more than six livebirths (18%, 441 births). There was no difference between female and male headed households (RR 1.00 95% CI 0.93– 1.07).

Determinants of Institutional Delivery (Hospital and First-Line)

This section presents the crude analysis of determinants of uptake of delivery care. Uptake of delivery care differed between the districts. Women from Nachingwea district reported a higher proportion of births in a hospital (37%, 1,507 births) than women from the other districts (30% in Lindi Rural and Ruangwa, 26% in Newala and 23% in Tandahimba, Table 44). Reported uptake of delivery care in a first-line facility was highest in Lindi Rural (17%, 1,020 births) and lowest in Newala district (7%, 294 births). Women belonging to the two predominant ethnic groups, Makonde and Mwera, reported a lower uptake of delivery care in a hospital (26%, 3,125 births and 30%, 2,077 births respectively) than women belonging to the ethnic minority groups.

Table 44: Delivery in hospital and first-line facilities by socio-demographic factors (22,243 answers)

	Delivery in hospital			Delivery in first-line facilities		
	N	**%**	**Prevalence ratio between categories** (95% CI)	**N**	**%**	**Prevalence ratio between categories** (95% CI)
District			p<0.001#			p<0.001#
Lindi Rural	1,828	30	1 (reference)	1,020	17	1 (reference)
Nachingwea	1,507	37	1.22 (1.14-1.30)	424	10	0.61 (0.55-0.69)
Ruangwa	890	30	0.99 (0.92-1.08)	312	11	0.62 (0.55-0.71)
Newala	1,073	26	0.87 (0.81-0.94)	294	7	0.43 (0.38-0.49)
Tandahimba	1,177	23	0.77 (0.71-0.83)	521	10	0.61 (0.55-0.68)
Ethnic group			p<0.001#			p<0.001#
Makonde	3,125	26	1 (reference)	1,233	10	1 (reference)
Mwera	2,077	30	1.15(1.09-1.21)	902	13	1.27 (116-1.38)
Makuwa	435	38	1..46 (1.32-1.62)	115	10	0.98 (0.81-1.19)
Yao	339	39	1.51 (1.35-1.69)	124	14	1.40 (1.16-1.68)
Others	499	37	1.43 (1.31-1.58)	197	14	1.43 (1.24-1.67)
Wealth quintiles (assets)			p<0.001^			0=0.0136^
Most poor	758	23	1 (reference)	371	11	1 (reference)
Very poor	875	22	0.97 (0.88-1.07)	379	10	0.86 (0.74-0.99)
Poor	1,213	26	1.15 (1.05-1.26)	565	12	1.10 (0.96-1.25)
Less poor	1,233	26	1.15 (1.05-1.26)	599	13	1.14 (1.00-1.30)
Least poor	2,143	45	1.99 (1.83-2.17)	543	12	1.03 (0.91-1.18)
Missing (4% of births)	253	29	1.26 (1.09-1.45)	114	13	1.16 (0.94-1.43)
Maternal education			p<0.001^			p=0.1527^
No education	1,423	22	1 (reference)	711	11	1 (reference)
Some primary education	884	27	1.21 (1.11-1.32)	389	12	1.08 (0.94-1.21)
Completed primary	4,105	33	1.50 (1.41-1.59)	1,456	12	1.07 (0.97-1.17)
Secondary and higher	36	80	3.62 (2.60-5.04)	6	13	1.21 (0.54-2.70)
Occupation			p<0.001#			P=0.005#
Farming	5,687	27	1 (reference)	2,460	12	1 (reference)
Housewife	375	66	2.42 (2.46-3.80)	51	9	0.76 (0.58-1.00)
Employed	82	83	3.05 (2.46-3.80)	5	5	0.43 (0.18-1.04)
Others	160	71	2.62 (2.24-3.07)	16	7	0.61 (0.37-0.99)
Missing (2% of births)	171	44	1.62 (1.39-1.89)	39	10	0.85 (0.62-1.17)

Table 44: Delivery in hospital and first-line facilities by socio-demographic factorss… cont

	Delivery in hospital			Delivery in first-line facilities		
	N	%		N	%	
Maternal Age			p<0.001			P=0.0003
13 & 14	11	39	1.25 (0.69-2.26)	3	11	0.89 (0.29-2.78)
15 & 16	129	38	1.19 (1.00-1.43)	31	9	0.75 (0.53-1.08)
17-19	1,018	36	1.15 (1.06-1.24)	264	9	0.78 (0.68-0.90)
20-24	1,862	31	1 (reference)	709	12	1 (reference)
25-29	1,326	28	0.88 (0.82-0.94)	613	13	1.06 (0.95-1.18)
30-34	1,082	27	0.85 (0.79-0.92)	490	12	1.02 (0.91-1.14)
35-39	658	25	0.79 (0.72-0.86)	292	11	0.92 (0.80-1.14)
40-44	319	24	0.77 (0.68-0.86)	144	11	0.91 (0.76-1.09)
45-49	70	24	0.76 (0.60-0.96)	25	9	0.71 (0.48-1.06)
Parity (only livebirths)			p<0.001^			p=0.6358^
1st birth	2,222	43	1 (reference)	518	10	1 (reference)
2nd& 3rd	2,680	27	0.64 (0.60-0.68)	1,246	13	1.27 (1.15-1.41)
4th& 5th	1,044	22	0.52 (0.48-0.56)	555	12	1.19 (1.05-1.34)
6 and more	528	21	0.49 (0.45-0.54)	252	10	1.01 (0.87-1.18)
Sex of head of household			p=0.091			p=0.0507
Female	1,460	31	1 (reference)	512	11	1 (reference)
Male	5,011	29	0.93 (0.88-0.98)	2,059	12	1.09 (0.99-1.21)
Overall	**6,475**	**29**		**2,571**	**12**	

#p-values are from the Chi-squared test and the ^score test for trend (wealth quintiles, education and parity

Makuwa, Yao and women of other smaller minority groups reported uptake of 38% (435 births), 39% (339 births) and 37% (499 births), respectively. Women from the ethnic group Yao had the highest overall uptake with 39% (339 births) for hospital delivery and 15% (124 births) for deliveries in first-line facilities. Thirty-eight percent of Makuwa women (435 births) delivered in a hospital and 10% (115 births) in first-line facilities.

An increase in uptake of delivery care in a hospital in relation to wealth quintiles was observed. Two times more (RR 1.99, 95% CI 1.83 – 2.17) women in the least poor wealth quintile compared to the most poor women reported to have delivered in a hospital. The reported proportion decreased from 45%, (2,143 births) to 23% (758 births) between women of the highest to the lowest quintile. In contrast, no difference in relation to wealth status was observed for uptake of care in first-line facilities. Twelve percent of women (543 births) from the highest wealth quintile reported to have delivered in a first-line facility compared to 11% (371 births) of women being the most poor (RR 1.03, 95% CI 0.91 – 1.18).

As expected, schooling had an effect on uptake of delivery care. Reported uptake of hospital care ranged from 22% (1,423 births) in women with no education, to 33% (4,105) in women who had completed primary education to 80% (36 births) in women with secondary or higher education. Women with secondary or higher education compared to women with no education reported having delivered in a hospital almost four times more (RR 3.62, 95% CI

2.60– 5.04). However, only few births in this study area were to women with completed secondary school education (total 45 births).The effect of education on using delivery care in first-line facilities was small and confidence intervals were overlapping when comparing women with secondary or higher education to women with no education (RR 1.21 95% CI 0.54– 2.70).

Eighty-three percent of women with formal employment reported having delivered in a hospital (82 births) and a further 5% (five births) were in a first-line facility.

Uptake of care was lower with higher age (Table 44). A total of 39% of women aged 13– 14 years (11 births) reported having delivered in a hospital. Women aged 20– 24 years reported a hospital delivery in 31% (1,862) of births, and women aged 45– 49 reported having delivered in a hospital in only 24% (70) of births. Forty-three percent of women (2,222births) having their first livebirth reported delivering in a hospital compared to only 21% (528 births) of women having six or more previous livebirths. The sex of the head of household had a weak association with uptake of delivery care at the hospital. Households headed by men reported a slightly lower proportion of births in a hospital compared to households headed by a woman (RR 0.93, 95% CI 0.88– 0.98). Households headed by women reported a slightly lower proportion of delivery in a first-line facility (11%, 512 births in female-headed household compared to 12%, 2,059 births in male-headed households).

Distance and uptake of delivery care

There was strong evidence of an association between uptake of delivery care in a hospital and distance to a hospital (p<0.001). Within 5 km distance of a hospital 1,328 women (72%) reported having delivered in a hospital (Table 45), whereas only 26 (1%) women living within 5 km to a hospital delivered in a first-line facility (data not shown).

Table 45: Delivery in hospital by distance to hospital

		Delivery in hospital (22,243 answers)		
Distance	**% births in category**	**N**	**%**	**Relative risk between categories** (95% CI)
<5 km	**8**	1,328	**72**	1 (reference)
5-10 km	**11**	824	**34**	0.47 (0.43-0.51)
10-20 km	**35**	1,957	**25**	0.34 (0.32-0.37)
20-30 km	**25**	1131	**21**	0.29 (0.26-0.31)
30-40 km	**7**	379	**25**	0.34 (0.31-0.38)
>40 km	**4**	189	**21**	0.29 (0.25-0.34)
Missing	**10**	667	**30**	0.42 (0.38-0.46)
Overall	**100**	6,475	**29**	

Within a distance of 5– 10 km of a hospital, 824 (34%) of women reported having delivered in a hospital. The percentage of women delivering in a hospital who lived more than 10 km from a hospital leveled out at around 23% and was thus about 70% lower compared to women living within 5 km of a hospital.
Women living more than 40 km from a hospital had a 71% lower uptake of hospital delivery than women living within 5 km from a hospital (RR 0.29, 95% CI 0.25– 0.34).

The proportion of deliveries in a hospital by ward is seen in Figure 44. The pattern suggests that distance to the hospitals is a major determining factor in whether women will deliver there. The reported proportion of births in hospitals was over 42% for wards directly neighboring a hospital.

Areas with low uptake of hospital deliveries (below 18%) are reported in the northern part of Lindi Rural, Ruangwa and Nachingwea, which are sparsely populated and without a good road network. Uptake is also low in large parts of the slopes of the Makonde plateau in Tandahimba and Newala districts despite two all-weather roads passing through the two districts.

The proportion of deliveries in first-line facilities by ward ranged from 1% to 39% (Figure 45).

Four wards had an uptake of delivery in first-line facilities of over 30%: Kitomanga, Mipingo, Kiegei, and Mihambwe wards. The analysis of information available from the health facility census gave no clear indication about characteristics that might explain higher uptake in the four wards.

Overall, wards with an uptake of 26% or higher were mostly in Lindi Rural. The proportion of births in first-line facilities was 17% in Lindi Rural and ranged between 7– 11% in the other districts, suggesting a 40% lower uptake in the other districts in the crude analysis ($p<0.001$) (Table 44). Wards with low uptake were lying in Newala and Tandahimba districts. As expected, delivery in first-line facilities was lowest in places with high uptake of hospital delivery.

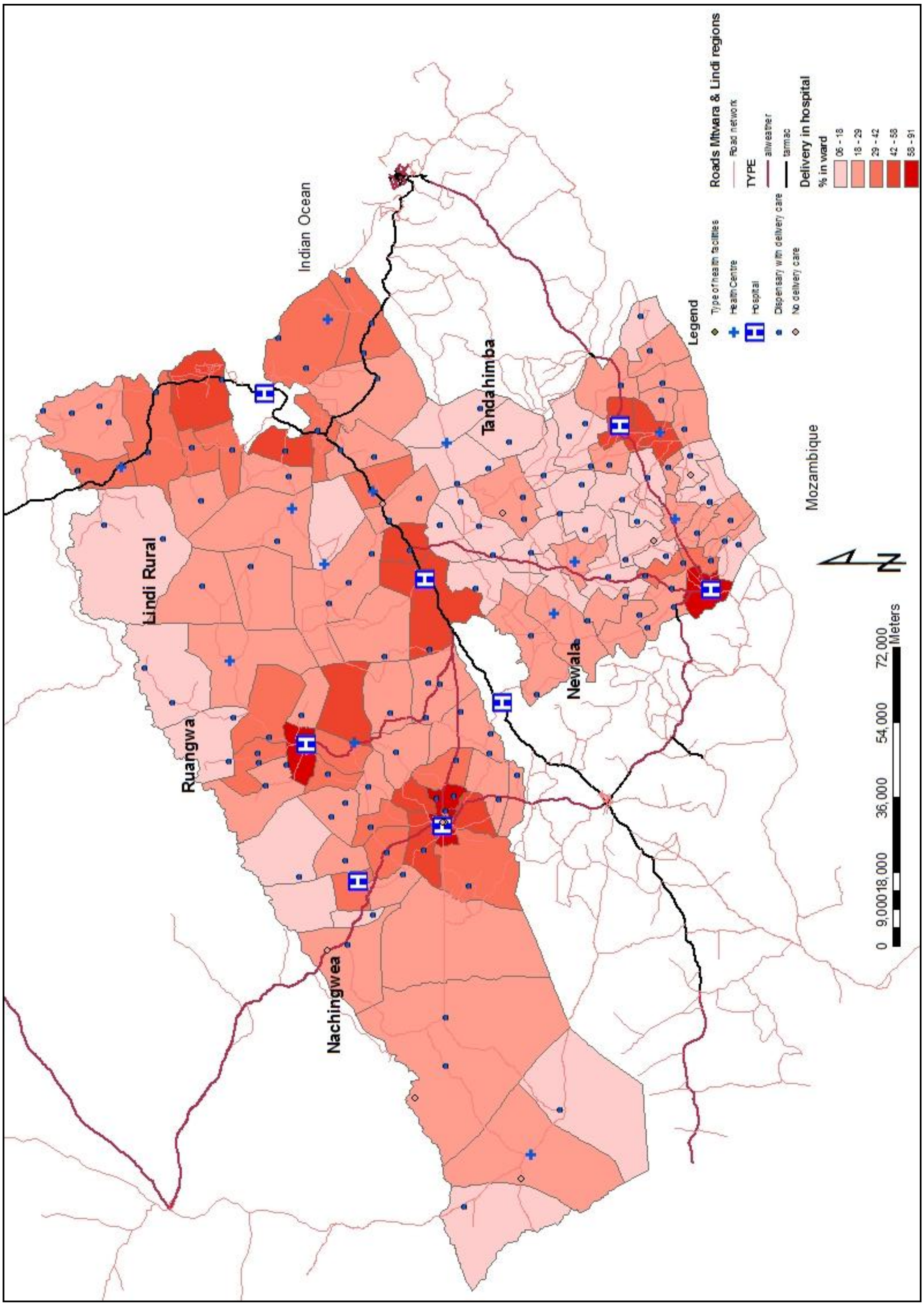


Figure 44: Proportion of deliveries in a hospital by ward

(22,243 answers)

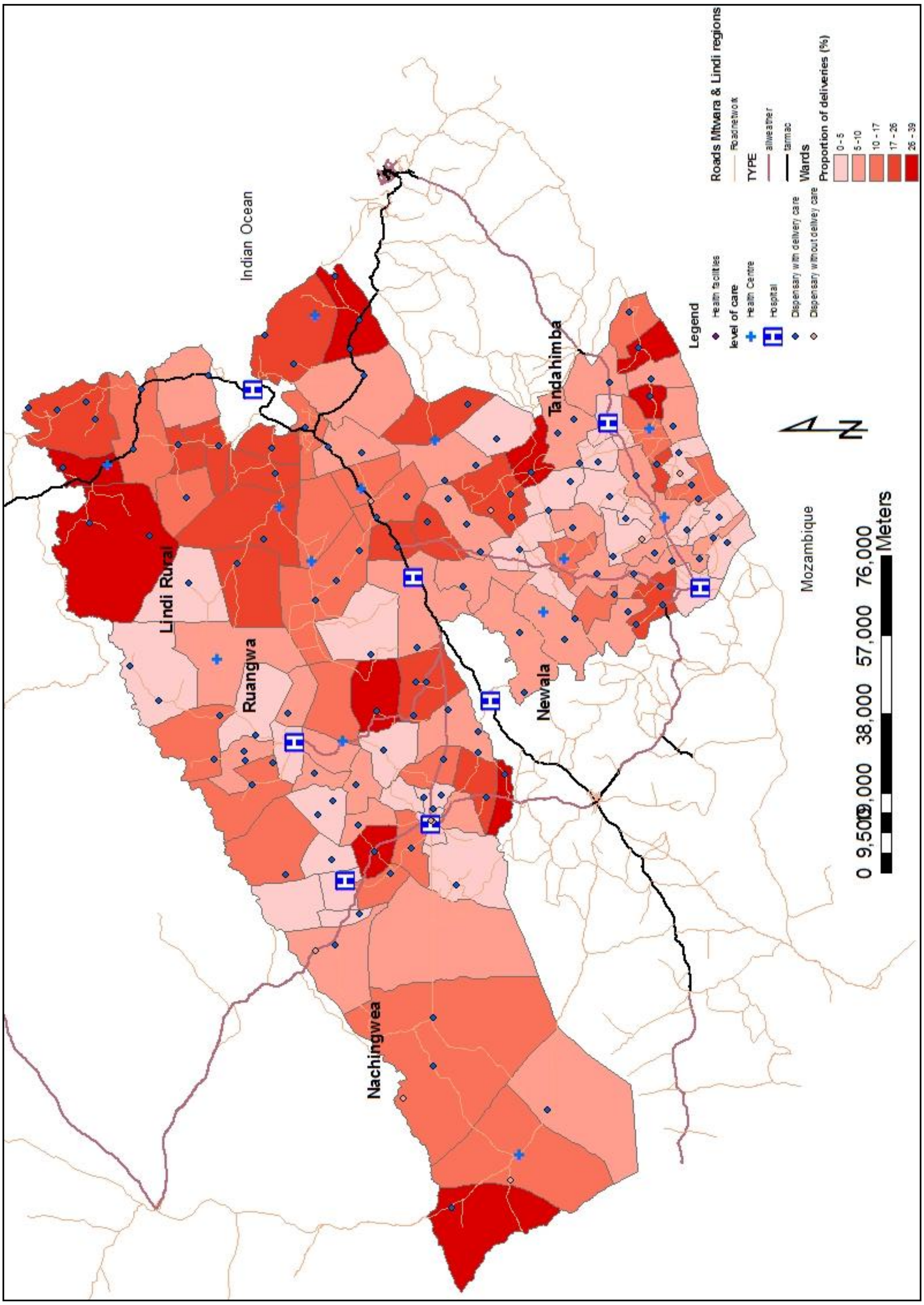


Figure 45: Proportion of deliveries in first-line facilities by ward

(22,243 answers)

Contextual factors

The framework for analysis of uptake of maternal care and of pregnancy-related mortality (Figure 26) hypothesized that community factors such as the overall uptake of care in the ward are important determinants for the individual uptake of maternal care.

The highest proportion of deliveries in hospital was in the only urban ward in the study area, Nambambo ward, which includes Nachingwea town. In the 16 wards classified as mixed (partly urban and partly rural population), 42% of the women reported delivering in a hospital compared to 24% of women from rural wards (Table 46).

Table 46: Delivery in hospital and first-line facility by contextual factors
(22,243 answers)[20]

	Delivery in hospital			Delivery in first-line facility		
	No	%	Prevalence ratio between categories (95% CI)	No	%	Prevalence ratio between categories (95% CI)
Ward classification of residence						
Rural (97 wards)	4,224	**24**	1 (reference)	2,166	**13**	1 (reference)
Mixed (16 wards)	1,924	**42**	1.74 (1.65-1.84)	402	**9**	0.71 (0.64-0.79)
Urban (1 ward)	327	**91**	3.72 (3.32-4.16)	3	**1**	0.07 (0.02-0.21)
Uptake of four or more ANC visits in the ward of residence (quintiles)						
Very low uptake (18-31%)	1,115	**26**	1 (reference)	328	**8**	1 (reference)
Low uptake (32-36%)	1,508	**35**	1.36 (1.26-1.47)	433	**10**	1.32 (1.15-1.53)
Medium uptake (37-41%)	1,026	**23**	0.89 (0.82-0.97)	537	**12**	1.58 (1.38-1.81)
Higher uptake (41-51%))	1,566	**34**	1.33 (1.23-1.44)	623	**14**	1.80 (1.57-2.05)
Highest uptake (51-64%)	1,260	**28**	1.10 (1.02-1.19)	650	**15**	1.93 (1.69-2.21)
Uptake of delivery in first-line facility in the ward of residence (quintiles)						
Very low uptake (7-24%)	1,731	**40**	1 (reference)	85	**2**	1 (reference)
Low uptake (24-34%)	1,045	**25**	0.62 (0.57-0.67)	255	**6**	3.08 (2.41-3.93)
Medium uptake (34-42%)	1,189	**25**	0.62 (0.58-0.67)	428	**9**	4.55 (3.61-5.75)
Higher uptake (43-56%)	1,239	**29**	0.72 (0.66-0.77)	621	**14**	7.30 (5.82-9.16)
Highest uptake (57-91%)	1,271	**28**	0.69 (0.64-0.74)	1,182	**26**	13.04 (10.46-16.25)
Uptake of delivery in hospital in the ward of residence (quintiles)						
Very low uptake (6-17%)	566	**13**	1 (reference)	390	**9**	1 (reference)
Low uptake (17-22%)	862	**20**	1.54 (1.38-1.71)	485	**11**	1.26 (1.10-1.43)
Medium uptake (22-28%)	1,110	**25**	1.93 (1.75-2.14)	651	**15**	1.64 (1.45-1.86)
Higher uptake (28-38%)	1,428	**32**	2.49 (2.26-2.75)	629	**14**	1.59 (1.40-1.81)
Highest uptake (38-91%)	2,509	**56**	4.36 (3.98-4.78)	416	**9**	1.05 (0.91-1.21)

Women living in a ward where overall uptake of four or more ANC visits was high (between 51%-64%) were almost two times more likely to deliver in a first-line facility compared to women coming from a ward with the lowest ANC uptake (RR 1.93, 95% CI 1.69– 2.21). In

[20] The quintiles were constructed by assigning an equal number of respondents in wards to each group why the cut-off points are not equal, see method section p 116

contrast, there was no clear pattern for uptake of hospital delivery in relation of overall use of four or more ANC visits.

Individual uptake of delivery in first-line facilities clearly increased when the overall uptake of birth in first-line facilities in the ward was high. Women were 13 times more likely to deliver in a first-line facility (RR 13.04, 95% CI 10.46–16.25) if they lived in a ward with the highest uptake of delivery in a first-line facility (57–91%) compared to women living in a ward where uptake was the lowest (7–24%).

Individual uptake of delivery in a hospital was also higher when the overall uptake of hospital delivery in the ward was high. Women living in a ward with the highest quintile of uptake (38–91% hospital delivery) had four times higher individual uptake of hospital delivery (RR 4.36, 95% CI 3.98– 4.78) compared to women living in a ward with the lowest overall quintile of uptake (6– 17%).

Uptake of Care at First-line Facilities categorized by the Index of Maternal Care

Table 47 and Table 48 and Figure 46, Figure 47, and Figure 48 present uptake of delivery care in distance categories to facilities categorized by: being a health centre or a dispensary; the index of maternal care; and health facilities having a midwife and transport. This analysis only included 90% of the livebirths recorded where the first-line facility was the nearest facility. Therefore, livebirths among women where a hospital was the nearest facility were excluded. This analysis thus compares how the effect of distance differs in relation to different options to categorise first-line facility.

Table 47: Uptake of care by distance to first-line facility and level of care

Delivery in first-line facility by category of nearest facility*		
Health centre closest facility (13 HC, 11% of deliveries*)		
	N=2,234	% (95% CI)
<1km	160	27 (23-30)
1-2.5 km	66	17 (13-21)
2.5-5 km	64	9 (7-11)
5-7.5 km	34	8 (6-11)
>7.5 km	9	7 (2-11)
Dispensary with delivery care closest facility (131 dispensaries, 79% of deliveries)		
	N=15,813	% (95% CI)
<1 km	1059	22 (21-23)
1-2.5 km	314	12 (11-13)
2.5-5 km	358	7 (7-8)
5-7.5 km	158	6 (6-7)
>7.5 km	54	6 (4-7)

*Excluding livebirths where the hospital was the closest facility

Within a distance of 1 km, 27% (95% CI 23 – 30%) of women with a livebirth reported to have delivered in a facility if the nearest facility was a health centre. The reported proportion was slightly lower when the nearest facility was a dispensary. For dispensaries, 22% (95% CI 21– 23%) of women living within 1 km reported having delivered in a first-line facility (Table 47 and figures 46-48). Within a distance of 1– 2.5 km to a health centre or dispensary, the uptake of care was 17% (95% CI 13– 21%) and 12% (95% CI 11– 13%), respectively. Thus, the uptake of care was about five percentage points higher if the facility was a health centre compared to a dispensary within 1 km distance (Table 47, Figure 46).

Using the index of maternal care, slightly more marked differences in relation to quality categories within 1 km distance of a facility were seen (Table 48, Figure 47). Uptake within a 1 km distance declined from 28% (95% CI 25– 31%), to 21% (95% CI 20– 23%), to 22% (95% CI 20– 24%) and finally to 18% (95% CI 11-25%) when the facility was categorised as providing advanced basic care, basic care, poor care and very poor care respectively. Within the distance category 1– 2.5 km, uptake reduced quickly, except for facilities rated as providing advanced basic care where the uptake was still 19% (95% CI 15– 23%) even within 1– 2.5 km.

Table 48: Uptake of care by distance to first-line facilities and quality level

Delivery in first-line facility by category of nearest first-line facility					
Index Maternal care			**Availability of midwife and transport**		
Advanced basic care (18 HF, 12% of deliveries)			**Transport and midwife (15 HF, 11% of deliveries)**		
	N=2231	% (95% CI)		N=2200	% (95% CI)
<1 km	201	28 (25-31)	<1 km	222	30 (27-34)
1-2.5 km	71	19 (15-23)	1-2.5 km	53	15 (11-19)
2.5-5 km	60	9 (7-11)	2.5-5 km	69	11 (8-14)
5-7.5 km	22	6 (3-8)	5-7.5 km	22	6 (4-9)
>7.5 km	6	4 (1-7)	>7.5 km	9	7 (3-11)
Basic care (82 HF, 55% of deliveries)			**Midwife but no transport (69 HF, 44% of deliveries)**		
	N=11080	% (95% CI)		N=8783	% 95% CI)
<1 km	684	21 (20-23)	<1 km	225	20 (17-22)
1-2.5 km	262	13 (11-14)	1-2.5 km	77	11 (9-13)
2.5-5 km	253	8 (7-8)	2.5-5 km	65	6 (5-7)
5-7.5 km	119	7 (5-8)	5-7.5 km	138	7 (6-8)
>7.5 km	42	6 (4-8)	>7.5 km	437	11 (10-12)
Poor care (39 HF, 20% of deliveries)			**Neither midwife no transport (60 HF, 35% of deliveries)**		
	N=4021	% (95% CI)		N=7064	% (95% CI)
<1 km	296	22 (20-24)	<1 km	453	23 (21-25)
1-2.5 km	45	9 (6-11)	1-2.5 km	187	17 (15-19)
2.5-5 km	95	7 (5-8)	2.5-5 km	200	8 (7-9)
5-7.5 km	45	8 (6-11)	5-7.5 km	87	8 (6-10)
>7.5 km	15	7 (4-11)	>7.5 km	32	6 (4-8)
Very poor care (5 HF, 3% of deliveries)					
	N=625	% (95% CI)			
<1 km	27	18 (11-25)			
1-2.5 km	2	3 (0-6)			
2.5-5 km	14	5 (3-8)			
5-7.5 km	6	5 (1-8)			
>7.5 km	0	0			

*Excluding livebirths where the hospital is closest facility

The 15 first-line facilities that were staffed by a midwife and that also reported having referral facilities in place had the highest uptake of care, albeit still low at 30% (95% CI 27– 34%) (Table 48, Figure 48). The graphical displays (Figure 46, Figure 47, Figure 48) illustrate that there were only small differences in uptake of care by distance categories compared for different quality levels. Moreover, the patterns were very similar, regardless of the method of categorization (using the level of care, the index of quality of care or the categorization by transport and midwife).

The few facilities providing better care led to a small increase in overall uptake of delivery in first-line facilities of about 5– 10% within 2.5 km of the nearest health facility.

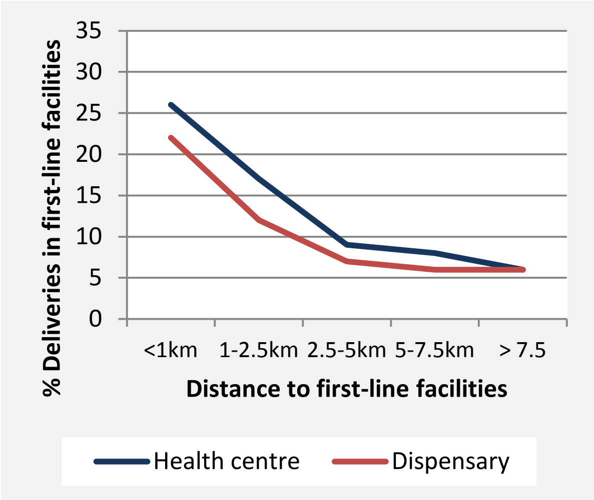


Figure 46: Uptake of care by distance to first-line facility by level of care
(health centres and dispensary)

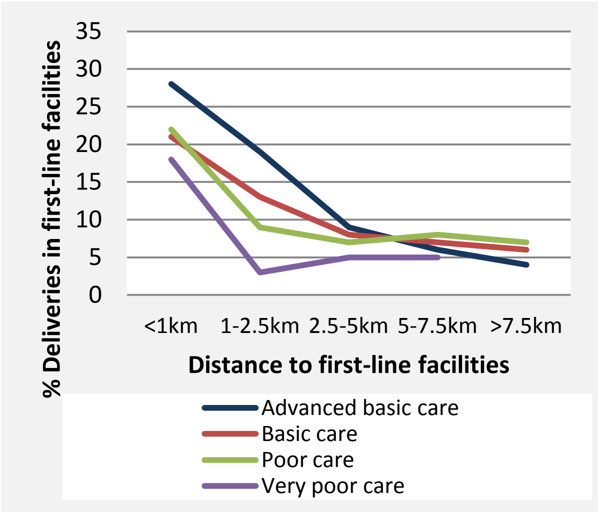


Figure 47: Uptake of care by distance to first-line facilities by categorization of the index of maternal care

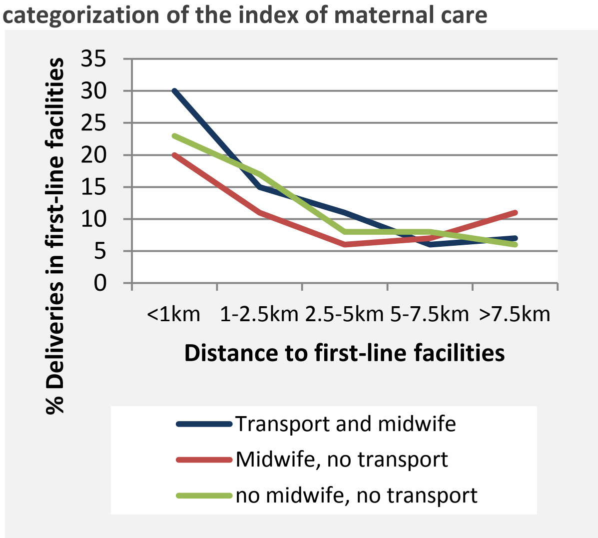


Figure 48: Uptake of care by distance to first-line facility by availability of transport and midwife

In distances of more than 2.5 km, very similar overall uptake of delivery in first-line facilities was observed, ranging from 5– 11% between distance categories.

The effect estimates for the effect of distance on uptake of care are shown in Table 49. Delivery in a dispensary or health centre was 75% lower for women living a distance more than 7.5 km from a first-line health facility compared to women living within 1 km. The decline was large within the first 2.5 km. Women living 2.5– 5 km from a facility had a lower uptake of delivery care of more than 60% compared to women living within 1 km, regardless whether the facility was a dispensary or health centre (Table 49). The reduction in uptake of care due to distance was very similar for the three quality categorizations.

Regardless of the categorization used, compared to women living less than 1 km from a health facility, uptake of care was less than half among women living within 2.5– 5 km of a first-line facility and around 25% in women living more than 7.5 from a facility. This is why only the estimates for the effect of distance on delivery in a dispensary and health centre but not for the other categories are shown in Table 49.

Table 49: Effect estimates for delivery in first-line facilities by level of care and distance to first-line facility

Distance to first-line facility	**Prevalence ratio between categories (95% CI)**	**Prevalence ratio between categories (95% CI)**
	Health centre N=2,234	Dispensary N=15,813
<1 km	1 (reference)	1 (reference)
1-2.5 km	0.65 (0.49-0.87	0.55 (0.49-0.63)
2.5-5 km	0.34 (0.26-0.46)	0.33 (0.29-0.37)
5-7.5 km	0.31 (0.21-0.45)	0.30 (0.25-0.35)
>7.5 km	0.24 (0.12-0.48)	0.27 (0.21-0.36)

Determinants of Livebirths by Caesarean Section

Overall, 4.1% (913 births) of women with a livebirth in the year prior to the survey reported a delivery by Caesarean section. There was very weak evidence that the proportion of Caesarean sections differed between the districts (Table 50). Tandahimba district had a slightly lower proportion (3.5%, 178 births, RR 0.82, 95% CI 0.68– 1.00)[21].

Table 50: Birth by Caesarean sections by socio-demographic factors

	Caesarean Section (22,145 answers)		**Prevalence ratio between categories** (95% CI)
	No	%	
District			P=0.072#
Lindi Rural	256	4.3	1 (reference)
Nachingwea	162	4.0	0.93 (0.76-1.13)
Ruangwa	128	4.3	1.02 (0.82-1.26)
Newala	189	4.7	1.09 (0.91-1.32)
Tandahimba	178	3.5	0.82 (0.68-1.00)
Ethnic group			P=0.862#
Makonde	487	4.1	1 (reference)
Mwera	290	4.2	1.03 (0.89-1.19)
Makuwa	41	3.6	0.88 (0.64-1.21)
Yao	38	4.4	1.09 (0.78-1.51)
Others	57	4.3	1.05 (0.80-1.38)
Wealth quintiles (assets)			P<0.001^
Most poor	115	3.5	1 (reference)
Very poor	127	3.2	0.93 (0.72-1.19)
Poor	169	3.7	1.06 (0.83-1.34)
Less poor	173	3.7	1.06 (0.84-1.35)
Least poor	286	6.1	1.75 (1.41-2.18)
Missing	43	4.9	1.41 (0.99-1.99)
Maternal education			P<0.001^
No education	189	3.0	1 (reference)
Some primary	138	4.2	1.42 (1.14-1.77)
Completed primary	574	4.6	1.58 (1.34-1.86)
Secondary +	8	17.8	6.02 (2.97-12.21)
Work			P<0.001#
Farming	788	3.8	1 (reference)
Housewife	49	8.6	2.29 (1.72-3.05)
Employed	20	20.2	5.35 (3.43-8.34)
Others	23	10.2	2.71 (1.79-4.10)
Missing	33	8.5	2.26 (1.60-3.21)

There was evidence of an association between livebirths by Caesarean section and wealth quintile (p=0.001). Women reported a proportion of livebirths by Caesarean section of 3.5% (115 births) and 3.2% (1,127 births) in the most poor and very poor quintile groups, respectively. Of women in the least poor wealth quintile, 6.1% (286 births) were delivered by Caesarean section, a 75% higher level (RR 1.75, 95% CI 1.41– 2.18) compared to the poorest quintile.

Strong evidence of an association between education and birth by Caesarean section was observed. Women with secondary education were six times more likely (RR 6.02, 95%CI 2.97– 12.21) to have a Caesarean section than women with no education.

[21]The operating theatre in Tandahimba was only opened in 2008, before the year 2008 patients were referred with an ambulance to Newala hospital

Table 50 Births by Caesarean section by socio-demographic factors...cont

	Caesarean Section		Relative risk between categories (95% CI)
	No	%	
Maternal Age			P<0.001
13 & 14	2	7.1	1.55 (0.39-6.25)
15 & 16	26	7.6	1.65 (1.10-2.47)
17-19	150	5.3	1.16 (0.95-1.42)
20-24	271	4.6	1 (reference)
25-29	164	3.4	0.74 (0.61-0.90)
30-34	153	3.8	0.83 (0.68-1.01)
35-39	89	3.4	0.73 (0.58-0.93)
40-44	50	3.8	0.82 (0.61-1.12)
45-49	8	2.7	0.59 (0.29-1.20)
Parity (only livebirths)			P<0.001
1^{st}birth	383	7.4	1 (reference)
2^{nd}& 3^{rd}	352	3.6	0.49 (0.42-0.56)
4^{th}& 5^{th}	121	2.6	0.35 (0.29-0.43)
6 and more	57	2.3	0.31 (0.23-0.41)
Sex of head of household			P=0.382
Female	206	4.4	1 (reference)
Male	707	4.1	0.93 (0.80-1.09)
Overall	**913**	**4.1**	

p-values are from the Chi-squared test and the ^ score test for trend (wealth, education and parity)

There was strong evidence of an association between occupation and livebirths by Caesarean section. The proportion of livebirths by Caesarean section ranged from 3.8% (788 births) in women who were farmers to 20.2% (20 births) in women who were employed. Women who were housewives or in formal employment had two (RR 2.29, 95% CI 1.72– 3.05) and five times (RR 5.35, 95% CI 3.43– 8.34) higher proportion of Caesarean section compared to farmers (Table 50).

With regards to maternal age, the proportion of births by Caesarean section was highest in the group of women below 16 years of age (7.1%). A continuous decline in the proportion of births by Caesarean section was seen with increasing age, and only 2.7% of livebirths reported by women aged 45-49 years were by Caesarean section.

A similar trend was seen for parity. Caesarean sections were most common in women having their first child (7.4%, 383 births) and least common in women with six or more livebirths (2.3%, 57 births). The relative risk of Caesarean section for women with six or more previous births to women compared to women having their first baby was estimated at RR 0.31, 95% CI 0.23– 0.41. The sex of the household head was not associated with births by Caesarean section (RR 0.93, 95% CI 0.80– 1.09).

As expected, distance to a hospital had an association with the proportion of livebirths by Caesarean section (Figure 49 and Table 51). The proportion was 8% (146 births by Caesarean section) in women living within 5 km to a hospital and 5% (122 births by Caesarean section) for women living within 10 km of a hospital. Women living within 10-20 km of hospital were 50% less likely to deliver by Caesarean section than women living within 5 km (RR 0.50, 95% CI 0.41– 0.60). Women living 30-40 km from a hospital were 60% less likely to deliver by Caesarean section than women living within 5 km (RR 0.40, 95% CI 0.30– 0.56). Therefore, the recommended level of at least 5% of births by Caesarean section was only reached amongst women living within 10 km to a hospital, which corresponded to 19% of livebirths (Table 51, Figure 51).

Table 51: Birth by Caesarean sections by distance to hospital

	% of births	**Caesarean sections** (22,145 answers)		**Relative risk between categories (95% CI)**
Distance		No	**%**	P<0.001^
<5 km	8	146	**8.0**	1 (reference)
5-10 km	11	122	**5.0**	0.63 (0.50-0.81)
10-20 km	35	308	**3.9**	0.50 (0.41-0.60)
20-30 km	24	178	**3.3**	0.41 (0.33-0.51)
30-40 km	7	49	**3.2**	0.40 (0.30-0.56)
> 40 km	4	21	**2.4**	0.30 (0.19-0.47)
Missing	10	89	**4.0**	0.51 (0.39-0.66)
Overall		913	**4.1**	

^test for trend from score test

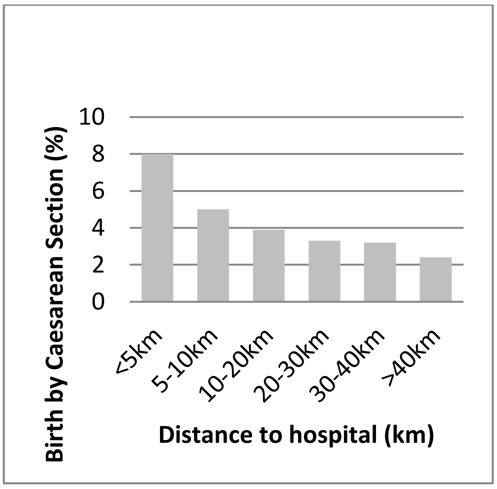


Figure 49: Birth by Caesarean section by distance to hospital

The proportion of livebirths by Caesarean section was 3.9% for women living 10– 20 km from a hospital and 3.3% for women living 20– 30 km from a hospital. Most women with a livebirth were living within this distance (35% and 24% of births respectively). The pattern of proportion of Caesarean section in the ward is displayed in Figure 50. As expected, the highest uptake was seen in wards with a hospital. But also other wards had relatively high proportions of birth by Caesarean section, a few of them were along a major trunk road which might have facilitated improved accessibility.

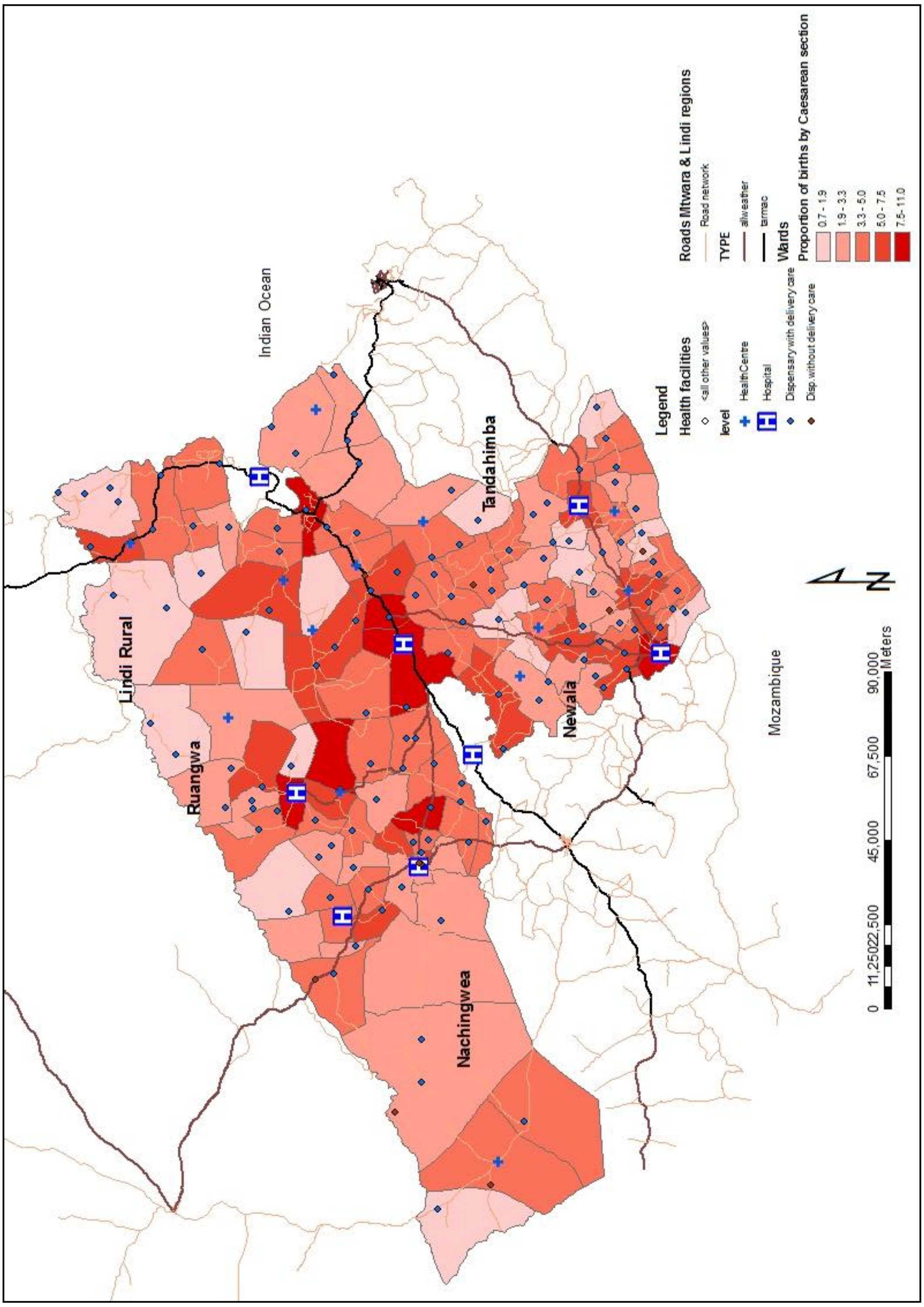


Figure 50: Proportion of Caesarean section by ward

(22,145 answers)

Contextual factors

The proportion of livebirths by Caesarean section was around two times higher in the mixed and urban wards than in the rural wards (Table 52). As expected, birth by Caesarean section was three times higher among women who lived in a ward where the overall uptake of hospital delivery was in the highest quintile (between 38– 91%) compared to women living in a ward with low overall uptake of hospital delivery (7– 24%)(RR 2.73, 95% CI 2.19– 3.40). This pattern is expected as wards with a higher uptake of hospital delivery are likely to be wards with better accessibility to hospital care and therewith Caesarean section.

Table 52: Birth by Caesarean section by contextual factors

	Birth by Caesarean section		**Relative risk between categories (95% CI)**	**Test for trend#**
	N= **22,145**	%		
Ward classification of residence				
Rural (97 wards)	601	3.5	1 (reference)	p=<0.001
Mixed (16 wards)	285	6.3	1.81 (1.57-2.08)	
Urban (1 ward)	27	7.5	2.15 (1.46-3.16)	
Uptake of four ANC visits in the ward of residence (quintiles)				
Very low uptake (18-31%)	180	4.2	1 (reference)	p=0.326
Low uptake (32-36%)	208	4.8	1.16 (0.95-1.42)	
Medium uptake (37-41%)	158	3.5	0.85 (0.69-1.05)	
Higher uptake (41-51%)	188	4.1	0.99 (0.81-1.22)	
Highest uptake (51-64%)	179	4.0	0.97 (0.79-1.20)	
Uptake of delivery in first-line facility in the ward of residence (quintiles)				
Very low uptake (7-24%)	206	4.8	1 (reference)	p=0.251
Low uptake (24-34%)	155	3.7	0.77 (0.63-0.95)	
Medium uptake (34-42%)	192	4.0	0.84 (0.69-1.03)	
Higher uptake (43-56%)	174	4.0	0.85 (0.69-1.03)	
Highest uptake (57-91%)	186	4.1	0.85 (0.70-1.04)	
Uptake of delivery in hospital in the ward of residence (quintiles)				
Very low uptake (6-17%)	107	2.4	1 (reference)	p=<0.001
Low uptake (17-22%)	144	3.3	1.36 (1.06-1.74)	
Medium uptake (22-28%)	174	3.9	1.60 (1.26-2.04)	
Higher uptake (28-38%)	191	4.3	1.76 (1.39-2.23)	
Highest uptake (38-91%)	297	6.6	2.73 (2.19-3.40)	
Uptake of CS in the ward of residence (quintiles)				
Very low uptake (1-2%)	73	1.7	1 (reference)	p=<0.001
Low uptake (2-3%)	113	2.7	1.60 (1.19-2.15)	
Medium uptake (3-4%)	174	3.8	2.30 (1.75-3.02)	
Higher uptake (4-5%)	204	4.7	2.83 (2.16-3.69)	
Highest uptake (6-11%)	349	7.6	4.57 (3.55-5.88)	

p-values are from the Chi-squared test and the score test for trend (wealth quintiles, education and parity)

Similarly, there was a clear trend between the individual chance of having a Caesarean section and the overall proportion of birth by Caesarean section in the ward the women was living. The individual chance increased from 1.7%, 2.7%, 3.8%, 4.7% to 7.6% in the highest uptake quintile. Women living in a ward with high overall uptake of Caesarean section (6– 11%) were 4.6 times more likely to report a Caesarean section (RR 4.47, CI 3.55– 5.88). In contrast overall uptake of four or more ANC visits in the wards or overall delivery in first-line facilities in wards was estimated to have no effect on reported birth by Caesarean section (p=0.326 and p=0.251, respectively).

Overall Uptake of Maternal Care by Distance and Socio-Demographic Groups

This section summarizes the uptake of care pattern described in the previous section to display differences in the effect of distance between the five uptake of care variables (ANC four times, delivery in a hospital, delivery in a first-line facility, birth by Caesarean section and PNC). Differences between uptake of care by wealth and education are displayed. Thus, this section repeats the information described before.

Distance and uptake of maternal care

Uptake of care varied with distance to a hospital and distance to a first-line health facility and strongly between the different uptake of care variables (Figure 51).

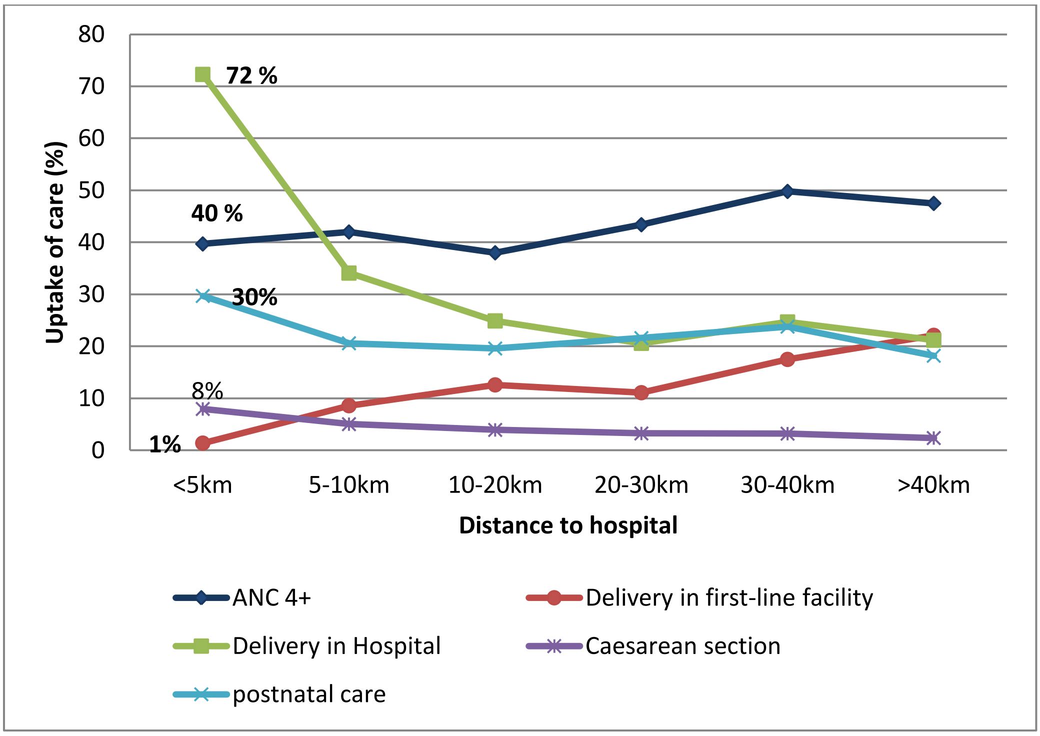


Figure 51: Uptake of maternal care by distance to a hospital
(N=22,243)

The percentage of women delivering in a hospital was over 70% when the distance was less than 5 km and was reduced to just over 30% when the distance was 5 – 10 km. Thereafter, distance seemed to have little further effect.

Regardless of the distance, little over 20% of women delivered in a hospital. As expected, an inverse pattern was seen for births in first-line facilities. Within a distance of 5 km to a hospital, only 1% of women delivered in first-line facility, whereas the level increased to around 15% when the distance was more than 15 km. The percentage of livebirths by

Caesarean section was 8% within 5 km of a hospital. The level reduced to about 4% of women residing within 10 – 20 km of a hospital, but leveled out to 3 – 4% at greater distances.

Figure 52 describes the pattern of uptake of four or more ANC visits, delivery in first-line facilities, birth by Caesarean section and PNC in relation to the distance to any first-line facility providing delivery care to the population. This graph excludes women living closest to the hospital, as the uptake for delivery care is much higher in hospitals if one is the closest facility.

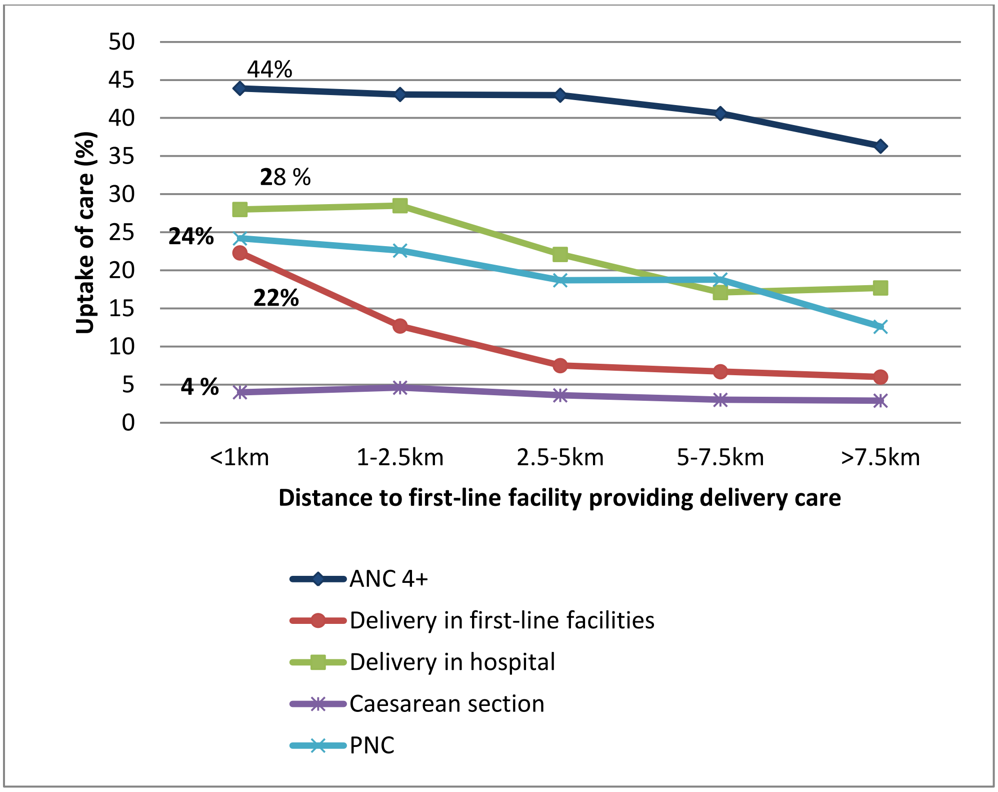


Figure 52: Uptake of maternal care by distance to first-line facility
(Excluding 1,972 births for which the hospital was the nearest facility)

Uptake of four or more ANC visits was slightly over 40% among women living within 7.5 km of a health facility. Uptake reduced to 33% in women living more than 10 km from a health facility. An almost parallel pattern is seen for PNC, but at a lower level. The percentage of women delivering by Caesarean section shows a similar pattern. More than 4% of women within 2.5 km of a health facility providing delivery care delivered by Caesarean section, which reduced to only 2.9% for women living more than 7.5 km from this type of facility.

Comparison of uptake of care by wealth and education groups

Uptake of maternal care differed little by wealth groups except for the least poor (Figure 53). The proportion of women attending ANC four or more times or delivering in a first-line facility was very similar within all wealth groups. Larger differences between wealth groups were observed for delivery in a hospital.

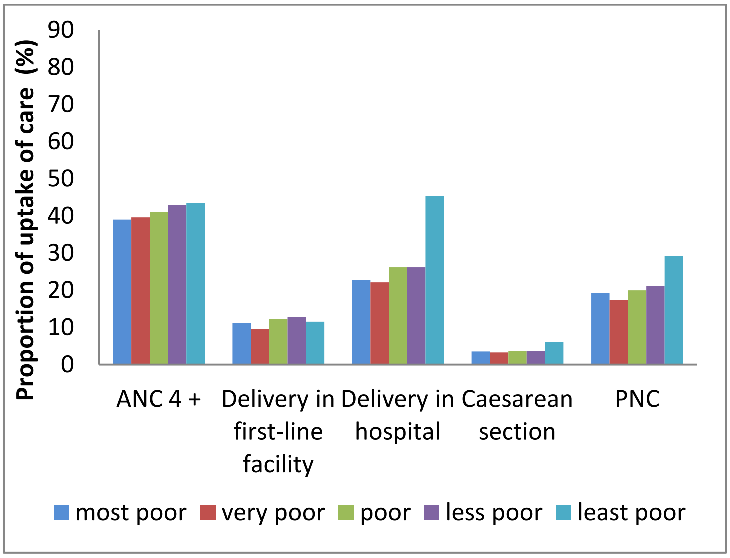


Figure 53: Uptake of maternal care by wealth group (N=22,243)

Twenty-three percent, 22%, 26% and 26% of women from the lowest four wealth groups respectively reported to have delivered in a hospital. However, 45% of women from the highest wealth group reported a hospital delivery. Differences were also reported for birth by Caesarean section (see Table 50)

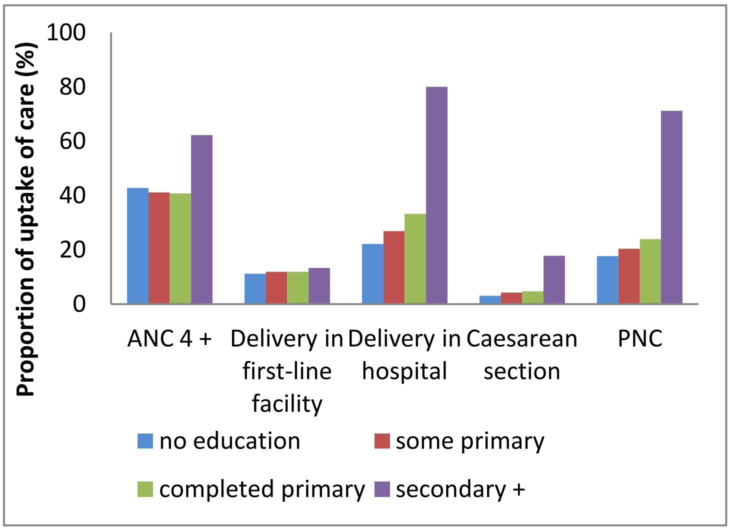


Figure 54: Uptake of maternal care by education (N=22,243)

A similar pattern as observed for wealth was reported for education. Women who had no education, some primary education or had completed primary education reported a similar pattern of uptake of care for four or more ANC visits, delivery in first-line facilities, hospital delivery, birth by Caesarean section and PNC (Figure 54).

Women with secondary education and higher reported to have delivered in a hospital in 80% of livebirths compared to 22%, 27% and 33% of livebirths among women with no education, some primary education or having completed primary education respectively (see also Table 44). Differences were also large for birth by Caesarean section.

Multivariate Analysis of Delivery in Hospital and First-line Facility and Birth by Caesarean Section

All the variables used in the bivariate analysis were associated with at least one of the main outcome measures (uptake of hospital delivery, delivery in first-line facilities and birth by Caesarean section) and were thus considered as confounders in the multivariate analysis. Moreover, all socio-demographic variables (Table 44, Table 50) were very strongly associated ($p<0.001$) with distance, except maternal age, which showed a weak association ($p=0.036$). Women living closer to a hospital were wealthier, more educated, less likely to be farmers, had fewer previous livebirths and were more likely to be part of the ethnic minority groups.

All potential confounders of the effect of distance on uptake of care were assessed one at a time to examine whether they changed the logOR of the effect of distance on uptake of care by more than 10% (Table 53). For the multivariate analysis of the effect of distance on delivery in a hospital and birth by Caesarean section the variable “distance to a hospital” was used, whereas in assessing the effect of distance on delivery in first-line facilities, the variable “distance to health centre” and “distance to dispensaries” were used.

The effect of distance on birth by Caesarean section was confounded by district, wealth, education and occupation, whereas the other socio-demographic variables changed the logOR by less than 10%. None of the potential confounders changed the logOR of the effect of distance on delivery in a hospital or delivery in a first-line facility by more than 5% (Table 53).

Table 53: Confounding of the effect of distance on uptake of care by potential socio-demographic confounders

(Distance to a hospital for births by Caesarean section and hospital delivery and distance to first-line facility for delivery in a dispensary or health centre)

Potential confounders	Change in the logOR of the effect of distance on uptake			
	Birth by Caesarean section	Delivery in hospital	Delivery in first-line facility	
			If health centre is closest	If dispensary is closest
District	14%	5%	1%	1%
Ethnic group	1%	1%	0%	0%
Wealth	14%	4%	3%	2%
Education	11%	5%	3%	1%
Occupation	16%	4%	2%	-*
Maternal age	2%	1%	0%	0%
Parity	9%	1%	0%	0%
Sex of the head of household	0%	0%	2%	0%

*calculation not possible as initial values not possible

The adjusted ORs for the effect of distance on delivery and birth by Caesarean section are presented in Table 54 and Figure 55. Only district, wealth, education and occupation were included, as ethnic group, age and parity did not change the effect of distance on any of the uptake variables by more than 10%.

The crude and adjusted effect estimates were virtually identical to the crude estimates for the outcome hospital delivery. The odds of delivering in a hospital were around 75% lower when the hospital was more than 40 km from the mother's household compared to less than 5 km from her household in the crude and the adjusted analysis (OR 0.23,95% CI 0.15-0.34 and adjusted OR 0.22, 95% CI 0.15-0.34) respectively.

In contrast, adjustment for district, wealth, education and occupation changed the effect of distance on birth by Caesarean section within a distance of 5– 10 km compared to <5 km from OR 0.68 (95% CI 0.50– 0.91) to 0.82 (95% CI 0.61– 1.19). Overall the confounding effect of other socio-demographic factors on distance on uptake of care was limited.

Table 54: Crude and adjusted effect estimates for uptake of hospital delivery and birth by Caesarean section by distance to a hospital

		Delivery in hospital N=22,243		**Birth by Caesarean section** N=22,145	
	% of births	Crude OR	Adjusted OR*	Crude OR	Adjusted OR *
Distance					
<5 km	8	1 (reference)	1 (reference)	1 (reference)	1 (reference)
5-10 km	11	0.33 (0.25-0.43)	0.36 (0.28-0.46)	0.68 (0.50-0.91)	0.82 (0.61-1.19)
10-20 km	35	0.22 (0.17-0.29)	0.24 (0.19-0.31)	0.54 (0.41-0.71)	0.61(0.49-0.81)
20-30 km	24	0.20 (0.15-0.26)	0.21 (0.16-0.28)	0.45 (0.34-0.61)	0.50 (0.38-0.67)
30-40 km	7	0.22 (0.16-0.31)	0.24 (0.17-0.33)	0.44 (0.30-0.66)	0.42 (0.28-0.63)
> 40 km	4	0.23 (0.15-0.35)	0.22 (0.15-0.36)	0.33 (0.19-0.56)	0.36 (0.21-0.61)
Missing	10	0.26 (0.19-0.34)	0.28 (0.21-0.37)	0.54 (0.40-0.75)	0.59 (0.43-0.81)

*adjusted for district, wealth, education and occupation

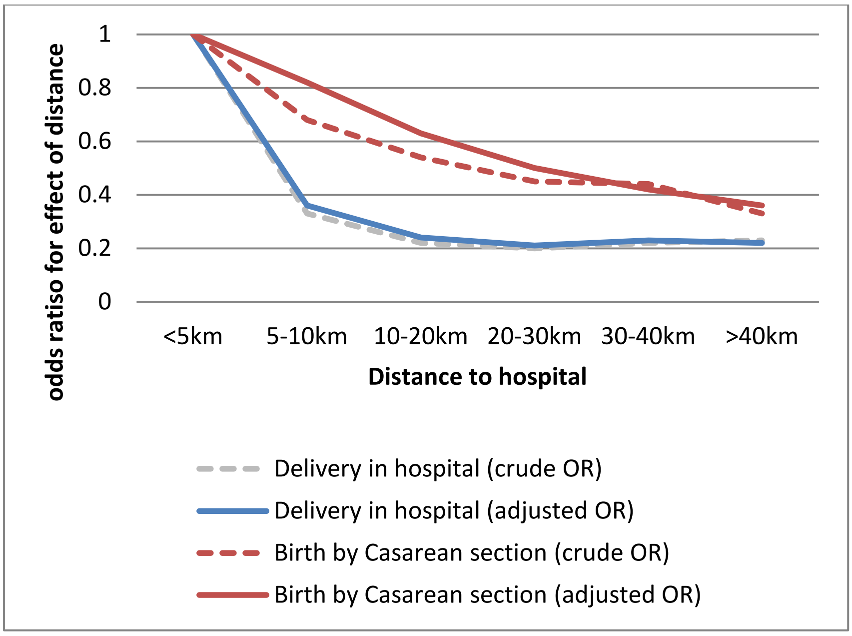


Figure 55: Crude and adjusted odds ratios for distance to hospital on uptake of hospital care

It was further examined whether the available socio-demographic variables had an independent effect on uptake of care when adjusted for other factors. This was done using a stepwise approach, first including all the factors which were identified as potential confounders, and then including the other available factors such as parity, age and ethnic group. The relevance of the factor in the model was assessed by using log-likelihood tests. Thus, in the final model, ethnic group was not included, as it did not improve the model significantly.

District (Newala and Tandahimba of Mtwara region), wealth, education, occupation, parity and age had an independent effect on delivery in a hospital and birth by Caesarean section (Table 55). For each unit increase in wealth quintile, the odds of delivering in a hospital or delivering by cesarean section were 15% (adjusted OR 1.15, 95% CI 1.12– 1.18) and 8% (adjusted OR 1.08, 95% CI 1.02– 1.14) higher respectively. Education also increased the odds of delivering in a hospital and of having a birth by Caesarean section.

A large effect was seen for parity. For each additional previous birth, the odds of delivering in a hospital were 20% lower. For birth by Caesarean section, the odds were 32% lower for every increase in the number of previous livebirths (Table 55). There was evidence that the age of the mother had an association with uptake of care at the hospital. For each additional year of maternal age, the odds of delivering in a hospital or of having a birth by Caesarean section were 2% and 5% higher, respectively. The sex of the head of household was only associated with hospital delivery.

Table 55: Multivariate analysis of predictors of hospital delivery and birth by Caesarean section

	Delivery in hospital		Birth by Caesarean section	
Distance (<5 km is reference)	Adjusted Odds ratio (95% CI)	Wald test (p-value)	Adjusted Odds ratio (95% CI)	Wald test (p-value)
5-10 km	0.36 (0.28-0.46)	<0.001	0.86 (0.65-1.14)	0.290
10-20 km	0.24 (0.19-0.31)	<0.001	0.66 (0.51-0.84)	0.001
20-30 km	0.22 (0.16-0.29)	<0.001	0.53 (0.40-0.70)	<0.001
30-40 km	0.24 (0.17-0.33)	<0.001	0.44 (0.30-0.67)	<0.001
> 40 km	0.23 (0.15-0.35)	<0.001	0.40 (0.24-0.67)	0.001
District (Lindi Rural is Reference)				
Nachingwea	0.88 (0.65-1.21)	0.437	0.67 (0.53-0.86)	0.002
Ruangwa	0.93 (0.65-1.33	0.675	0.82 (0.63-1.06)	0.122
Newala	0.51 (0.37-0.70)	<0.001	0.77 (0.61-0.97)	0.026
Tandahimba	0.55 (0.40-0.76)	<0.001	0.67 (0.54-0.85)	0.001
Wealth quintile (OR per quintile)	1.15 (1.12-1.18)	<0.001	1.08 (1.02-1.14)	0.008
Education (OR per full years)	1.07 (1.06-1.08)	<0.001	1.05 (1.02-1.08)	<0.001
Occupation (OR non-farmers/ Farmers	1.95 (1.62-2.35)	<0.001	1.49 (1.14-1.95)	0.003
Parity (OR per livebirths)	0.80 (0.78-0.83)	<0.001	0.68 (0.63-0.73)	<0.001
Age (OR per year)	1.02 (1.01-1.03)	<0.001	1.05 (1.04-1.07)	<0.001
Sex of head of household	0.86 (0.78-0.94)	0.001	0.92 (0.77-1.10)	0.373

In contrast, age and parity had no independent effect on uptake of care at first-line facilities and their inclusion also did not improve the model using the log-likelihood ratio test, therefore, they were not included in the final model (Table 56). Ethnic group and sex of the head of the household did not improve the model, and Wald tests were not significant.

The effect of wealth on uptake of care at first-line facilities was in a similar order to the effect of wealth on uptake of hospital delivery (Table 55, Table 56). Occupation had the opposite effect on delivery in a first-line facility than for delivery in a hospital. Women not being farmers compared to women who were famers were at two times greater odds of delivering in a hospital (OR 1.95 95% CI 1.62– 2.35) but a reduced odds of delivering in a first-line facility when the health centre was closest (OR 0.35, 95% CI 0.14– 0.87). These results give some indication that women not being farmers preferred to deliver in a hospital but not a first-line health facility.

Table 56: Multivariate analysis of predictors of delivery in first-line facilities

	Delivery in first-line facility when			
	Health centre is closest(N=2110)		Dispensary is closest (N=1477)	
	Odds ratio (95% CI)	Wald test (p-value)	Odds ratio (95% CI)	Wald test (p-value)
Distance (<1 km is reference)				
1-2.5 km	0.52 (0.31-0.86)	0.012	0.48 (0.39-0.59)	<0.001
2.5-5 km	0.21 (0.12-0.35)	<0.001	0.28 (0.23-0.34)	<0.001
5-7.5 km	0.18 (0.10-0.34)	<0.001	0.22 (0.17-0.28)	<0.001
>7.5 km	0.09 (0.03-0.25)	<0.001	0.18 (0.12-0.29)	<0.001
District (Lindi rural is reference)				
Nachingwea	0.56 (0.20-1.58)	0.274	0.63 (0.39-1.02)	0.059
Ruangwa	0.40 (0.22-0.73)	0.003	0.53 (0.30-0.93)	0.028
Newala	0.36 (0.19-0.66)	0.001	0.33 (0.20-0.55)	<0.001
Tandahimba	0.14 (0.07-0.28)	<0.001	0.47 (0.29-0.76)	0.002
Wealth quintile (OR per quintile)	1.12 (1.01-1.25)	0.034	1.06 (1.02-1.11)	0.006
Education (OR per full years)	0.96 (0.92-1.01)	0.106	1.03 (1.02-1.05)	<0.001
Occupation (OR non-farmers /farmers	0.34 (0.14-0.87)	0.023	0.81 (0.58-1.15)	0.242

Sensitivity Analysis for the Effect of Distance to on Delivery Care using Original GIS Data

The data cleaning and imputation procedure changed slightly the mean and median distances to the hospital and first-line facilities (Table 24). To investigate to what extend the cleaning and imputation changed the effect estimates for distance on uptake of care a sensitivity analysis was done restricting the multivariable analysis to original GIS data (Figure 16). Table 57 shows the results of the effect estimates only based on original GIS data. The effect of distance on hospital delivery and Caesarean section were slightly strengthened whereas the effect of all other variables included in the final model remained virtually identical (Table 60 & Figure 56).

Table 57: Multivariate analysis of predictors of hospital delivery and birth by Caesarean section restricted to original GIS coordinates

	Delivery in hospital		**Birth by Caesarean section**	
Distance (<5 km is reference)	Adjusted Odds ratio (95% CI)	Wald test (p-value)	Adjusted Odds ratio (95% CI)	Wald test (p-value)
5-10 km	0.30 (0.23-0.40)	<0.001	0.77 (0.55-1.08)	0.135
10-20 km	0.19 (0.14-0.24)	<0.001	0.60 (0.44-0.81)	0.001
20-30 km	0.16 (0.12-0.22)	<0.001	0.50 (0.36-0.70)	<0.001
30-40 km	0.16 (0.11-0.23)	<0.001	0.37 (0.24-0.61)	<0.001
> 40 km	0.15 (0.09-0.23)	<0.001	0.31 (0.17-0.58)	<0.001
District (Lindi Rural is Reference)				
Nachingwea	0.78 (0.57-1.07)	0.127	0.66 (0.53-0.86)	0.005
Ruangwa	0.84 (0.59-1.20)	0.340	0.88 (0.65-1.19)	0.395
Newala	0.47 (0.34-0.65)	<0.001	0.71 (0.53-0.94)	0.017
Tandahimba	0.52 (0.37-0.71)	<0.001	0.66 (0.50-0.86)	0.003
Wealth quintile (OR per quintile)	1.13 (1.10-1.17)	<0.001	1.07 (1.00-1.15)	0.044
Education (OR per full years)	1.07 (1.05-1.08)	<0.001	1.04 (1.01-1.07)	0.005
Occupation (OR non-farmers/ Farmers	1.98 (1.58-2.47)	<0.001	1.48 (1.06-2.06)	0.020
Parity (OR per livebirths)	0.80 (0.77-0.83)	<0.001	0.67 (0.61-0.73)	<0.001
Age (OR per year)	1.02 (1.01-1.03)	<0.001	1.06 (1.04-1.08)	<0.001
Sex of head of household	0.87 (0.78-0.96)	0.001	0.95 (0.77-1.17)	0.636

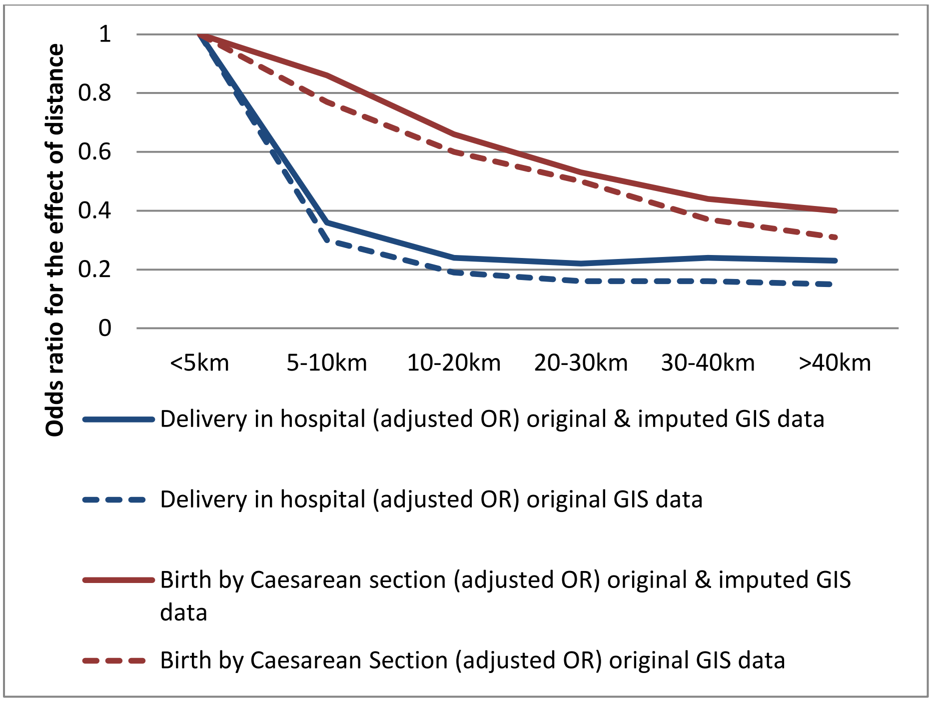


Figure 56: Comparison of the effect of distance to a hospital on uptake of care by GIS data quality

The effect estimates for distance on delivery in a first-line facility, both when the health centre or the dispensary was closest, were virtually identical (Table 58 & Figure 57).

Table 58: Multivariate analysis of predictors of delivery in first-line facilities restricted to original GIS data

	Delivery in first-line facility when			
	Health centre is closest (N=1645)		Dispensary is closest (N=12166)	
	Odds ratio (95% CI)	Wald test (p-value)	Odds ratio (95% CI)	Wald test (p-value)
Distance (<1 km is reference)				
1-2.5 km	0.46 (0.27-0.77)	0.004	0.47 (0.38-0.59)	<0.001
2.5-5 km	0.19 (0.11-0.33)	<0.001	0.30 (0.24-0.36)	<0.001
5-7.5 km	0.18 (0.09-0.35)	<0.001	0.23 (0.18-0.30)	<0.001
>7.5 km	0.06 (0.02-0.19)	<0.001	0.17 (0.11-0.28)	<0.001
District (Lindi rural is reference)				
Nachingwea	0.89 (0.29-2.75)	0.846	0.63 (0.39-1.02)	0.062
Ruangwa	0.46 (0.24-0.88)	0.021	0.51 (0.29-0.91)	0.022
Newala	0.38 (0.19-0.75)	0.005	0.33 (0.20-0.56)	<0.001
Tandahimba	0.17 (0.06-0.31)	<0.001	0.48 (0.29-0.79)	0.003
Wealth quintile (OR per quintile)	1.11 (0.99-1.26)	0.079	1.07 (1.02-1.12)	0.005
Education (OR per full years)	0.98 (0.93-1.03)	0.430	1.03 (1.01-1.05)	0.004
Occupation (OR non-farmers /farmers	0.40 (0.14-1.13)	0.083	0.77 (0.53-1.13)	0.184

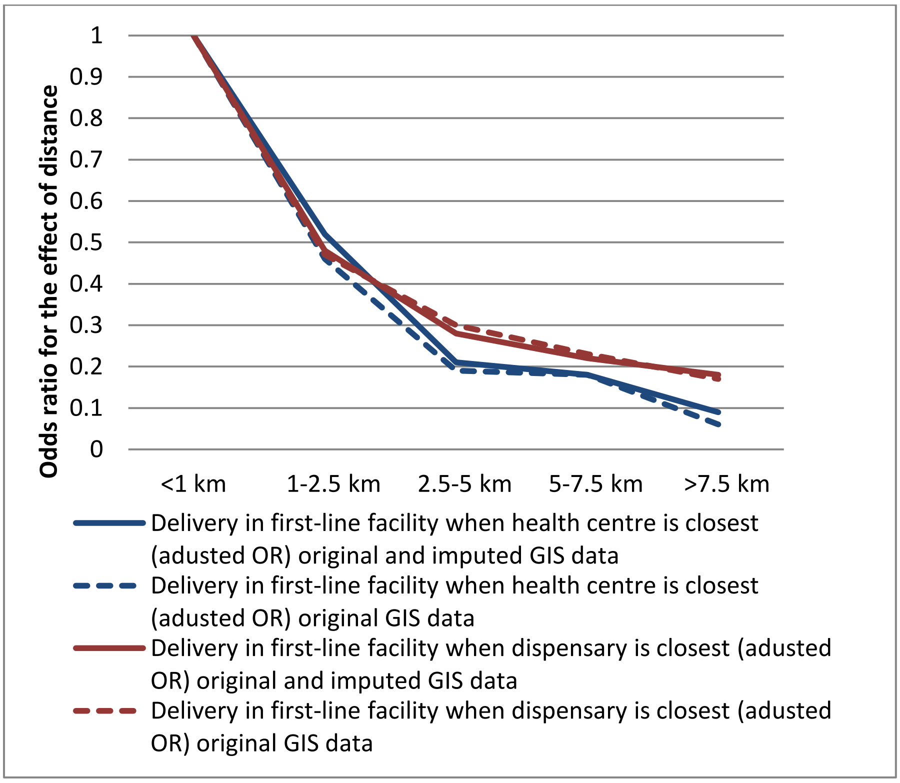


Figure 57: Comparison of the effect of distance to a first-line facility on uptake of care by GIS data quality

3. Pregnancy-Related Mortality and Cause of Maternal Death

Description of Deaths Reported as Pregnancy-Related

A total of 507 deaths were reported as being pregnancy-related during the defined time period from 1st June 2004 to 31st May 2007. For 439 of these deaths, verbal autopsy were done so that information on timing of death (pregnancy or postpartum), delivery mode, status of the newborn and other information were available. For five of these 439 deaths for which a verbal autopsy was done the information was not electronically available and the final diagnosis assigned by the physician was missing for one of these deaths.

Cross-tabulating available information from the verbal autopsy questionnaires and household information highlighted some inconsistencies. Thirty-six deaths (8%) reported to be pregnancy-related by the head of household during the census were not confirmed to be so by the verbal autopsy (thus no maternal deaths). The verbal autopsies suggested that these women were not pregnant or in the postpartum period when they died (Table 59). In addition, 20 postpartum deaths (5%) were reported to have taken place outside of the two month postpartum period. Further, seven deaths needed to be excluded to comply with the standard definition of maternal death being within six weeks postpartum.

Table 59: Pregnancy status of reported pregnancy-related deaths

Pregnancy status (439 deaths)	No	%
1st Trimester	31	7
2nd trimester	49	11
3rd trimester	68	16
Up to 6 weeks postpartum	205	47
Pregnant, gestational age not known	11	3
Postpartum, timing of deaths not known	7	2
Confirmed pregnancy-related deaths	371	85%
Information missing	5	1%
No maternal deaths	36	8
6 weeks to 2 months postpartum	7	2
3 to 12 months postpartum	20	5
No maternal deaths or outside period	63	14%
	439	100

Thus 63 (14%) were likely not to be maternal deaths, or the deaths took place more than six weeks postpartum period (Table 59). 371 deaths (86%) were confirmed to be pregnancy-related with verbal autopsy information and for 5 deaths information was missing. For some of the analysis presented in this section a sub-analysis is presented excluding these 63 not-confirmed deaths from the analysis..

Causes of Maternal Death

For 438 of the 439 pregnancy-related deaths for which a verbal autopsy was done a diagnosis on a probable cause of deaths was available. For the 375 confirmed maternal deaths (Table 59) a probable cause of deaths was available from two physicians' review and for one death this information was missing A final cause of deaths diagnosis (where agreement between physicians was reached) was available for 267 deaths (Figure 58, Table 60). In 108 (29%) cases no agreement could be reached even after consulting a third physician. There was no difference in the proportion of deaths where no agreement was reached throughout the three years period for which verbal autopsies were done [32 deaths (30%) with no confirmed diagnosis in period 1 June 2004-31st May 2005, 35 (28%) in period 1 June 2005-31st May 2006 and 41 (29%) in period 1 June 2006-31stMay 2007].

Table 60: Final causes of maternal deaths according to verbal autopsy interviews and physician review (376 confirmed maternal deaths)

Cause of deaths	Number	%
Antepartum/postpartum haemorrhage[22]	86	22.9
Puerperal Sepsis	16	4.3
Tetanus	1	0.3
Eclampsia	23	6.1
Obstructed labour	9	2.4
Abortion	11	2.9
Other direct	16	4.7
Sub-total direct maternal deaths	**162**	**43**
AIDS/tuberculosis	20	5.3
Malaria	31	8.3
Anaemia	27	7.2
Cardio-vascular disease	1	0.3
Cervical cancer	1	0.3
Other indirect	15	4.0
Sub-Total indirect maternal deaths	**95**	**25**
Injuries/accidents	2	0.5
Undetermined	8	2.1
Total with available cause	**267**	**71**
Unresolved	**108**	**29**
Missing	**1**	**0**
All	**376**	**100**

[22] The coding list did not allow a further split up of hemorrhage into pre- and post-partum hemorrhage (p 294).

Direct and indirect maternal deaths accounted for 60% and 36% of the deaths for which agreement was reached, respectively (Table 61, Figure 58). The main causes of death were haemorrhage, eclampsia, AIDS/tuberculosis, malaria and anaemia. Eighty six deaths (32% of deaths for which agreement between physicians was reached) were due to haemorrhage (pre- and postpartum), 16 deaths (6%) were due to puerperal sepsis, one death was due to tetanus, 24 deaths (8%) were due to eclampsia, nine deaths (3%) were due to obstructed labour, and 11 deaths (4%) were due to abortion.

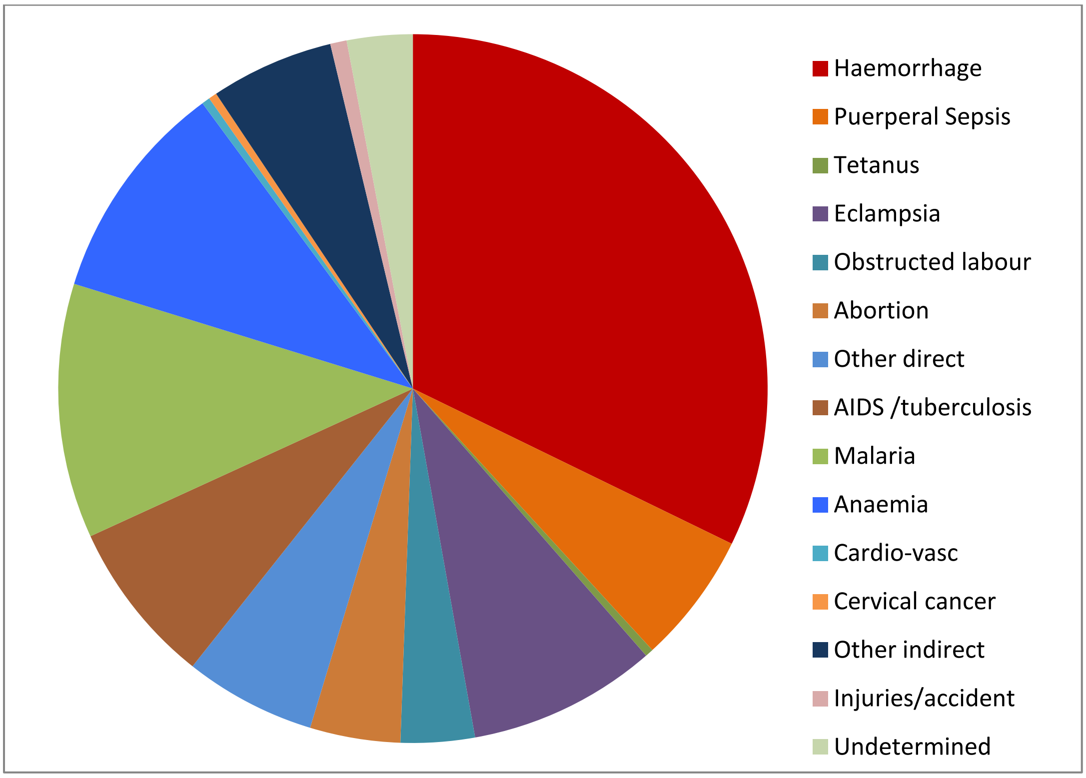


Figure 58: Causes of maternal deaths for agreed causes of deaths
(267 confirmed maternal deaths)

AIDS/tuberculosis and malaria were the diagnosis for 20 deaths (7%) and 31 deaths (12%) respectively for the deaths in which agreement was reached, followed by anaemia (10%, 27 deaths). Accidental causes were only responsible for two deaths (1%).

The causes of deaths for the 63 deaths which were not confirmed to be maternal deaths are given in Table 61.

Table 61: Diagnosis of non-maternal deaths or outside the 6 weeks postpartum period

Diagnosis (63 cases)	Number	%
AIDS / TB	16	**25**
Malaria	9	**14**
Anaemia	1	**2**
Cardio-vascular disease	3	**5**
other indirect	7	**11**
Eclampsia	1	**2**
Undetermined	2	**3**
Unresolved	24	**38**
	63	**100**

For resolved cases, the predominant cause of deaths was AIDS or tuberculosis (16 cases, 25%), followed by malaria (nine cases, 14%). There was one case of eclampsia, which was reported to have taken place 150 days postpartum.

There were differences in the distribution of cause of death between the two physicians assigning the probable cause of death and the final diagnosis, particularly for AIDS/tuberculosis, anaemia and abortion (data not shown).

The further analysis includes a category of “maternal deaths” which excludes the 63 deaths which were not confirmed to be due to maternal causes by the verbal autopsy (Table 59) and two coincidental cases (Table 60). Thus the category of “maternal death” includes 442 deaths and ignores that for 66 of these 442 deaths no verbal autopsies were available and thus the pregnancy status and cause of deaths could not be confirmed.

Further, the analysis proceeds with some sub-group analysis of the 376 maternal deaths for which the verbal autopsy data were available.

Seasonal Variation of Pregnancy-related and Maternal Deaths

There was some variation of the number of death by month. The graph suggests fewer pregnancy-related and maternal deaths in the dry season from August to December and a few more deaths, although fluctuating, in March to Mai the main rainy season. However, differences were small.

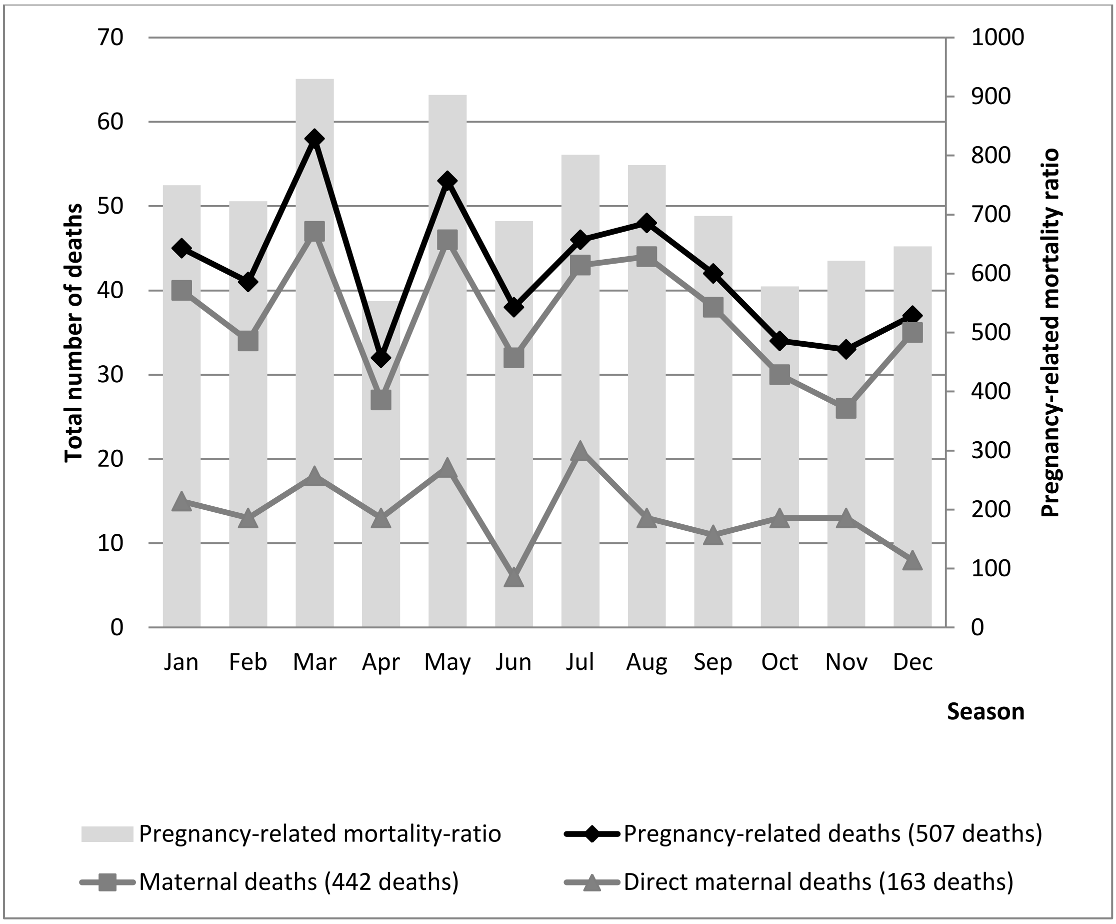


Figure 59: Mortality ratio and number of pregnancy-related, maternal and direct maternal deaths by months of death

Timing, place of death and other determinants of maternal deaths

While most deaths took place in the postpartum period (205 deaths, 55%), 148 deaths (40%) were reported having taken place while the mother was pregnant (see Table 59).

Out of the 205 deaths that were reported to have occurred postpartum, the largest number took place on the day of birth (93 deaths, 45%). During the first week postpartum, a mean number of seven deaths occurred per day. After the first seven days, the mean number reduced to less than two deaths per day (Figure 60).

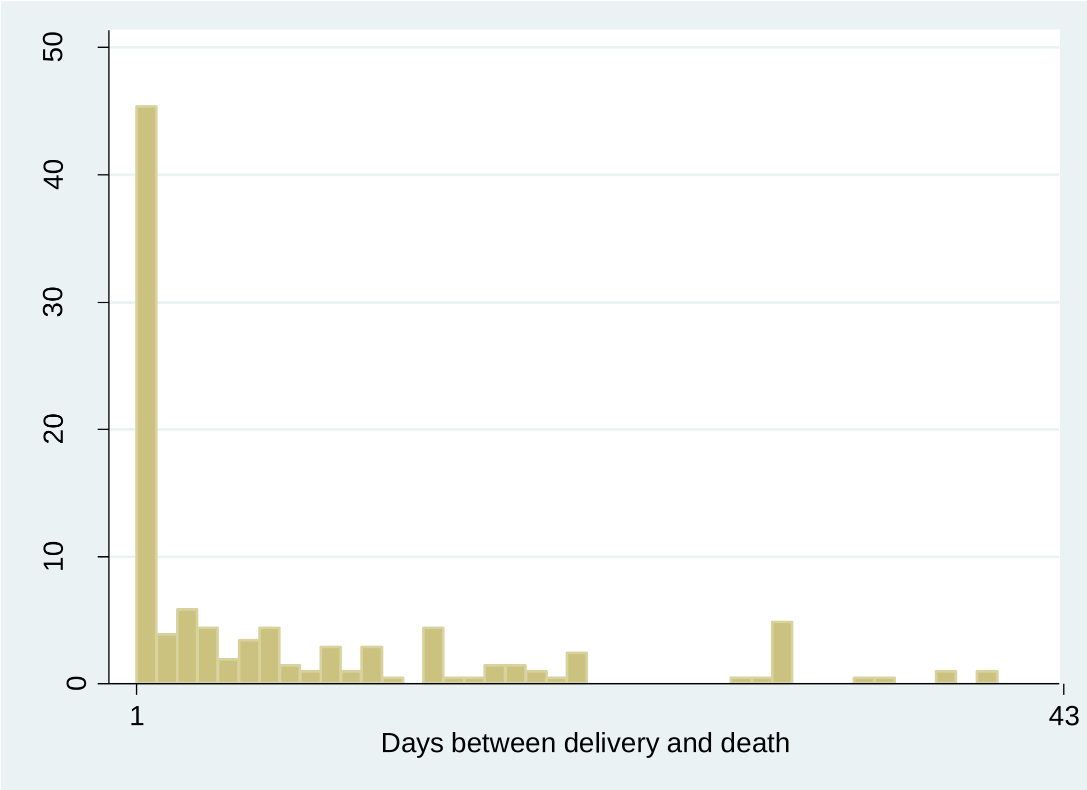


Figure 60: Time between delivery and death for 205 postpartum deaths

(day 1 means within the first 24 hours)

Table 62: Number of ANC visits of women who died

	ANC status of women (376 records)	
	Number	%
No any visit	41	**11**
1 visit	20	**5**
2-3 visits	97	**26**
4 or more	88	**23**
Not applicable	21	**6**
Not known	104	**28**
Missing	5	**1**
Total	376	**100**

For many women who died, the respondent could not give any answer of how often the mother went for ANC (104 women, 28%). For 26% of women, the respondents said the women went to ANC two-to-three times, and 23% respondents said the deceased woman had more than four ANC visits. For 11% it was reported that the women did not go for ANC, and for a further 6% the question was not applicable (Table 62).

Table 63: Marital status of women who died

	Marital status of women (376 records)	
	Number	%
Single	83	**22**
Married	265	**71**
Divorced	16	**4**
Don't know	1	**1**
Missing	11	**3**
Total	376	**100**

Most women who died were married (265 women, 71%), 83 were single (22%) and 16 women were divorced (4%). Information was missing for 3% of the mothers (Table 63).

Table 64: Place of deaths

	Place of deaths of women (376 records)	
	Number	%
Home	126	**34**
Health facility	186	**50**
Other place	36	**10**
Not known	23	**6**
Missing	5	**1**
Total	376	**100**

Most of the deaths were in a health facility (186 women, 50%), followed by deaths at home (126 women, 34%). For 36 women (10%) the respondents gave the answer "other place" and for 23 cases (6%) the place was not known (Table 64).

Table 65: Status of the baby at birth of mothers who died

	Status of baby (376 records)	
	Number	%
Alive	186	**50**
Dead	51	**14**
Not applicable	116	**31**
Missing	23	**6**
	376	**100**

For many of the deaths, the outcome of the baby at birth was not given (31%, 116 deaths). Among these, 91% (106) of deaths took place when the mother was pregnant. One hundred eighty-six babies were reported to be alive (50%) and 51 babies (14%) had died at birth. For 23 deaths (6%) the status of the baby was missing (

Table 65).

Table 66: Mode of delivery

	Mode of delivery (376 records)	
	Number	%
Spontaneous	185	**49**
Vacuum extraction	4	**1**
Caesarean Section	38	**10**
Not applicable	124	**34**
Not known	20	**5**
Missing	5	**1**
Total	376	**100**

For a large part of the reported deaths there was no answer to the mode of delivery was not available because the question was not applicable (124 deaths, 34%). A total of 113 of these deaths were in pregnancy. One hundred eighty-five women (49%) who died delivered spontaneously A total of 38 women (10%) were reported to have died after a Caesarean section was done (Table 66).

Levels and Determinants of Pregnancy-Related and Maternal Mortality

This section includes an analysis of all deaths which were reported to be pregnancy-related at the household level and a sub-analysis excluding the 65 deaths which were, according to the verbal autopsy, not pregnancy-related, took place outside the commonly defined six weeks period postpartum or accidental/coincidental cases.

Table 67: Pregnancy-related and maternal mortality by socio-demographic factors

	Pregnancy-related deaths (507 deaths and 64,098 livebirths)			Maternal deaths ~ (442 deaths)
	Number of deaths	Deaths / 100,000 livebirths[1]	Crude odds-ratios (95% CI) ^Test for trend	* Chi-squared test
District			p* <0.001	p=*0.171
Lindi Rural	170	959	1 (reference)	1 (reference)
Nachingwea	98	705	0.75 (0.56-1.01)	0.77 (0.56-1.07)
Ruangwa	63	634	0.69 (0.49-0.97)	0.75 (0.52-1.09)
Newala	83	620	0.67 (0.48-0.92)	0.70 (0.49-0.98)
Tandahimba	93	573	0.64 (0.47-0.86)	0.73 (0.52-1.01)
Ethnic group			P*<0.264	p*=0.412
Makonde	254	661	1 (reference)	1 (reference)
Mwera	172	771	1.18 (0.94-1.48)	1.18 (0.93-1.50)
Makuwa	25	710	1.05 (0.68-1.62)	1.16 (0.74-1.82)
Yao	27	1015	1.48 (0.98-2.24)	1.46 (0.94-2.29)
Others	29	681	0.99 (0.66-1.50)	1.03 (0.67-1.58)
Wealth quintiles (assets)			P^ =0.094	P^=0.047
Most poor	87	796	1 (reference)	1 (reference)
Very poor	90	723	0.92 (0.70-1.26)	0.88 (0.65-1.21)
Poor	101	692	0.89 (0.67-1.19)	0.82 (0.61-1.12)
Less poor	103	682	0.90 (0.68-1.20)	0.77 (0.57-1.05)
Least poor	89	581	0.79 (0.58-1.07)	0.76 (0.55-1.04)
Missing	37	1317	1.79 (1.21-2.65)	1.71 (1.14-2.57)
Maternal education			P^ 0.008	P^=0.020
No education	102	505	1 (reference)	1 (reference)
Some primary	64	589	1.28 (0.93-1.75)	1.28 (0.91-1.80)
Completed primary	266	674	1.47 (1.16-1.86)	1.44 (1.11-1.86)
Secondary and more	1	625	1.49 (0.20-10.83)	1.68 (0.23-12.24)
Missing	74	15063	70.29 (49.34-100.13)	79.60 (55.41-114.36)
Education of head of household			P^ <0.001	P^ <0.001
No education	162	916	1 (reference)	1 (reference)
Some primary education	130	1021	1.16 (0.92-1.46)	0.18 (0.92-1.51)
Completed primary	201	529	0.59 (0.48-0.73)	0.61 (0.48-0.77)
Secondary or higher	3	514	0.62 (0.20-1.97)	0.72 (0.23-2.27)
Missing	11	507	0.56 (0.30-1.03)	0.59 (0.31-1.13)
Occupation			P*=0.030	P^ <0.001
Farming	410	613	1 (reference)	1 (reference)
Other	24	936	1.67 (1.09-2.59)	1.80(1.15-2.82)
Missing	73	4271	15.78 (12.01-20.73)	18.46 (14.04-24.28)

Table 67: Levels and determinants of pregnancy-related and maternal mortality by socio-demographics factors …cont

	Pregnancy-related deaths 507 deaths and 64,098 livebirths			Maternal deaths ~ (442 deaths)
	Number of deaths	Deaths / 100,000 livebirths[1]	Crude odds-ratios (95% CI) p-values # ^Test for trend	* Chi-squared test
Maternal Age			P*=0.002	P*=0.005
13&14	2	1515	2.51 (0.61-10.38)	2.95 (0.72-12.19)
15&16	11	737	1.21 (0.65-2.26)	1.29 (0.67-2.49)
17-19	58	613	1.05 (0.76-1.44)	1.07 (0.76-1.52)
20-24	104	552	1 (reference)	1 (reference)
25-29	112	701	1.29 (0.99-1.69)	1.29 (0.97-1.73)
30-34	119	957	1.71 (1.31-2.22)	1.74 (1.31-1.31)
35-39	56	698	1.32 (0.95-1.84)	1.38 (0.98-1.96)
40-44	36	896	1.65 (1.12-2.41)	1.66 (1.10-2.50)
45-49	9	1095	2.10 (1.05-4.18)	2.45 (1.23-4.90)
Sex of head of household			P*=0.167	P*0.591
Female	127	684	1 (reference)	1 (reference)
Male	379	584	0.91 (0.74-1.11)	0.94 (0.75-1.17)
Period			P* = 0.074	P*=0.216
1 June 2004-31st May 2005	149	697	1 (reference)	1 (reference)
1 June 2005-31st May 2006	163	647	0.93 (0.74-1.16)	0.91 (0.72-1.15)
1 June 2006-31st May 2007	195	838	1.19 (0.96-1.47)	1.11(0.89-1.41)
Overall	**507**	**712**		

[1]adjusted for age-standardized birth rate applied to the number of missing birth history in respective categories (adjustment results in 71,198 livebirths)
p-values are from the Chi-squared test and the score test for trend (wealth quintiles and education)
~excluding 63 deaths not pregnancy-related and 2 coincidental deaths (table59 and 60).

The overall pregnancy-related mortality was 712 deaths per 100,000 livebirths in the five districts during the period June 2005 to May 2007 (95% CI 652-777). The number of births was adjusted by the age-standardized birth rate of women of reproductive age reported during the three years period applied to the 9% of missing birth histories. Thus the total number of birth used to construct the pregnancy-related mortality ratio was 71,198 births, not 64,098 births. The logistic regression model was done without any adjustment.

The estimated pregnancy-related mortality was highest in Lindi Rural district (959 deaths per 100,000 livebirths). Tandahimba district had the lowest pregnancy-related mortality (573 deaths per 100,000 livebirths) (Table 67).

Reported pregnancy-related deaths differed according to wealth group from 796 per 100,000 in the poorest wealth group to 581 per 100,000 livebirths in the highest wealth group. There was weak evidence of lower mortality in the least poor women (p=0.094) and the effect was strengthened when unconfirmed pregnancy-related deaths were excluded. The odds of dying were about 20% lower in women from the highest wealth group compared to women from the lowest wealth group. No wealth categorization was available for 37 (7.3%) deaths and 1,417 (2.2%) livebirths.

The analysis of the effect of education and occupation on mortality was constrained by a high proportion of missing information, and results suggest that the information is biased by recall and reporting bias. The head of household was the main source of information of the education status of both women who died and for mothers with a livebirth (p 117). A recall and reporting bias has to be considered when asking about the education status of women who died up to three years prior the survey.

Information on the education level of the head of household was less constrained by recall and reporting bias as it was assessed during the main census by asking the head of household him or herself about the attained education. The results indicated the expected trend of lower mortality with higher education. The odds of dying were 30% lower for women living in households where the head of the household had completed secondary or higher education compared to no education when including only maternal deaths.

The analysis of age at very young age is constrained by small numbers of birth in the extreme of childbearing age. The study included only 13 deaths in women aged 16 years and below. However, the pattern of pregnancy-related mortality in relation to maternal age was as expected, where mortality was highest in very young mothers and in mothers of older age (Figure 61. Mortality was more than twice as high in women aged 13– 14 years (OR 2.5, 95% CI 0.61– 10.29) than in women between 20– 24 years.

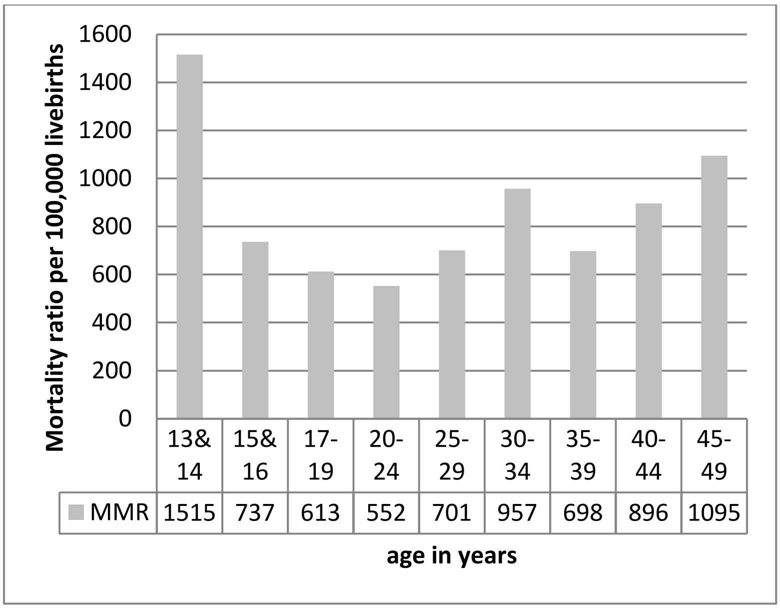


Figure 61: Pregnancy-related mortality by maternal age
(507 deaths)

Mortality was similar in the 15 – 16, 17 – 19 and 20 – 24 years old women. Women aged 45–49 years old had a mortality ratio twice as high as mothers in the age group 20-24 years (OR 2.1, 95% CI 1.08– 4.26). The odds ratios were strengthened at the extremes of childbearing age when only maternal deaths were included (Table 67).

There was no variation between the main categories of causes of pregnancy-related deaths (direct, indirect, unknown/undetermined or accidental causes) by district, wealth and education of the head of household (data not shown). The share of direct maternal deaths was greater in women aged 34– 49 years compared to 20– 35 years (46% compared to 34%), which is expected, as a large number of deaths were due to haemorrhage, which is more common in older age. A total of 27 deaths (35%) in the age group 35– 49 years were due to haemorrhage.
The proportion of indirect deaths due to AIDS/tuberculosis varied slightly between the districts. Two cases (3% of all deaths in the district) were reported in Tandahimba to be due to AIDS or tuberculosis, two (3%) in Newala, five (7%) in Nachingwea, three (6%) in Ruangwa and eight (7%) in Lindi Rural (data not shown).

Pregnancy-Related and Maternal Mortality and Distance to Hospital

The pregnancy-related mortality ratio varied surprisingly little by distance to a hospital (Table 68). Mortality was high even within 5 km of a hospital (MM-ratio 664, 42 deaths). However, reported pregnancy-related mortality was highest in women living 40 km or more from a hospital (MM-ratio of 1,021). For 55 pregnancy-related deaths, no distance information was available. In this group, mortality was slightly higher than the average (MM-ratio of 787 compared to 712 per 100,000 livebirths over all distance categories).

Table 68: Pregnancy-related mortality by distance to hospital

	% Livebirths & deaths in category	**Deaths**	**Pregnancy-related mortality ratio[1]**	**Pregnancy-related deaths (507 deaths)**	**Maternal death s* (442 deaths)**
				Crude OR (95% CI)	
Distance				P^=0.043	P^=0.149
<5km	**10**	42	**664**	1 (reference)	1 (reference)
5-10km	**12**	60	**783**	1.12 (0.72-1.76)	1.04 (0.65-1.67)
10-15km	**19**	72	**602**	0.89 (0.57-1.38)	0.85 (0.54-1.35)
15-20km	**21**	90	**651**	0.94 (0.62-1.45)	0.98 (0.57-1.39)
20-25m	**15**	47	**504**	0.73 (0.45-1.18)	0.69 (0.42-1.13)
25-30km	**12**	75	**984**	1.34 (0.86-2.11)	1.20 (0.75-1.93)
30-35km	**6**	29	**782**	1.11 (0.64-1.91)	1.04 (0.59-1.85)
35-40km	**2**	9	**860**	1.19 (0.54-2.61)	0.86 (0.34-2.15)
>40 km	**4**	28	**1,021**	1.47 (0.84-2.60)	1.40 (0.78-2.53)
Missing	**10**	55	**787**	1.11 (0.70-1.77)	1.11 (0.69-1.78)
Overall	**100**	507	**712**		

[1] adjusted for age-standardized birth rate applied to the number of missing birth history in respective categories (adjustment results in 71,198 livebirths)
[#] excluding 65 deaths not maternal/coincidental deaths

There was weak evidence of higher mortality in greater compared to smaller distances to a hospital (test for trend p=0.043). Comparing mortality in distances above 25 km from a hospital to distances of less than 25 km to a hospital, the odds of mortality were almost 50% higher (OR 1.44, 95% CI 1.14 - 1.82) if all deaths reported to be pregnancy-related at household level were included. If the 65 deaths not confirmed to be pregnancy-related or coincidental death were excluded, the association between mortality and distance was not significant (p=0.148). However, comparing mortality in women living more than 25 km from a hospital with those women living less than 25 km from a hospital suggested that the odds of dying were 40% higher in greater distance (1.37, 95% CI 1.06– 1.76).

The comparison of the main categories of pregnancy-related deaths (indirect and direct deaths) and all pregnancy-related deaths by distance indicted that the effect of distance was strongest for direct causes of maternal deaths (Table 69) The test for trend when comparing mortality in 5 km categories indicated a trend of higher mortality with increasing distance from a hospital (0.005). For indirect maternal deaths, no such trend was seen (p=0.560).

Table 69: Mortality by distance to a hospital and main causes of maternal mortality

Distance	Direct causes 162 deaths		Indirect causes 95 deaths	
	Mortality ratio[1]	Crude OR (95% CI)	**Mortality ratio**[1]	Crude OR (95% CI)
		Test for trend p=0.005		Test for trend p=0.560
<5 km	**111**	1 (reference)	**158**	1 (reference)
5-10 km	**183**	1.59 (0.62-4.08)	**157**	0.97 (0.40-2.36)
10-15 km	**209**	1.85 (0.80-4.45)	**75**	0.46 (0.18-1.19)
15-20 km	**260**	2.32 (0.99-5.43)	**123**	0.75 (0.33-1.72)
20-25m	**139**	1.26 (0.48-3.28)	**86**	0.52 (0.20-1.38)
25-30 km	**302**	2.65 (1.09-6.48)	**223**	1.36 (0.59-3.12)
30-35 km	**216**	1.89 (0.65-5.48)	**162**	0.98 (0.34-2.85)
35-40 km	**478**	4.03 (1.21-13.44)	**96**	0.59 (0.07-4.80)
>40 km	**401**	3.54 (1.29-9.71)	**146**	0.90 (0.38-3.03)
Missing	**286**	2.50 (1.02-6.13)	**157**	0.96 (0.39-2.38)

[1] adjusted for age-standardized birth rate applied to the number of missing birth history in respective categories (adjustment results in 71,198 livebirths)

Compared to women living within 25 km of a hospital, the odds of dying from direct maternal causes were 70% higher in women living more than 25 km from a hospital (OR 1.67, 95% CI 1.11– 2.54) but there was no significant difference for indirect maternal deaths (OR 1.55, 95% CI 0.88– 2.71).

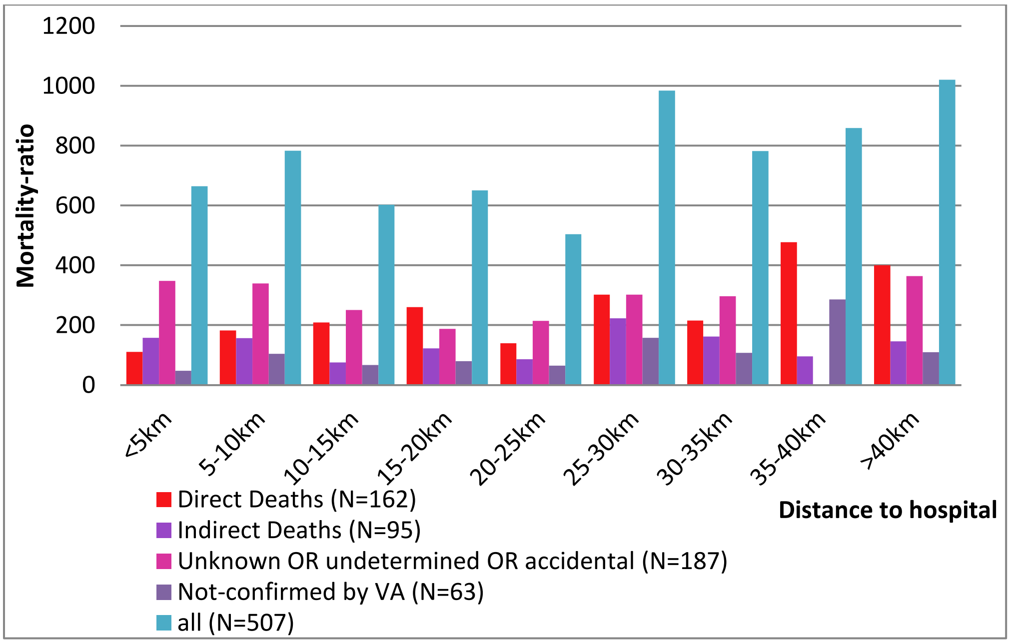


Figure 62: Mortality ratio by causes of pregnancy-related deaths and by distance to hospital

The ratio of pregnancy-related deaths per 100,000 livebirth by division is shown in Figure 63.

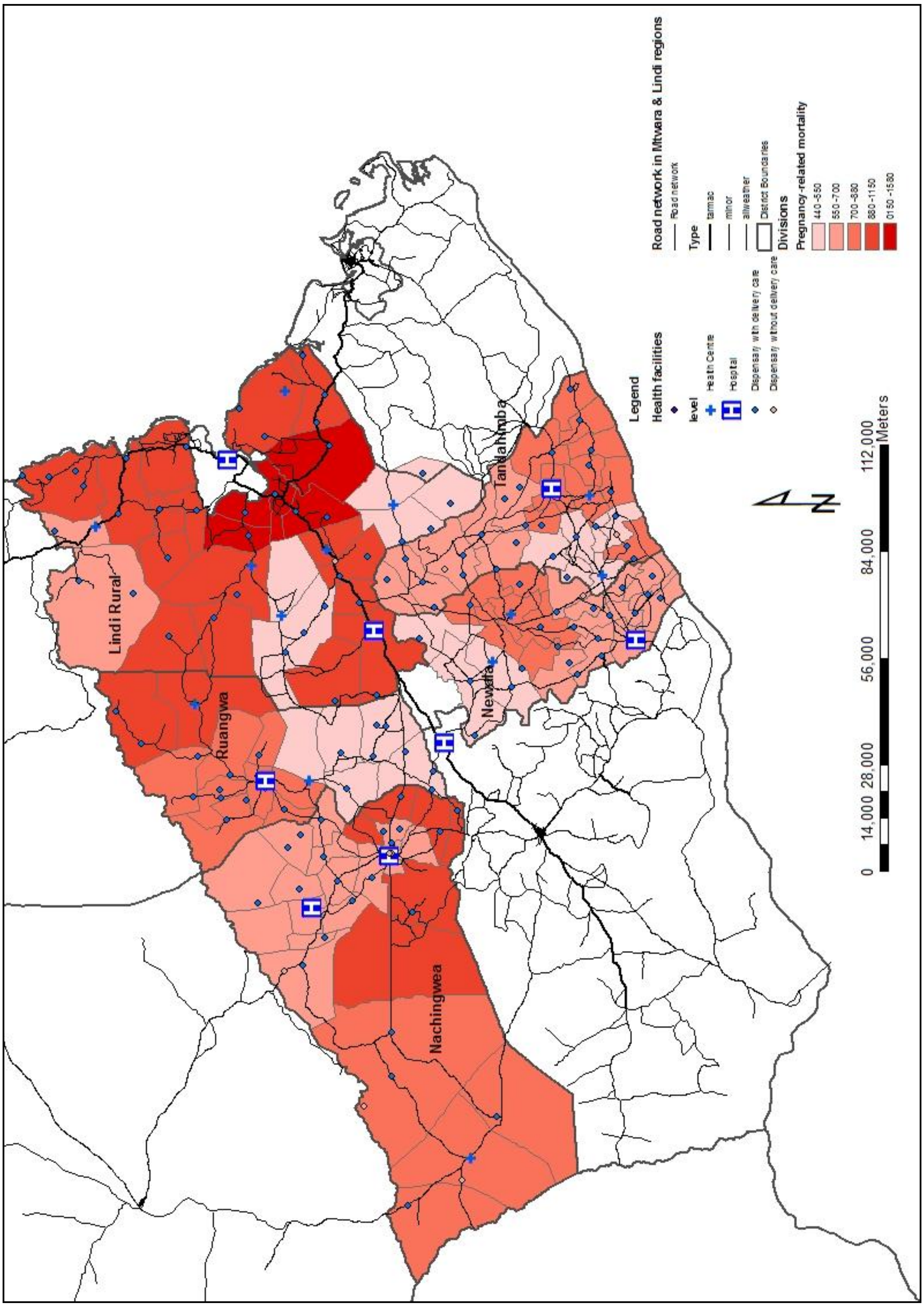


Figure 63: Pregnancy-related mortality by division

Pregnancy-related mortality by contextual factors

Pregnancy-related mortality varied little in relation to classification of the ward (urban/rural) or overall uptake of maternal services in the ward (four of more ANC visits, delivery in first-line facilities or hospital or births by Caesarean section)(Table 70). Mortality was estimated to be 525 per 100,000 livebirths in the only urban ward in the study area. For the rural and mixed wards, a mortality ratio of 730 and 724 per 100,000 livebirths was estimated. Mortality was about a quarter lower in the urban wards compared to rural wards, but confidence intervals were overlapping (OR 0.73, 95% CI 0.25– 2.13).

Table 70: Pregnancy-related mortality by contextual factors

	Number of livebirths	Pregnancy-related mortality		Odds ratio (95% CI)	Score test for tend
		No	Ratio*		
Ward classification of residence					P=0.644
Rural(97 wards)	49,870	397	730	1 (reference)	
Mixed (16 wards)	13,179	104	724	1.00 (0.75-1.33)	
Urban (1 ward)	1,049	6	525	0.73 (0.25-2.13)	
Uptake of four or more ANC visits in the ward of residence (quintiles)					P=0.011
Very low uptake (18-31%)	12,655	81	587	1 (reference)	
Low uptake (33-36%)	12,843	99	707	1.22 (0.85-1.76)	
Medium uptake (37-41%)	12,904	99	704	1.14 (0.79-1.64)	
Higher uptake (41-51%)	12,840	111	793	1.35 (0.94-1.92)	
Highest uptake (51-64%)	12,856	117	835	1.44 (1.01-2.04)	
Uptake of delivery in first-line facility in the ward of residence (quintiles)					p=0.057
Very low uptake (7-24%)	12,751	97	698	1 (reference)	
Low uptake (24-34%)	12,341	79	587	0.83 (0.57-1.19)	
Medium uptake (34-42%)	13,319	114	785	1.03 (0.72-1.45)	
Higher uptake (43-56%)	12,850	97	678	0.94 (0.66-1.33)	
Highest uptake (57-91%)	12837	122	872	1.22 (0.88-1.71)	
Uptake of hospital delivery in ward of residence (quintiles)					p=0.037
Very low uptake (6-17%)	12,662	80	579	1 (reference)	
Low uptake (17-22%)	12,675	92	666	1.14 (0.80-1.63)	
Medium uptake (22-28%)	12,955	121	857	1.38 (0.98-1.96)	
Higher uptake (28-38%)	12,580	101	736	1.25 (0.88-1.78)	
Highest uptake (38-91%)	13,226	113	784	1.34 (0.95-1.90)	
Uptake of CS in the ward of residence (quintiles)					p=0.814
Very low uptake (0.7-2.2)	12,476	89	654	1 (reference)	
Low uptake (2.3-3.1)	12,447	113	833	1.19 (0.84-1.70)	
Medium uptake (3.2-4.2)	13,232	108	749	1.14 (0.80-1.61)	
Higher uptake (4.2-5.4)	13,035	99	697	1.04 (0.73-1.48)	
Highest uptake (5.5-10.7)	12,908	98	696	1.07 (0.74-1.53)	

[1] adjusted for age-standardized birth rate applied to the number of missing birth history in respective categories (adjustment results in 71,198 livebirths)

There was a weak association that mortality was higher when the overall uptake of four or more ANC visits were higher (test for trend p=0.011). Wards in which the overall uptake of four of more ANC was highest (between 51 - 64%) the pregnancy-related mortality was also higher (OR1.44, 95% CI 1.01-2.04). There was no evidence of an association between overall uptake of delivery in first-line facilities and mortality (test for trend p=0.057). There was a weak association between the uptake of hospital delivery in the ward of residence and mortality (p=0.037). Uptake of care in a hospital indicated an inverse from the expected trend. Mortality was higher in women living in a ward with the highest uptake of hospital delivery compared to women living in a ward with lowest uptake (1.34, 95% CI 0.95-1.90). There was no association between overall proportion of birth by Caesarean section in wards and pregnancy related mortality.

Pregnancy-Related Mortality and Distance, Final Model

The bivariate analysis indicated that the district where the mother lived, maternal age, wealth and the education of the head of household were associated with pregnancy-related mortality. There was a strong association between education and occupation and pregnancy-related mortality, but these variables had many missing values and there was indication off selection bias (Table 22). Therefore, education of the mother and her occupation were not included in the analysis. District, maternal age, wealth and the education of the head of household were assessed for the extent to which they confounded the effect of distance to a hospital on pregnancy-related mortality. Maternal age did not change the effect estimate of distance (logOR) on pregnancy-related mortality. District, wealth and education of the head of household changed the effect estimates of distance on pregnancy-related mortality by 10% or more (district 26%, wealth 21% and education of the head of household 10%). Thus district, wealth and education of the head of household were included in the multivariate analysis.

Table 71: Crude and adjusted OR for the effect of distance on mortality for confirmed and direct causes of maternal mortality

Distance	Maternal deaths ~ (442 deaths)		Direct maternal deaths (162 deaths)	
	OR (95% CI)			
	Crude OR	Adjusted OR	Crude OR	Adjusted OR
<5 km	1 (reference)	1 (reference)	1 (reference)	1 (reference)
5-10 km	1.04 (0.65-1.67)	0.92 (0.56-1.49)	1.59 (0.62-4.08)	1.64 (0.61-4.39)
10-15 km	0.85 (0.54-1.35)	0.71 (0.45-1.15)	1.85 (0.80-4.45)	1.86 (0.74-4.66)
15-20 km	0.90 (0.57-1.39)	0.75 (0.47-1.19)	2.32 (0.99-5.43)	2.16 (0.88-5.31)
20-25 km	0.69 (0.42-1.13)	0.54 (0.32-0.91)	1.26 (0.48-3.28)	1.12 (0.40-3.11)
25-30 km	1.20 (0.75-1.93)	1.05 (0.64-1.72)	2.65 (1.09-6.48)	2.64 (1.03-6.76)
30-35 km	1.04 (0.59-1.85)	0.81 (0.44-1.49)	1.89 (0.65-5.48)	1.96 (0.64-5.91)
35-40 km	0.86 (0.34-2.15)	0.70 (0.27-1.78)	4.03 (1.21-13.44)	4.08 (01.16-14.32)
>40 km	1.40 (0.78-2.53)	1.19 (0.65-2.20)	3.54 (1.29-9.71)	3.91 (1.38-11.03)
Missing	1.11 (0.69-1.78)	1.04 (0.65-2.20)	2.50 (1.02-6.13)	2.70 (1.06-6.88)

~excluding 65 deaths not maternal/coincidental deaths according to table 59 & 60

Table 71 gives the crude and adjusted ORs for the effect of distance on mortality for pregnancy-related deaths (excluding the 65 deaths which were not maternal deaths) and the direct maternal deaths. Women living more than 25 km from a hospital compared to less than 25 km were at 40% higher odds of dying in the adjusted analysis excluding the 65 deaths not confirmed to be pregnancy-related (adjusted OR 1.38, 95% CI 1.04– 1.82). The odds of dying from direct maternal causes were almost 70% higher (adjusted OR 1.67, 95% CI 1.11– 2.54) in women living farther compared to within 25 km of a hospital. The estimates were very similar when including only original GIS data (data not shown).

Sensitivity Analysis of the Effect of Distance to a Hospital on Mortality using Original GIS data

To investigate to which extend the cleaning and imputation changed the effect estimates for distance to a hospital on mortality a sensitivity analysis was done restricting the multivariable analysis to best quality original GIS data. Table 72 shows the results of the effect estimates based on 1) original and computed and 2) only based on original GIS data. The effect of distance to a hospital on mortality for all causes of maternal deaths was very similar for both groups of data (Table 72, Figure 64).

Table 72: Adjusted OR for the effect of distance to hospital on mortality for confirmed and direct causes of maternal mortality by GIS data quality

Distance	Maternal death ~ (442 deaths)		Direct maternal deaths (162 deaths)	
	Adjusted OR (95% CI)*			
	All GIS data	Original GIS data	All GIS data	Original GIS data
	442 deaths	321 deaths	162 deaths	109 deaths
<5 km	1 (reference)	1 (reference)	1 (reference)	1 (reference)
5-10 km	0.92 (0.56-1.49)	1.06 (0.61-1.83)	1.64 (0.61-4.39)	1.65 (0.53-5.14)
10-15 km	0.71 (0.45-1.15)	0.70 (0.41-1.22)	1.86 (0.74-4.66)	1.64 (0.55-4.93)
15-20 km	0.75 (0.47-1.19)	0.86 (0.51-1.45)	2.16 (0.88-5.31)	2.10 (0.73-6.08)
20-25 km	0.54 (0.32-0.91)	0.47 (0.25-0.87)	1.12 (0.40-3.11)	0.66 (0.18-2.40)
25-30 km	1.05 (0.64-1.72)	1.14 (0.65-1.99)	2.64 (1.03-6.76)	2.21 (0.72-6.76)
30-35 km	0.81 (0.44-1.49)	0.82 (0.41-1.64)	1.96 (0.64-5.91)	1.00 (0.24-4.17)
35-40 km	0.70 (0.27-1.78)	0.39 (0.11-1.36)	4.08 (01.16-14.32)	1.45 (0.25-8.24)
>40 km	1.19 (0.65-2.20)	1.27 (0.65-2.48)	3.91 (1.38-11.03)	3.73 (1.16-11.96)

~excluding 65 deaths not maternal/coincidental deaths according to table 59 & 60
*adjusted for district, wealth and education of the head of household

In contrast, the effect estimates for distance to a hospital on the mortality due to direct maternal deaths were weakened when the analysis was restricted to deaths for with only original GIS data. The effect of distance on mortality was in particular weakened in the distance groups 30-35 km and 35-40 km.

Comparing the adjusted effect estimates of mortality due to direct maternal deaths for women living at a distance of over 25 km compared to less than 25 km suggested a 50% higher mortality in women living further away (OR 1.47, 95% CI 0.92-2.35). Thus the when restricting the analysis to only original data the effect on all cause maternal mortality changed little whereas the effect seen on direct maternal deaths was slightly weakened and not significant any longer.

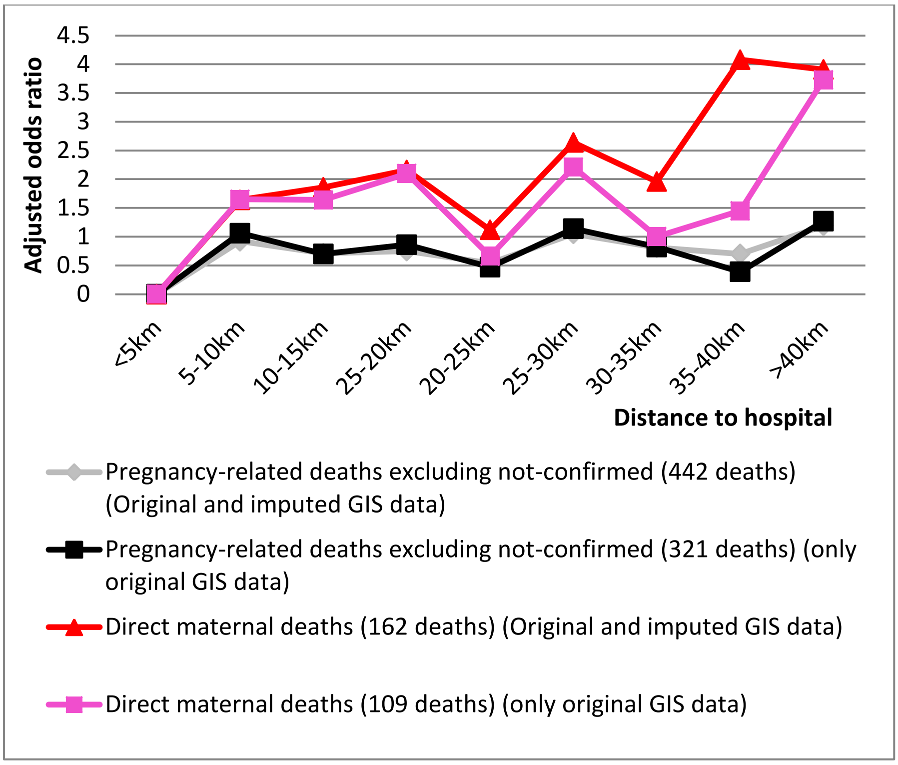


Figure 64: Comparison of adjusted OR for the effect of distance to hospital on mortality by GIS data quality

4. Distance, Uptake of Care and Pregnancy-Related Mortality

The main aim of the study was to assess the relationship between mortality and access to maternal care. The following graphs bring together the results from the analysis of uptake of care and pregnancy-related mortality.

Figure 65 displays the pregnancy-related mortality by distance and overlays the proportion of deliveries in hospitals and births by Caesarean section using a log-scale. Whereas delivery in a hospital declines from 72% within 5 km of a hospital to 34% within 5– 10 km distance from a hospital, pregnancy-related mortality was only higher in women living more than 25 km from a hospital. The proportion of births in a hospital or by Caesarean section was relatively constant within 10– 40 km of a hospital at around 22% for hospital delivery and 3.2% for birth by Caesarean section.

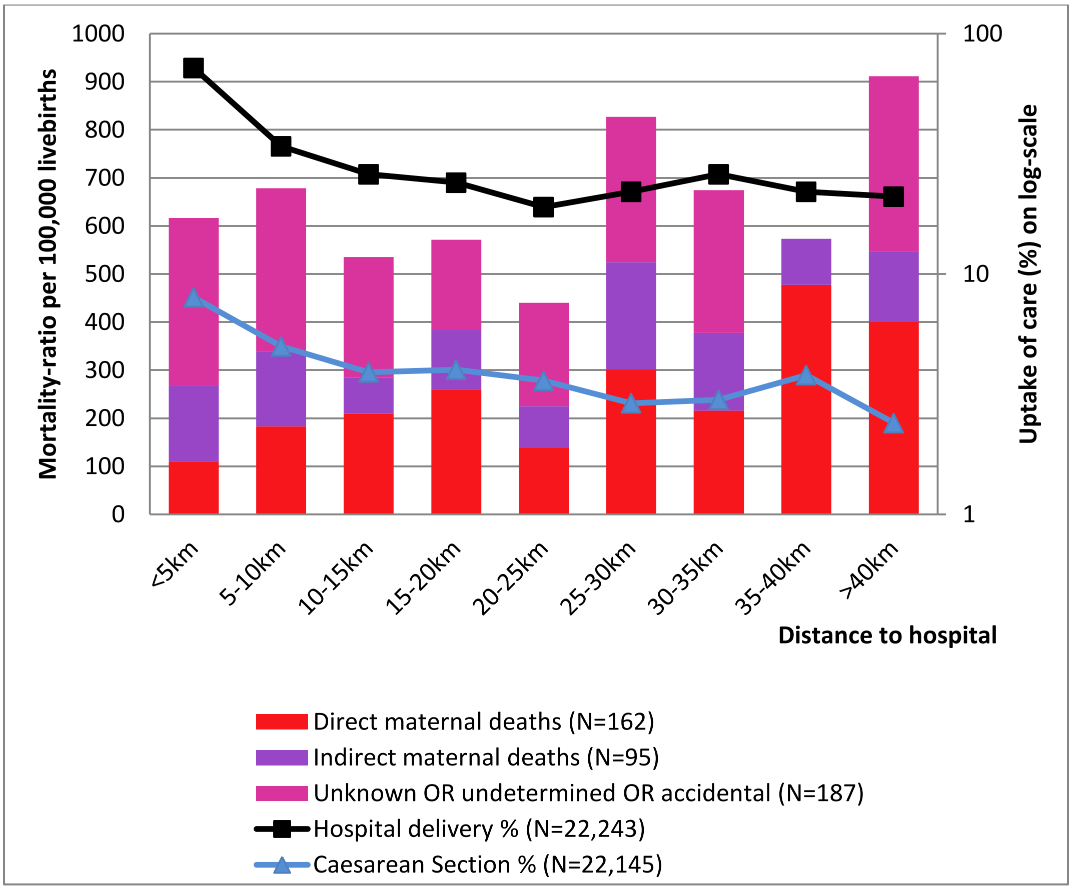


Figure 65: Uptake of care and pregnancy-related and maternal mortality by distance to hospital

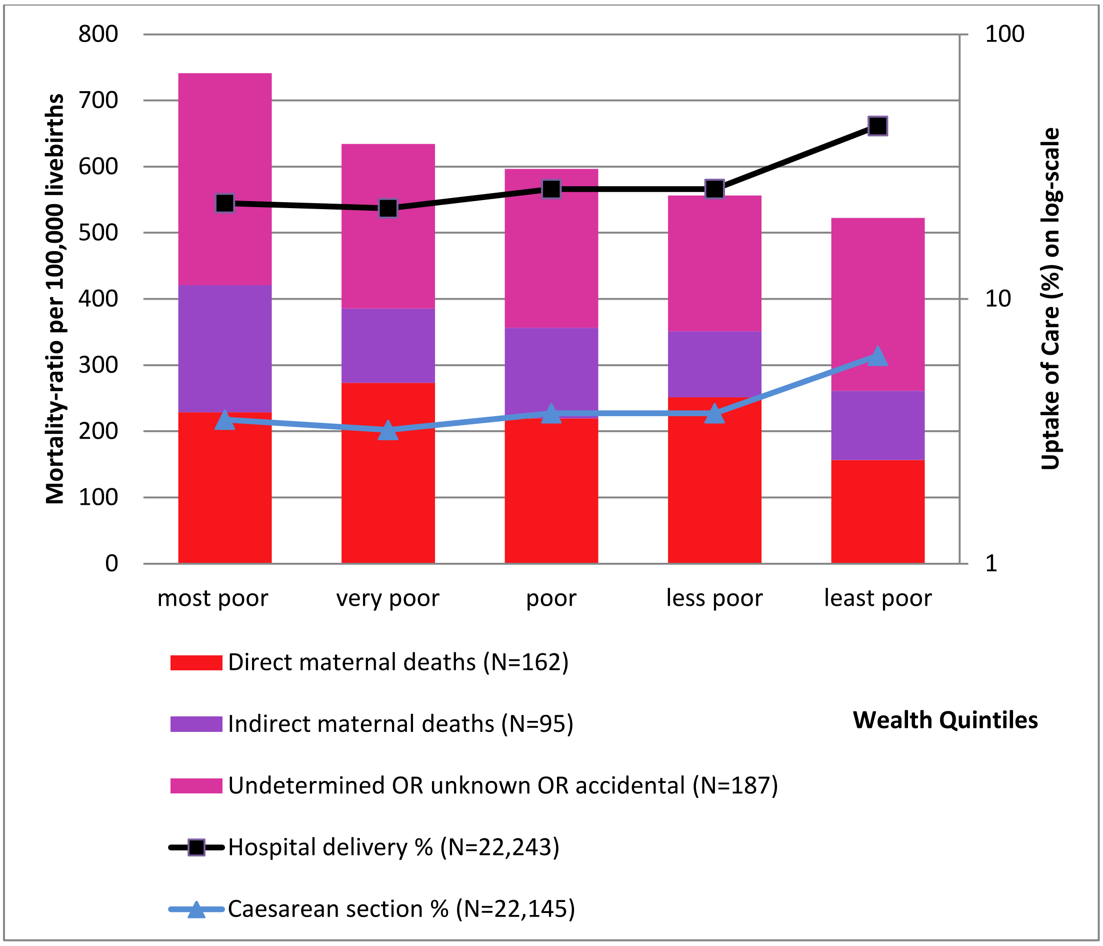


Figure 66: Uptake of care and pregnancy-related and maternal mortality by wealth quintiles

Pregnancy-related mortality was the highest in the lowest wealth quintile, declining slowly to the lowest levels in the highest wealth quintile (Figure 66). An inverse pattern was seen for uptake of care, as expected, suggesting that the higher uptake of care in the highest wealth group might have contributed to the lower mortality. Both uptake of hospital care and the proportion of births by Caesarean section are almost twice as high in women in the least poor compared to the poorest quintile, still, the level of pregnancy-related mortality is only approximately 25% lower among women in the least poor quintile compared to the most poor.

Figure 67 shows the adjusted OR for the effect of distance on uptake of care (hospital delivery and birth by Caesarean section) and all-cause pregnancy-related mortality and direct maternal mortality. The pattern suggests that the odds of delivering in a hospital or having a birth by Caesarean section declined with increasing distance from a hospital. An inverse effect was seen for mortality due to direct maternal causes. In contrast, no clear pattern between mortality and distance was seen for indirect maternal deaths.

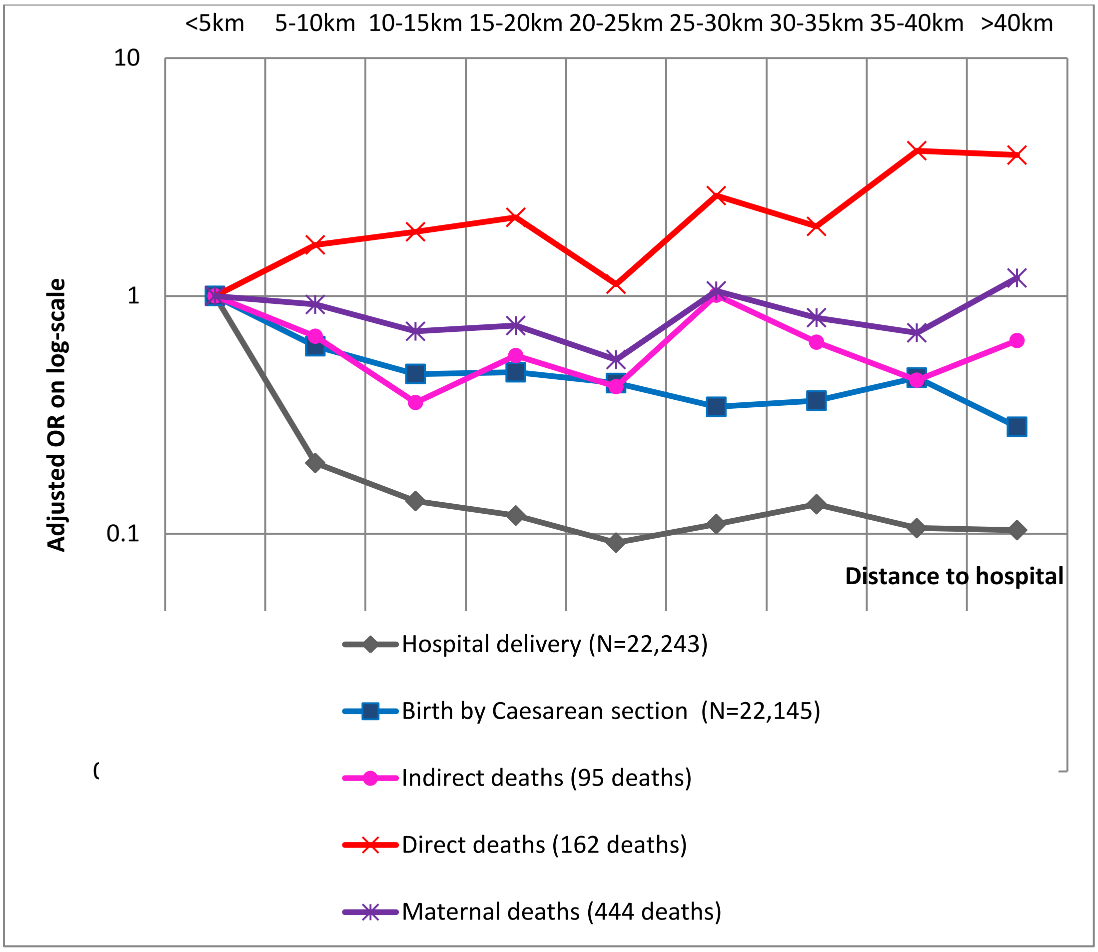


Figure 67: OR for the effect of distance to a hospital on uptake of care and pregnancy-related and maternal mortality

*Hospital delivery and birth by Caesarean section adjusted for district, wealth, education and occupation. Pregnancy-related mortality estimates adjusted for district, wealth and education of the head of household

Comparing women living farther than 25 km of a hospital to women living within 25 km of a hospital, the odds of dying were 40% higher when excluding the 65 non-maternal deaths, and 70% higher when including only direct maternal causes. However, no significant association was seen for indirect maternal deaths (excluding 65 non-maternal deaths: OR 1.37, 95% CI 1.04– 1.82; direct maternal causes: OR 1.68, 95% CI 1.11– 2.54, indirect maternal causes: OR 1.55, 95% CI 0.88– 2.71).Thus, the pattern of uptake of care and maternal mortality in relation to distance suggests that hospital delivery and birth by Caesarean section have the largest impact on direct maternal deaths, which is expected.

Chapter 4: Discussion

The discussion chapter will first address data quality and measurement issues, including completeness and representativeness of information. Secondly, this chapter will comment on the findings of the results section, including: an assessment of the quality of maternal care assessed through the health facility census; the pattern of uptake of maternal care; the results from the index of maternal health and its assessment of uptake of delivery care at first-line facilities; and finally, the determinants of pregnancy-related mortality.

In each section, the main findings are summarized and compared with results from other studies in Tanzania and elsewhere. Strengths and limitations are discussed and conclusions are made. In the last section on recommendations for health policy and planning, I bring the results from the different sections together. The main implications of the findings for quality of care, accessibility and uptake of maternal care as well as the determinants of pregnancy-related mortality were scrutinized in order to make recommendations for improved policy and health care organization to reduce pregnancy-related mortality. In addition, suggestions for further research based on identified limitations and strengths are outlined.

1. Data Quality and Measurement Issues

In this section, an assessment of the completeness and representativeness of data for rural Tanzania is provided to allow for discussion of potential bias. Misclassification and selection bias are important considerations, as well as reduced power and precision due to missing data. A final judgment on the extent to which the provided estimates are likely to be valid and representative for other areas in rural Tanzania is given.

Completeness and Representativeness of Data for Rural Tanzania

Our census included 813,583 people in the five districts. A total of 6.5% of households were empty. The total number of people found in the households was lower than one would expect, even taking the empty households and refusals into account. The total population was estimated at 890,939 in the five districts according to the census in 2002. The national census 2002 reported that Lindi region had the lowest population growth rate in Tanzania between the national censuses of 1988 and 2002 (annual increase of 1.4%) [336]. Using the 1.4% average annual population increase for Lindi region, the projected population would have stood at 938,301 people in 2007. New population data from the 2012 census are not yet available for comparison, thus, no final judgment on whether people were truly missed despite the careful approach taken (p 104) can be given.

The population distribution (Figure 28) was similar to distributions obtained across other demographic sites in Tanzania [366], described by the most recent DHS [255], and the most recent national census [336]. We found that 24% and 19% of women and men were aged 15 – 49 years. The respective figures reported by the latest DHS were 22% for women and 20% for men [255]. The national census in 2002 reported that 25% of the population were women and 22% were men aged 15 – 49 [336].

The percentage of female headed households was slightly higher in our study area in southern Tanzania at 29% compared to an average of 25% of households in Tanzania described in the most recent DHS. The population age distribution in our data and the higher level of female headed households both suggest that some men in the age group 15 – 49 years were missing at the time of interview (see Figure 28), possibly due to out-migration.

The mean household size in the study area was 3.6 members, which was considerably less that the mean household size of 4.9 in mainland Tanzania reported by the most recent DHS [255]. The definition of households used in our study was very similar to the one use in the DHS (people living and eating together). The lower fertility in southern Tanzania compared to other areas in Tanzania might partly explain the smaller household size [255].

The study area in southern Tanzania has often been described as a poor and disadvantaged area in Tanzania. The most recent DHS classified 41% and 36% of households in Lindi and Mtwara regions as belonging to the poorest quintile [255]. Comparison of information on ownership of assets and housing conditions provided by the Tanzanian AIDS and Malaria Indicator Survey 2007 and the household budget survey 2007 indicated lower levels of ownership and poorer housing conditions in our study population [259, 367]. The education level of women aged 20 – 24 years in the study area was lower than the average levels described by the most recent DHS for Tanzania. Our 2007 census reported that 56% of women aged 20 – 24 years completed primary school and 0.3% completed secondary school in the study area. The corresponding figures from the DHS were 65% with completed primary school, and 1.9% of women with completed secondary school for this age group [255].

In contrast, geographical accessibility to health care in the study area was slightly better than average in rural Tanzania as reported by the household budget survey [367]. However, in the household budget survey, respondents were asked to estimate distance to the nearest health facility, whereas in our study, the distance was computed as straight-line distance using geographical positioning, which limits comparability of information.

Overall, the comparison of assets, household characteristics and educational attainment suggests that the households in the study area were poorer and women were less educated than in mainland Tanzania.

The census on which the analysis is based aimed to (i) to investigate the effectiveness of intermittent preventive treatment in infants aged 2– 22 months; (ii) and to estimate baseline newborn mortality for a larger cluster randomized trial to investigate into the community effectiveness of a novel approach using community volunteers to improve neonatal survival in rural southern Tanzania (INSIST). Both studies are unlikely to have influenced the pattern of uptake of care during pregnancy and childbirth or pregnancy-related mortality as described in this study. First, the trial to investigate in the effect of intermittent preventive treatment in infants aged 2– 22 months included the application of malaria medication during routine vaccination. This intervention was thus only targeting mothers with children but not pregnant women and it is not likely that it had altered any pattern of uptake during antenatal and childbirth care. Secondly, the INSIST intervention was only implemented two years after this large census had been finalised.

Completeness of Livebirths and Pregnancy-Related Deaths

For 9% of women living in the study area, no birth histories were available (p 143). The missing birth histories can potentially introduce bias in both main analyses: the analysis of the determinants of uptake of care and in the analysis of pregnancy-related mortality. Moreover, missing data may reduce the power of the study to detect an association, which is why an effect might be missed. Estimates may have lower precision, which affects the assessment of confounding and interaction.

Missing birth histories

Missing birth histories posed a problem in the analysis of pregnancy-related mortality. Missing birth histories are likely to have caused an underestimate of livebirths by approximately 9%. This inaccuracy potentially leads to an overestimation of the pregnancy-related mortality ratio, therefore, the estimated ratio of the number of livebirths has been inflated by the age-standardized birth rate observed within the three years applied to missed birth histories.

The response rate was slightly lower in women with higher education, in the least poor wealth quintile, for those with employment and for women living in Tandahimba district (Table 21). The higher missing values among more educated, wealthier, and employed women might be due to their greater absenteeism from home during the day time, making it more difficult for interviewers to find them. The higher proportion of missing data in Tandahimba district might reflect the fact this was the last district surveyed and interviewers might have reduced their efforts to find all women of reproductive age.

There is no evidence that the reason for the missing birth histories has an association with any outcome measurements. Uptake of care and pregnancy-related mortality differed within sub-groups and mortality was associated with socio-demographic characteristics. Thus, we cannot be sure that the data were missing at random. Only if data are "missing at random" or "missing completely at random" can a complete case analysis be safely performed with results that are assumed to be unbiased [368], which might not hold true for our data. Therefore, multiple data imputation exercises and further research are needed (see implications for research p 285).

The higher number of missing birth histories in women with higher education, those belonging to the least poor wealth quintile and those with employment could potentially lead to an underestimation of the effect of higher wealth, higher education or formal employment on uptake of care. Women being higher educated and employed are likely to have a higher uptake of care. However, missing data in the sub-groups only varied by up to four percentage points above and below the mean missing value of 9%. Moreover, fertility in higher educated and formally employed women is commonly lower than average, which is why they have had fewer births than other women on average. The selection bias might be small with missing data being unlikely to change the main findings of the analysis of uptake of care. The presented effect estimates for uptake of care in higher educated, wealthier and employed women might be slightly reduced.

Completeness of recording of livebirths

The completeness of livebirths attained during the birth history interviews seems to be reasonable for the period of analysis (Figure 32). However, some livebirths were missed by not recording the livebirths of women who had died in pregnancy or from other causes. One can assume that around 250 livebirths from mothers who died in pregnancy were missed[23]. The number of livebirths missed by not obtaining information about livebirths from mothers who died from non-pregnancy-related causes is more difficult to judge. If the birth rate among these women is similar to the women who were interviewed,[24] about 1,000 livebirths would have been missed. But, as these women have died at different times during the recording period, they are not likely to have given birth with the same proportions as women who were alive and interviewed. Therefore, less than half can be assumed to have had a livebirth prior to their deaths. We can assume that more than 650 livebirths were missed (approximately 400 livebirths from mothers with a non-pregnancy-related death and 250 livebirths from mothers who died in pregnancy). Thus, the overall number of livebirths included in the analysis is likely to be around 1% too low (64,098 instead of 64,748 if corrected) by omitting livebirths in women who died.

Issues using livebirths as denominator

Although it is convention to express maternal mortality as deaths per 100,000 livebirths, this overestimates the risk of mortality per pregnancy as it excludes around 35% of pregnancies ending in abortion (spontaneous and induced) and stillbirth [369]. Our census in southern Tanzania did not collect information on stillbirth, abortion or miscarriage. Documentation of

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[23] **Assuming that 50% of women who died in pregnancy and childbirth had a livebirth as our analysis suggested (**

Table 65).

[24] 64,098 livebirths to 193,867 women in reproductive age gives a birth rate of 0.33 livebirths per women in the defined time period. About 3000 women died from non-pregnancy related causes (Figure 299).

stillbirths is prone to being unreliable [370, 371]. Information on the number of pregnancies is even more difficult to obtain as women might have a miscarriage before they recognize a pregnancy in the first trimester. Thus, the denominator available for this study was the number of livebirths.

The limitation of birth histories to women with a livebirth also reduced the number of deliveries and thus affects the results on the determinants of uptake of care. Overall, 28 stillbirths per 1000 total births are estimated to occur in sub-Saharan Africa [371]. Using this value, about 3% of deliveries were missed by not including deliveries resulting in a stillbirth. Women with complications are both more likely to deliver in a hospital and more likely to have a stillbirth. It can be assumed that women with complications, living further away and being transferred to a hospital have a higher proportion of stillbirths. Thus, the omission of stillbirths introduced a bias, which is likely to result in a reduction of deliveries in women living further away and might have strengthened the effect of distance.

Ascertainment of pregnancy-related deaths

The ascertainment of pregnancy-related deaths was done by asking the head of household about any deaths in the household since January 2004. A single question was used to ascertain the pregnancy-related deaths instead of the more common three-question sequence. However, there is no clear indication from the literature that the three-question sequence is superior [39, 73].

Ascertainment of pregnancy-related death through a household census always faces limitations in completeness [39]. Households may dissolve after a female death. Stigma and shame might reduce reports on deaths, particularly when considered to be due to stigmatized causes such as HIV or abortion. In addition, the head of household might not be aware of the pregnancy status. This is why reproductive age mortality surveys using a variety of sources such as civil registration, community informants, household visits, burial statistics and others to identify deaths are commonly considered more likely to identify all pregnancy-related deaths [1].

Cross-tabulating information from the household questionnaires and the verbal autopsies (Table 59) indicated that 15% of deaths were probably not maternal deaths according to the conventional definition [20]. No judgment on the number of pregnancy-related deaths missed can be given, as no verbal autopsies for non-pregnancy-related deaths were done (see also p 268). This presents a clear limitation of this study and no indication is available on the approximate number of false negative pregnancy-related deaths. In Burkina Faso, a large number of deaths reported to be non-pregnancy related were reclassified as pregnancy-related when verbal autopsies were done for all deaths of women in reproductive age (see more p 268) [73].

Ascertainment and completeness of explanatory variables

The completeness and data quality of explanatory variables recorded at household level and during the birth history interviews with women of reproductive age were very high (Table 22) except for geographical positioning (see p 111 and p 152). The use of personal digital assistants for data recording is likely to have contributed to the high completeness and data quality [344, 372, 373]. Thus, no major selection bias due to missing explanatory data is likely to have affected the analysis of household and individual factors on uptake of care except for education and occupation in the analysis of determinants of pregnancy-related mortality.

The ascertainment of education and occupation of women who died was done through verbal autopsy interviews. For 14% (73 out of 507 deaths) of pregnancy-related deaths, no verbal autopsy was available and thus information on education, occupation and cause of deaths was missing[25]. There is no indication that verbal autopsies were missed because of any factor related to the households or the outcome measures. The comparison of household characteristics for women who died and for whom a verbal autopsy questionnaire was available with women without such questionnaire did not suggest that missing information was greater in any sub-group (Table 19).

The reason for the missing verbal autopsies is not clear (Figure 30). Thus, there is insufficient information to gain a clear understanding of why interviews were not done. Overall, the percentage of missing values was similar, at 84% to that reported by another study in Tanzania [56].

The information on explanatory variables and uptake of care was collected from mothers with a livebirth in the year prior to the survey. This timeframe limits the recall period to one year, which reduced misclassification of the distance to health facility at time of delivery, as the number of women having moved within a year is likely to be limited. A questionnaire in Swahili, which is widely spoken by the target population, was used. Both the short recall period and the use of Swahili for interviewing are likely to have limited any recall bias [374]. In contrast, the analysis of pregnancy-related mortality used reported deaths and recorded birth

[25] There was a mismatch in electronically and physically available verbal autopsy interviews as a cause of death diagnosis based on physician review was available.

for a period of three years prior the survey. It is likely that this longer recording period had a negative effect on data quality. This might also be a reason for the questionable results found for the effect of education and occupation on mortality risk. Recall bias is likely to have constrained the assessment of the mother's education and occupation status, particularly for mothers who died (see Table 67).

The wealth index used included household assets and housing characteristics and a principle component analysis for data reduction. Both the use of an asset index and principle component analysis for data reduction are established methods that have been applied in several other studies in the area [271] and elsewhere in Tanzania to examine effects on child mortality [375]. The wealth index is described as a proxy for socioeconomic status and is broadly consistent with income or expenditure measurements, which are much more difficult to obtain [376, 377]. Wealth indices have been widely used in DHSs in the last decade [14, 378]. There are also shortcomings with these methods, most importantly, that the choice of assets has an effect on the classification of households [104].

The wealth index might not give a good indication of the amount of cash available. Availability of cash might be of great importance for uptake of hospital delivery, where there are costs for transport, food and accommodation while waiting for the onset of labour, as well as official and unofficial costs for admission and treatment. Studies indicate that costs for transport, admission and treatment may amount to as much as 15 USD [327, 328].

Education was assessed by determining full years of schooling. Categories constructed were in line with categories used in the latest DHS [255]. The construction of education levels on the basis of years of schooling might not always reflect the true education level because of repeated years. Some women might not have reached the education level they were assigned to using the years of schooling. Moreover, there is some ambiguity in the definition of secondary school attainment. Most Tanzanians attending secondary school never get beyond four years of secondary school. For testing of confounding and adjustment of effect estimates, a continuous variable of years of schooling was used. Therefore, ambiguity in the definition of secondary education should not be an issue. The advantage of using the same categories as used in the DHS was that the analysis could be compared with national estimates.

Information on parity was constructed on the basis of livebirths reported by mothers, which differs from the conventional definition where stillbirths are included. "Parity" as used in this study is not comparable with parity as used in studies based on the standard definition. The number of total births (livebirths and stillbirths) was likely to be underreported by 3% [371].

No differential bias was introduced because the definition was the same for all participants included in the analysis of uptake of care. Parity could not be included in the analysis of pregnancy-related mortality because the verbal autopsies did not include any information on previous births.

Completeness and Reliability of the Distance Measurement

The analysis of distance to a health facility used household coordinates. The measurement reflects the true distances from each household to a health facility, which is a great strength, as in the study area settlements often expanded over more than 1 km.

However, the data were constrained by quality assurance problems during data collection and by missing data. A total of 26% of coordinates were missing before the data cleaning and imputation procedure. In addition, 7,262 coordinates (3%) were wrongly assigned to individual households, causing a mismatch between actual location indicated by the GIS data and the location (sub-village, ward) to which the household belonged according to the household listings. Extensive data cleaning and imputation of missing data was done to rectify this problem (p 111). A total of 7,262 household coordinates were corrected and 35,385 were imputed. Despite this, 10% of distance coordinates remained missing in the analysis of uptake of care and the analysis of pregnancy-related mortality.

All tables examining distance have included a row specifying uptake of care and mortality in the group of women with missing data. The results in the group of women with missing data in relation to uptake of care were virtually identical to the average of all women. However, in the analysis of pregnancy-related mortality, death rates were higher than average among women with missing distance data (Figure 64).

The missing data are concentrated in one district (Newala district), around Newala hospital and Lindi Regional hospital (Figure 33). There was some variability with socio-demographic variables (see Table 74 in annex). Thus, it is possible that some bias was introduced, although the mechanism of missing data is not related to the outcome [368]. In order to explore the bias introduced by the missing GIS information multiple imputation exercises and further research is needed. However, the sensitivity analysis restricting the analysis of the effect of distance to a hospital or first-line facility to the original quality data proposes that the results are little flawed as effect estimates changed very little (see Figure 56).

The largest bias introduced in the analysis of distance and uptake of care and pregnancy-related mortality is that the actual place of delivery was not known. We calculated the distance to the nearest facility, but mothers might have delivered in a different facility than the nearest one (see discussion p 256). This complicates the interpretation of the factor distance of uptake of care and pregnancy-related mortality. Some women might have been misclassified living close to a health facility whereas they travelled far to receive care from another facility [307]. Thus for these women the factor distance was of little importance why the effect of distance of uptake of care might be less important than actually described in this analysis. No question on the actual place of delivery was included, which is why no estimation can be given to which extent this misclassification occurred. There were only few facilities in the area which have an outstanding reputation so that this effect of delivering in another that the nearest first-line facility might be limited. In addition, women also move to their original families for delivery and might have delivered even outside the study area [163].

Interpretation

The combined use of data from a household and health facility census, which were linked using GIS, provided a unique opportunity to investigate the relationships between accessibility and functioning of health facilities, uptake of care and pregnancy-related mortality [90]. The study included 507 pregnancy-related deaths and 64,098 livebirths recorded in the three years prior to the survey. A total of 22,243 women with livebirths in the year prior to the census were included in the analysis of uptake of care. This number is much larger than what is commonly included in national DHS surveys. The most recent DHS included less than half the number of pregnancy-related deaths and only about a quarter of women with a livebirth.

A main strength of the data used for this analysis is that they were obtained through a census of all households and health facilities, thus, no sampling error constrains the results. Moreover, the total number of livebirths and deaths were large, which made it possible to calculate levels of uptake of care and mortality levels, even for sub-groups with narrow confidence intervals. In addition, verbal autopsies for a large number of these deaths were done, providing information on the cause of death. Data quality was high as recall bias and misclassification of distance were reduced by a one year recall period. Geographical information was available for single households, not village centres, which also increased precision of estimates.

Although this study faced limitations due to missing birth histories and missing GIS information, overall the data are of high quality. The data were collected in slightly poorer and disadvantaged areas in Tanzania, but the main findings are likely to be largely applicable to other rural areas in Tanzania. It is not likely that the fact that this study was done within a larger trial to estimate the effect of a strategy of intermittent preventive treatment in infants aged 2– 22 months has altered results.

2. Quality of Maternal Care at Health Facilities in the Five Districts

The analysis of quality of care in health facilities in Lindi and Mtwara regions suggests that there are major deficiencies in quality of ANC and childbirth care at all levels. There are three major challenges for childbirth care in rural southern Tanzania. Firstly, dispensaries are inadequately staffed to provide quality childbirth care on a full-time basis. Secondly, coverage levels for essential childbirth care interventions such as AMTSL, screening for pre-eclampsia and infection prevention measures including prophylaxis of ophthalmia neonatorum are insufficient, even at the hospital level. Thirdly, the number of deliveries in dispensaries and health centres is low. Only a few cases of emergency obstetric complications are seen at first-line facilities and only a quarter of health centres reported having implemented any of the EmONC key signal functions during the past six months. Thus, none of the facilities would qualify as providing BEmONC if the EmONC classification was used [156].

Comparison with Other Studies

Staffing levels were below national standards for clinicians and midwifery staff, particularly at the dispensary level as described elsewhere [264, 269, 271, 379]. MCHA and assistant clinical officers, the predominant health providers in first-line health facilities in the 1990s, have largely been replaced by better qualified staff, a positive trend that has also been reported by the Safe Motherhood Assessments of 1999 and 2007 in the same area [260, 380]. Despite the improvement of staff qualifications, half of dispensaries do still not have certified midwifery staff and the median staffing level is only 2.5 health workers. Very similar staffing levels were also described in a health facility census done in 2004 in the same area, highlighting little improvement over time [271].

Both the availability and distribution of staff for maternal care were inadequate, hindering the provision of quality delivery care on a full-time basis. The situation is unlikely to improve in the short term with currently low outputs from training institutions [268, 381] and as general budget ceilings limit the expansion of health staff in the government sector.

The reported **quality of care during ANC and childbirth** care echoes the known deficiencies regarding critical interventions as described in several studies from Tanzania. Coverage was higher for interventions such as vaccination and prevention of malaria and HIV, which are supported by global initiatives. Low coverage levels were found for measurement of blood pressure, haemoglobin and urine protein as reported elsewhere as well [295, 296, 382].

The low level of implementation of very cost effective and technically simple interventions such as AMTSL and blood pressure screening for pre-eclampsia were striking. Inadequate implementation of AMTSL has also been reported from other studies in Tanzania [235]. Our data suggest that low implementation cannot be entirely explained by the lack of uterotonics. Health workers often explain "saving" oxytocics for cases of postpartum haemorrhage. Other major deficiencies were seen in the availability of sterilization equipment. A qualitative study done in the study area suggested that, providers often have to use the second or third best option for sterilization, putting patients at risk [383]. Partographs were reported to be used in hospitals in Tanzania, but not always in a satisfactory manner [311, 384, 385]. We also reported a relatively high proportion of general usage, but insufficient recoding of fetal and maternal wellbeing.

The **caseload**, particularly for deliveries in first-line facilities was low. The mean number of deliveries at health centres and dispensaries was eight and four deliveries per month, respectively, during 2008. This low caseload was also reported by the Safe-Motherhood Assessment carried out in 2007 in the same study area [386], but much lower than reported by the national SPA 2007 (median of six and 16 vaginal deliveries per months in dispensaries and health centres, respectively) [264]. The differences can be partly explained by the fact that the SPA gives an average estimate for urban and rural areas, and that fertility in southern Tanzania is lower than in some other parts in Tanzania [255].

High levels of home deliveries and the fact that women prefer hospitals and mission facilities are key factors contributing to the low caseloads in dispensaries and health centres [255, 307]. Low caseload may compromise the technical quality of care [387]. Although no threshold of minimum caseload has been put forward, it has been suggested that midwives ought to handle up to a maximum of 175 deliveries per year [369]. This caseload would allow trained attendants to experience and regularly handle complications such as postpartum haemorrhage and pre-eclampsia. The fact that only 2% of dispensaries reported a case of eclampsia, and that sedatives had been given in only 1% of facilities further suggests that in this setting, either skill maintenance has to be ensured through strong supervision and regular obstetric practice or retraining or delivery care needs to be more centralized to maintain skills [135].

Health centres seem to be greatly underused, despite data suggesting that the quality of care was substantially better than in dispensaries (38% provided all selected essential interventions compared to 5% for dispensaries). One reason contributing to the low use of health centres might be that their role in delivery care is ill-defined [322, 323]. The perceived quality of care might be low, partly because women might not be informed of the better technical quality at health centres. Perceived quality of care is a major driver of care-seeking, and hence, many studies suggest that women prefer to deliver at higher level facilities despite increased distance and costs [293, 307, 330].

Overall, few **obstetric complications and emergency obstetric interventions** were reported by health facilities. The most common complications were postpartum haemorrhage and obstructed labour, followed by abortion complications. Overall complications seem to be under reported. Postpartum haemorrhage is likely to complicate at least 10% of deliveries in sub-Saharan Africa [236, 237]. Thus all dispensaries should have reported at least one case and health centres two-to-three cases in the preceding six-month period. The lack of a clear case definition for postpartum haemorrhage as well as documentation deficiencies might partly be responsible for the unrealistically low account of bleeding complications[26]. The low level of reports of pre-eclampsia and eclampsia might be the results of the low use of diagnostic measurements (blood pressure and urine protein tests). Although more than 50% of facilities reported that magnesium sulfate was available, only one dispensary, no health centres and only 50% (three of the six) of the hospitals reported to have given parenteral sedatives to a patient.

Only one of the six hospitals included in the study reported to have used vacuum extraction in the six months prior to the health facility census. Under use of assisted deliveries has also been reported from referral institutions with levels around 2% of deliveries in Tanzania [317, 318]. The Safe-Motherhood Assessment done in 2007 reported that the use of vacuum extraction in hospitals declined between 1999 and 2007 from a total of 73 to 12 extractions performed in all four hospitals in the three districts in Lindi region included in this study [386]. The proportion of births by instrumental vaginal delivery is around 6% in many high income countries [388-390]. The WHO Global Survey reported a proportion of 1.5% and 3.6% of all deliveries to be by forceps or vacuum in Africa and Asia, respectively [391]. Thus, in some countries, particularly sub-Saharan Africa, the practice is waning [392]. SPAs carried out during previous years in Uganda, Tanzania, Rwanda, Namibia and Kenya indicated that only 50% of hospitals are equipped with forceps or vacuum extraction instruments [277].

[26] The health management information system (MTUHA) request documentation of post-partum haemorrhage but no clear definition is provided

Reasons for low use put forward by health professionals in Tanzania include the HIV epidemic and the higher expected HIV transmission rates from mother-to-child with assisted vaginal deliveries [393], although strong evidence is lacking [394, 395].

The result that no first-line health facility was offering BEmONC is comparable to other studies from Tanzania [264, 315, 316, 396] and elsewhere [231, 240, 277], which indicate low availability of BEmONC in first-line facilities.

Validity of Health Provider Reports on Implemented Interventions

The implementation levels for ANC interventions reported by health providers during the health facility census were higher than reported by women with a livebirth in the year prior to the survey (see Table 77 in annex). This finding is expected. Health providers' accounts are likely to be strongly influenced by social desirability bias, thus, health provider reports of services will be higher than the true implementation level. In contrast, women's reports might be lowered by recall bias. Comparison with women's reports obtained through birth histories, other published observational studies and ANC card case reviews suggests that the levels reported by health providers were about 10% higher for physical examinations (height, weight and blood pressures) and tetanus immunization [299, 382]. Reports on laboratory testing were very similar regardless of source and method (health provider reports, observations or birth histories). However, health provider reports suggest higher levels of counseling on danger signs and birth preparation as well as on IPTp and bednet promotion than reported in observational studies [299, 300] and by women with a livebirth the year prior to the survey.

Sarker and colleagues, comparing observation and self reports by staff, reported that intervention levels were around 25 percentage points lower for observed versus reported activities, but gaps differed greatly by the type of intervention or services and were highest for counseling [300]. Other observational studies suggest low implementation of counseling activities. In a study in 18 first-line health facilities in Rufiji district, only about 50% of pregnant women were informed about danger signs in pregnancy [303].

Thus, comparing our results of health providers' reports with observational studies or population-based surveys suggests that implementation levels based on health provider reports might overestimate true implementation by 10 – 30 percentage points. The differences were more pronounced for counseling activities than for physical examination, laboratory investigation and tetanus vaccination.

Strength and Limitations of the Health Facility Census

The data were collected through a census and they are not a sample but a complete account of what is offered at the time of assessment of health facilities in the five districts. Only four health facilities were missed, three due to unavailability of staff, which is a common problem [379] and not likely to be indicative of a different performance level. One private health facility was excluded because it did not provide care for mothers and children. Two hospitals, which provide services for a large part of the population in the five districts, were not included in the study because they were situated outside the study area.

This study was primarily a structural assessment based on reports from staff and observations of availability of commodities, but neither included observations of ANC visits and delivery care, nor any assessment of delivery records or partographs. Client-provider observations are time and resource consuming. Particularly, observation of deliveries demands much research time and special arrangements, as only few occur per month and not necessarily during normal working hours.

By using staff reports the results are likely to be biased to give an overly positive view of the quality of ANC and childbirth care as discussed above. The assessment of the coverage levels of essential childbirth care was able to point to major deficiencies such as the low reported implementation level of AMTSL. To reduce the social desirability bias of the health provider reports, we applied a question using a five answer option ranging from “always implemented” to “never implemented”. Using this range, reported implementation levels might have been lowered, as only the answer “always used” but not “mostly used” was regarded as indicative of consistent implementation of the intervention in the health facility.

Review of ANC cards and delivery records are an important option to assess quality of care and are used in Safe-Motherhood Assessments [225] but have not been included in this study because of resource limitations that made it impossible to cross-check provider reports with what was documented in ANC cards or delivery records.

Another weakness of the study was that demand-side factors, provider-client interactions and client perceived quality of care were not part of the assessment. These are important factors with a direct effect on the function of the health care delivery system. Several studies from Tanzania using quantitative and qualitative study designs point to the importance of the reputation of health facilities for uptake of delivery care as well as the perceived quality of care, [307, 326, 397-399].The unexplained differences between wards in uptake of delivery care at first-line facilities (Figure 45) underlines the need to have such measurements.

Interpretation

This study indicated low quality of childbirth care services, including deficiencies in the availability of human resources and commodities for childbirth care. The low caseloads in dispensaries and health centres constrain skill maintenance, as many complications are unlikely to be seen more than once a year. Health centres seemed to perform substantially better than dispensaries and are better staffed, but the number of deliveries performed there was also low. Health centres seemed to be greatly underused for childbirth care and the management of obstetric complications, reflecting that referral advice was mainly towards hospital care [400]. Only reports of removal of retained abortion residuals were high, reflecting that the scale up of abortion care has prioritized implementation at the health centre level.

The study also pointed to deficiencies in the quality of care at the hospital level. Although hospitals generally performed better than first-line facilities in terms of essential childbirth and emergency obstetric care, important interventions were not routinely implemented. In particular, prevention and care of pre-eclampsia and eclampsia were found to be insufficient.

We presented information on essential childbirth care such as implementation levels for AMTSL. Such coverage information is missing at the national and international level [233]. The Countdown Group has recently requested comparable indicators reflecting quality of care, particularly care during childbirth, to complement the established indicators of skilled attendance and birth by Caesarean section [401]. Provider reports or health facility documentation are generally rated inferior to reports by mothers assessed in population surveys due to issues in completeness and quality, which is why coverage levels are mainly based on representative household surveys using birth histories to assess care received.

Levels of AMTSL implementation are likely to be misreported by women when assessed in household surveys. The mother’s attention is focused on the newborn at the moment of birth and she may not remember clinical interventions. Thus, data compilation based on provider reports and information from delivery records might be better options. More narrative investigations into care provided at birth such as “last event” questionnaires might yield more correct information [402]. Validation of any of these methods to establish a common methodology of ascertainment of implementation levels of AMTSL is needed and could include direct observations of birth or comparative analysis of levels reported using different methods.

3. The Index of Maternal Care

Summary of Findings

The analysis of uptake of care by categories of first-line facilities was based on: the index of maternal care; the level of care (dispensary and health centre); or the availability of a midwife and transport. These three measures all indicated that better-performing facilities had slightly higher reported uptake of care for defined distance categories compared to facilities in lower quality categories.

The index of maternal care showed differences in uptake of care for mothers living within 1 km of a health facility for different levels of quality. A total of 28% (95% CI 52 – 31%) of mothers reported having delivered in a first-line facility when the nearest facility was rated providing “advanced basic care” compared to 18% (95% CI 11 – 25%) when the facility was rated as providing “very poor care”. Similarly, within a radius of 1 – 2.5 km, 19% (95% CI 15 – 23%) of women reported having delivered in a facility when the nearest facility was rated providing “advanced basic care” compared to 3% (95% CI 0 – 6%) when the facility was rated as providing “very poor care”.

Similarly, uptake of care within 1 km and 1 – 2.5 km differed by around 10 percentage points between dispensaries and health centres and health facilities with and without ambulance services. Thus, facilities categorized as providing “advanced basic care”, being a “health centre” or having “transport and a midwife” all had about 6 – 10% higher uptake rates compared to lower categories within a 2.5 km distance of a first-line facility.

Strength and Limitations

The use of the index of maternal care made it possible to categorize first-line facilities according to coverage levels of essential intervention as an aspect of quality of maternal care provided, which would not have been the case if we had used the established EmONC categorization as done in a similar study in Zambia [156, 250]. It was expected that few, if any, facilities would reach BEmONC status, which was confirmed by our findings Table 37; even if the performance of vacuum extraction was excluded (often classified at BEmONC-1), none of the facilities would have reached BEmONC status.

However, it is less clear whether our categorization is superior to simply using the level of care (health centre or dispensary). The analysis indicated that a few dispensaries were performing at the level of health centres, one of the reasons for creating the index. However, the overall finding that uptake of care improves with higher levels of care was also seen when the classification of "health centre" and "dispensary" was used.

The quality and validity of any index depends on included factors [403]. Some potentially important factors were not included in the index, foremost, user satisfaction or user perceived quality of care. Friendliness and trustworthiness of the provider have been reported to be the main drivers of uptake of care in Tanzania [307, 330, 398] and elsewhere [219, 404]. These are important elements of quality of care [180] and experience is growing to establish such measurements (Table 7). Many different tools are available to investigate client satisfaction with reproductive and obstetric services [191].

We did not include other elements, which might have an impact on perceived quality of care, such as overall availability of drugs [330], electricity and running water in facilities. A separate analysis of the number of deliveries in facilities with functioning electricity suggests that this is of importance (data not shown).

The index of maternal care was based only on input and intervention coverage, omitting the inclusion of outcome and impact indicators, which are commonly included in quality of care frameworks [186]. There were two reasons for this exclusion. Firstly, the index was based on the provision of evidence-based interventions and was thus process-oriented. Secondly, common outcomes or impact indicators at the facility level, such as case fatality rate, are biased by delays in women coming to facilities and by referral conditions, making them difficult to interpret.

Further, in the weighting we did not fully apply the disease burden for the different causes. As explained before, the estimation of the effect of single interventions on maternal mortality is often not available, but rather for packages of interventions, precluding the use for more exact weighting.

We might have forgone an opportunity to detect first-line facilities with higher capacities to tackle emergency obstetric complications by asking providers whether BEmONC interventions had been performed during the defined period rather than readiness to perform the intervention. We changed the time period for assessment from three to six months because we expected a low caseload. Many signal functions were not performed in the respective period, maybe partly because no cases demanding the intervention were seen. Thus, the assessment of emergency obstetrics might have been improved by questions investigating "readiness" by asking the provider whether he/she was trained, felt confident to perform the respective intervention and whether equipment and supplies were available. Assessment of "readiness" instead of "actual performance" might be superior in areas of low caseload in facilities. On the other hand, reported readiness is likely to overestimate actual capacities in dealing with complications [156].

A flaw might have been introduced in the analysis because the assessment of uptake of care used reports from women with a livebirth in the year 2006 and 2007, whereas quality of care information was collected in 2009. Thus, there is a two-to-three year time lag between the assessment of quality of care at facilities and the ascertainment of uptake of care through the household census.

The quality of care provided in first-line facilities might have changed between 2007 and 2009, perhaps in a positive direction as more resources have been made available to maternal and newborn health [405]. However, an improved resource level would rather have led to a better score overall, but not to a differential bias.

Comparison with other studies assessing quality of care in facilities over time suggests that improvements in quality of care in facilities have been slow and volatile in the past.

Comparison of the staffing level with an earlier health facility census in the same area [271] suggests, that staffing for prescribers (assistant medical officers, clinical officers or assistant clinical officers) and nurses had improved at health centres but not at dispensaries between 2004 and 2009. Similarly, a Safe-Motherhood Assessment in three of the five districts suggested that in both 1999 and 2007, half of the facilities had no certified midwifery staff, supporting the finding that staffing levels at dispensaries has not changed greatly [386].

The availability of services in facilities reported in the health facility survey in 2009 and levels reported by the Safe-Motherhood Assessment in 2007 were similar, except for PMTCT, where large improvements were achieved after 2007 [406]. The Safe-Motherhood Assessment suggested that availability of key equipment to provide maternal care did not improve between 1999 and 2007 except for manual vacuum aspiration for abortion care, which was found in 20% of health facilities in 2007 compared to none in 1999. Management of postpartum haemorrhage and retained placenta were similar to reports from our study in 2009 [386].

In summary, it cannot be excluded that single health facilities have improved or have worsened between 2006/07 and 2009, which biases the analysis of the effect of quality of care on uptake of care. However, overall results might be still valid for a number of reasons. Firstly, the level of improvement between 2007 and 2009 seemed to be limited as described above. Secondly, a similar difference with regard to quality provided in the facility was seen for all three categorizations employed in this study, including the level of care (health centre and dispensary). The categorization of health centres and dispensaries had not changed between 2006/07 and 2009, so these results are not biased by the time lag between assessment of quality and assessment of uptake of care. Thirdly, the weak association between quality and uptake of care was seen when comparing quality scores with the number of deliveries performed in the facilities in the year 2008 (**Figure 23**). Here there was no time lag, as the assessment was in March 2009 and reports of deliveries were from 2008.

Gabrysch [250] reported a similar time lag of two-to-three years between assessment of quality and recording of uptake of care in mothers in Zambia, but could use a household survey before and after the assessment of quality. The results from both analyses were similar, which supports the assumption that quality of care might improve relatively evenly.

Another flaw introduced in the analysis of the effect of distance and quality of care on uptake of delivery in first-line facilities is that our data did not include the facility where the women actually delivered. This discrepancy is a common weakness in studies analyzing uptake of care within distance categories to health facilities as underlined by Gabrysch [250]. In the analysis of uptake of care at first-line facilities we excluded women for whom the hospital is the closest facility and assessed the association only in women who reported to have delivered in a first-line facility. Beyond a radius of 10km to a hospital around 23% of women delivered in a hospital, regardless of distance. By excluding births in a hospital and thus excluding this non-differential bias, the estimates of the effect of distance to first-line facilities were likely to be strengthened.

It is not known whether the women had chosen the nearest facility or another first-line facility. Several studies reported that women prefer to deliver in higher level or mission facilities or other facilities with a good reputation [307, 407]. In southern Tanzania, only a few health centres and dispensaries have an outstanding reputation, thus bypassing the nearest facility to deliver in another dispensary nearby might be limited. It is assumed that by excluding hospital deliveries and women living near hospital, a large part of this bias was excluded. A certain number of women might have overcome larger distances to obtain delivery care and might have been misclassified as living near a dispensary. It is prudent to assume that the factor distance might be slightly less important than actually described in this study because of this misclassification of distance.

The construction of the index used scoring and weighting based on clinical evidence presented in standard textbooks and guidelines [356]. We did not employ mathematical methods of data reduction such as principle component analysis or factor analysis, largely because we wanted an index with high “face validity”. Some investigation into groupings and clustering was done by presenting scores in relation to the level of care (dispensary and health centre), enhancing the understanding of how much the index distinguishes between dispensaries and health centres [403]. Investigations were done assessing the overall scoring levels for the different indicator domains (ANC, essential childbirth care, EmONC or cross-cutting issues) in relation to the level of care and availability of a midwife (Table 14).

No cross-validation of the index was done using mortality levels as an outcome measurement. The analysis found a weak association of distance to hospital- and pregnancy related mortality. There was no evidence for an association between mortality and distance and level of first-line care (data not shown), which is why mortality levels could not be used to cross-validate the index.

However, some validation was done using the secondary outcome, uptake of delivery care in first-line facilities, by investigating the association between the overall scores and the number of deliveries reported by facilities in 2008 (Table 15). No association was seen for any of the four indicator domains with the scores obtained. This finding suggests that “clinical” quality of care as defined in this study seemed to have little effect on uptake of care.

Comparison with Other Studies

The study of Gabrysch et al in Zambia indicated a strong association between uptake of institutional delivery in relation to quality of care when using the EmONC classification for categorization of facilities and assessing the effect of distance on facility delivery. Each step increase in level of care was associated with a 26% higher odds of facility delivery (95% CI 7 – 48%) [250, 253]. Categories and the model for assessments in the Zambia study were different from our study in southern Tanzania. The comparison of our results with the findings in Zambia suggest that to examine uptake of care in relation to quality of care categories, the categories need to clearly separate better and worse performing facilities with “visible” characteristics to the target population.

Hounton et al [90] used an index of physical inputs in health centres and assessed whether uptake of institutional births and Caesarean section differed in relation to physical inputs in health centres expressed in quintile groups in a rural population in Burkina Faso. There was no association with institutional births (p=0.365). Birth by Caesarean section, however, increased from 0.4% to 0.6% with increasing levels as assessed by physical inputs indicating a significant trend (p=0.030). The study also assessed the effect of distance to health centres and hospitals for institutional birth and reported, similar to our study, differences in relation to the proportion of institutional birth in distance categories between hospitals and health centres.

Brentlinger et al [408], when investigating determinants of uptake of delivery care in a Mexico, reported a difference in travel time to a hospital comparing women who delivered in a hospital or at home (travel time of 154 minutes compared to 107 minutes, p-value for difference p<0.001) in their bivariate analysis. In contrast, the travel time was similar in both groups to get to the nearest clinic (25.0 and 24.4 minutes travel time in women delivering at home and in a hospital, respectively). Other studies investigating the relationship between distance and uptake of care did not report results for different levels of care [251, 409-412].

Interpretation

The index of maternal care indicated small, albeit significant, differences in uptake of care in relation to quality categories. Within a 1 km distance, 28% (95% CI 25 – 31%) of women delivered in a first-line facility when the quality was rated as “advanced basic care” compared to 15% (95% CI 11 – 25%) if the quality was rated as “very poor care”.

Two reasons may explain the unexpectedly small increase in uptake in relation to the quality of care within distance categories. Firstly, women might not be able to distinguish between better or worse “clinical” quality of maternal care at first-line facilities because they are not informed about the care they are entitled to receive such as AMTSL or the use of a partograph. In contrast, women seem to have an understanding that hospitals offer better care, a finding similarly reported by an earlier study in southern Tanzania [293]. The lack of an increase in uptake of delivery care in first-line facilities in response to the availability of a certified midwife further suggest that women might not distinguish or value higher or less trained staff. In contrast, the availability of transport seemed to be a factor that increased uptake of care.

Secondly, other factors not measured in this study such as client-perceived quality, friendliness of the provider, culture and tradition possibly have a much stronger effect on uptake than clinical quality of care. The large variation in uptake of delivery care between wards suggests that such factors are of outmost importance (Figure 45).

The examination of the index and the analysis of the effect of quality categories on uptake of care gave valuable possibilities to examine and rate the quality of maternal care provided in first-line facilities. The results underlined that, for assessment of status of functioning of first-line facilities to provide maternal and newborn care, an alternative classification different from the common BEmONC and CEmONC categorization is needed. This suggestion was also put forward in the World Health Report 2005 "Making Every Mother and Child Count" [369], but it was not picked up in the revision of the EmONC assessment methodology [156] .

Moreover, a recent WHO review on essential interventions [224] suggests—different from the EmONC concept—that the management of postpartum haemorrhage and retained placenta should be implemented in all facilities where deliveries are attended. This proposal overlaps with the "essential childbirth" packages defined in LiST [222]. Gabrysch et al recently published a proposal for indicators of key newborn care functions for routine childbirth care also calling for more attention to essential (or routine care) [354]. In addition, inclusion of indicators such as availability of transport, availability of electricity and drugs, and client satisfaction should be considered, as these are likely to be important factors for women, increasing the uptake of care. Thus, it would arguable to engage in monitoring of a package of essential childbirth care in line with the new WHO recommendations and LiST tool complemented by a few indicators on user friendliness and availability of drugs, supplies and other resources.

More work is needed on how to generate such indicators. Asking women about birthing experience might not be the most appropriate method, whereas improved health management information systems might give some indication on implementation levels (.

Box 4: Proposed essential childbirth care package for monitoring

Elements for monitoring
1) Clean delivery 2) Monitoring of labour including maternal and fetal wellbeing 3) AMTSL 4) Essential newborn care (infection prevention including hygienic cord care, thermal care, early breastfeeding and prophylaxis of ophthalmia neonatorum), 5) Management of postpartum haemorrhage (uterotonics and manual removal of placenta) 6) Management of pre-eclampsia and eclampsia 7) Organization of referrals (ambulances) 8) Client satisfaction/user friendliness /mother friendliness 9) Availability of essential drugs and supplies as well as electricity and running water

4. Determinants of Uptake of Care including Distance

Women's reports suggest that 29% of livebirths in the year prior to the survey were delivered in a hospital, 11% in first-line facilities and 59% at home. Overall uptake of care followed the expected pattern of higher uptake of hospital delivery and birth by Caesarean section in more educated, wealthier, and employed women. No such trend was seen for care at first-line facilities (delivery at first-line facility, four or more ANC visits and PNC).

Distance had a strong association with uptake of care for childbirth (delivery in hospital and first-line facility and birth by Caesarean section) but very little association with preventive care (four or more ANC visits or PNC). These findings suggest that there is universal geographical accessibility for preventive care but not for childbirth care in southern Tanzania.

Whereas one or two kilometres seems to be a major barrier for uptake of delivery care at first-line facilities, the level of uptake of hospital delivery and birth by Caesarean section was high within 5 km and only declined thereafter.

Summary of Findings and Comparison with Other Studies

The proportion of women who delivered in a facility was 41% in the study area. This estimate is similar to estimates provided by the DHS 2004/05 (47% and 37% in Lindi and Mtwara, respectively) but lower than the estimate given by the most recent DHS in 2010 for the period five years prior to the survey (52% and 59% in Lindi and Mtwara regions, respectively) [255]. Changes over time and the exclusion of the urban settlements of Lindi and Mtwara towns in our study are likely to explain the lower level obtained compared to the most recent DHS estimates.

District and ethnic group

This study reported an association between district and ethnic groups and uptake of care for all uptake variables in the bivariate analysis (four or more ANC visits, birth in a hospital, birth in a first-line facility, birth by Caesarean section and PNC).

The effect estimates of the effect of "district" on delivery in a hospital and birth by Caesarean section obtained from the multivariate analysis were very different from crude estimates (Table 44, Table 55). The effect estimates, for example for Nachingwea compared to Lindi Rural district, on uptake of hospital delivery changed from OR 1.3 (95% CI 1.2 – 1.5) to OR 0.9 (95% CI 0.7 – 1.2) in the multivariate analysis. Such strong confounding of effects of distance on factors as "district" is expected. Variables of administrative location or area include spatial characteristics. Thus the inclusion of variables of administrative location or areas in multivariate analysis assessing the association between distance and uptake of care can, in particular, pose problems if the factor distance is measured imperfectly, as they may distort findings.

The minority ethnic group Yao and other smaller groups had a higher uptake of hospital delivery compared to the most dominant ethnic group (Makonde) (p 180), but estimates weakened after being adjusted for distance to a hospital and other socio-demographic factors. Yao women were at 1.5 times higher odds of delivering in a hospital, even after adjustment for distance to a hospital (data not shown). This finding was reported by an earlier study in the same area [326]. In the final model, the ethnic group was not significant and thus not included (p 201).

There were no differences in the proportion of births by Caesarean section between ethnic group in neither the bivariate analysis nor when adjusted for distance to a hospital.

Ethnic differences in uptake of care were described in other studies in Tanzania. In Morogoro region, the second most common ethnic group was reported as having two times higher odds of delivering in a facility than the most common ethnic group in a multivariate analysis adjusting for several factors including proximity to a health facility [321]. In northern Tanzania, tribal affiliation was the only significant factor for skilled birth attendance after adjustment for several confounders including distance to health facilities [329]. Thus, the study in southern Tanzania and findings from other studies suggests that differences in uptake of care in relation to ethnic group go beyond the location where the ethnic groups lives and may reflect varying perceptions of the importance of uptake of care.

Education, wealth and occupation

This study confirmed commonly reported differences in uptake of care in relation to wealth, education and occupation [162, 369]. The differences were much larger for births in a hospital and birth by Caesarean section than for four or more ANC visits, birth in first-line facilities or post-natal care (see p 198).

The wealthiest, most educated, and employed women had two-to-threefold higher uptake of hospital care compared to women in the lowest wealth and education groups and women who reported being farmers (Table 44). Similarly, women being the least poor, having secondary or higher education or being employed reported two-to-six times higher rates of birth by Caesarean section compared to the lowest wealth and education categories (Table 50). In contrast, the least poor women, having higher levels of education or being non-farmers reported only minor differences of around 3% - 5% in uptake of four or more ANC visits, birth in a first-line facility and PNC compared to women being poorer, less educated or being farmers.

In an area with good geographical accessibility to first-line facilities and user-fee exemptions for pregnant women as in Tanzania, the factors wealth, education and occupation might become less important for uptake of four or more ANC visits, birth in a first-line facility and PNC than for hospital care and births by Caesarean section, where transport costs and charges for drugs and supplies can be significant, despite nominally free health care [327, 413]. Particularly unofficial fees and transport costs are major barriers [414]. The unofficial costs may amount to 2 or 3 USD as a 'thank you' and women are expected to buy a number of items such as gloves, soap, syringes, cotton wool and others [321]. This study thus gives further evidence that the uptake of ANC is less strongly associated with poor-rich differentials than skilled attendance, as suggested by a comparative study using DHS data from 45 countries [415].

Some studies from Tanzania have reported small differences or no differences in the uptake of care by wealth and education. A study from Kigoma region in western Tanzania reported that both education and wealth were not associated with facility delivery in the multivariate model. The authors discussed the relatively homogeneous rural population in terms of wealth and education as a possible explanation [397, 398].

In contrast, the most recent DHS reported that 34% of women with no education and 85% with secondary or higher education delivered in a health facility, which is very similar to our results, which indicated that 80% of women with secondary and higher education delivered in a hospital. The differences between the wealth groups were less pronounced than those reported by the DHS. A total of 33% of women in the lowest wealth group compared to 90% in the higher wealth group delivered in a health facility according to 2010 DHS [255].

The differences between the study in Kigoma and our findings—although both from a rural population—might be that we used other education categories and slightly different assets for the construction of the wealth index. In particular, we classified education by using the same education categories as the DHS and singled out the few women with a high education status for which we found similarly high levels of uptake of care as reported in the DHS. This study confirmed that differences between the most poor, very poor and poor (indicating the lowest three wealth groups) or women with no or some education are small in Tanzania, suggesting deprivation of a large part of the population from needed care [369].

Age and parity

The study indicated that age and parity (total number of livebirths) had an association with hospital delivery, birth by Caesarean section and PNC whereas variations for four or more ANC visits and delivery in a first-line facility were small.

Around 50% fewer women having more than six livebirths reported uptake of hospital delivery, birth by Caesarean section and uptake of PNC compared to women having their first child. No differences between parity and age groups were observed for births in a first-line facility in the crude and adjusted analysis.

Higher uptake of care at hospital level among women having their first child reflects the higher physiological risk of complications in women with no previous livebirths. The differences reflect the risk perception of mothers, which is rooted in the risk approach in ANC as proposed in the 1990s, recommending hospital delivery for the first birth [416]. A study carried out in 1996 in the same area reported high uptake of hospital delivery among women having their first baby, but low uptake among women with the risk factor of more than seven previous births [293]. The risks in the higher age and higher parity group may not be sufficiently emphasized in counseling sessions during ANC [397, 417] and may not be stressed in the training of health care providers.

Interestingly, this study indicated very minor differences in uptake of care between women aged 19 and younger compared to women aged 20 – 24 years. Uptake of hospital care for delivery was slightly higher in adolescent mothers compared to mothers aged 20 – 24 years in the bivariate analysis (Table 44). The higher uptake of care in adolescents was seen even after adjustment for parity (data not shown). Similarly, birth by Caesarean section was higher in adolescent mothers compared to mothers aged 20 – 24 years in the bivariate analysis and adjusted for parity (data not shown).

Adolescent pregnancies have been repeatedly described as high risk [119], not only because of the higher biological risk but also because care-seeking in young women commonly differs from older women [418, 419]. In our study, uptake of care did not differ greatly between adolescents and women aged 20 – 24. Similarly, Gross et al. [420] found no difference in the gestational age of the first ANC visits between adolescent and adult women from southeastern Tanzania. The most recent DHS reported that the proportion of skilled attendance was 57% in adolescent and 50% in women aged 20 – 35 years [255]. Stanton et al 2007 described, based on DHS data, a continuous decline of uptake with higher age in sub-Saharan Africa, which is similar to what we observed in the unadjusted analysis [127].

Gender of the head of household

This study revealed very little difference in uptake of care in relation to the gender of the head of the household. For the uptake variable four or more ANC visits, PNC or birth in a first-line facility, no association between the gender of the head of household and reported uptake was observed. The difference for birth in a hospital was small. About 7% fewer mothers delivered in a hospital if the head of household was male compared to female. Seven percent fewer mothers delivered by Caesarean section if the head of household was male compared to female. In the multivariate analysis, the effect of the sex of the household was larger (OR 0.86, 95% CI 0.78 – 0.94) on hospital delivery comparing male-headed to female-headed households.

Mrisho et al [326] reported a similar difference comparing male- and female-headed households (OR 0.8, 95% CI 0.75 – 0.85) in the adjusted analysis of the same area based on a sample survey. Gender imbalances leading to women not having enough control over financial and other resources have been described as important factors for uptake of skilled attendance in Tanzania [398] and elsewhere [88, 421, 422]. Our results could be interpreted that access to household resources for hospital delivery are improved if the head of household is a women.

Distance to health facilities

In this study we found an association between distance to health facilities and all uptake of care variables (delivery in a hospital or first-line facility, birth by Caesarean section, four or more ANC visits and PNC). The pattern, nevertheless, differed between the five uptake of care variables.

Care offered at the hospital level (birth in a hospital and birth by Caesarean section) was high within a radius of 5 km and declined thereafter to levels about 50 – 70% lower (Table 45,Table 50, Figure 49). For hospital delivery and birth by Caesarean section, the levels were similar between 10 km and 30 km distances, suggesting that the effect of distance on uptake of care was strongest within the first 10 km. In contrast, uptake of care declined only slightly but continuously for four or more ANC visits and PNC with increasing distance to a first-line facility. Delivery in first-line facility declined rapidly after a 1 km distance.

This different pattern of uptake in relation to distance points to different obstacles and facilitating factors for care at the hospital compared to care at first-line facility and for preventive care (ANC or PNC) compared to care during labour.

Hospitals are mostly situated in urban areas or in wards classified as mixed (urban/rural) where public transport or motorized vehicles have become increasingly available. Problems in accessibility seem to start at a distance upwards of 5 km from a hospital, thus an area commonly outside the more populated and accessible areas. Outside a 10 km radius around a hospital, problems in accessing health care seemed to be relatively similar regardless of whether the distance is 10 km or higher. The visualization of uptake of hospital delivery and birth by Caesarean section (see the maps, Figure 44 and Figure 50) suggests further that tarmac roads and ambulances might facilitate access to hospital care, a finding which is plausible, although a recent review was not able to find evidence of the positive effect of emergency obstetric referral interventions such as ambulances [423].

An interesting finding of this study is the similarity in Caesarean section rates between Tandahimba district and the other districts, although the hospital in Tandahimba had no functioning operation theatre and only an ambulance to refer patients to the neighboring Newala hospital at the time of the study. This scenario gives some evidence that ambulance services, if functioning, can improve access to Caesarean section. Other explanations might be that women moved to other hospitals before giving birth in the area knowing that Tandahimba has no functioning operation theatre.

Uptake of delivery care at first-line facilities declined rapidly in the first 2.5 km. As motorized transport is rare in this rural community, the mode of travel is likely to have been by foot or bicycle. In such a setting, already a few kilometers seem to present a major barrier. In general, it is assumed that it is possible to walk 5 km within one hour, but this is unlikely for women in labour. Here, a much lower speed must be assumed, explaining why small differences in distance might lead to large reduction in the uptake of care.

The distance patterns observed for preventive care (four or more ANC visits and PNC) in contrast suggest that distance is of relatively little importance in the setting in southern Tanzania and that “universal geographical access” has been, to a large extent, achieved. The relatively dense network of first-line facilities in this area means that 75% of mothers live within 4.6 km or 1 hour of walking time. Here, other factors such as perceived importance and cultural barriers might be of much larger importance than distance, as described in qualitative studies from the area [304, 399].

It is likely that the factor distance, and its larger effect on access to delivery care than on preventive care is accentuated by the factor costs. Delivery at the hospital and birth by Caesarean section are not only constrained by geographical accessibility, but if distance is larger the costs for transport are also higher. In addition, unofficial user costs and costs for buying consumables are likely to explain a part of the low uptake of delivery care at first-line facility. Costs might be a major reason for the low proportion of delivery in first-line facilities even if the mother lives nearer than 1 km.

Several studies have pointed to financial barriers being a major reason why women do not access obstetric care, so also in Tanzania [326], 285, 286].

Comparison with findings from other studies meets the difficulties that many studies have only used relatively crude categories such as comparison of uptake in women living more than 5 km and less than 5 km from a health facility or travel time of less than one hour compared to more than one hour [320]. The pattern of uptake is often only available for delivery at a health facility or skilled attendance, combining deliveries in hospitals and first-line facilities [251, 409-412].

A few studies have described uptake patterns in more detail. Similar to our study, Hounton et al [90] described pattern of uptake in relation to distance to a hospital and distance to a health centre. The odds of delivering in a first-line facility were reported to decline by almost 25% for every additional kilometer a women lived from a health centre for the first 7.5 km (OR 0.77, 95% CI 0.75 – 79). Thereafter, the effect of distance leveled off. For distance to a hospital, a continuous reduction was described. However, the levels of uptake within a distance of 1 km for health centres were much higher in Burkina Faso than in our study (77% of women living within 1 km from a health facility delivered in a health centre compared to 22% in our study).

The study from Gabrysch et al in Zambia, cited previously, indicated a strong association between uptake of institutional delivery and both less distance and higher quality of care [250, 253]. Categories and the model for assessments in the Zambia study were different from our study in southern Tanzania. Both studies underline that women can overcome distance if the quality of care is better, therefore, the pattern of uptake in relation to distance is modified by the level of care and quality of care offered.

The study from Chowdhury et al [251] was the only study found where the actual place of delivery was available. A similar rapid decline in uptake of care within the first 2 km of distance was described for deliveries in first-line facilities.

Other studies from Tanzania assessing distance have reported results different from ours. Another study from southern Tanzania suggested that a distance of less than 5 km compared to more than 5 km to a facility increased uptake by OR 4.1 (95% CI 2.7 – 6.2) in the multivariate analysis, but the way distance was measured is not described and the study area included an urban and rural district and combined estimates [320]. In western Tanzania, Kruk et al [397] found no evidence of higher uptake of facility-based delivery care in villages with or without a health facility (OR 0.6, 95% CI 0.3 – 1.8), but confidence intervals were wide.

Strengths and Limitations

This assessment indicated that the effects of socio-demographic factors differed between the different uptake variables, as was also described in several other studies [14, 415]. The most important findings were that the effect of distance was different between preventive care (four or more ANC visits and PNC) and childbirth care (birth in hospital, in first-line facilities and by Caesarean section). Such a detailed analysis of the effect of distance using several uptake variables and distinguishing hospital delivery from delivery in first-line facilities is seldom available.

As discussed before (p 241), the strength of this study included its completeness, the high number of women included, the fact that no sampling errors constrained results and the fact that household GIS coordinates were used rather than GIS coordinates from the village centre. In addition, the study used a multilevel analysis to account for the hierarchical structure of the data to account for the intracluster variations.

Some misclassification has to be considered for the outcome measurements: 1) delivery in a hospital or 2) first-line facility and 3) birth by Caesarean section. A comparison of reports from health facilities and the results from births histories (Table 76 in annex) indicated differences in the number of births reported at the three levels of health facilities (dispensaries, health centres and hospitals). Some over-reported hospital deliveries and under-reported health centre and dispensary deliveries have to be considered because of the ambiguity of the Swahili terms to categorize levels of care. Our findings suggest a plausible uptake pattern in relation to socio-demographic factors and distance for hospital delivery and delivery in a first-line facility.

Some misclassification also has to be considered for Caesarean sections. There is some ambiguity in the Swahili term for Caesarean section, which might have led to over-reporting of Caesarean sections. Cross-tabulation of birth by Caesarean section and place of birth revealed inconsistencies. In line with common recommendations, Caesarean sections reported to have taken place in lower level facilities not equipped to perform the operation have been put to missing [424]. Some residual misclassification has to be assumed. The literature points to difficulties in getting reliable data on Caesarean section at the household level and over-reporting Caesarean section in health facility surveys [347].

Another limitation of our study might be the use of straight-line distance, but not travel time to approximate geographical accessibility. Travel time commonly uses algorithms to account for differences in the speed of travel in relation to the surface and road network. A recent review has pointed to insufficiencies using the straight-line distance in places where not only foot paths, but also roads and different modes of transport such as bicycles, donkeys, or sporadic buses are used [249].

In the rural areas included in our study, walking is likely still to be the main mode of travel to first-line facilities. In this situation, the straight-line distance is proposed as a valid approximation [249]. Moreover, a study in the same five districts in southern Tanzania described an association between under-five mortality and distance to a health facility (OR 1.25, 95% CI 1.0 – 1.5 comparing >5 km to <5 km distances), supporting that the straight-line distance is sensible as a proxy for geographical accessibility in this setting.

In urban and mixed (urban and rural) settings, the situation might be different. Here, public transport and availability to motorcycles or cars is likely to change the main mode of travel. Walking might exist in parallel with motorized transport within smaller distances. In this setting, travel time is likely to “correct” for the better geographical accessibility due to improved availability of transport facilities. However, it is likely that both methods present measurements of access are likely to give relatively similar uptake patterns, but on a different scale (time versus distance).

It can be argued that the use of travel time instead of straight-line distance is likely to increase comparability between rural areas where walking is the predominant mode of travel and urban or mixed areas around a hospital because, where access is improved by motorized transport. Travel time translates both modes of travel into a comparable measurement. Distance of a few kilometers in rural areas is a much greater barrier that the same amount of kilometer if transport is available why the use of travel time is superior to the straight-line distance when comparing different settings.

Both the straight-line distance and travel time are likely to be imperfect to describe geographical accessibility of hospitals beyond a radius of 10 km around a hospital. Public transport in rural areas is irregular and sporadic. Women fear going out at night as cited in a paper by Mrisho et al. “It is so dangerous to cross the forest at night; there are wild animals such as lions” [326]. Roads might become impassable during the rainy season. Women move to relatives closer to the hospital or to use maternity waiting homes as cited in the same paper, “I was advised by a nurse to go to the district hospital but decided to go to the regional hospital because I had a relative who lives near the hospital”[326]. Travel time algorithm commonly adjusts distance to different speeds of travel when using food, bicycle or cars. However, it is very difficult to elaborate travel time algorithms including such different factors such as delayed travelling at night or use of irregular public transport. Thus, both the travel time and the straight-line distance might fail to approximate geographical accessibility in areas where other factors than distance in kilometers is of greater concern.

Although the analysis of geographical accessibility by using the straight-line distance has its limitations, findings point to different patterns of healthcare uptake and suggest different barriers for delivery at hospital and first-line facility, which are important results. Further research would be needed to get a more in-depth understanding of facilitating factors for hospital delivery beyond socioeconomic factors and distance. These might include observed risks during pregnancy, personal risk perception and facilitating factors such as relatives or friends living near the hospital or regularly available public transport.

Another limitation of our analysis is that for a few births the distance to the hospital and the first-line facility might have been misclassified, as mothers might have moved after giving birth and therefore lived at a different distance to health facilities at birth than during the household census. Migration might mostly occur towards urban areas, therefore, some deliveries classified as being within a short distance from a health facility might have been deliveries among women living larger distances from a health facility. This potential misclassification might have weakened the effect of distance to a hospital on uptake of hospital care. The bias is likely to be very limited, as only births in the year prior to the survey were included.

Another limitation is that no variables on women’s position in the household, their decision-making power, available financial resources (cash), complications during pregnancy and previous childbirth, perceived importance of facility delivery or other variables were available for further explanation and adjustment of the distance factor. However, such variables are likely to explain a large part of the unexplained variation observed in this study [88]. As unofficial fees have been described in several studies as a major barrier, the lack of any indicator assessing available financial recourses presents a clear limitation.

In addition, no information was available whether women were included in any of the insurance schemes available in Tanzania. In a study in western Tanzania, being enrolled in community health insurance increased the odds of delivery in a health facility by almost two times [397]. The most recent DHS suggested that less than 5% of people living in southern Tanzania are included in any insurance scheme [255].

Finally, missing data could have biased our findings. The sensitivity analysis restricting the analysis to only original data suggested that the pattern was not altered by extensive data cleaning and imputation exercise (Figure 56, Figure 57). However, final assessment of the bias introduced by the missing GIS data would need a multiple imputation exercise (p 285).

Interpretation

Our findings suggests that uptake of care at the hospital (delivery in a hospital and birth by Caesarean section) is constrained by a distance greater than 5 – 10 km. Delivery care in first-line facilities declines rapidly after the first 2.5 km. In contrast, as expected, the impact of distance on preventive care (more than four ANC visits and PNC) is small.

Uptake of care was very similar for the four lowest wealth quintiles and in women with no, some or complete primary school education. Only women in the highest wealth group, with secondary school education and being housewives or employed had a much higher uptake of delivery care and birth by Caesarean section than observed in the other groups.

The overall low uptake of delivery care in first-line facilities and the pattern described in relation to socioeconomic factors and distance underlines that factors other than distance, wealth and education are also important for uptake. However, as this study on uptake of care did not include any measures of perceived quality of care, complications during pregnancy and perceived benefit of institutional delivery, we were unable to report their effects.

Improvement in quality and friendliness towards clients have been put forward by Kruk et al [330] as having a greater importance than improving financial accessibility. Our study suggests indirectly that the risk perception is also important, as the level of uptake of care during childbirth was markedly higher for women having their first baby than for those who had several previous livebirths. However, the marked differences between women having their first compared to subsequent births might also be due to many years of counseling on the higher risk in the first birth during ANC.

5. Levels, Causes and Determinants of Pregnancy-Related Mortality

In this study we estimated a high pregnancy-related mortality of in the five districts in southern Tanzania. The main cause of mortality was haemorrhage. Almost 40% of the deaths were due to indirect causes, predominantly HIV, malaria and anemia. Pregnancy-related mortality was slightly higher in lower wealth groups, but differences were small. A U-shaped association between mortality and age was obtained. There was weak evidence of higher mortality with increasing distance to hospitals, which was accentuated if the analysis was restricted to deaths due to direct obstetric causes.

Summary of Findings and Comparison with Other Studies

Level of pregnancy-related mortality

Pregnancy-related mortality was high, with 712 deaths per 100,000 livebirths (95% CI 652-777) during the period from 2004 – 2007. The verbal autopsy data indicated that up to 14% of the deaths were most likely not pregnancy-related or took place outside the defined period (Table 59). Assuming that a similar proportion of deaths identified at household level as pregnancy-related for which no verbal autopsy was available were also maternal deaths one might assume that at least 431 deaths (85% out of the 507 pregnancy-related deaths) were truly maternal death in the respective period. Calculating the MM-ratio on the basis of these 431 confirmed maternal deaths and the 71,198 livebirth when adjusting the reported livebirth by the age-standardized birth rate applied to the missing birth histories the MM-ratio would stand at 605 deaths per 100,000 livebirths.

In addition, more livebirths might have been missed by not recording birth records in mothers who died (see details p 236). Adding a further 650 livebirths for mothers who died would give a total number of livebirth of 71,848 and a MM-ratio of 600 deaths per 100,000 livebirths.

This level might constitute the lower uncertainty bound point estimate of the “maternal mortality ratio” in the study area with 600 per 100,000 for the period 2004 – 2007 based on 431 deaths and 71,848 livebirths.

It is commonly assumed that over-reporting balances out under-reporting of deaths [29]. In Burkina Faso, the total number of pregnancy-related deaths increased by 23% from 321 to 396 deaths when verbal autopsies of all deaths of women of reproductive age were analyzed [73]. In our study, no verbal autopsies were done for deaths of women of reproductive age which were reported to be non-pregnancy-related at household level. Therefore, no indication of the extent deaths were missed is available, which presents a clear limitation of this study. No upper level of uncertainty bound can be given.

Only 4% of pregnancy-related deaths in our study were due to abortion. This level is much lower than the level commonly put forward by the WHO for East Africa. The WHO latest publication on this subject estimated an abortion-related mortality rate of 100 per 100,000 livebirths, or 18% of maternal deaths [239]. Other WHO estimates propose that 9% of maternal deaths are due to abortion [7]. However, the likely under-reporting of abortion-related deaths in our study might not only be due to missed cases at the household level. There are also some doubts about physician coding, as some causes of death in the first trimester of pregnancy were coded to anemia, which is unlikely, except if the anemia is caused by abortion complications (analysis not shown). It is likely that abortion-related deaths were missed, which is a common problem in household based studies [6] and particularly in areas where abortion is illegal, as in Tanzania (see p 95).

It is difficult to cross-validate estimates of pregnancy-related mortality because measurements are rare; still, a few studies are available from Tanzania. The most recent DHS gives an estimate for Tanzania of 454 deaths per 100,000 livebirths (95% CI 353 – 556) in the 10 years prior to the survey. The 2004/05 DHS estimated a level of 578 deaths per 100,000 livebirths (95% CI 466 – 690). Both of these DHS estimates are based on rural and urban areas, but included only 142 and 203 deaths, respectively [255, 257].

The DHS further reported that the proportion of maternal deaths of all deaths of reproductive age was 17% and 18% in the 2010 and 2004/05 surveys, respectively, a level very similar to the one observed in this study (16%, Figure 29). Results from three demographic sites of the Adult Morbidity and Mortality Project estimated a MM-ratio of 1099 per 100,000 livebirths for Morogoro district, an area similar in terms of poverty and access to health care to the five districts in southern Tanzania for the period 1992 – 1999. Data from a demographic site in the Rufiji district, a district neighboring Lindi region, with a similar disease burden, reported a MM-ratio of 573 per 100,000 livebirths in 2000 [287].

The estimates from the latest WHO publication about maternal health and the IHME gave point estimates of 460 and 418 deaths per 100,000 livebirths respectively for the year 2010 and 2011, respectively [1, 2]. These estimations are 25% lower than ours. However, considering the different reporting period (2004 – 2007 for our study and 2010/11 for the WHO and IHME estimates) and the fact that our estimates are from a rural and disadvantaged area, the estimates are not contradictory. The data from the Adult Morbidity and Mortality

Project pointed to a higher mortality in rural areas compared to urban Tanzania, and marked differences between regions. These findings further support that our estimate of 712 deaths per 100,000 livebirths, with a lower uncertainty bound of 600 deaths, is likely to approximate the correct figure.

Causes of pregnancy-related mortality

Approximately one third (132 out of 439 deaths with verbal autopsy, 30%) of reported pregnancy-related deaths had no final cause assigned because the physicians were not able to agree on one diagnosis. This level is high, but similar to the level reported by another study from Tanzania [56] and levels reported elsewhere [72, 425]. The fact that the verbal autopsies were only an adjunct of the large household census might have led to too little quality assurance. Moreover, verbal autopsies were done for deaths up to three years prior to the survey which might introduce a recall bias. The analysis of proportion of deaths for whom no agreement was reached indicated however that there were not more unresolved cases in mothers that died two or three years prior to the survey, suggesting no difference in the quality of verbal autopsies for deaths further in the past.

We reported a high level (36%) of indirect maternal causes, predominantly AIDS or tuberculosis, malaria or anemia. This proportion of indirect causes of pregnancy-related deaths is higher than reported in the systematic review by Khan et al. [6] or the WHO estimates for sub-Saharan Africa proposing that 17% of deaths were due to indirect causes [7]. Similarly high levels of indirect causes have also been reported by a study from rural Burkina Faso, where 42% of deaths were reported to be due to indirect obstetric causes. This paper discussed the high burden of general ill health in Africa as a possible explanation [73]. A hospital-based autopsy study from Mozambique also pointed to a high burden of infectious causes of maternal deaths, including HIV/AIDS-related conditions, bronchopneumonia and severe malaria [426].

Of the cases resolved, 32% were reported to be due to haemorrhage and 8% due to eclampsia, reflecting the common distribution of causes of maternal deaths. There were some differences in the coding between physicians, in particular for anemia, eclampsia and infection (data not shown), reflecting the difficulties of assigning a diagnosis for diseases without a clear and distinguishable illness pattern before death [427]. Physician coding, although discussed as the best available method [55], is prone to inter-coder-variability [44]. Moreover, it is not clear whether the physicians strongly adhered to the coding recommendations by the WHO [20].

The high number of deaths due to malaria is unexpected, as prevention measures for malaria are relatively well established in Tanzania. Malaria is, according to health facility statistics, the most common reason why people attend health care in this area [428]. The most recent Tanzanian AIDS and Malaria Indicator Survey reported a high burden of malaria, with over 30% of children aged 6 – 59 months having positive malaria tests in Lindi and Mtwara regions [259], although almost 60% of the population in Lindi and Mtwara regions reported to have slept under some type of mosquito net the night before the survey and 64% of households possessed long lasting insecticide-treated nets [255]. Results from our study suggest that 65% and 86% of pregnant women received IPTp and a voucher for a bednet, respectively, during ANC (see Table 78 in annex). However, we have no information regarding how many women received two doses of prophylactic malaria treatment. A study carried out in Kilombero and Ulanga Districts of the Morogoro Region in southeastern Tanzania between April 2007 and May 2009 reported that only 27% of women received two doses [301]. Another partial explanation for the high malaria mortality might be the reported resistance to sulfadoxin pyrimethamine, the drug of choice for IPTp as described in a study from 2002 – 2005 in Muheza district, eastern Tanzania [429] and from other sites in Tanzania [430, 431].

The pattern of AIDS mortality in pregnancy in the five districts followed the HIV prevalence provided by the Health Management Information System in the districts. HIV prevalence in pregnant women was reported at 3% in Lindi Rural, 4% in Nachingwea and Ruangwa, 3% in Newala and 2% in Tandahimba during 2009 [337]. The proportion of deaths due to AIDS/tuberculosis was 3% in Newala and Tandahimba districts, 7% in Nachingwea and Lindi Rural districts and 6% in Ruangwa.

Overall, the mortality pattern observed is generally comparable with patterns described in other studies [6, 7]. However, the high proportion of maternal deaths due to indirect causes warrants further investigation and could also be due to coding problems often observed for infectious diseases [57, 66, 427] and inappropriate coding practices [20]. Comparing the probable causes of deaths assigned by a physician with the InterVA-M model might help to increase the understanding of the cause of mortality pattern in the area [72, 432]. Verbal autopsy is only a “crude substitute for proper medical certification of causes of deaths” as Setel et al. pointed out [433], and distribution of causes of mortality have to be interpreted with caution.

Socio-demographic factors and pregnancy-related mortality

Wealth had the expected effect of higher mortality in lower wealth quintiles. The MM-ratio was 796 per 100,000 livebirths in the lowest wealth quintile compared to 581 per 100,000 livebirths in the highest wealth quintile. Unexpectedly, the level of pregnancy-related mortality was still high, even among the wealthiest women, of whom 57% delivered in a facility, and 6% had a birth by Caesarean section.

The results that more education and being employed contributed to higher mortality in women were questionable. These findings were most likely biased by high missing data, differences in reporting when assessing schooling and occupation by asking a member of the household of the deceased rather than the woman herself [374] and different answer categories for occupation (Table 20). The clear trend of lower mortality when the head of the household had higher education added to the suspicion that the positive association between education of the mother and mortality was due to selection and reporting bias.

Mortality varied with age, and the U-shaped mortality pattern as described in many publications was confirmed. The data from this study adds evidence that mortality is much higher in very young mothers aged below 15 years, whereas mothers aged 16 – 19 years have a similar risk of mortality to women aged 20 – 25 years. This result was very similar to those reported in a study on mortality in adolescents in South America [118]. Nevertheless, all mothers younger than 20 years are a high risk group according to the Tanzanian national ANC card [323].

Both very young women aged 13 – 14 years and women aged 45 – 49 years were at two times greater odds of dying when compared to women aged 20 – 24 years. Four pregnancy-related deaths were reported in 12-year-old women. These deaths could not be included in our analysis because livebirths were not recorded for women aged 12 years. This finding highlights that pregnancies in very young women pose a high risk. Unfortunately, information on parity is not available from verbal autopsy questionnaires, thus, the odds ratio of the effect of age could not be adjusted for parity.

There was no clear relationship between the main categories of pregnancy-related deaths (direct, indirect and accidental/incidental causes) and wealth and education. Direct obstetric deaths were slightly higher in women aged 35 – 49, pointing to the higher biological risk of dying from haemorrhage in this age group [417].

Contextual factors and pregnancy-related mortality

There was no association between pregnancy-related mortality and uptake of delivery in first-line facilities in wards and also not with birth by Caesarean section in wards. Even in wards where the birth by Caesarean section was between 5.5% and 10.7% (the highest quintile), pregnancy-related mortality was similar to wards where birth by Caesarean section was between 0.7% and 2.2%. We observed an opposite effect than expected for uptake of four or more ANC visits and delivery in a hospital, where pregnancy-related mortality was higher in wards with increased uptake. When adjusting for district, distance and the education of the head of household, there was no difference seen within uptake quintiles (data not shown). These findings were surprising. Hounton et al. [434] described a clear trend of lower mortality in health facility catchment areas with a higher proportion of institutional births and ANC uptake.

One explanation might be that, although uptake of hospital delivery was 38 – 91% and birth by Caesarean section was 6 – 11% in the highest quintiles, women most in need may not have been reached, such as women with postpartum haemorrhage. In addition, the quality of care provided in hospitals might not be sufficient to prevent mortality. A high risk of morbidity and mortality in births by Caesarean section among women without indications in sub-Saharan Africa has been described [161], which might partly balance out the potential life-saving effect of Caesarean section.

Distance and pregnancy-related mortality

Our study revealed slightly lower pregnancy-related mortality in women who lived closer to a hospital than those who lived farther away. The odds of dying were 40% higher in women living more than 25 km from a hospital compared to women living within a 5 km radius. The trend of increasing mortality with increasing distance from a hospital was greatly enhanced if only direct maternal deaths were included in the analysis. The odds of dying from direct maternal causes were 70 % higher in the adjusted analysis if the mother lived more than 25 km from a hospital compared to a distance of up to 5 km. No such trend was seen for indirect causes, where mortality was similar in all distances. We observed no association between mortality and distance to first-line facilities (data not shown).

Analysis of distance and mortality is always constrained by small sample sizes within distance categories. A few population-based studies have also pointed to higher mortality in longer distances (Table 3). Two studies, one from Asia and one from Africa, reported a seven-fold increase in mortality in longer compared to shorter distances [78, 83]. In contrast, Fikree et al

[85] reported only a small, non-significant increase in maternal mortality when comparing women living more than 40 miles to less than 40 miles from a hospital (adjusted OR 1.3, 95% CI 0.9 – 1.8). In Burkina Faso, Bell et al [73] described a 50% higher mortality in women living farther than 5 km from a health facility compared to women living within 5 km of a health facility in one district (MM-ratio of 429 per 100,000 livebirths compared to 292 per 100,000 livebirths), but not in the other district that was part of their study.

Our analysis provided some evidence that both the cause of deaths and the level of care determined whether distance has an effect on of pregnancy-related mortality. Two studies that analyzed the effect of distance on child mortality also pointed to the importance of examining the effect of distance as part of a cause of death analysis. In rural Kenya, travel time to the nearest facility was not a significant predictor of child mortality and the authors discussed the high mortality due to HIV in urban areas as a reason for the lack of an effect [435]. A recent review also indicated that there are differences in the association between distance and causes of child mortality. A greater effect of distance on newborn mortality than on child mortality was described [248].

The lack of effect of distance to first-line facilities on pregnancy-related mortality was anticipated after having analyzed the pattern of uptake of care. Only 11% of women reported the use of first-line facilities for delivery care. Moreover, quality of care offered in most facilities was low (p 163).

Although a recent study on child mortality suggests some advantages of travel time compared to straight-line distance to measure geographical accessibility [246], we think that the use of the straight-line distance was appropriate in the study area as discussed earlier (see p 263).

Distance and accessibility have a two-path effect on pregnancy-related mortality as described elsewhere by Gabrysch et al [88]. Preventive care-seeking before the start of labour may depend on factors other than care-seeking for an emergency during childbirth. The effect of distance and travel time might play a greater role in the case of obstetric emergency than in a situation without emergency.

Uptake of hospital care before any emergency may be influenced rather by the availability of accommodation near the hospital (relatives living near the hospital or maternity waiting homes) [326]. In contrast, emergency transport is very difficult to arrange in remote area and large distance presents a clear obstacle.

The lack of any information as to whether the woman was able to arrange to move closer to a facility for delivery complicates the conclusion to be drawn on the factor distance. It is likely that the factor distance to the hospital has a larger effect on mortality in women delivering at home and experiencing complication. A sub-analysis of such women could not be done because no information was collected on the place where the women stayed before she went into labour.

Strength and Limitations

The major strength of our study was that it was based on 507 pregnancy-related deaths--a relatively large number. The study included both a cause of death analysis based on verbal autopsy and an analysis of distance to health facilities based on GIS information, which is rare.

The limitation caused by the missing birth histories and missing GIS coordinates has been discussed previously (p 237 and p 240). The potential bias introduced due to misclassification of distance has also been discussed (p 263). Cause of death analysis in the absence of a medically certified cause of death certificate is always a limitation of verbal autopsies, which can only be a rough substitute [53]. Although a recent analysis suggested that physician review is superior to the InterVA method, it would be interesting to compare the distribution of cases between the two methods in this population and to test whether the InterVA method would confirm the high burden of indirect maternal causes [55, 63].

Interpretation

We estimated high pregnancy-related mortality of 712 in this rural area in southern Tanzania. The lower uncertainty interval may be at 600 per 100,000 livebirths whereas no information is available on missed maternal deaths, which presents a clear limitation of this study.

Almost 40% of the deaths were due to indirect causes, underpinning a high general burden of disease caused by infectious diseases including HIV and malaria.

Mortality was lower in women from wealthier households, but differences were small. Similarly, mortality was high even in women living within 5 km distance of a hospital and was not lower in wards were the overall uptake of hospital delivery was in the highest quintile (wards with 38 – 91% hospital delivery) or where Caesarean section uptake was the highest (wards between 5.5% and 10.7% livebirths by Caesarean section.

The stronger effect of distance to a hospital on direct compared to indirect maternal deaths suggests that the functioning of hospital care is better for obstetric care than infectious diseases or other indirect causes of deaths such as anemia. Around 7% of deaths were estimated to be due to AIDS/tuberculosis. During the time of the study, care and treatment for HIV-positive mothers in need of treatment was not yet scaled up. The high burden of malaria and anemia warrants further research to determine whether physician coding or health systems failure can explain the high burden.

6. Conclusions and recommendations

Relevance of the Results for Health Policy and Planning in Tanzania

The conceptual framework used for this analysis proposed that household and individual factors such as wealth, education and occupation influence uptake of care and pregnancy-related mortality. The effect of these individual and household factors is moderated by distance to a health facility (geographical accessibility). Depending on the quality of care provided in facilities, increased uptake will decrease pregnancy-related mortality. In addition, age and parity were proposed to have a direct effect on mortality, while also affecting uptake of care.

The analysis of the effect of **distance on uptake of care** indicated that distance had a large effect on uptake of childbirth care at hospitals and first-line facilities, whereas there was "universal geographical accessibility" for preventive care (ANC and PNC).

However, our study also indicated that childbirth care in this rural area was constrained by **quality of care** offered in the health facilities. The health facility census pointed strongly to insufficiencies in quality of care in first-line facilities and hospitals alike. Most essential and life-saving interventions were not available. The results from the health facility census were supported by the results from the analysis of the effect of distance on pregnancy-related mortality, indicating that even if women live close to a hospital and uptake of care is high, pregnancy-related mortality is still high.

Thus, our findings suggest that while uptake of care is constrained by geographical accessibility of health facilities, the limited quality of care both in first-line facilities and hospitals reduced the potential effect that better accessibility and improved uptake of institutional delivery could have on survival. This is supported by the following findings: Women living in the only urban ward where geographical accessibility might be little constraint had a MM-ratio only 25% lower women living than in the rural wards (Table 70). The MM-ratio in women living not more than 5 km from a hospital is still high at 664 per 100,000 livebirths (Table 68) and women living in a ward where the uptake of hospital care was highest (between 38-91%) faced still a MM-ratio of 784 per 100,000 livebirths (Table 70)

Therefore, without gains in quality of care, improvements in geographical accessibility will yield limited gains in mortality reduction.

The existing Tanzanian heath policy and strategic documents are strongly focused on improved geographical accessibility. The primary health care policy aims to have a facility providing delivery care in every village [284]. The Tanzania National Roadmap Strategic Plan to Accelerate Reduction of Maternal, Newborn and Child Deaths in Tanzania (2008 – 2015) further outlines that all of these facilities should be equipped to provide basic emergency obstetric care [290].

Therefore, the health policy targets both quantity and quality, but increasing the number of health facilities might constrain quality improvements. It is questionable whether such large quantities of health facilities providing full basic emergency obstetric care can be built up in the next few years against the backdrop of a lack of financial and human resources as described in this study and elsewhere [264]. The total number of staff employed in the districts has improved in the past 10 years, but to a lesser extent at the dispensary level because of an increase in the number of facilities [380]. It is unlikely that the training and employment of staff will be resolved within a short time. Limited training capacity [269] and general budget ceilings limit the expansion of health staff in the government sector.

Moreover, the low caseload per facility or per provider would make it hard to maintain essential skills in preventive and emergency obstetric care. A recent published study from Tanzania confirms this constraint that some of the upgraded centres might have a limited caseload. The monthly number of Caesarean section after upgrading was only five in two but 20 in the third health centre included in the intervention [436].

This study revealed that other barriers beyond distance are important for uptake of care at first-line facilities. About 50% of women living within 1 km of a first-line facility providing childbirth care delivered at home, and this was so even if the facility provided better care. Therefore, many more women could be potentially reached without expanding the number of facilities providing delivery care. Other studies in Tanzania have argued that mothers value quality of care above other aspects of accessibility [307, 330]. This finding further supports that improving the quality of care – particularly client-perceived quality of care - , not just increasing the number of facilities, should be the first concern in this rural setting.

Although our study did not investigate community perceptions and knowledge on quality of care, the study indirectly provides the hint that women might not be sufficiently informed about what they are entitled to receive. Other studies in East Africa have indicated that better knowledge within the population about entitlements of care provided in facilities can improve both quality of care and uptake of care [437].

Geographical accessibility could also be enhanced by outreach for childbirth care, which has never been employed and investigated in this setting. Outreach or home-based provision of skilled attendance is often regarded as a second or third best choice [422, 438], as teams of health workers with different skills are typically seen as the better option [173, 369]. Most equipment and supplies could be taken in a birthing case by a midwife when attending home deliveries. Further, increasing availability of mobile phones would make referral or the request for help from a colleague as feasible from home as from a health facility.

The common strategy of providing delivery care in facilities is based on the argument that at the health facility level, a large number of interventions can be offered and a team of providers with a different skill set is available [173]. However, the dispensaries in this setting only offer a limited number of services and have rarely more than two staff members, hence why the main argument of the "health centre" approach does not hold for the dispensaries in southern Tanzania.

Large expansions of hospital care are also planned. The national primary care policy and the previously mentioned roadmap for maternal, newborn and child health both target the upgrading of health centres to provide comprehensive emergency obstetric care in the next few years [284, 290] to double or triple the number of facilities with operating theatres in the area.

The uptake pattern for Caesarean section suggests that after a distance of more than 10 km from a hospital, birth by Caesarean section was reduced to levels below 50% of those seen among women living within 5 km of a hospital. Although there is no international recommendation for a ratio of hospital to population, some authors point to the need of one hospital for 100,000 to 150,000 members of the population [439]. The WHO presented their calculation in "Planning for Universal Access" of a ratio of one hospital for 120,000 members of the population [369]. The ratio in our study area was below that estimate, at 1 hospital per 160,000 members of the population.

Two or three higher-level facilities with operating theatres would without a doubt increase geographical accessibility to Caesarean section in this respective rural area. Similar to the discussion of the provision of institutional delivery care to every village, issues of quality of care and low caseload are likely to compromise the anticipated improvement in accessibility of care for mothers. The existing hospitals were all placed in highly populated areas (Figure 36) and any newly built hospitals (upgraded health centres) would be situated in areas with much lower population densities and would serve a relatively small dispersed population, which would result in limited caseloads. Therefore, the cost-effectiveness of such an approach might compromise the quality of care, as retention of skills, and regular availability of drugs, supplies and equipment might be challenging.

The small differences between the level of Caesarean section within the district and the 5 km radius to the hospital in Tandahimba--without a functioning operating theatre at the time--compared to the other districts gives some, albeit limited, evidence that ambulance services can help to achieve similar accessibility to that of new hospitals. A study comparing the feasibility, sustainability and cost effectiveness of building new hospitals versus strengthening ambulance services could greatly assist in giving better evidence on how to improve access to CEmONC in resource poor and rural settings with limited public transport options, as in our study area.

Ambulances have in the past often not yielded the results that they promised [322]. However, it could be argued that with existing resource levels due to basket funding, increased donor resources for maternal and newborn health and availability of mobile phones would make it possible to maintain ambulances, retain drivers, mobilize funds for fuel from district resources--rather than patient resources—and organize timely referral. In contrast, the maintenance of functioning operating theatres, retention of highly qualified staff as needed for surgery and anesthesia in remote rural areas, and the regular supervision and provision of needed supplies might be above existing resource levels. The posting and retention of qualified staff in particular will pose problems due to remoteness [268].

Health policy and planning should take resource limitations into consideration and use options other than expanding the number and types of facilities to increase access to CEmONC. With the existing health budget it is likely to be unrealistic to have one functioning hospital providing comprehensive emergency obstetric care for 100,000 people by 2015 [27]. Instead,

[27] Calculating that half of the 481 health centres would become hospitals as outlined in the Tanzanian roadmap in addition to the existing 211 hospitals and a population of app 45,000,000.

well supported and strategically planed upgrading of selected health centres in remote areas [436] in parallel to an improvement in ambulance services might be considered.

In addition, care packages might be adapted. For example, instead of aiming to establish facilities fully equipped to provide BEmONC including all seven basic functions in every village, prioritizing provision of the highest-impact interventions such as AMTSL, screening and referral for pre-eclampsia, and care for the most frequent complications such as postpartum haemorrhage, retained placenta and asphyxia [156] might be more effective in improving outcomes [224]. Moreover, quality improvement initiatives might help to improve the quality of care, even within the existing resource level [16, 233].

The marked differences in uptake of care at the hospital level between women having their first birth and higher parity deliveries suggests that better counseling might encourage women to find their own solutions to overcome geographical barriers.

Box 5: Implications for health policy in Tanzania

- Increase attention towards quality improvement, training and strengthening of equipment and supplies for better quality of care provided in first-line facilities and hospitals
- Base health policy and planning on actual and expected caseloads in facilities and consider the resource gap (human, financial and management capacities) so that implementation of key strategies is in line with existing health system capacities
- Develop packages of interventions to be implemented at different levels of care and adapted to the resource level and case load instead of employing the defined packages of basic and comprehensive emergency obstetric care
- Experiment with alternative measures such as outreach for childbirth care and improved ambulance services to reduce geographical barriers
- Revisit and revise danger sign and birth preparation counseling and expand information on interventions that mothers are entitled to received and on the importance of facility delivery for all birth
- Revise training curricula and health care strengthening for the prevention and care of indirect causes of maternal mortality such as malaria, AIDS and anemia

Lastly, the observed burden of indirect causes of pregnancy-related mortality points to the need for a greater emphasis on care for malaria, HIV and anemia during pregnancy and childbirth. Treatment for HIV was not yet well-established during the time that period pregnancy-related mortality was assessed. However, the study clearly supports that women should be tested for HIV and--if needed--should receive antiretroviral treatment. The life saving skills curriculum in Tanzania [440] includes one module on prevention and treatment of indirect causes of maternal mortality, but the chapter is short and prevention and treatment guidelines might need to be revised in light of new developments and possibilities in recent years.

Implications for International Maternal Health Policy

This section will take the recommendations for health policy and planning outlined in the section before to the international level and will formulate recommendations for international policies. In light of the strength and limitations of this study outlined in discussion section this section will also give further research questions.

Health care in most low resource settings is constrained by both quality of care and accessibility. Quality deficiencies are embedded in health system constraints and the lack of financial and human resources, which are problems affecting most low-income countries [227]. Therefore, recommendations made for health policy and planning for Tanzania might also be valid for other countries. Health systems and the organization of health care differ between countries, which is why the recommendations in the previous section cannot be universally generalized. A few issues are likely to be highly relevant for other countries. Firstly, that greater attention needs to be paid to quality improvement, including measurement of quality. Secondly, adapted care packages might be drafted more in line with the country-specific actual resource situation, health care organization and health system functioning.

The established monitoring strategy focusing on indicators of uptake of care (coverage for ANC, skilled attendance, birth by Caesarean section and PNC) [221] make the quality issues in provision of childbirth care barely visible in international publication [7]. In particular, the indicator proportion of birth by a skilled attendant is not accompanied by any measurement of qualifying the content of the intervention package. Moreover, the monitoring of EmONC has made countries focus on care for obstetric complications, whereas essential childbirth care and care for indirect causes of mortality have not been given the same attention. Both greater attention needs to be paid to the quality of essential childbirth care and better monitoring, including quality of care indicators for essential childbirth care, are needed.

The existing strategy of emergency obstetric care is based on monitoring guidelines, which propose that seven signal functions need to be provided for a health facility to provide BEmONC and a further two functions to provide CEmONC. However, the categorization is in conflict with the definition of skilled attendance (Figure 5). Moreover, a recent review on evidence-based essential interventions for maternal, newborn and child care [224] suggested that prevention and care for postpartum haemorrhage and pre-eclampsia/eclampsia should be made available in all facilities and not only at the first referral level.

Thus, in light of the most recent evidence, revised policies are needed to support countries to make the most of essential elements of childbirth care available in all facilities where childbirth care is provided. New adapted packages of essential and emergency obstetric care, with reference to required resource levels, should be drafted.

Guidelines for monitoring the quality of care and availability of essential and emergency obstetric care would need to be in line with the intervention packages outlined and might have a three- or four-level monitoring approach including essential, (most) basic and comprehensive care-level indicators.

The EmONC guidelines propose to assess the geographical distribution of EmONC facilities [156]. Although this proposal is important for monitoring, it is also important for planning of health care. The increasing availability of digitalized maps and even geo-referenced data makes planning on the basis of maps, population density and predicted births in most low-income countries now possible.

Box 6: Implications for International Maternal Health Policy

- Increase attention towards the quality of maternal care, particularly to the quality of essential childbirth care by increasing training, improving quality improvement strategies and overall health system strengthening
- Include measurements of quality of care of essential childbirth care in international monitoring recommendations such as the coverage with AMTSL, monitoring of labour and others.
- Revise the existing basic and comprehensive emergency obstetric care definitions so that they are in line with the most recent evidence about what interventions should be provided at which levels
- Assist countries to better define packages of interventions provided at different levels of care in accordance with their health system characteristics
- Encourage countries to strategize investments in maternal health based on maps, population density and predicted births
- Give greater attention in care packages addressing indirect causes of maternal mortality such as malaria, HIV and anemia

Implications for Research

Our study brought up research questions in several areas; a few relevant only to this study or to the Tanzanian context and a few also relevant for other settings such as research on quality of care, accessibility of maternal care and causes of maternal mortality in other low- and middle-income countries.

Missing data on birth histories and distance

The missing data from both birth histories and distance presented a clear limitation of this study. Higher numbers of missing values among birth histories of wealthier, more educated women is a common problem in population-based household studies. Therefore, further research using multiple imputations to assess the bias introduced by using a complete data analysis as presented in this study would have implications beyond the actual relevance for this study. Having a clear understanding of this potential bias could help to better interpret and adjust estimates of maternal mortality from census or survey data with missing birth histories.

Similarly, missing distance variables presented a limitation that potentially introduced bias into the presented effect estimates. A multiple imputation exercise would be needed to get a clear indication if the missing values introduced a bias, to which direction and to what extent. However, unlike the examination into the missing birth histories, this further analysis would only be relevant for this specific study.

Box 7: Recommendation for further research on missing data

Research into the Bias Introduced Through Missing Data

- Use multiple imputation methods to examine the effect of missing data on birth histories on the effect estimates for uptake of care and pregnancy-related mortality
- Use multiple imputation methods to examine the effect of missing data on distance variables on the effect estimates for uptake of care and pregnancy-related mortality

Measuring quality of maternal health

The analysis of quality of care provided in health facilities and the construction of the index of maternal health pointed to the lack of standard indicators, standard packages and standard methods to describe the quality of maternal care at defined levels in line with the most recent evidence [224]. The lack of information on quality of care and coverage levels on the most essential interventions makes it difficult to keep attention on quality of care at the national and international level as outlined before.

Data on quality of care or interventions and services provided to clients are commonly available from routine health management data. International monitoring of maternal and child health has often rejected health facility data as incomplete and of low quality, although they are widely used for monitoring of tuberculosis [441]. Continuous monitoring and use of data can be an important stimulus for continuous quality improvement [442]. Thus, continuous collection of quality indicators using health management information data should be encouraged at local and international level. The “German perinatal study” might also be a good example how continuous documentation of quality of care of ANC and childbirth care interventions can assist in improving quality of care [443]. The extent to which local data can guide quality improvement at the local level is also part of the EQUIP intervention research project [444]. However, using health management information data in resourse poor settings for monitoring on quality of care clearly presents a challenge in reliability and completeness (Table 76).

A limitation of our study was the lack of any measurement on client-perceived quality of care and client satisfaction. It is likely that women can overcome larger distances if they feel that they will benefit from delivering in a respective health facility. Such measurements were not available in this study to adjust estimates. One reason why no such measurement was included in that no standard indicator has yet been established – although frameworks include client satisfaction as an important measure of outcome [220].

Different qualitative and qualitative methods have been proposed to measure client-perceived quality and satisfaction [191]. The review on published literature on this topic indicated a larger variation of topic and domains included in studies (Table 7). Information obtained during health facility surveys, as exit interviews with women attending care are time consuming. In addition, exit interviews might yield biased results.

Further work is needed to include such measurements in household surveys, as this might give more appropriate results. Whether accreditation initiatives assessing different elements of client-centred care—similar to the "baby-friendly hospital" [445]—could provide in addition a useful measurement or indicator remains to be discussed.

Box 8: Recommendations for measuring progress in maternal health

- Develop a methodology and a standard set of indicators measuring "essential childbirth care" as defined by LiST and the WHO, which should include the most critical interventions such as AMTSL (see Box 4 p 249)
- Further develop a standard measure of client-centred care and provider-perceived quality for population-based and health facility surveys

Measuring geographical accessibility of care and its effect on mortality

This study focused on the assessment of geographical accessibility on uptake of care and pregnancy-related mortality. Our study suggests that other factors beyond distance, wealth and education are important for uptake of care. The large unexplained variation, particularly for the use of first-line facilities in the 114 wards, underlined that more knowledge is needed to identify the most relevant factors (Figure 45). As outlined before, no such standard indicators measuring user-perceived quality of care are established neither for health facility nor population-based surveys.

Studies assessing the effect of distance on uptake of care are often constrained by the fact that it is not known which facilities women actually did choose for services, which is a limitation in this study. Documenting the exact place of delivery would make it possible to calculate not only the distance to the nearest facility, but true distances to the services where care was sought. Moreover, other factors such as the possibility of staying with family members while waiting for labour are factors that are likely to affect care-seeking behavior. Uptake of care differs if complications in pregnancies are seen.

Box 9: Recommendations for measuring geographical accessibility of care and its effect on uptake of care and mortality

- Wherever possible, record the actual place of delivery and where women stayed when they went into labour in surveys
- Include measurements of complications in pregnancy and obstetric risk factors
- Include facilitating factors beyond distance such as available public or private transport
- Compare results using the straight-line distance and travel time

- Perform separate analyses for sub-sets of causes of mortality wherever possible

The use of the straight-line distance is likely to have limitations. The advantage is that measurements are produced using a defined scale (meter or kilometer). Travel time is commonly based on algorithms, which aim to adjust for different modes of travel and geographical surface characteristics and do not necessarily enhance comparability as algorithms differ. As both methods are widely used, it would be helpful to have a clearer understanding of the settings in which results are comparable, or the settings in which each method is superior. For our study, it is likely that within defined areas, travel time and straight-line distance generate comparable results, as discussed before. This assumption would need to be tested and warrants further research.

Lastly, this analysis of the effect of distance on pregnancy-related mortality indicated that distance had a much larger effect on direct maternal mortality but not on indirect maternal mortality. Thus, a sub-group analysis can yield more important information regarding which women are most vulnerable to distance.

Reasons for the low availability of essential ANC and childbirth care interventions

The analysis of the information from the health facility census indicated low implementation of certain interventions. More knowledge is needed as to why certain interventions are not implemented to scale. For some, such as syphilis screening, the lack of testing materials and missing international attention might explain why implementation is lower than for PMTCT, although syphilis screening and PMTCT can be done simultaneously, demanding the same testing procedure. Other interventions such as screening for blood pressure or application of eye ointment for ophthalmia neonatorum cannot be explained by lack of equipment alone, but might also be due to insufficient attention by health providers. The low use of vacuum extraction is often explained by high HIV prevalence, although evidence is lacking as to whether vacuum extraction increases transmission rates. Research on vacuum extraction might further investigate whether the application of the method truly increases the risk for transmission of HIV from the mother to the baby. To target improvement work for better quality during ANC and childbirth care, more detailed knowledge of health system factors preventing full implementation is needed.

Box 10: Recommendations for further implementation and health systems research

Implementation and Health System Research on Bottlenecks for Low Implementation of Selected Interventions
• Such as syphilis screening; prevention and care of pre-eclampsia, particularly use of magnesium sulfate; vacuum extraction; ophthalmia neonatorum prophylaxis; and others

Improving accessibility through alternative measures other than increasing the number of service delivery points

In the discussion (p 277), the tension in health care organization between accessibility and quality of care was outlined. International maternal health policies have favored health facility-based provision of skilled attendance [173]. Moderate improvements in mortality after the introduction of the community midwifery approach in Indonesia [89, 151] has further contributed to a cautious stand against community approaches for delivery care. The rationale for the facility-based strategy is convincing [173], however, not in all settings, such as in southern Tanzania. Here, the assumptions that first-line health facilities offer an enabling environment with a wide availability of services and a team of staff with different skills are not met. In such settings, outreach services might still be an interim option before larger availability of transport makes such approaches unnecessary. However, the effectiveness, cost-effectiveness and acceptability of an outreach approach would need to be tested. Similarly, increasing availability to EmONC could be done by building more hospitals, or alternatively, by strengthening referral systems and ambulance services. The effectiveness, cost-effectiveness and acceptability of strengthening referral systems would need to be tested.

Box 11: Recommendation for further research on improving access to obstetric care

Investigate the Feasibility, Acceptability, Effect and Cost-Effectiveness of Alternative Models to Increase Accessibility to Childbirth Care
• Outreach childbirth care services in comparison with health facility based childbirth care • Improved ambulance services in comparison with establishment of hospitals

Causes and determinants of pregnancy-related mortality

Finally, the analysis of pregnancy-related mortality and the causes of deaths revealed a high burden of indirect causes such as malaria, anemia, AIDS and tuberculosis. As physician coding based on verbal autopsy has its limitations, it cannot be excluded that the presented distribution of causes of pregnancy-related deaths overestimates the burden of indirect causes. Using an alternative approach to assign causes of deaths, such as the INTER-VA method, will not overcome the limitations of verbal autopsies. However, if the high burden of indirect causes of deaths could be confirmed, it would further add evidence to the finding that a large burden of pregnancy-related mortality is due to malaria, anemia and AIDS in this setting.

Further, our study faced the limitation that important explanatory variables were not available for mothers who died. The assessment of education and occupation of mothers who died was not done during the household census, but during the verbal autopsy interviews carried out after the main study, and some verbal autopsies were missing. When adding verbal autopsy to larger household studies it is important to harmonize assessment tools and questions. However, this would not rule out recall bias when asking about education and occupation of a deceased person, which will always present a limitation.

Another limitation was that the variable "parity" was not available from the verbal autopsy questionnaire. The very recently published new verbal autopsy from the WHO now include a question assessing the number of previous births [48]. This additional question will make it possible in the future to investigate the effect of parity on pregnancy-related mortality and the confounding effect of parity on the effect of age.

Box 12: Recommendations for further research on causes and determinants of pregnancy-related mortality

Investigation Into Causes and Determinants of Pregnancy-Related Mortality

- Investigate whether the described mortality pattern would be similar if the Inter-VA method would be used to analyze the verbal autopsies
- Harmonize questions and categories for socio-demographic variables between different questionnaires within one larger investigation

Finally, this investigation into determinants of pregnancy-related mortality was only possible because the research team planning the assessment of two public health interventions (IPTi and improving newborn survival) added the assessment of pregnancy-related mortality to the main research objectives and included the respective questions in the household census. Such an openness to add research questions is not generally seen. Only such openness and farsightedness can make better use of existing resources. Thus, my final recommendation is that teams planning larger population-based studies might carefully assess whether open questions from other public health areas can be answered without major additional resources and diversion from the main research objective. Much has been talked about synergies and linkages in implementation. System thinking for strengthening health systems in low- and middle-income countries is high on the agenda [446]. This thesis can be used to highlight opportunities that arise from employing synergies and linkages and system thinking in research.

Box 13: Recommendations on employing synergies in public health research

Investigate opportunities to answer research questions from related fields when planning larger population-based studies

Annex

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Additional Information and Tables

Figures and tables evidence FP

Figure 68: Flow diagram of the process of identifying references for the meta-analysis of the effect of age and parity on maternal mortality

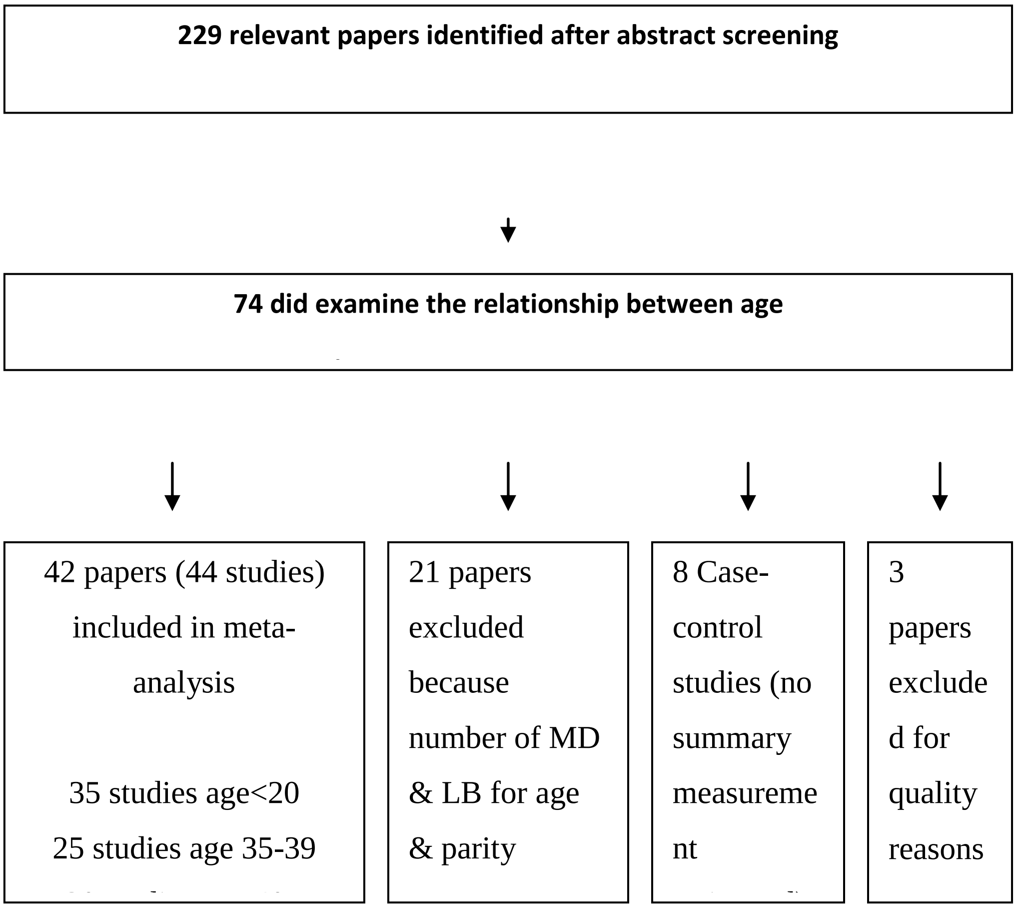

Table 73: Studies included in the systematic review of the effect of age and parity on maternal mortality

Source	Country (Region)	MMR	Definition of maternal mortality	Sample size (live births)	Type of study	Risk-factor	main findings
Temmerman et al. 2004 [447]	Belgium, 1991-2000	5.8	ICD-10	639365	Retrospective-population-based-cohort	Age	increase with age
Augensen & Bergsjo 1984[448]	Scandinavia, 1970-79	7.2	ICD-8	2930408	Population-based-cohort	Age	increase with age
Salanave & Bouvier-Colle[449]	France and England, 1988-90	7.4 & 9.4	ICD-9	France: 2299148 England: 2086700	Population-based-cohort	Age	j-shaped
Hoyert et al. 2000 [79]	United States & Canada, 1982-1997	8.4	ICD-9	3874574	Population-based-cohort	Age	increase with age
Koonin et al. 1997[80]	United States, 1987-1990	9.2	ICD-9 + within 1 year	15918074	Population-based-cohort	Age	increase with age
Nagaya et al. 2000[450]	Japan, 1991-92	9.5	ICD-9	2432179	Cross-sectional, population based	Age	j-shaped
Chang et al. 2003[81]	United States, 1991-1999	11.8	ICD-9 + within 1 year	35593220	Population-based-cohort	Age	increase with age
Kaunitz et al. 1985[101]	United States, 1974-1978	15.3	ICD-9	16176471	Population-based-cohort	Age	increase with age
Tuncer et al, 1995 [451]	Turkey, 1983-92	17	ICD-9	100531	Hospital-based	Age, parity	j-shaped, increase with parity
Al-Meshari et al. 1996[452]	Saudi Arabia, 1989-92	18	ICD-9/10	880248	hospital-based cohort	Age, parity	increase with age
Donoso Sina, 2004[453]	Chile, 1990-2000	19	ICD-9	3108173	Population-based-cohort	Age	increase with age
Callaghan & Berg, 2003[454]	United States, 1991-1997	20	ICD-9 + within 1 year	10862197	Population-based-cohort	Age	increase with age
Mertz et al. 1992 [98]	United States, 1975-1989	20	Whilst pregnant or within 42d	1522167	Population-based-cohort	Age	increase with age

Donoso-Sina & Valdivieso 2003[455]	Chile, 1990-1999	26.8	ICD-9	2376754	Population-based-cohort	Age	increase only <15 years
Lee & Corpuz[456]	United States, 1966-1980	30	?	51109606	Population-based-cohort	age	Increase with age
Donoso-Sina & Villarroel, 2003[457]	Chile, 1999	30	ICD-10	45MD	Nested case-control-study in population-based-cohort	Age	increase with age
Schaffner et al. 1977[100]	United States, 1950-71	34	Direct maternal deaths	3984395	Prospective-population-based-cohort	Age	increase with age
Miller, 1973[458]	Australia, 1964-69	35	Deaths during pregnancy or within 42d	125454	community-based-retrospective-cohort	Age	Increase with age
Dorfman 1990[102]	United States,1981-83	36	pregnancy related or associated	332387	Population-based-cohort	Age	increase with age
Conde-Agudelo et al. 2005[353]	Latin America, 1985-2003	46	ICD-10	854377 deliveries	Cross-sectional retrospective hospital-based-cohort	Age	increase only in the group <= 15 years
Theme-Filha et al. 1999 [94]	Brasil, 1993-1996	57	ICD-9	388789	Population-based-cohort	Age	increase with age
Keeling et al. 1991[459]	Jamaica, 1986/87	115	Whilst pregnant or within 1 year	54200	Population-based-cohort	Age, parity	increase with age and parity
Mhango et al. 1986 [460]	Zambia, 1982-1983	118	Whilst pregnant or within 42d	50780	Hospital-based-cohort	Parity	j-shaped-association
Kane et al. 1992[461]	Egypt, 1985/86	126	FIGO-classification incl. accidental deaths	115727	Population-based-cohort	Age	increase with age
Kestler & Ramirez, 2000 [462]	Guatemala, 1993-1996	156	ICD-9	276432	Population-based-cohort	Age	increase with age
Varner et al. 1982[463]	United States, 1926-1980	176	Deaths during pregnancy or within 42d	83851	Hospital-based retrospective-cohort	Age, parity	increase with age and parity
Fortney et al. 1988 [464]	Indonesia, 1980-82 and Egypt, 1981-83	190 & 718	Whilst pregnant or within 42d	Egypt: 20280 Indonesia: 77454	Population-based-cohort	Age	j-shaped-association

Bouvier-Colle et al. 2001[465]	West Africa, 1994-1996	311	ICD-10	17694	Prospective-population-based-cohort	Age	j-shaped-association
Magadi et al 2001[77]	Kenya, 1993	313	?	58151 admissions	Hospital-based-retrospective cohort	Age	j-shaped increase
Andersson et al. 2000[96]	Sweden, 1800-1899	321	ICD-10+ late MD (1 year)	150932 births	Retrospective population-based cohort	Parity	parity not a risk-factor in multivariate analysis
Westhoff, et al. 2008 [466]	Dominican Republic, 1979-93	348	MD within 2 months, sibling survivorship technique	46 MD	Survey, population based	age	Increase with age
Abdullah, et al. 1992 [82]	Egypt, 1987	368	Not defined	8656 pregnancies	Population-based	Age, parity	j-shaped
Eastman 1940[128]	United States, 1896-1939	420	MD excluding abortion	45514	Hospital-cohort	Parity	increase only parity 9+
Bell et al, 2008 [73]	Burkina Faso, 2002-06	441	ICD-10	82289	Population-based	age	j-shaped
Fauveau et al. 1988[467]	Bangladesh, 1976-85	550	ICD-9	72517	Demographic site, community-based cohort	Age, parity	j-shaped
Koenig et al. 1988 [468]	Bangladesh, 1976-85	550	Whilst pregnant or within 90d	70286	Population-based-cohort	Age, parity	j-shaped association
Alauddin 1986[92]	Bangladesh, 1982-1983	555	ICD-8	8485	Prospective-population-based-cohort	Age, parity	j-shaped-association
Chen et al. 1974 [469]	Bangladesh, 1968-70	570	Whilst pregnant or within 90d	20816	Population-based-prospective-cohort	Age, parity	j-shaped association
Khan et al. 1986[470]	Bangladesh, 1982-1983	623	Whilst pregnant or within 42d	9317	Population-based, cross-sectional	Age, parity	j-shaped-association
Christian et al. 2008 [110]	Nepal	723	All-cause pregnancy-related deaths, 42d & 1 year	25580 pregnancies	Population based longitudinal cohort-study	parity	Decrease with parity
Høj et al.2002[78]	Guinea-Bissau, 1990-96	778	ICD-10 +late MD (90d)	10931 pregnancies	Prospective population-based-cohort	parity	

Koum et al. 2002 [114]	Cambodia, 1998	785	ICD-10	5985 deliveries	Retrospective-hospital-based-cohort	Age, parity	j-shaped association

Abbreviations: ICD, International Classification of Disease; d, days; MD, maternal deaths

Table 74: Original, imputed and missing data for 22,243 women with a livebirth by socio-economic

	Original data	Cleaned and imputed data	Missing data	Chi-squared test
	N=15,977	N=4,043	N=2,223	
District				p<0.001
Lindi Rural	79	12	9	
Nachingwea	73	18	10	
Ruangwa	72	23	6	
Newala	64	16	20	
Tandahimba	69	25	6	
Ethnic group				p<0.001
Makonde	70	19	11	
Makuwa	70	19	11	
Yao	72	18	11	
Mwera	76	17	7	
Others	69	18	12	
Wealth quintiles (assets)				p<0.001
Most poor	72	19	9	
Very poor	73	17	11	
Poor	73	18	9	
Less poor	73	17	10	
Least poor	69	21	10	
Missing	74	16	11	
Maternal education				p=0.070
No education	72	19	9	
Some primary education	72	18	9	
Completed prim. Education	71	18	11	
Secondary and more	64	24	11	
Missing (0.5% of births)	70	21	9	
Work				p<0.001
Farming	72	18	10	
Housewife	65	25	11	
Employed	64	26	10	
Others	67	24	8	
Maternal Age				p=0.434
12-19	71	19	10	
20-29	72	18	10	
30-39	72	18	10	
40-49	74	18	9	
Parity (only livebirths)				p=0.073
1st birth	71	19	10	
2nd & 3rd	72	19	10	
4th & 5th	72	17	11	
6 and more	72	18	10	
Sex of head of household				p=0.999
Female	72	18	10	
Male	72	18	10	
Overall	**72**	**18**	**10**	

Table 75: Comparison of assisting person at last birth between the census 2007 and DHS 2004/05 & 2010

Most trained person assisting during births	Doctor AMO or Clinician	Nurse / midwife	MCHA	TBA	Relative or other person	No one	% Skilled attendant
DHS 2004/05 Lindi and Mtwara combined	4	34	4.4	28	23	1.8	42
DHS 2010 Lindi and Mtwara combined	3	53	0.2	26	16	1.5	56
Census Lindi/Mtwara 2007	9	36		30	22	2.8	45

Table 76: Comparison of place of birth between health facility and population based data

	Health facility reports 2008			Reports from women with a live birth in the year prior the census (mid 2006-mid 2007)	
	Mean number of reported deliveries	No of facilities	Sum	Number	%
Hospital	930	6	5579	6475/6993*	29.1
Health centre	102	13	1320	472 / 509*	2.1
Dispensary	62	131	8118	2099 /2267*	9.4
			15016	**9046 /9770***	40.7
Home/other place	NA	NA	NA	13,197	59.3
Total	NA	NA	NA	**22,243**	**100.0**

*inflated by 8% missing births

Table 77: Comparison of information on interventions during ANC from the health facility census 2009 and the household census survey 2007 and an observational study from the neighbouring Rufiji region

	Health facility survey 2009 (Self reports from head of reproductive health unit) % (CI)^	Women's report (with a live birth in the past year prior the census) (2006/2007)	Observational study observing 36 ANC visits*
	136 HFs	N=22048 women with ANC	36 ANC visits, 4 HF
Physical examination			
Measure height	93% (89.5-97.3)	70%	
Measure weight	93% (89.5-97.3)	91%	
Measure blood pressure	76 % (68.2-84.5)	66%	83% (30/36)
Laboratory examination including counselling			
Urine protein test	27% (14.9-38.1)	41%	
Haemoglobin testing	37% (25.6-47.7)		
PMTCT (offering services incl. Testing)	85% (79.2-90.9)		43% (6/14)
Information on PMTCT		60%	
Syphilis testing (incl. testing)	59% (51.1-68.6)		
Blood test (for haemoglobin, PMTCT or syphilis)		70%	
Preventive care			
IPTp	95% (91.0-98.5)	65%	44% (8/18)
Tetanus vaccination	98% (CI 95.3-100)	76%	
Folic acid/iron supplementation	Not assessed	73%	
Counselling / health education			
Counselling/treatment for STIs	85% (79.3-91.1)	53%	28%(10/36)
Family planning counselling	96% (90.2-100)	Not assessed	8 % (1/12)
Bed net promotion /voucher	96% (92.7-89.9)	86%	29 %(4/14)
Birth preparation counselling	99% (98.2-100)	59%	50% (18/36
Danger Signs	99 % (98.2-100)	40%	3% (1/36)

^weighted analysis taking the pattern of uptake of care (dispensary/health centre/hospital) into account

*14 first visits in 4 HF in 4 public health facilities [299]

Table 78: Interventions and counseling during ANC by number of visits

	Number of women with answers	1 visit (2% of women)	2-3 visits (56% of women)	4+ visits (41% of women)	Overall
		%	%	%	%
Physical examination					
Measure height	21388	62	69	72	70
Measure weight	21921	86	91	91	91
Measure blood pressure	21591	52	64	68	66
Laboratory examination including counseling					
Urine test	21894	30	39	45	41
Information on PMTCT	21829	44	59	61	60
Blood test (not specified)	21821	56	70	72	70
Preventive care					
IPTp	21521	43	65	67	65
Tetanus vaccination	21912	58	74	80	76
Folic acid/iron supplementation	21812	57	72	76	73
Counseling / health education					
Counseling/treatment for STIs	21768	37	51	55	51
Bed net promotion /voucher	21946	63	85	88	86
Birth preparation counseling	21924	43	57	63	59
Danger signs	21728	30	38	42	40

Census 2007 Questionnaire

Tathmini ya afya katika wilaya sita 2007 / *Health evaluation in six districts 2007*

Maelekezo ya dodoso kwa wahojaji / Instructions of the questionnaire for the interviewer

Utangulizi / introduction

Maswali ya dodoso hili yameandaliwa kwa lengo la kuyauliza katika kaya. / *The questions in this questionair have been set for the purpose of asking in the household*. Kaya ni watu wanaoishi na wanaokula pamoja kama familia. / *Household is a group of people who live together and eat together as a family*. Katika tathmini hii, utapewa orodha ya kaya za kuhoji kila siku. / *In this evaluation you will be given a list of household to interview*. Idadi ya kaya kwa siku moja kwa mhojaji mmoja inaweza kufika kumi na tano au zaidii. / *The number of household for the interviewer to interview per day may reach fifteen and above.* Kila siku utakuwa katika kitongoji au kijiji tofauti. / *Everyday you will be in a different subvillage or village.*

Kwanza, jitambulishe kwa mkuu wa kaya. / First of all introduce yourself to the head of the household. Hakikisha kwamba amepata mwaliko wa kushiriki na bado hawajahojiwa. / Make sure that you got the consent form and they are not yet interviewed. Msomee mwaliko na muombe ridhaa. / Read the form and ask for a conent. Kuna SOP (maelekezo ya utendaji kazi) yaliyoambatanishwa../ There is a SOP (Standard operating procedure) attached.

Katika dodoso hili, kuna vipengele viwili: / in this questionair there are two modules

Kipengele cha kaya Baada ya kujieleza na kuomba ridhaa kwa mkuu wa kaya, utaomba ruhusa kuuliza maswali kutoka kwa mkuu wa kaya. / Household Module: After introduction and getting the consent of the head of the household, ask for permission from the head of the household to ask questions. Kama anakubali kushiriki, unaorodhesha watu wote wanaokaa katika kaya, pamoja na tarehe ya kuzaliwa kwa watu wote. / If he agrees to participate, list all the people that live in the household, including their dates of birth. Pia, kwa mkuu wa kaya na wanawake wenye umri wa miaka 13-49, utauliza maswali juu ya kazi yake na elimu yake. / Also, to the head of the household and women with the age 13 – 49 years old, you will ask ther work and their education. Halafu utauliza kujua kabila la mkuu wa kaya, na kama watakuwa na vifaa kama redio, baisikeli, au vyandarua katika kaya. / Then you will ask to know the tribe of the head of the household if they will be having things like radio, bicycle, or bed nets in their household. Halafu utauliza juu ya matukio ya misiba tangu 2003 katika kaya yake. / Then you will ask death events in their houseldhold from 2003.

Kwa kaya yenye wazee pekee, au kaya ya wanaume pekee, uhojaji umeisha, na unaweza kuendelea kwa kaya nyingine./ For the household with old people only or with men only the interview ends there, you can continue with another households. Kwa kaya yenye wanawake wenye umri wa miaka 13 mpaka 49, kuna kipengele kingine, kipengele cha wanawake. / For the household with women with the age between 13 and 49 years old, there is another module of women.

Kipengele cha wanawake: Katika kipengele hiki, unahoji mwanamke kati ya umri ya miaka 13 na 49. / Tho module for women: In this module, you will interview women with the age group between 13 and 49 years old. Kuna maswali juu ya watoto wote ambao amezaa mwenyewe *katika maisha yake, na hasa kwa watoto waliozaliwa tangu mwaka 2002. / There are questions about all the children she delivered in her, mostly to the children who were born form 2002. Kwa akina mama waliozaa mtoto ndani ya mwaka mmoja uliopita, kuna maswali juu ya afya ya ujauzito na mtoto mwenyewe wakati wa kuzaliwa. / For the women who delivered within the last one year, there are questions about the health of their pregnancy and the health of the child during delivery. Kama mwanamke mmojawapo hayupo, uliza muda atakao kuwepo hapo nyumbani ili urudi tena baadaye. / If one of the women is not around, ask for the time that she will return, so that you comeback again.*

Kwa mwanamke aliyezaa mtoto ndani ya mwaka mmoja uliopita kuna maswali kuhusu afya yake wakati wa ujauzito na kujifungua, na afya ya mtoto alipokuwa mchanga. / For a woman who delivered within a last one year, there are questions about her health during pregnancy and delivery, and the health of the child after delivery.

Kwa kaya yenye wanawake wawili au zaidi, unawahoji wote. / For the households with two or more women, you interview all of them.

<u>Kujaza dodoso</u> Tumia kikompyuta kidogo (PDA). / Filling the questionair. Use your small computer (PDA). Taarifa zinazokusanywa ni siri. / Information you are collecting are confidential. Usimshirikishe mtu yeyote ambaye hahusiki na mradi huu isipokuwa pale tu inapokuwa ni kwa ajili ya kufanikisha mahojiano. / Do not involve any person who is not involved with this Project, unless it is for facilitationg the interview exercise. Kama unahitaji kuandika kitu chochote katika karatasi, kwa mfano katika orodha za kaya, tumia HERUFI KUBWA. / If you want to write anything on the paper, for exaple in the form of the list of households use CAPITAL LETTERS. Masahihisho yatafanyika kwa kukata neno zima au tarakimu zote au mfululizo wa maneno kwa mistari miwili sambamba. / Correction will be done by canceling the whole word or all the numbers or a sentence by two parallel lines. Usahihi utafanyika juu ya makosa au kulia kwake. / Correction will be done on top of the mistakes or at its right hand side. Tumia fomu ulizopewa kuandikia taarifa. / Use the form you will be given to write information. Kama unahitaji kuandika kitu kingine wakati wowote, tumia daftari lako. / If you need to write other things any time, use your note book. Usisahau kuandika tarehe, namba ya kitongoji na nambari ya kaya. / Don't forget to write the date,the number of subvillage and the number of the household.

KIPENGELE CHA KAYA / *Household module*

Jaza kipengele hiki mara moja tu kwa kila kaya. / Fill this module only once in every household. Kumbuka maana ya kaya ni watu ambayo wanakula pamoja. / Remember the meaning of an householdas as a group of people who live and eat together. Msimamizi wako atakupatia majibu ya maswali HH1–HH7 na HH11. / Your supervisor Hill give you the asnwers for question HH1 – HH7 na HH11

HH1 **Wilaya / District** |__|__|

HH2 **Tarafa / Division** |__|__|__|__|__|__|__|__|__|__|__|_ |__|

HH3 **Kata / Ward** |__|__|__|__|__|__|__|__|__|__|__|_ |__|

HH4 **Kijiji / Village** |__|__|__|__|__|__|__|__|__|__|__|_ |__|

HH5 **Kitongoji / Sub-village** |__|__|__|__|__|__|__|__|__|__|__|_ |__|

HH6 **Kitongoji Namba / Sub-village number** |__|__|__|__|

HH6a **Herufi ya leo / Letter of today** |__|

Kila siku ya kazi utaambiwa herufi ya siku hiyo na supervisor / On every working day you will be told the letter of the day by your supervisor.

HH7 **Kaya Namba / Household number** |__|__|__|

HH8	**Mhojaji / Interviewer**	|__|__|
HH9	**Tarehe ya leo / date of today** *(Tarehe/ date / mwezi / month / mwaka / year)*	|__|__|/|__|__|/|__|__|__|__|
HH10(a)	**Muda wa kuanza / Starting time** *saa/hour : dakika/minute*	|__|__|:|__|__|
HH10(b)	**Muda wa kumaliza/finishing time** *saa/hour : dakika/minute*	|__|__|:|__|__|
HH10(c)	**Time taken for household module (minutes)/muda uliotumika katika kipengele cha kaya**	|__|__|__|
HH11	**Mkuu wa kaya/head of the household**	|__|__|__|__|__|__|__|__|__|__|__|__|__|__|__|__|__|__|__|__
HH12	**Umemsomea mwaliko wa ushiriki? / did you read the consent?** *Kama hakuna mtu katika kaya hii, au unawakuta watoto pekee, lazima kurudi baadaye pamoja na msimamizi au mhojaji mwingine. / If there is no body in the household or children alone, it is must to return again later with the supervisor or with another interviewer* *(Kama hayupo, umemaliza / if they there is nobody, you have finished)*	Ndiyo / yes / hapana / no / hayupo/ not around
HH13	**Je, mkuu wa kaya amekubali? / Has the head of the household agree?** *(Kama hapana, mshukuru na mueleze msimamizi wako / If not thank the head of the household and report to your supervisor)*	Ndiyo / yes / hapana / no

Katika jedwali namba HH14, jaza majina na tarehe ya kuzaliwa kwa watu wote katika kaya. / In the graph number HH14, fill the names and birth dates of all the people in the household. Anza na mkuu wa kaya na watu wazima. / Start with the head of the household and elders. Omba kadi ya kupiga kura kwa watu wazima, na kadi ya kliniki kwa kila mtoto na akina mama. / Ask for the voting card for the elders and clinic cards for every child and mothers. Uliza kwanza mwaka aliozaliwa. / Ask first the year she/he was born. Kwa watoto ambao wamezaliwa kuanzia 2002 mpaka 2007, uliza tarehe, mwezi na mwaka. / For the children who were born from 2002 up to 2007, ask the date, month and year. Kwa wanawake waliozaliwa mwaka 1957, 1958, 1994 au 1995, uliza tarehe, mwezi na mwaka waliozaliwa / For women who were born in 1957, 1958, 1994 or 1995, ask their dates, months and year they were born.

Tumia mstari mmoja kwa kila mtu. / Use one line for every person. Kwa majina, andika jina la kwanza tu, ili uwafahamu katika kaya. / For names, write their first names only, so as to identify them in the households.

Kwa mkuu wa kaya na wanawake wenye umri ya miaka 13-49, uliza anajishughulisha na nini. / For the head of the household and women with years between 13 and 49, ask they are involving in which activities. Lengo la swali hili ni kutaka kujua kama shughuli anayofanya ni kulima tu, au kama ana shughuli nyingine ambayo anapata kipato, hata kama ni kidogo. / The aim of this question is to know the activity he/she involving is only farming, or has other ctivities that he/she earns an income, even if a small income. Dadisi zaidi ya kazi moja. / Probe for more than one job.

Kwa elimu, uliza amesoma mpaka darasa la ngapi. . / For education, ask he or she has studied up to which class. Jumlisha miaka yote ambayo amesoma. / Add all the years that she/he has studied. Kwa mfano, kama amesoma mpaka darasa la saba, andika 7 /For example, he/she has studied up to standard seven, you write 7. Kama amesoma mpaka form 4, jaza 11/ If she/he studied up to form four, write 11. Kama ni chini ya mwaka mmoja, jaza 0./ if it is below one year, write 0 Kama hajui, andika 99./ if she/he do not know, write 99.

Kwa mtoto chini ya miaka 13, andika jina la mama au mlezi wake. / For a child less than 13 years, write the name of her mother or the guardian. Andika jina la kwanza tu. / Write the first name only. Lengo la swali hili ni kupata jina la mtu anayemlea katika kaya hii, ili aweze kuhojiwa baadaye. / The aim of this question is to get the name of the person that takes care of the child in this household, so as can be interviewed later.

<table>
<tr><th>Namba ya mtu / Number of the person

hh14a</th><th>Jina la mtu / Name of the person

hh14c</th><th>Jinsia / Sex
ME/M / KE/F

hh14d</th><th>Tarehe ya kuzaliwa* / Date of birth

Hh14e</th><th>Mwanamke mwenye umri kati ya 13-49 / Woman between 13 – 49 years
Ndio/ Yes/ hapana/ No
hh14f</th><th>Umri chini ya miaka miwili/ Age below two years
Ndio / Yes/ hapana /No

hh14g</th><th>Jina la mama/mlezi / Name of the mother/guardian
(kwa watoto chini ya miaka kumi na tatu tu/for a child below 13 years) (chagua kutoka drop-down list/select from drop-down list)
hh14h</th><th colspan="2">Anajishughulisha na nini?** / Is involved in which activity?

hh14i / hh14j</th><th>Elimu / Education

hh14k</th><th>Mtu mwingine katika kaya? / Any other person in the household?
Ndiyo / Yes / hapana / No</th></tr>
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<tr><td>18</td><td>|__|__|__|__|__|__|__|__|__|__|</td><td>|__|</td><td>|__|__|/|__|__|/|__|__|__|__|</td><td>|__|</td><td>|__|</td><td>|__|__|__|__|__|__|__|__|__|__|</td><td>|__|</td><td>|__|</td><td>|__|__|</td><td>|__|</td></tr>
<tr><td>19</td><td>|__|__|__|__|__|__|__|__|__|__|</td><td>|__|</td><td>|__|__|/|__|__|/|__|__|__|__|</td><td>|__|</td><td>|__|</td><td>|__|__|__|__|__|__|__|__|__|__|</td><td>|__|</td><td>|__|</td><td>|__|__|</td><td>|__|</td></tr>
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</table>

*Uliza kwanza mwaka alipozaliwa. / Ask first the year she/he was born. Kwa watoto ambao wamezaliwa kati ya miaka 2002 na 2007, uliza tarehe, mwezi na mwaka. / For the children who were born between 2002 and 2007, ask the date, month and the year when they were born. Kwa wanawake waliyozaliwa mwaka 1957, 1958, 1994 na 1995, uliza mwezi na mwaka waliyozaliwa. / For women who were born in 1957, 1958, 1994 and 1995, ask month and the year they were born.

** ***Jaza kwa mkuu wa kaya na wanawake wenye umri wa miaka 13-49***. / Fill for the head of the household and for women with the age between 13 – 49 years.

Kazi./ Job. *Dadisi zaidi ya kazi moja./ Probe for more than one job.* Mkulima / Farmer, Muajiriwa / employed, Shughuli nyingine ambayo inmpatia kipato, hata kama ni kidogo, / other activities that help him/her to get income even if a small income. Mama wa nyumbani / House mother/ hana kazi / don't have a job, Anasoma / Studying

Elimu / Education. Jumlisha miaka yote ambayo amesoma. / Add all the years that she/he has studied. Kama ni chini ya mwaka mmoja, jaza 0 / If it is less than one year, write 0. Kama hajui, andika 99. / If she/he do not know, write 99.

KUHUSU KAYA / About the household *(muulize mkuu wa kaya kama yupo / Ask the head of the household if he/she is available. Kama hayupo, muulize mtu mwingine / If she/he is not available, ask another person)*

HH15	**Je, mhojiwa ni mkuu wa kaya? / Is the interviewee the head of the household?**	Ndiyo/Yes / hapana/No
HH16	**Jina la mhojiwa / Name of the interviewee** *(Chagua jina kutoka kwenye orodha / Select the name from the list)*	|__|__|__|__|__|__|__|__|__|__|__|
HH17	**Naomba kuuliza kabila la mkuu wa kaya? / I beg to ask for the tribe of the head of the household?**	Yao / Makonde / Matumbi / Mwera / Ndonde Ngindo / Nyasa / Ngoni / Makuwa / Nyingine
HH18	**Je, nyumba hii mnayoishi, mmepanga? / This house you are staying, did you rent?**	Ndiyo/Yes / hapana/No
HH19	**Je, katika kaya hii, mnamiliki baisikeli? / In this household, do you own a bicycle?**	Ndiyo/Yes / hapana/No
HH20	**Je, katika kaya hii, mnamiliki redio?/ In this household, do you own radio?**	Ndiyo/Yes / hapana/No
HH28	**Je, katika kaya hii kuna mtu anamiliki simu?/ In this household do you own telephone?**	Ndiyo/Yes / hapana/No
HH21	**Je, katika kaya hii mnavyo vyandarua?/ In this household, do you own bednets?** *Kama jibu ni hapana nenda swali namba HH22/If the answer is No, go to question number HH22*	Ndiyo/Yes / hapana/No
HH21a	**Je, vyandarua mlivyo kuwa navyo ni vingapi?** / How many mosquito nets do you have? (*andika idadi / Write the total;* 999=hajui / doesn't know)	|__|__|__|
HH22	**Je, kaya hii mnatumia nishati gani kupikia? / In this household which power are you using for cooking?** *Chagua moja tu / choose only one*	Umeme / electricity / Mafuta ya taa / kerosene / Mkaa / charcoal / Kuni / firewood / Nyingine / other
HH23	**Je, katika kaya hii, mnao wanyama – kama kondoo, mbuzi au ngombe? / In this household do you have anoamals like a sheep, goat or a cow?** *Kama jibu ni hapana nenda swali namba HH24 / If the answer is No go to question number HH24*	Ndiyo / Yes / hapana /No
Hh23a	**Je, idadi yao ni wangapi? / What is the total of them?** (*andika Idadi / Write the total*; 999=hajui / doesn't know)	|__|__|__|
HH24	**Je, katika kaya hii mnao kuku na bata? / In this household do you have chickens and ducks?** *Kama jibu ni hapana nenda swali namba HH25 / If the answer is No go to question HH25*	Ndiyo / Yes / hapana / No
HH24a	**Je, idadi ya kuku au bata ni wangapi? / What is the total of chickens or ducks** (*andika idadi / Write the total* ; 999=hajui / doesn't know)	|__|__|__|
HH25	**Je, nyumba hii imeunganishwa kwenye umeme? / Is this household connected with electricity** *Kama kawaida, usiulize hilo swali: / Normally you don't have to ask this question: angalia tu kujua kama nyumba imeunganishwa kwenye umeme. / Just look around to see if the house is connected with electricity Lakini ukiwahoji shambani, uliza kuhusu umeme katika nyumba wanapokaa kwa muda mrefu zaidi. / But if you are interviewing them in the farm, ask about electricity in the house they live for most of their time. Kama wanatumia sola, nyumba imeunganishwa kwenye umeme / If they are using solar power, the house is connected to the electricity.*	Ndiyo / Yes / hapana / No
HH26	**Aina ya paa ? / Type of the roof?** Kama ni paa mchanganyiko, jaza bati au vigae. / If the roof is mixed, fill corrugated iron or tiles. Ukiwahoji shambani, uliza aina ya paa katika nyumba wanapokaa kwa muda mrefu zaidi. / If you interview them in the farm, ask the type of the roof of the house they live for most of their time.	bati au vigae / Corrugated irons or tiles/ nyasi au makuti / normal leaves or leaves from the coconut tree

HH27	**Naomba kuuliza kuhusu matukio ya vifo katika kipindi cha miaka mitatu iliyopita, yaani kuanzia mwezi wa kwanza mwaka 2004, kuna mtu yeyote aliyefariki katika kaya hii? / I would like to ask you about death events in a period of the last three years, I mean from January 2004, were there any body died in this household?** *Ikibidi, tumia kalenda ya matukio ya kihistoria. / If necessary use the event calendar. Kama hapana au hajui, nenda swali HH30 / If Not or she/he do not know go to question HH30*	Ndiyo / Yes / Hapana / No / Sijui / don't know

Namba ya mtu / Number of the person HH28a	Jina la mtu / Name of the person HH28b	**Jinsia / Sex** ME / M / KE / F HH28c	**Umri wake alipofariki / The age when dying** (Miaka* / Years) HH28d	*Kama marehemu alikuwa mwanamke kati ya umriwya miaka 12-49, uliza: / If the women was between 12 – 49 years:* **Alipofariki, alikuwa mjamzito, au anajifungua, au alikuwa amejifungua katika kipindi cha miezi miwili iliyotangulia? / when she died, was she pregnant, or delivering, or delivered in a period of past two months?** HH28e	*Kama HH28e ni ndiyo / If HH28e is yes* **Alifariki tarehe ngapi? / Which date he/she died?** *Mwezi / Month / mwaka / Year* HH28f
1	|__|__|__|__|__|__|__|__|__|__|	|__|	|__|__|	Ndiyo/ Yes / hapana / No / sijui / Don't know	|__|__| / |__|__|__|__|
2	|__|__|__|__|__|__|__|__|__|__|	|__|	|__|__|	Ndiyo / Yes / hapana / No / sijui / Don't know	|__|__| / |__|__|__|__|
3	|__|__|__|__|__|__|__|__|__|__|	|__|	|__|__|	Ndiyo / Yes / hapana / No / sijui / Don't know	|__|__| / |__|__|__|__|
4	|__|__|__|__|__|__|__|__|__|__|	|__|	|__|__|	Ndiyo / Yes / hapana / No / sijui / Don't know	|__|__| / |__|__|__|__|
5	|__|__|__|__|__|__|__|__|__|__|	|__|	|__|__|	Ndiyo / Yes / hapana / No / sijui / Don't know	|__|__| / |__|__|__|__|
6	|__|__|__|__|__|__|__|__|__|__|	|__|	|__|__|	Ndiyo / Yes / hapana / No / sijui / Don't know	|__|__| / |__|__|__|__|
7	|__|__|__|__|__|__|__|__|__|__|	|__|	|__|__|	Ndiyo / Yes / hapana / No / sijui / Don't know	|__|__| / |__|__|__|__|
8	|__|__|__|__|__|__|__|__|__|__|	|__|	|__|__|	Ndiyo / Yes / hapana / No / sijui / Don't know	|__|__| / |__|__|__|__|

**Kama ni chini ya mwaka mmoja jaza sifuri / If it is less than one year write zero*

HH30	*Kwa vitongoji vya coverage survey / For sub villages of coverage survey (vitongoji vinane katika kila tarafa / Eight sub villages in each division):* **Baada ya wiki chache wahojaji wengine watarudi katika kitongoji hiki, na baadhi ya kaya zitachaguliwa kwa bahati nasibu kwa uhojaji zaidi juu ya afya ya watoto wadogo na malaria. / After few weeks other interviewers will return in this sub village, and some of the household will be randomly selected for more interviews on the health of the children and about malaria. Je, kama kaya yako ingechaguliwa, ungekubali mahojiano hayo? / I f your household will be selected, will you agree to participate for the interview?**	Ndiyo /Yes / Hapana / No / Sijui / Don't know
HH31	*Kama jibu la HH28e ni ndiyo: / If the answer of HH28e is yes: mkuu wa kaya ameeleza walikuwa na mama ambaye alipofariki, alikuwa mjamzito, au anajifungua, au alikuwa amejifungua katika kipindi cha miezi miwili iliyotangulia, muulize mkuu wa kaya: / The head of the household explained that the had a mother who died, when she was pregnant, or when delivering, or delivered in a period of the last two months before she died, as the head of the household:* **Baada ya wiki chache, wahojaji wengine watarudi hapa kuuliza maswali mengine kwa watu waliofiwa na mama ambaye alipofariki alikuwa mjamzito, au anajifungua, au alikuwa amejifungua katika kipindi cha miezi miwili iliyotangulia. Je, ungekubali mahojiano hayo? /**	Ndiyo / Yes / Hapana No / Sijui / Don't know

After few weeks, other interviewers will come back here to ask other questions for people with relatives who died when they were pregnant, or when delivering, or delivered in a period of the last two months before she died, as the head of the household:

Mshukuru mkuu wa kaya, na muombe kuwahoji wanawake wenye umri ya miaka 13 – 49. / Thank the head of the household and ask him/her permision to interview women with the age between 13 – 49 years.

M: KIPENGELE CHA WANAWAKE WENYE UMRI 13-49 / The module of women with the age between 13 and 49 - BIRTH HISTORY

Jina la mama /Name of the mother	|__|__|__|__|__|__|__|__|__|__|__|__|__|__|
	Wilaya / District / Kitongoji/ Sub village # / Kaya/Household # / Mtu / Person #
ID ya mama / ID of the mother	|__|__| / |__|__|__|__| / |__|__|__| / |__|__|

M3	Maswali katika kipengele hiki yanaweza kuwa nyeti. / Questions in this module can be sensitive. Ni lazima kutafuta sehemu ya uhojaji ambayo mhojiwa anaweza kuongea kwa siri, kwa wewe na yeye tu kusikilizana. / It is important for looking a condusive place that the interviewee can talk the sectrets to you and for understanding. Jitambulishe, na eleza kwamba unafanya kazi na IHRDC, na tunafanya utafiti juu ya afya na uhai wa watoto wadogo. / Intriduce yourself, and explain that you are working with IHRDC, and we are evaluating the health and lives of the mothers and children. Halafu sema / And then say: Sasa, naomba kuuliza maswali machache juu ya afya yako na watato wote ambao umezaa mwenyewe. / Now I beg to ask you few questions about your health and the health the children you delevered. Taarifa utakayotoa itasaidia kuboresha hudumu za afya. / Iformation that you will give will help to improve health servives. Maswali haya yatachukua mudi mfupi. These questions will take a short time. Tunakusanya taarifa zote kwa siri. / we are collecting all the information secretly **Unahiari kukubali au kutokubali kuhojiwa. / You are free to be interviewed or not. Hata hivyo, tutafurahi kama utakubali kwa sababu uzoefu wako na maoni yako ni muhimu sana. / However, we will be happy if you will agree, because your experience and ideas are very important.** **Kama una swali, unaweza kuuliza. / If you have a question you can ask.** ***Je, umekubali? / Do you agree?***	Ndiyo / Yes / Hapana / No
M4	*Msisitize mama ataje watoto wote aliyowazaa hata wale waliofariki mara baada ya kuzaliwa / Insist the mother to mention all the children she delivered even those who died soon after being delivered.* ***Naomba kukuuliza kuhusu watoto wako wote ambao umewazaa mwenyewe katika maisha yako. / I want to ask you about all the children that you delivered in your life. Je, umewahi kuzaa mtoto? Have you ever delivered a child?*** Kama hapana, nenda swali namba M11 / If not, go to question number M11	Ndiyo / Yes / Hapana / No
M5	***Je, unao watoto ambao umezaa mwenyewe na wanaokaa hapa pamoja na wewe siku hizi? / Do you have children that are delivered by you and are staying here with you?*** Kama hapana, nenda swali namba M8 / If not, go to question number M8	Ndiyo / Yes Hapana / No
M6	***Je, watoto wako wavulana wangapi wanakaa hapa na wewe? / How many boys of yours are staying here with you?*** Kama hamna, andika 0 / If not, write 0	|__|__|
M7	**Je, watoto wako wasichana wangapi wanakaa hapa na wewe? / How many girls of yours are staying here with you?** *Kama hamna, andika 0 / If not, write 0*	|__|__|
M8	**Je, unao watoto ambao umezaa mwenyewe na ambao bado wako hai lakini wanakaa sehemu nyingine? / Do you have children that are delivered by you and are still alive but are staying in another place?** *Kama hapana, nenda swali namba M11 / If not, go to question number M11*	Ndiyo / Yes / hapana / No
M9	**Wavulana wangapi wako hai lakini wanakaa sehemu nyingine? / How many boys are still alive and are staying in another place?** *Kama hamna, andika 0 / If not, write 0*	|__|__|
M10	**Na wasichana wangapi wako hai lakini wanakaa sehemu nyingine? / How many girls are still alive and are staying in another palce?** *Kama hamna, andika 0 / If not, write 0*	|__|__|
M11	**Je, umewahi kuzaa mtoto ambaye amezaliwa hai lakini baadaye, kwa bahati mbaya, amefariki? / Have you ever delivered a child that was born alive, but unfortunately died after?** *Kama ndiyo, nenda swali namba M13 / If yes, go to question number M13*	Ndiyo / Yes / Hapana / No
M12	**Je, umewahi kuzaa mtoto ambaye, wakati wa kuzaa, amelia au ameonyesha dalili zozote za uhai lakini bahati mbaya akafariki wakati huo huo*? / Have you ever delivered a child, during delivery had cryied or showed some signs of being alive, But unfortunately died at the same time?*** *Kama hapana, nenda swali namba M15 / If not, go to question number M15*	Ndiyo / Yes / Hapana / No

M13	Wavulana wangapi, kwa bahati mbaya, wamefariki? / How many boys had unfortunately died?	|__|__|
M14	Na wasichana wangapi, kwa bahati mbaya, wamefariki? / How many girls had unfortunately died?	|__|__|
M15	Ili kuhakikisha kama nimekuelewa sawa sawa: / To prove that I understood you well. katika maisha yako, umezaa watoto hai / in your life, you delivered children who were alive ________ . Je, hii ni sawa? / Is it correct? ***Ikibidi, dadisi na fanya marekebisho. / If necessary, probe and make correction.*** ***Kama hajawahi kuzaa mtoto, andika hapana halafu mshukuru mhojiwa. / If she has never delivered a child, write no and thank the interviewee.***	Ndiyo / Yes / Hapana / No
M16	***Kama jumla ya watoto aliowazaa ni mmoja au zaidi, muulize: / If the total of children she delivered is one or mere, ask:*** Je, umezaa mtoto ndani ya miaka mitano iliyopita, yaani tangu 2002? / Did you deliver a child within the last five years, since 2002? ***Kama hajazaa mtoto tangu 2002, andika hapana halafu mshukuru mhojiwa. If she did not deliver a child since 2002, write no and thank the interviewee.*** ***Hakikisha kwamba mhojiwa ameelewa swali, hasa , unachomaanisha ukisema 'tangu 2002'. / Make sure that the interviewee understand the question, when you mean since 2002. Ikibidi, tumia kalenda ya matukio ya kihistoria. / If necessary, use historical events calender.***	Ndiyo / Yes / hapana / No

Naomba kuandika majina ya watoto wote uliyozaa tangu mwaka 2002 hadi sasa, hata kama wamefariki. */ I beg to write the names of all the children you delivered since 2002 up to now, even if they are dead.* ***Anza na mtoto mdogo zaidi. / start with the youngest. Kwa mapacha, andika kila mtoto katika mstari moja. / For twins, write each child in one line. Kwa majina, andika jina moja tu. / For names, write only one name. Lazima kuwa makini sana kwa tarehe za matukio yote, ama ni tarehe ya kuzaliwa au tarehe ya bahati mbaya, kufariki. / You must be veru careful for the dates of events, or dates of birth or dates of unfortunates, death. Dadisi na tumia kalenda ya wakulima na kalenda ya matukio ya kihistoria ya kila wilaya kukusaidia kupata mwezi na mwaka za matukio. / Probe and use farmers historical events calendar of each district to help to get the months and years of events.***

M17a	M17b	M17c	M17d	M17e	M17f	M17g	M17h	M17i	M17j	M17k
Namba/ number	Jina la mtoto / Name of child (Anza na mdogo zaidi / start with the youngest)	Je, amezaliwa na pacha mwenzake ? / was s/he born with his/her twin Pekee / alone / Mapacha / twins	Jinsia /Sex ME / M / KE / F	Amezaliwa lini? / When was s/he born.	Je, bado yuko hai? /Is s/he still alive Ndiyo / Yes / Hapana / No	KAMA YUKO HAI: Naomba kuhakikisha / IF S/HE IS ALIVE: I want to prove: je, umri wake hi miezi / Her/his age is ____ (umri kwa miezi / her/his age in months)	KAMA AMEFARIKI / If s/he is dead. Amefariki lini? whan has s/he died	KAMA AME-FARIKI / If s/he is dead: Naomba kuhakikisha / I want to prove: je, umri wake ilikuwa / It is that her/his age was (umri kwa miezi / age in months) :	KAMA AME-FARIKI **na** ALIKUWA NA MIEZI 2-11 **na** AME-ZALIWA 2004-7: / If s/he died and was between 2-11 months and was born 2004-7: Je, unadhani kifo cha mototo kilisabab-ishwa na kuugua vipele? / The death of the child was caused by suffering from lashes? Ndiyo / Yes / Hapana / No	Je, umezaa watoto wengine kati ya / did you deliver a child between(JINA / name) na (JINA/name KUTOKA MISTARI HAPO JUU)? / from the lines above Ndiyo/Yes hapana/ No
01	|__|__|__|__|__|__|__|__|__|	|__|	|__|	|__|__| / |__|__| / |__|__|__|__|	|__|		|__|__| / |__|__| / |__|__|__|__|			
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03	|__|__|__|__|__|__|__|__|__|	|__|	|__|	|__|__| / |__|__| / |__|__|__|__|	|__|		|__|__| / |__|__| / |__|__|__|__|			|__|
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05	|__|__|__|__|__|__|__|__|	|__|	|__|	|__|__| / |__|__| / |__|__|__|__|	|__|		|__|__| / |__|__| / |__|__|__|__|			|__|

M18 ***Swali hili liulizwe kama ni miezi tisa au zaidi tangu mtoto wa mwisho kuzaliwa katika jedwali hapo juu. / This question will be asked if it is nine months or more since the last child was born, from the graph above.***
Je, umezaa watoto wengine baada ya (*jina la mtoto mdogo zaidi*) kuzaliwa? / Did you deliver other children after (name of the youngest child) to be born? ***Kama ndiyo, muongeze hapo juu / If yes, add in the list above***

Ndiyo / Yes / Hapana / No

Kama amezaa mtoto ndani ya mwaka mmoja uliyopita, nenda swali namba N1 / If she delivered a child in the one last year, go to question number N1
Kama hajazaa mtoto ndani ya mwaka mmoja uliyopita, nenda swali namba N94 / If she did not deliver a child in the last one year, go to question number N94

KIPENGELE CHA WANAWAKE WALIYOZAA MTOTO NDANI YA MWAKA MMOJA ULIOPITA / The module of women who delivered within the last one year

Sasa, naomba nikuulize maswali machache juu ya afya ya ujauzito, ulipokuwa na ujauzito ya mtoto wako wa mwisho / Now I want to ask you few questions about the health of your pregnancy, the pregnancy of your last child (TAJA JINA LA MTOTO WA MWISHO / Mention the name of the last child)

N1	**Je, wakati ulipokuwa mjamzito, ulilala ndani ya chandarua? / when you were pregnant, did you sleep inside the mosquito net?** ***Kama hapana au hajui nenda swali namba N4 / If not or dont know go to question number N4***	Ndiyo /Yes / hapana/ No / sijui/Don't know
N2	**Je, chandarua hicho kimewahi kuchovywa kwenye dawa ?** / Has the mosquito net been treated?*(ikibidi, mtajie dawa ya Ngao / if necessary mention Ngao) Kama hapana au hajui nenda swali namba N4* ***/ If not or dont know go to question number N4***	Ndiyo/Yes / hapana/No / sijui/Don't know
N3	**Je, chandarua hicho kilichovywa kwenye dawa ndani ya mwaka mmoja kabla ya mtoto wako kuzaliwa?** / Has the mosquito net been treated within the year before the child was born? *(ikibidi, mtajie dawa ya Ngao/ If necessary mention Ngao)*	Ndiyo/Yes / hapana/ No / sijui /Don't know
N4	**Je, wakati ulipokuwa mjamzito, uliwahi kwenda kliniki? / When you were pregnant, did you go to the clinic?** *Kama hapana au hajui nenda swali namba N22 / If no or does not know go to question number N22*	Ndiyo/Yes / hapana/No / sijui/Don't know
N5	**Ulikuwa na ujauzito wa miezi mingapi ulipoenda kliniki kwa mara ya kwanza? / Whe you went to the clinic for the first time the pregnancy was in which month?**	|__|__|
N6	**Ulihudhuria kliniki mara ngapi kupata huduma wakati wa ujauzito huu? / When you were pregnant, how many times did you attend at the clinic to get services?**	|__|__|
	Ulipoenda kliniki wakati wa ujauzito huu: / When you went at the clinic with this pregnant:	
N7	**Ulipimwa uzito angalau mara moja? /were you checked your weight, atleast once?**	Ndiyo/Yes / hapana/No / sijui/Don't know
N8	**Ulipimwa urefu angalau mara moja? / were you checked your height, atleast once?**	Ndiyo/Yes / hapana/No / sijui/ Don't know
N9	**Ulipimwa mapigo ya moyo, yaani BP, angalau mara moja? Were you checked your heart beats, BP, atletas once?**	Ndiyo/Yes / hapana/No / sijui/Don't know
N10	**Ulipimwa mkojo angalau mara moja? / were you checked urine, atleast once?**	Ndiyo/Yes / hapana/No / sijui/Don't know
N11	**Ulipimwa damu angalau mara moja? / were you checked blood atleast once?**	Ndiyo/Yes / hapana/No / sijui/Don't know
N12	**Wakati wa ujauzito huu, uliambiwa kuhusu dalili za hatari wakati wa ujauzito? / During this pregnancy were you told about danger signs of the pregnant?** *Kama hapana au hajui, nenda swali N14 /If not or does not know go to question number N14*	Ndiyo/Yes / hapana /No / sijui/Don't know
N13	**Je, uliambiwa mahali pa kwenda ukipata matatizo hayo? / Were you told where to go if you get those problems?**	Ndiyo/Yes / hapana/No / sijui/Don't know
N14	**Wakati wa ujauzito huu, ulipata ushauri nasaha kuhusu magonjwa ya zinaa? / During this pregnancy were you counselled about sexual tranmitted diseases?**	Ndiyo/Yes / hapana/No / sijui/Don't know
N15	**Wakati wa ujauzito huu, ulipata ushauri nasaha kuhusu kupimwa ukimwi? / During this pregnancy were you counseled about testing HIV/AIDS?**	Ndiyo/Yes / hapana/No / sijui/Don't know
N16	**Wakati wa ujauzito huu, ulipata sindano ya kinga ya pepopunda? / During this pregnancy did you get an injection for protecting against tetanus?**	Ndiyo/Yes / hapana/No / sijui/Don't know
N16a	**Je, kwa maisha yako, umepata sindano ya kinga ya pepopunda mara ngapi? (99=sijui) / In you life, how many times did you get injection of protection of tetanus? (99=dont know)**	|__|__|

N17	**Wakati wa ujauzito huu, ulipewa au ulinunua dawa ya maji au vidonge ya madini ya chuma, yaani dawa kuongeza damu? / During this pregnancy did you receive or buy iron supplementation either syrup or tablets for increasing blood?**	Ndiyo/Yes / hapana/No / sijui/Don't know
N18	**Je, ulipokwenda kliniki, ulipewa vocha ya Hati Punguzo, ili kupata chandarua kwa bei nafuu? / When you went at the clinic, did you get the discount voucher of Hati punguzo, for buying mosquito net?**	Ndiyo/Yes / hapana/No / sijui/Don't know
N19	**Je, ulipokwenda kliniki, ulipewa dawa ya kukinga malaria? / When you went at clinic were you given anti-malaria drugs?** *Kama hapana au hajui, nenda swali N22 / If not or does not know, go to question number N22*	Ndiyo/Yes / hapana/No / sijui/Don't know
N20	**Dawa gani ulipewa kukinga malaria? / which anti-malaria drugs were you given?** *(usidadisi / dont probe)*	SP / Fansidar / dawa nyingine /other drugs / hajui/Don't know
N21	**Je, wakati ulipokuwa mjamzito, ulimeza dozi ngapi ya dawa hiyo? / When you were pregnant, how many doses of those drugs did you take?** *(99=hajui /doesn't know)*	|__|__|
N22	**Wakati wa ujauzito huu, wewe au familia yako, mlipanga mpango wa sehemu ya kujifungulia? / During this pregnancy, did you or your family plan for a place for delivery?** *Kama hawakuwa na mpango, nenda swali namba N28 / If they did not had a plan, go to question number N28*	Ndiyo/Yes / hapana/No / sijui/Don't know
N23	**Je, mlipanga ujifungulie wapi? / Where did you plan to deliver?**	Nyumbani au nyumba nyingine/ Home or in another house / Hospitali/Hospital, kituo cha afya au zahanati/Health centre or dispensary / Sehemu nyingine/Another place
N24	**Je, ulijifungulia sehemu mliokuwa mmepanga? / Did you deliver in a place which you planned?** *Kama jibu ni ndiyo nenda swali namba N28 / If the answer is yes go to question N28*	Ndiyo/Yes / hapana/No
N25	**Je, ni sehemu gani uliojifungulia? / Which place did you deliver from?**	Njiani kuelekea sehemu waliyopanga/On the way to a place they planned / Sehemu nyingine/Another place
N28	**Ulijifungulia wapi mtoto huyu? / Where did you deliver this child?** *(Dadisi/probe)*	Kaya yake/at her household / Kaya nyingine/at another household / Hospitali/Hospital / Kituo cha afya/Health centre / Zahanati/Dispensary / Sehemu nyingine/another place / Hajui/doesn't know
N26	**Mtoto wako wa mwisho kuzaliwa, wakati unamzaa, alikuwa mkubwa kuliko kawaida, mdogo kuliko kawaida, au kawaida? / The last child to be delivered, when was delivereing was she/he bigger than normal, smaller than normal or normal.** *(Pamoja na kumsikiliza mama, angalia kadi ya mtoto:/ Even if you listen from the mother, also check the clinic card of the child. kama uzito alipozaliwa ni chini ya kg 2.5, ni mdogo kuliko kawaida/ If the weight is less than 2.5kg, it is smaller than normal)*	Mkubwa kuliko kawaida/bigger than normal / mdogo kuliko kawaida/smaller than normal / kawaida/Normal / hajui/ doesn't know
N27	**Nani alikuhudumia wakati wa kujifungua mtoto huyu? / Who supported you when delivering this child?** *Dadisi aina ya mtu aliyemhudumia na kuorodhesha kila mmoja. / Probe the type of the person who supported her, and list down each person. Kama amesema hakuna aliyemhudumia, dadisi kama alikuwepo mtu yeyote mzima / If she said there was no person who supported her, probe if there was an elder person.*	Mganga/doctor Mama mkunga/midwife, nesi/nurse Mkunga wa jadi/Traditional birth attendant Jamaa/relative / Nyingine/other Hakuna Mtu/no one
N29	**Je, ulijifungua mtoto huyu kwa njia ya operesheni? / Did you deliver this child through cesarean section?**	Ndiyo/Yes / hapana/No / sijui/Don't know
	Sasa, naomba kuuliza kuhusu matatizo wakati wa kujifungua: / Now I want to ask you about the problems during delivery.	
N30	**Je, ulipoteza fahamu? / Were you unconscious?**	Ndiyo/Yes / hapana/No / sijui/Don't know
N31	**Je, ulipata homa? / Did you get fever?**	Ndiyo/Yes / hapana/No / sijui/Don't know
N32	**Je, uzi wa kitovu ulitangulia kabla ya mtoto? / Did the cord of the child come out before the child?** *Ikibidi, mueleze unachomaanisha na uzi wa kitovu /If necessary, explain what you mean with the*	Ndiyo/Yes / hapana/No / sijui/Don't know

cord.

N33	**Je, chupa ya uzazi ilipopasuka, maji yalikuwa na rangi gani? / When the labour water bursted, what was the colour of the water?**	Rangi ya kijani/green / rangi nyingine/another colour / rangi ya kawaida/normal colour / sijui/Don't know

Kama amezaa katika hospitali, kituo cha afya au zahanati (N28) nenda swali namba N56 / If she delivered at the hospital, health centre, or at the dispensary (N28) go to question number N56

Sasa naomba kuuliza ulijiandaaje kujifungua. / Now, I want to ask you how you prepared for delivery.

N34	**Je, uliandaa sabuni? / Did you prepare soap ?**	Ndiyo/Yes / hapana/No / sijui/Don't know
N35	**Uliandaa nguo au kitambaa maalum kwa ajili ya kumkaushia mtoto mara tu atakapozaliwa? / Did you prepare a cloth or a piece of cloth for drying the child soon after being delivered?** *Kama hapana au hajui nenda swali namba N37/If not or doesn't know go to question number N37*	Ndiyo/Yes / hapana/No / sijui/Don't know
N36	**Ilikuwa mpya, au ilifuliwa, au hakunakimojawapo?/ Was it new, or it was washed, or none of them?**	Mpya/New / Ilifuliwa/washed / hakunakimojawapo/none of them / sijui/Don't know
N37	**Je, uliandaa nguo au mkeka kutandika sehemu ya kujifungulia? / Did you prepare a cloth or a mat at a place for folivery?** *Kama hapana au hajui nenda swali namba N39/If not or doesnt know go to question N39*	Ndiyo/Yes / hapana/No / sijui/Don't know
N38	**Ilikuwa mpya, au ilifuliwa, au hakunakimojawapo? / Was it new, or it was washed, or none of them?**	Mpya/New / Ilifuliwa/washed / hakunakimojawapo/none of them / sijui/Don't know
N39	**Je, sakafu ilifagiliwa kwa ajili ya kujifungulia? / Was the floor cleaned for delivery?**	Ndiyo/Yes / hapana/No / sijui/Don't know
N40	**Je, uliandaa nguo au kitambaa maalum kwa ajili ya kumfunika mtoto? / Did you prepare a special cloth or a piece of cloth for covering the child?** *Kama hapana au hajui nenda swali namba N42/If not or doesn't know go to question N42*	Ndiyo/Yes / hapana/No / sijui/Don't know
N41	**Ilikuwa mpya, au ilifuliwa, au hakunakimojawapo? /Was it new, or it was washed, or none of them?**	Mpya/New / Ilifuliwa/washed / hakunakimojawapo/none of them / sijui/Don't know
N42	**Je, ulifanya mpango iwapo kutatokea dharura wakati wa kujifungua? / Did you make a plan for emergency during delivery?**	Ndiyo/Yes / hapana/No / sijui/Don't know

Je ni watu gani walikuwepo wakati wa kujifungua?/ What type of people were there during delivery?

N44	**Mkunga wa jadi/Traditional birth attendant**	Ndiyo/Yes / hapana/No
N45	**Mama yako mzazi/Your mother**	Ndiyo/Yes / hapana/No
N46	**Mama mkwe/Your mother inlaw**	Ndiyo/Yes / hapana/No
N47	**Mtu mwingine wa kike/Another female person**	Ndiyo/Yes / hapana/No
N49	**Hakuna mtu/No body**	Ndiyo/Yes / hapana/No
N50	**Mwingine/other**	Ndiyo/Yes / hapana/No

N51	**Je, ulijifungulia katika sakafu au kitanda ya aina gani? / Did you deliver on the floor or on the bed of which type?**	Isiyotandikwa kitu/not covered with cloth / Iliyotandikwa nguo/covered with cloth / Iliyotandikwa mkeka/covered with mats / Nje ya nyumba/outside of the house / Nyingine/others / Sijui/Don't know

N53	**Je, sabuni ilitumika wakati wa kujifungua? / was soap used during delivery?**	Ndiyo / hapana/No / sijui/Don't know
N54	**Je, wakati unajifungua, mtu aliyekuwa anakusaidia alinawa mikono mwanzoni au katikati mwa kujifungua? / During delivery, the person who was helping, did she/he wash his/her hands at the beginning or at the middle of delivery?** *(Kama jibu ni hajananawa, sijui, au baada ya mtoto kuzaliwa nenda swali namba N55a / If the answer is she/he didn't wash, don't know or after the child being born, go to question N55a)*	Hajanawa/didn't wash / Alinawa mwanzoni/washed at the begining / Alinawa katitkati/washed at the middle / Baada ya mtoto kuzaliwa/washed alter the child was born/ Sijui/Don't know
N55	**Je, alitumia sabuni aliponawa? When washe did she/he used soap?**	Ndiyo/Yes / hapana/No / sijui/Don't know
N55a	**Je, mtu aliyekuwa anakusaidia wakati wa kujifungua alivaa gloves?/ The person who was helping you, did she/he wore gloves?**	Ndiyo/Yes / hapana/No / sijui/Don't know
N56	**Je, kuna kitu chochote au jambo lolote lilifanyika kuharakisha kujifungua? / Was there anything done to easier the process of delivering?**	Hakuna/nothing / Kunwya mitishamba iliyochemshwa/drinking traditional medicine / Kujifukiza na mvuke wa mitishamba sehemu ya ukeni/use the smoke from traditional medicine in the vagina / Maji ya uchungu/labour water / Nyingine, taja/other, mention___________________
N57	**Je, kulikuwa na mtu aliyemshughulisha mtoto kuangalia kama amelia, amejitikisa, au ana dalili za uhai, mara tu alipozaliwa? / was there a person who helped the child to see if the child cries, moves, and has signs of life, soon after being born.**	Ndiyo/Yes / hapana/No / sijui/Don't know
N57a	**Je, nini kati ya hivi kilifanyika kuhakikisha kwamba mtoto ana afya njema? / From the following, what had been done to make sure that the child has good health?**	Kumzamishwa kwenye maji baridi/deeping the child in the cold water Kushikwa mikononi na kupigwa-pigwa/holding the child and slap/beat Kingine/other Sijui/Don't know
N58	**Ilichukua muda gani tangu mtoto alipozaliwa mpaka kutoka kondo la nyuma lenyewe? / How long did it take for the placenta to come out?** *Kama jibu ni mata baada ya kujifungua nenda swali namba N60 /If the answer is soon after delivery, go to question number N60*	Mara baada ya kujifungua/soon after delivery/ Haikuzidi nusu saa/it didnt past an hour / Imezidi nusu saa/past half an hour / Sijui/Don't know
N59	**Mtoto aliwekwa wapi tangu alipozaliwa mpaka kutoka kondo la nyuma? / Were had the child kept from delivery up to the time of coming out of the placenta?**	Kitandani/on the bed / Chini sakafuni/down on the floor / Katika nguo safi/on the clean cloth / Kifuani mwa mama yake/on the chest of her mother / Sehemu nyingine / sijui/Don't know
N60	**Ilichukua muda gani tangu mtoto alipozaliwa mpaka mtoto alipokaushwa? / How long did it take from the time the child was born up to the time of being dried?**	Chini ya dakika tano baada ya mtoto kuzaliwa/less that five minutes after the child was born / Dakika 5-15 baada ya mtoto kuzaliwa/5-15minutes after the child was born / Dakika 16-30 baada ya mtoto kuzaliwa/16-30minutes after the child was born / Zaidi ya dakika 30 baada ya mtoto kuzaliwa/More than 30 minutes after the child was born / sijui/Don't know
N61	**Ilichukua muda gani tangu mtoto alipozaliwa mpaka mtoto alipofunikwa? / How long did it take from the time the child was born up to the time when the child was covered?**	Chini ya dakika tano baada ya mtoto kuzaliwa less that five minutes after the child was born / Dakika 5-15 baada ya mtoto kuzaliwa/5-15minutes after the child was born / Dakika 16-30 baada ya mtoto kuzaliwa/16-30minutes after the child was born / Zaidi ya dakika 30 baada ya mtoto kuzaliwa/More than 30 minutes after the child was born / Sijui/Don't know

N62	**Ilichukua muda gani tangu mtoto alipozaliwa mpaka mtoto kuogeshwa kwa maji? / How long did it take from the time when the child was born up to the time when the child was bathed?** *Kama jibu ni sijui na hajazaliwa hospitalini, kituo cha afya au zahanat nenda swali namba N64 / If the answer is don't know , and the child was not born at the hospital, health centre or dispensary, go to question number N64 Kama jibu ni sijui na amezaliwa hospitalini, kituo cha afya au zahanati nenda swali namba N68 / If the answer is don't know, and the child was born at the hospital, health centre or dispensary, go to question number N68*	Chini ya saa moja/Less than an hour / Saa moja mpaka masaa sita/One hour up to six hours / Zaidi ya masaa sita/ More than six hours / sijui/Don't know
N63	**Aliogeshwa na maji ya aina gani? /Which water was used to bath the child?** *Kama amezaliwa hospitalini, kituo cha afya au zahanati nenda swali namba N68 / If the child was born at the hospital, health centre or dispensary, go to question number N68*	Maji baridi/cold water / Maji ya uvuguvugu/warm water / Sijui/Don't know
N64	**Nini kilitumika kufunga kitovu? / What was used to tie the cord?**	Uzi mpya/New thread / uzi uliyotumika/Used thread / Nyingine/Other / sijui/Don't know

N65	**Nini kilitumika kukata kitovu cha mtoto? / What was used to cut the naval of the child?** *Kama siyo wembe nenda swali N68 /If not razor blade, go to question number N68*	Wembe/Razor blade / Kitu kingine/Other thing / Hajui/doesn't know
N66	**Je, wembe ulikuwa mpya, au umeshatumika? / Was the razor blade new or used?** *Kama ni mpya au hajui, nenda swali N68 / If its new or doesnt know, go to question N68*	Mpya/New / imeshatumika/Used / Hajui/Doesn't know
N67	**Je, wembe ulichemshwa kabla ya kutumika? Was the razor blade boiled before being used?**	Ndiyo/ Yes / Hapana/No / Hajui/doesn't know
N68	**Mtoto aliwekwa wapi baada ya kukata kitovu? / After cutting the cord where was the child placed?**	Kitandani/on the bed / Chini sakafuni/on the floor / Katika nguo safi/on a clean cloths / Kifuani mwa mama yake/on her mothers chest / Sehemu nyingine / sijui/Don't know
N69	**Mtoto aliwekwa wapi siku ya kwanza baada ya kuzaliwa? / Where the child was placed on the first day after being born?**	Kitandani karibu na mama yake/on the bed near her mother / Kifuani kwa mama yake/on her mothers chest / Aliachwa pekee/was left alone / Nyingine/other
N70 N71	**Je, kwa mara ya kwanza kabisa ulianza kumnyonyesha mtoto, ilikuwa baada ya muda gani tangu alipozaliwa? / For the first time to start breastfeeding the child it was after how long since the child was born?** (*Kama ni chini ya saa moja, jaza masaa 0 / if it is less than one hour, write 0)*	Masaa /hours / siku/days |__|__|
N72	**Katika siku tatu za mwanzo, kabla ya maziwa yako kutoka kwa wingi, mtoto huyu alinyweshwa kitu chochote zaidi ya maziwa yako? / In the first three days, before your breast milk start coming out in a big quantity, did you give the child anything apart from the milk from the breast milk?** *Kama hapana au hajui nenda swali namba N74 / If no or doesnt know go to question number N74*	Ndiyo/Yes / hapana/No / sijui/Don't know
N73	**Alinyweshwa nini? / What was she/he given?**	Maziwa (ukiacha ya mama / Milk except of the mother) Maji / water / Maji ya sukari / water of sugar / Kitu kingine / other thing
N74	**Je, kitovu kilipakwa dawa yoyote ilikikauke haraka? / Were the naval applied something so that it get dry quickly?** *Kama jibu ni hapana au sijui nenda swali namba N76 / If the answer is no or doesn't know go to question number N76*	Ndiyo/Yes / hapana/No / sijui/don't know
N75	**Je, dawa gani aliyopakwa mtoto kwenye kitovu? / Which was the medicine that was applied on the naval of the child?**	Mitishamba/traditional medicine / mafuta/oil / majivu/ashes / chumvi/salt / nyingine/other / sijui/Don't know
N76	**Baada ya kujifungua, kuna mtaalum yeyote wa afya aliyekuchunguza afya yako? / After delivery, was there any health expert who examined you?** *Kama hapana au hajui, nenda swali N80 / If no or doesn't know go to question N80*	Ndiyo/Yes / hapana/No / sijui/Don't know
N77	**Ulifanyiwa uchunguzi baada ya muda gani? / After how long were you examine** *Kama ni chini ya siku moja andika siku 0 / If it is less than one day write 0.*	|__|__| siku au /Day or |__|__| wiki / week
N78	**Ni mtaalum yupi aliyekufanyia uchunguzi wakati huo? / What kind of an expert examined you?**	Mganga/Doctor / Mama mkunga au nesi / Midwife or Nurse / Mkunga wa jadi (aliyepata mafunzo au asiyepata mafunzo / Traditional birth attendant who was trained and non trained)
N79	**Uchunguzi huu ulifanyika wapi? / Where were you examined?**	Kaya yake/In the household / kaya nyingine/in another household Hospitali/Hospital, Kituo cha afya au zahanati/Health centre or dispensary Pengine/Other / Hajui/doesn't know

N80 **Je, katika kipindi cha miezi miwili baada ya kujifungua, ulipewa kidonge cha Vitamin A kama hiki? / In a period of two months after delivering, were you given Vitamin A tablet like this?** *(muonyeshe kidonge cha Vitamin A / Show the tablets of Vitamin A)* — Ndiyo/Yes / hapana/No / sijui/Don't know

Kama mtoto ameshafariki, nenda swali namba N94. / If the child is dead go to question number N94
Kwa watoto ambao wako hai tu: / For the children who are still alive only.

N81 **Je, mtoto alipokuwa na umri chini ya mwezi mmoja, alivaa kofia? / When the child was one month old, did he/she wore a cap?**
Kama jibu ni hapana au sijui nenda swali namba N85 / If the answer is No or don't know go to question N85 — Ndiyo/Yes / hapana/No / sijui/dont know

N82 **Wakati gani alivaa kofia? / What time did the child wore the cap?**
(Unaweza kujaza zaidi ya moja/you can mention more than one)
- Asubuhi tunapoamka/in the morning when we wake up
- Tukitoka nje ya nyumba/when we go outside
- Wakati wa baridi/when it is cold
- Sijui/don't know

Je, mtoto alikuwa na hali zifuatazo ndani ya mwezi mmoja tangu azaliwe: / Did the child had the following conditions within one month after being born.

N85	**Kutolia vizuri, au kutolia kabisa? / Not crying well, or not crying at all**	Ndiyo/Yes / hapana/No
N86	**Hachangamki au hajitikisi? / doesn't move or feel enthusiasm?**	Ndiyo/Yes / hapana/No
N87	**Kupumua kwa shida? / Problem in breathing?**	Ndiyo/Yes / hapana/No
N88	**Kupumua kwa haraka? / breathing fast?**	Ndiyo/Yes / hapana/No
N89	**Kuwa na mwili wa joto sana / high body temperature**	Ndiyo/Yes / hapana/No
N90	**Kuwa na degedege / having convulsion**	Ndiyo/Yes / hapana/No
N91	**Kuwa na rangi ya njanonjano machoni / Eyes being yellow**	Ndiyo/Yes / hapana/No
N92	**Kutapika kila kitu /vomiting everything**	Ndiyo/Yes / hapana/No
N93	**Kuwa na ugonjwa mkubwa sana mwingine, taja: / Having a serious disease, mention** ____________________________	Ndiyo/Yes / hapana/No

N94 *Kama jibu la M17 linaonyesha kwamba alikuwa na mtoto mdogo aliyefariki ndani ya kipindi cha miaka miwili iliyopita na alipofariki alikuwa chini ya mwaka mmoja: / If the answer of M17 shows that she had a young child who died within a period of the last two years and the child died whe she/he was less than one year.*

Baada ya wiki chache, wahojaji wengine watarudi hapa kuuliza maswali mengine kwa akina mama waliofiwa na mtoto ambaye alipofariki alikuwa na umri chini ya mwaka mmoja. Je, ungekubali mahojiano haya? / After few weeks, other interviewers will come back here to ask questions to the mothers who lost a child who were still less than one year. Could you accept the interview? — Ndiyo/Yes / Hapana/No / sijui/Don't know

Mshukuru mama na muuliza kama ana swali / Thank the mother and ask if she has a question

Verbal Autopsy Questionnaire and Coding List

Annex D – Verbal Autopsy questionnaire (Swahili version)

WAFIWA 3: WATOTO NA WATU WAZIMA (miaka 12 na kuendelea)

I. UTAMBULISHO NA TAARIFA ZA KIDEMOGRAFIA NA MAREHEMU

1.1 Jina …………………………………….. ID: [ ] PERMID

1.2 Jina la kijiji:………………………………………….. ID: [ ] **VILLGID**

1.3 Nambari ya kaya [| | | |] COMPID

1.4 Umri wa marehemu: [ ] AOD

1.5 Jinsia: | 1. Mme | 2. Mke | SEX_D

1.6 Alama ya mhojaji: [|] FW

1.7 Tarehe ya mahojiano: (dd/mm/yy) [| | | | |] DINT

1.8 Hali ya ndoa ya marehemu?

1. Hajaolewa	2.Ameachika/Wametengana	3. Mjane	4. NA	MSD

1.9 Miaka aliyosoma shule rasmi. [ ] NK EDUC

1.10 Kiwango cha juu cha elimu ya marehemu:

1. Msingi	2. Sekondari	3. Elimu ya juu	4. Hapana	HEDUC_D

1.11 Kazi yake:

1. Mkulima	2. Mfanyabiashara	3.Mwajiriwa serikalini/Binafsi	OCC_D
4. Nyingine (taja): ……………………………………………………………….			

II. UTAMBULISHO WA MHOJIWA

2.1 Jina la mhojiwa: ______________________________

2.2 Uhusiano wake na marehemu

1. Mke/Mume	2. Binti yake	3. Kijana wake	4.Mama	5. Baba	ROR
6. Mwingine (taja): ………………………………………………………………………………………					

2.3 Amemaliza rasmi miaka mingapi ya shule: [ ] EDUC_R

2.4 Kiwango cha juu cha elimu ya unayemhoji:

1.Msingi	2. Sekondari	3. Elimu ya juu	4. Hapana	HEDUC_R

III. TAARIFA ZA MSINGI ZA KIFO

3.1 Tarehe ya kifo: (dd/mm/yy)							DOD

3.2 Aliugua kwa muda gani (siku) kabla ya kufariki?		999. NK	ILLD

4.0 HISTORIA YA MATUKIO KABLA YA KIFO

4.1 Unaweza kunielezea matukio ya ugonjwa yaliyopelekea kifo chake?

Dadisi: Kuna kingine tena?

Maelekezo kwa mhojaji – Mruhusu mhojiwa akuelezee kuhusu ugonjwa kwa maneno yake mwenyewe. Usimkatishe , isipokuwa mwishoni kama kutakuwa na jambo lingine la kuongezea. Endelea kumdadisi hadi atakaposema hakuna la ziada. Wakati unaandika maelezo, pigia mstari maneno ambayo si ya kawaida katika kiswahili.

____
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4.2 Muhtasari wa dalili zilizotajwa na mhojiwa

Dalili	Siku ambayo dalili za ugonjwa zilianza (mfano: Siku 10 kabla ya kifo)	Dalili zilidumu kwa muda gani (siku)	Maumivu: Kidogo/Wastani=1 Makali=2
1.			
2.			
3.			
4.			
5.			
6.			
7.			
8.			

4.3 Taja kama alilazwa hospitalini katika miaka miwili iliyopita (Anzia tarehe za hivi karibuni kwenda chini)

Jina la kituo cha afya	Tarehe (Mwezi/Mwaka)	Sababu za kulazwa
1.	/ /	
2.	/ /	
3.	/ /	
4.	/ /	
5.	/ /	

4.4 Mahali alipofariki:

1. Nyumbani	2. Hospitalini/kituo cha afya	3. Sehemu nyingine (taja) …………………………………………………….	POD

(Kama jibu ni 1 au 3 nenda swali la 4.9)

4.5 Jina la hospitali/kituo cha afya alipofariki: ____________________

4.6 Je kuna mtu yeyote hospitalini/kituo cha afya alikuambia sababu ya kifo?

1. Ndiyo	2. Hapana	9. NK	8. NA	RIF

Kama Hapana nenda 4.9

4.7 Nani allikuambia?

1. Muuguzi	2. Daktari	8. NA	SOURC
3. Mtu mwingine (taja ……………………………………………………….			

4.8 Mtu huyo alikuambia sababu ya kifo ilikuwa nini?

……………………………………………………………………………………

……………………………………………………………………………………

Kama hukuambiwa sababu ya kifo hospitalini, muulize mhojiwa anafikiria nini ilikuwa sababu ya kifo

4.9 Je unafahamu sababu ya/za kifo chake?

1. Ndiyo	2. Hapana	9.NK	RKC

4.10 Kama jibu ni NDIYO dodosa akutajie sababu:

Sababu ya kwanza

Sababu ya pili

4.11 (Uliza kama alikuwa na kati ya haya magonjwa)

Shinikizo la damu:	1. Ndiyo	2. Hapana	9. NK	HYP
Ugonjwa wa moyo	1. Ndiyo	2. Hapana	9. NK	OHEA
Kisukari:	1. Ndiyo	2. Hapana	9. NK	DIAB
Kifafa:	1. Ndiyo	2. Hapana	9. NK	EPI
Kifua kikuu	1. Ndiyo	2. Hapana	9. NK	TB
UKIMWI:	1. Ndiyo	2. Hapana	9. NK	HIV
Pumu	1. Ndiyo	2. Hapana	9. NK	ASTH
Magonjwa mengine (taja)	1. Ndiyo	2. Hapana	9. NK	**ODIS**

V: MASWALI YANAYOLENGA KUBAINISHA DALILI ZA UGONJWA WA MWISHO

5.1 HOMA:

5.1.1 Je alikuwa na homa? *(Kama jibu ni 2 au 9 nenda swali la 5.2)*	1. Ndiyo	2. Hapana	9. NK		FEV
5.1.2 Je aliugua homa kwa siku ngapi?		888 NA	999.NK		DFE
5.1.3 Je homa ilikuwa:	1.Wastani	2. Kali	8. NA	9. NK	SFE
5.1.4 Je homa ilikuwa:	1. Mfululizo	2. Inakuja na kuondoka	8. NA	9. NK	TFE
5.1.5 Je alikuwa anasikia baridi/baridi kali	1. Ndiyo	2.Hapana	9. NK		RIG

5.2 UPELE:

5.2.1 Je alikuwa na upele? *(Kama jibu ni 2 au 9 nenda swali la 5.2.7)*	1. Ndiyo	2. Hapana	9. NK		RAS
5.2.2 Upele ulikuwa sehemu gani?	1. Usoni	2.Mwili mzima	3.Sehemu nyingine	9. NK	**LCRAS**
5.2.3 Je alikuwa na upele kwa siku ngapi?		888. NA	999. NK		DRA
5.2.4 Je upele ulikuwa na malengelenge yenye maji?.	1. Ndiyo	2. Hapana	9. NK		BLIRAS
5.2.5 Je ngozi illichanika au kubanduka baada ya upele kuanza?	1. Ndiyo	2. Hapana	9. NK		SKIRAS

5.2.6 Upele ulifananaje?

1. Upele wa surua	2. Upele wenye maji meupe	3. Upele wenye usaa	9. NK	TRA
4. Vingine (ainisha)				

5.2.7 Je macho yake yaliuma?	1. Ndiyo	2. Hapana	9. NK	SEY
5.2.8 Je ngozi yake iliwasha?	1. Ndiyo	2. Hapana	9. NK	ITC

5.3 KUPUNGUA UZITO:

5.3.1 Je alipoteza uzito siku chache kabla ya kifo chake? | 1. Ndiyo | 2. Hapana | 9. NK | LOW
(Kama jibu ni 2 au 9 nenda swali 5.4)

5.3.2 Je ni kwa siku ngapi kabla ya kifo chake? | | 888.NA | 999. NK | DLOW

5.3.3 Je alipoteza uzito kwa kiwango gani? | 1. Wastani | 2. Sana | 8. NA | 9. NK | SLW

5.4 KUPAUKA / MANJANO

5.4.1 Je kulikuwa na hali ya kupotea wekundu katika viganja? | 1. Ndiyo | 2. Hapana | 9. NK | PAL

5.4.2 Je rangi ya macho iligeuka kuwa njano? | 1. Ndiyo | 2. Hapana | 9. NK | JAU

5.5 KUVIMBA:

5.5.1 Je alikuwa amevimba sehemu za kifundo cha mguuni? | 1. Ndiyo | 2. Hapana | 9. NK | SAA
(Kamajibu ni 2 au 9 nenda swali 5.5.3)

5.5.2 Alivimba kwa siku ngapi:		888.NA	999.NK	DSA
5.5.3 Je uso wake ulijaa?	1. Ndiyo	2. Hapana	9. NK	PUF
5.5.4 Je shingo yake ilivimba?	1. Ndiyo	2. Hapana	9. NK	SWN
5.5.5 Je alivimba kwapani?	1. Ndiyo	2. Hapana	9. NK	SWA
5.5.6 Je alivimba kwenye mitoki ya mapajani?	1. Ndiyo	2. Hapana	9. NK	SWG
5.5.7 Je alikuwa na uvimbe au vidonda vingine?	1. Ndiyo	2. Hapana	9. NK	ULC

5.6 KIKOHOZI:

5.6.1 Je alikuwa na kikohozi? | 1. Ndiyo | 2. Hapana | 9. NK | COU
(Kama jibu ni 2 au 9 nenda swali 5.6.5)

5.6.2 Alikohoa kwa siku ngapi		888.NA	999. NK		DCO
5.6.3 Je kikohozi kilikuwa kikavu?	1. Ndiyo	2. Hapana	8. NA	9. NK	PCO
5.6.4 Je alikohoa damu?	1. Ndiyo	2. Hapana	8. NA	9. NK	BCO
5.6.5 Ni wakati gani kihozi kilizidi?	1.Mchana	2.Usiku	3. Wakati wote	9. NK	COUW

5.6.6 Je alitokwa jasho usiku? | 1. Ndiyo | 2. Hapana | 9. NK | NCOU

5.6.7 Je alipata shida kupumua? | 1. Ndiyo | 2. Hapana | 9. NK | DIB
(Kama jibu ni 2 au 9 nenda swali 5.7)

5.6.8 Alipumua kwa shida kwa siku ngapi? | | 888.NA | 999.NK | DDB

5.6.9 Je alipumua kwa kukoroma/kutoa sauti? | 1. Ndiyo | 2. Hapana | 9. NK | CHP

5.7 MAUMIVU YA KIFUA:

5.7.1 Je alikuwa na maumivu ya kifua? | 1. Ndiyo | 2. Hapana | 9. NK | CHP
(Kama jibu ni 2 au 9 nenda swali 5.8)

5.7.2 Maumivu yalikuwa wapi?

1. Juu ya chembe cha moyo	2. Juu ya moyo	8. NA	SCP
3. Mbavu	4.Sehemu nyingine (taja) …………………………………	9. NK	

5.7.3 Maumivu yalikuwa: | 1. Mfululizo | 2. Yanakuja na kuondoka | 8. NA | 9. NK | TCP

5.7.4 Wakati alipopata maumivu makali, yalidumu kwa muda gani?

< dakika 30	2 > dakika 30 lakini < saa 24.	3. saa 24	8. NA	9. NK	DCP

5.8 KUHARISHA:

5.8.1 Je alikuwa anaharisha? | 1. Ndiyo | 2. Hapana | 9. NK | DIAR
(Kama jibu ni 2 au 9 nenda swali 5.9)

5.8.2 Aliharisha kwa siku ngapi?

	888.NA	999.NK	DDI

5.8.3 Je aliharisha kwa:

1. Mfululizo	2. kuanza na kuacha	8. NA	9. NK	TDI

5.8.4 Choo chake kilikuwaje?

1. Kawaida	2. Laini	3. Majimaji	9. NK	CSDIA

5.8.5 Aliharisha mara ngapi kwa siku wakati hali ya kuharisha ilipozidi?

	88.NA	99. NK	FDI

5.8.6 Je kulikuwa na damu katika choo?

1. Ndiyo	2. Hapana	8. NA	9. NK	BTS

5.8.7 Je macho yaliingia ndani?

1. Ndiyo	2. Hapana	9. NK	SUNK

5.9 KUTAPIKA:

5.9.1 Je alitapika?
(Kama jibu ni 2 au 9 nenda swali 5.10)

1. Ndiyo	2. Hapana	9. NK	VOM

5.9.2 Alitapika kwa siku ngapi?

	88.NA	99. NK	DVO

5.9.3 Alitapika

1. Mfululizo	2. Aliacha na kuanza	8. NA	9. NK	TVO

5.9.4 Alitapika mara ngapi kwa siku wakati hali ya kutapika ilipozidi?

	88.NA	99.NK	FVO

5.9.5 Matapishi yalionekanaje?

1. Maji maji	2. Maji maji ya njano	3. Maji maji ya rangi ya kahawia	4. Na damu	CVO
5. Kama kinyesi	6. Vinginevyo 8. NA		9. NK	

5.10 TUMBO:

5.10.1 Je alikuwa na maumivu ya tumbo?
(Kama jibu ni 2 au 9 nenda swali 5.10.6)

1. Ndiyo	2. Hapana	9. NK	ABP

5.10.2 Maumivu yalikuwa ya aina gani?

1. Kunyonga	2. Maumivu kwa mbali	3. Kama kuungua	4. Mengine	8. NA	9. NK	CAP

5.10.3 Alikuwa na maumvu kwa siku ngapi

	88.NA	99.NK	DAP

5.10.4 Maumivu yalikuwa sehemu gani hasa?

1. Chini ya kitovu	2. Juu ya kitovu	3. Tumbo lote	SAP
4. Nyingine (taja): …………………………………………………………	8. NA	9. NK	

5.10.5 Maumivu yalikuwa ya namna gani?

1. Wastani	2. Makali	8. NA	9. NK	TAP

5.10.6 Je alishindwa kupata choo kwa siku kadhaa kabla ya kufariki?

1. Ndiyo	2. Hapana	CON

5.11 TUMBO KUJAA/KUVIMBA:

5.11.1 Je alijaa tumbo?
(Kama jibu ni 2 au 9 nenda swali 5.12)

1. Ndiyo	2. Hapana	9. NK	ABD

5.11.2 Je tumbo lilijaa kwa siku ngapi?

	88.NA	99.NK	DAD

5.11.3 Je tumbo lilijaa haraka kwa siku chache au taratibu kwa wiki kadhaa?

1. Haraka	2. Taratibu	8. NA	9. NK	TAD

5.12 KUMEZA:

5.12.1 Je alikuwa na matatizo katika kumeza?
(Kama jibu ni 2 au 9 nenda swali 5.13)

1. Ndiyo	2. Hapana	9. NK	DSW

5.12.2 Alishindwa kumeza kwa siku ngapi?		88. NA	99.NK	DDS

5.13 UVIMBE

5.13.1 Je alikuwa na uvimbe wowote tumboni? *(Kama jibu ni 2 au 9 nenda swali 5.14)*	1. Ndiyo	2. Hapana	9. NK	ABM

5.13.2 Uvimbe ulikuwa sehemu gani hasa?

1. Kulia juu ya kitovu	2. Kushoto juu ya kitovu	3. Chini ya tumbo		SAM
4. Nyingine (taja) …………………………………………………………………………		8. NA	9. NK	

5.13.3 Alikuwa na uvimbe kwa siku ngapi?		888.NA	999.NK	DAM

5.14 KUUMWA KICHWA:

5.14.1 Je aliumwa kichwa?	1. Ndiyo	2. Hapana	9. NK	HEA

5.15 SHINGO KUKAKAMAA:

5.15.1 Je shingo ilikakamaa? *(Kama jibu ni 2 au 9 nenda swali 5.16)*	1. Ndiyo	2. Hapana	9. NK	STN
5.15.2 Kama Ndiyo, kwa siku ngapi?		888.NA	999.NK	DSN

5.16 KIWANGO CHA FAHAMU:

5.16.1 Je aliweza kuonekana na mabadiliko yoyote katika hali ya fahamu? *(Kama jibu ni 2 au 9 nenda swali 5.17)*	1. Ndiyo	2. Hapana	9. NK	LUC

5.16.2 Alikuwa na fahamu kwa kiwango gani?

1. Alichanganyikiwa	2. Hajitambui	3. Nyingine	8. NA	9. NK	TUC

5.16.3 Alichanganyikiwa au hakujitambua kwa siku ngapi?		888.NA	999.NK	DUC

5.16.4 Kulianzaje?

1. Taratibu	2. Haraka katika siku moja	3. Taratibu kwa siku kadhaa		FFI1
4. Vingine:	8. NA	9. NK		

5.17 KIFAFA/MSHTUKO WA FAHAMU:

5.17.1 Je alikuwa na kifafa? *(Kama jibu ni 2 au 9 nenda swali 5.18)*	1. Ndiyo	2. Hapana	9. NK	FIT
5.17.2 Alikuwa na kifafa kwa siku ngapi		888.NA	999.NK	DFI
5.17.3 Je kwa kipindi alichozidiwa ilikuwa ni mara ngapi kwa siku? (NA=88; NK=99)				FFI2
5.17.4 Je kati ya kifafa alikuwa	1. ameamka (fahamu) 2. Hajitambui	8. NA	9. NK	BFA
5.17.5 Je alikuwa na matatizo katika kufungua mdomo?	1.Aliweza kufungua	2.Hakuweza kufungua	9. NK	LOC
5.17.6 Je alikuwa amekakamaa mwili mzima? *(Kama jibu ni 2 au 9 nenda swali la 5.18)*	1. Ndiyo	2. Hapana	9. NK	OPI
5.17.7 Je alikakamaa kwa siku ngapi?		888.NA	999.NK	DSTIF

5.18 KUPOOZA:

5.18.1 Je alipooza upande mmoja wa mwili? *(Kama jibu ni 2 au 9 nenda swali 5.19)*	1. Ndiyo	2. Hapana	9. NK	HEM
5.18.2 Alipooza kwa siku ngapi		888.NA	999.NK	DHE
5.19 Je alipooza miguu? *(Kama jibu ni 2 au 9 nenda swali 5.20)*	1. Ndiyo	2. Hapana	9. NK	PAR
5.19.1 Alipooza kwa siku ngapi?		888.NA	999.NK	DPA

5.20 RANGI YA MKOJO:

5.20.1 Je rangi ya mkojo ilibadilika? *(Kama jibu ni 2 au 9 nenda swali 5.21)*	1. Ndiyo	2. Hapana	9. NK	BIU

5.20.2 Mkojo ulikuwa wa rangi gani?

1. Njano iliyokolea	2. Kama kahawa	3. Una damu	8. NA	9. NK	URC

5.20.3 Rangi ilikuwa hivyo kwa siku ngapi?		888.NA	999.NK	DBU

5.21 KIASI CHA MKOJO:

5.21.1 Je kulikuwa na mabadiliko yeyote ya kiasi cha mkojo aliopata kwa siku? *(Kama jibu ni 2 au 9 nenda swali 5.22)*	1. Ndiyo	2. Hapana	9. NK	CQU

5.21.2 Alipata kiasi gani cha mkojo kwa siku?

1. Mwingi kupita kiasi	2. Kidogo sana	3. Hakuna kabisa	8. NA	9. NK	AQU

5.21.3 Ni kwa siku ngapi mkojo ulibadilika rangi? (NA=888; NK=999)				DQU
5.22 Alipata shida kukojoa? *(Kama jibu ni 2 au 9 nenda swali 6.1)*	1. Ndiyo	2. Hapana	9. NK	DPU

5.22.1 Alipata shida ya namna gani?

1. Kushindwa kukojoa	2. Mkojo kuchuruzika mfululizo		
3. Maumivu kama kuungua wakati wa kukojoa	4.Maumivu makali		TDP
5. Nyingine (taja)	8. NA	9. NK	

6.1 UPASUAJI :

6.1.1 Je alifanyiwa upasuaji wowote kabla ya kufariki?
(Kama jibu ni 2 au 9 nenda swali la 7.1)

1. Ndiyo	2. Hapana	9. NK	HOP

6.1.2 Je ni siku ngapi kabla ya kifo chake alifanyiwa upasuaji?

	888.NA	999.NK	OPD

6.1.3 (Uliza sehemu aliyofanyiwa upasuaji)

1. Tumboni	2. Kwingine	8. NA	9. NK	SYT

Angalia:	**Kama marehemu ni mwanamke na ni zaidi ya miaka hamsini (>50) nenda swali 7.13** **Kama ni mwanaume nenda swali la 8**

7.0: UJAUZITO/KUJIFUNGUA

7.1 Je alikuwa mjamzito katika kipindi cha kifo chake?
(Kama jibu ni 2 au 9 endelea na swali la 7.8)

1. Ndiyo	2. Hapana	9. NK	PRE

7.2 Je alikuwa akihudhuria kliniki katika kipindi cha ujauzito wake?

1. Ndiyo	2. Hapana	8. NA	9. NK	ANCCU

7.3 Je alihudhuria mara ngapi kliniki wakati akiwa mjamzito?

	88. NA	99. NK	FQANC

7.4 Je alikuwa akitumia vidonge vya kinga dhidi ya malaria wakati wa ujauzito wake kabla hajafariki?

1. Ndiyo	2. Hapana	8. NK	PROPH

7.5 Je alikuwa akihudhuria kliniki wakati wa mimba zilizotangulia?

1. Ndiyo	2. Hapana	8. NA	9. NK	ANCPR

7.6 Je alikuwa na kadi ya kliniki?

1. Ndiyo	2. Hapana	8. NA	9. NK	CARD

7.7 Je ni kwa miezi mingapi alikaa na ujauzito?

	88.NA	99.NK	MPR

7.8 Je alijifungua ndani ya muda wa siku 42 (wiki 6) kabla ya kufariki?
(Kama jibu ni 2 au 9 endelea na swali la 7.11)

1. Ndiyo	2. Hapana	8. NA	9. NK	DEL

7.9 Je ni siku ngapi kabla ya kifo chake alipojifungua?

	888.NA	999.NK	EDD

7.10 Alijifungulia wapi?

1. Nyumbani	2. Kliniki	3. Hospitali	8. NA	9. NK	PDE

7.11 Alishikwa na uchungu kwa muda gani?

1. Chini ya masaa 24	2. Zaidi ya masaa 24	8. NA	9. NK	DDE

7.12 Alitokwa na damu nyingi wakati wa kujifungua?

1. Ndiyo	2. Hapana	8. NA	9. NK	BDE

7.13 (Kama NDIYO, dadisi kujua kwamba damu ilianza kabla au baada ya kujifungua ?

1. Kabla	2. Baada	8. NA	9.NK	HDE

7.14 Je alijifungua kwa njia gani?

1. Njia ya kawaida	2. Vyuma au mpira wa kuvutia	3. Upasuaji	8. NA	9. NK	MDE

7.15 Je mtoto alizaliwa akiwa:

1. Hai	2. Mfu	8. NA	9. NK	BALV

7.16 Je alipata kujifungua kwa shida huko siku za nyuma?	1. Ndiyo	2. Hapana	8. NA	9. NK	PCD
7.17 Je mimba iliharibika siku 45 kabla ya kufariki?	1. Ndiyo	2. Hapana	8. NA	9. NK	ABO
7.18 Je alikuwa anatumika/hedhi kawaida?	1. Ndiyo	2. Hapana	8. NA	9. NK	ABV
7.19 Je alikuwa na uvimbe wowote au kidonda katika maziwa yake?	1. Ndiyo	2. Hapana	8. NA	9. NK	BTU

8. KUUMIA/AJALI:

8.1 Je alikuwa ana jeraha lolote lililompelekea kufariki? *(Kama jibu ni 2au 9 endelea na swali la 9)*	1. Ndiyo	2. Hapana	9. NK	INJ

8.2 (Kama ndiyo uliza:) Aina gani ya kuumia au ajali? *Ruhusu akupe majibu yake bila kumdadisi/kumuuliza)*. TINJ

1. Ajali ya gari (mtembea kwa miguu)	2. Ajali ya gari (abiria)	3.Kuanguka	4. Kuzama	5. Sumu (taja) ………………………
6. kuumwa na mdudu/mnyama	7.Kuungua	8. Risasi	9. Kitu chenye ncha kali- mfano kisu	10. Kutahiriwa
11. Kupigwa/Kudhalilishwa/adhabu kali (taja): ………………………………………..			12. Nyingine (taja):	

8.3 Je alifia katika sehemu ilipotokea ajali au kuumia? *(Nenda swali la 8.6 kama 8.3 = Hapana)*	1. Ndiyo	2. Hapana	9.NK	DSPOT
8.4 Je aliishi kwa siku ngapi kabla hajafariki?	1Chini ya masaa 24	2.Zaidi ya masaa 24	9. NK	INJDU
8.5 Je alipata matibabu kabla hajafariki?	1. Ndiyo	2. Hapana	9.NK	MDCARE
8.6 Je alikuwa na ugonjwa wa muda mrefu au alikuwa mgonjwa mwezi mmoja kabla ya ajali au kuumia?	1. Ndiyo	2. Hapana	9.NK	OILL
8.7. Je unafikiri kwamba alijiua?	1. Ndiyo	2. Hapana	9. NK	SUI

(Kama jibu ni 2 au 9 endelea hadisehemu ya 9)

8.8 Je ni namna gani alijiua?

1. Alijinyonga	2. Sumu	3. Kuungua	4. Mengineyo(taja)	8. NA	TSU

9.0: MATIBABU NA KUMBUKUMBU

9.1 Matibabu

9.1. 1 Je alipata dawa wakati akiugua?	1. Ndiyo	2.Hapana	8.NA	9. NK	TREAT

(Kama 9.1.1 ni Hapana , tafadhali nenda swali la 9. 2)

9.1.2 Je alipata madawa yoyote ya antibiotics wakati wa ugonjwa wake?	1. Ndiyo	2.Hapana	8.NA	9. NK	ANTIB
9.1.3. Je alipata dawa zozote za kutibu malaria wakati wa ugonjwa wake?	1. Ndiyo	2.Hapana	8.NA	9. NK	ANTIM

(kama Ndiyo nenda swali la 9.1.3, tafadhali taja katika 9.1.4 vinginevyo nenda 9.1.5)

9.1.4 Je ni dawa zipi za kutibu/kuzuia malaria ambazo alitumia?	1.kloroquine	2.Fansida	3.Kwinini	
	4.Nyinginezo	9.NK		ANTIM_T

9.1.5 Alipata dawa zozote za kutuliza maumivu na kushusha joto la mwili wakati wa ugonjwa?	1.Ndiyo	2.Hapana	9.NK	ANTIP

9.1.6 Dawa zipi za kutuliza maumivu na kushusha joto la mwili alizopata?	1.Paracetamol	2.Asprin	ANTIP_T
	3.Nyinginezo	9.NK	

9.2 KUMBUKUMBU ZA AFYA

9.2.1 Je kuna kumbukumbu zake zozote za afya? *Kama Hapana nenda swali la 9.2.6*	1. Ndiyo	2.Hapana	9. NK	HREC
9.2.2 Ninaweza kuziona kumbukumbu hizo?	1. Ndiyo	2.Hapana	8. NA	RECSEE

Kama mhojiwa atakuruhuse kuziona kumbukumbu, nakili maelezo yote katika kipindi cha mieze 12 kabla ya kifo.

9.2.3 Nakilli tarehe za vipimo viwili vya uzito wa hivi karibuni (anza na uzito wa hivi karibuni)	Tarehe ya 1 dd/mm/yy		DATEW1

Uzito wa1		WEIG1
Tarehe ya 2 dd/mm/yy		DATEW2
Uzito wa 2		WEIG2

Nakili tarehe na maelezo ya matukio muhimu *(zaidi ya tarehe moja)*

9.2.4 Tarehe *(dd/mm/yy):*_____/_____/_____

9.2.5 Andika taarifa ____

____

____

9.2.6 Cheti cha kifo kilitolewa?	1. Ndiyo	2.Hapana	9. NK	DCERT
9.2.7 Umekiona cheti cha kifo?	1. Ndiyo	2.Hapana	8. NA	SEEDC

9.2.8 Record immediate cause of death appearing in death certificate? ……………………………………………	Code		IMCAU
9.2.9 Record the first underlying cause of death? ………………………………………………	Code		**UCAU1**
9.2.10 Record the second underlying cause of death? ……………………………………………………	Code		**UCAU2**
9.2.11 Record the third underlying cause of death? ………………………………………………..	Code		**UCAU3**
9.2.12 Record the contributing cause(s) of death? …………………………………………………..	Code		CCAU

<u>10.0 JINSI ALIVYOISHI (LIFE STYLE) (OPTIONAL)</u>

10.1 UNYWAJI WA POMBE (ALCOHOL ABUSE)

10.1.1 Je marehemu alikuwa anakunywa pombe?	1. Ndiyo	2.Hapana	8. NK	ALC

10.1.2 Kama Ndiyo ni kwa muda gani alikuwa anakunywa pombe? — ALCD

1.Chini ya mwaka mmoja	**2**.Miaka 1-5	**3**. Miaka 6-10
4. Miaka 11-15	**5**. Katika umri wa utu uzima wake	**6**. NK

10.1.3 Je ni mara ngapi alikuwa akinywa pombe? — ALCOF

1.Kila siku	**2**. Kwa wiki	**3**.Wiki mbili
4. mara moja katiak kipindi kirefu	**5**. NK	

10.1.4 Je ni mara ngapi alikuwa akilewa? — ALCDK

1. Kila siku	**2**. Kwa wiki	**3**.Wiki mbili
4. mara moja katiak kipindi kirefu e	**5**. NK	

10.1.5 Kwa mawazo yako ni vipi unafikiri marehemu alianza kunywa pombe? — ALCRS

1.Ushawishi wa marafiki	**2**.Ilikuwa ni fasheni kunywa	
3. Kutaka kujaribu	**4**. Ili kusahau matatizo (kiuchumi, kijamii n.k.)	**5**. NK

10.1.6 Kwa mawazo yako kwa nini aliendelea kunywa pombe? — ALCCO

1.Kusahau matatizo	**2**. alikuwa hawezi kukaa bila kunywa (addicted)

3. Kwa starehe	**4**. Ili kujiweka katika hadhi yake	**5**. NK

10.1.7 Je marehemu alikuwa akinywa pombe gani? TALC

1.Bia	**2** Pombe kali	**3**. Mvinyo
3. Pombe ya kienyeji	**4**. Kienyeji na & pombe haramu	**5**. NK

10.1.8 Je hiyo alikuwa anaipata wapi? ALCS

1.Baa	**2**. Alitengeneza mwenyewe nyumbani	
3. Marafiki/au ndugu	**4**. Pombe ya kienyeji	**5**. NK

10.1.9 Je marehemu alipatwa na matatizo baada ya kunywa pombe? ALCTR

1. Ndiyo	2.Hapana	8. NK

10.1.10 Kama ndiyo ni aina gani ya mataizo alikumbana nayo? TALCTR

1.Uvunjaji wa sheria	**2**. Ugomvi (Ubakaji) n.k.	
3. Alikuwa akiugua (taja ugonjwa)	**4**. Alikuwa anazembea katika uwajibikaji(kuvunjika kwa familia, kupoteza kazi n.k.	**5**. NK

10.2. UVUTAJI WA SIGARA

10.2.1 Je marehemu aliwahi kuvuta sigara? SMOK

1. Ndiyo	2.Hapana	8. NK

10.2.2 Kama ndiyo, amekuwa akivuta kwa kipindi gani? DSMOK

1.Chini ya mwaka mmoja	**2**. Mwaka 1-5	**3**. Miaka 6-10
4. miaka 11-15	**5**. Katika kipindi cha utu-uzima wa maisha yake	**6**. NK

10.2.3 Je alikuwa akivuta mara ngapi? SMOKOF

1.Mvutaji wa kuunganisha (Chain-smoked)	**2** Baada ya saa moja	**3** Kwa siku mara moja
4. Kwa wiki mara moja	**5**. Wiki mbili	
6. Mara moja katika kipindi kirefu	**7.** NK	

10.2.4 Je kwa mawazo yako unafikiri ni vipi marehemu alianza kuvuta sigara? SMOKRS

1.Ushawishi wa marafiki zake	**2**. Ilikuwa ni fasheni kuvuta	
3. Curiosity	**4**. Kusahau matatizo (Kiuchumi, kijamii n.k.)	**5**. NK

10.2.5 Je unafikiri ni kwa nini aliendelea kuvuta? SMOKCO

1.Ili kusahau matatizo	**2**. Alikuwa hawezi kukaa bila kunywa (addicted)	
3. Kwa kustarehe	**4**. Ili kujiweka katika hadhi yake	**5**. NK

10.2.6 Je ni sigara ngapi alikuwa anavuta kwa siku/wiki/fortnight/mwezi? NSMOK

1.Chini ya sigara 5	**2**. Chini ya pakiti 1	
3. Pakiti 2-5	**4**. Zaidi ya pakiti 5	**5**. NK

10.2.7 Je marehemu alikuwa anavuta sigara za aina gani? CIGTYP

1Sigara yenye kichungi	**2**. Sigara isiyokuwa na kichungi	
3. Kiko	**4**. Cigar (sigara kubwa)	**5**. NK

10.2.8 Je sigara alizokuwa anavuta alikuwa akizipata toka wapi? CIGSOUR

1. Baa	2. Kutoka dukani	**3**. Kutoka nje ya nchi
3. Zilitengenezewa nyumbani	**4**. Marafiki au ndugu	**5**. NK

10.2.9 Je marehemu alikuwa ana matatizo/fujo alipokuwa amevuta? SMKTR

1. Ndiyo	2.Hapana	3. NK

10.2.10 Kama ndiyo ni aina gani ya mataizo alikumbana nayo? TSMKTR

1. Uvunjaji wa sheria	**2**. Ugomvi (Ubakaji) n.k.
3. Alikuwa akiugua (taja ugonjwa)	**4**. Alikuwa anazembea katika uwajibikaji (kuvunjika kwa familia, kupoteza kazi n.k.)
6. NK	

10.3. UTUMIAJI WA MADAWA YA KULEVYA (DRUG ABUSE)

10.3.1 Je marehemu aliwahi kutumia madawa ya kulevya?

1. Ndiyo	2.Hapana	3. NK	UDRG

10.3.2 Kama ndiyo amekuwa akitumia madawa ya kulevya kwa kipindi gani?

1.Chini ya mwaka mmoja	**2**. Miaka 1-5	**3**.Miaka 6-10	DDRG
4.Miaka 11-15	**5**. Katika kipindi cha utu-uzima wa maisha yake	**6**. NK	

10.3.3 Je alikuwa akilewa kwa kipindi gani?

1.Kwa siku	**2**. Kwa wiki	**3**.Wiki mbili	DRGOF
4. Kwa mwezi	**5.** Mara moja kwa kipindi kirefu	**6**. NK	

10.3.4 Je kwa mawazo yako unafikiri ni vipi marehemu alianza kutumia madawa ya kulevya?

1.Ushawishi wa marafiki zake	**2**. Ilikuwa ni fasheni kutumia madawa ya kulevya		DRUGRS
3.Kuataka kujaribu	**4. Ili kusahau matatizo**	**5.** NK	

10.3.5 Kwa mawazo yako unafikiri ni kwa nini aliendelea kutumia madawa ya kulevya?

1.Ili kusahau matatizo	**2**. Alikuwa hawezi kukaa bila kunywa (addicted)		DRGCO
3. Kwa kustarehe	**4**. Ili kujiweka katika hadhi yake	**5**. NK	

10.3.6 Je ni aina gani ya madawa ya kulevya marehemu alikuwa anatumia?

1. Heroine	**2**. Cocaine	**3**. Hisia za raha (Ecstasy)	TDRG
4. Bangi	**5.** Madawa aliyoandiki na daktari *	**6**. Mimeng'enyo ya ukuzaji (homoni)	
7. Dawa za kuvuta (Inhalants)**	**8**. Nyingine	**9**. NK	

*Taja (mfano: Dawa zinazoonyesha taathira ya ubongo kama kuleta usingizi pamoja na kuleta raha amphetamines, hallucinogens, diazepam (valium), phethidine, etc)…………………………………
** Taja (Mfano gundi, wino wa kufuta maandishi, paint thinner, etc)………………………………………………….

10.3.7 Je aliyapata kutoka wapi?

1. Baa	**2**. Duka la dawa	**3**.Kutoka dukani	DRGS
3. Kutoka nje ya nchi	**4**.Yalitengenezewa nyumbani		
5. Marafiki/ndugu	**6.** NK		

10.3.8 Je marehemu alileta matatizo pindi alivyotumia madawa ya kulevya?

1. Ndiyo	2.Hapana	3. NK	DRGTR

10.3.9 Kama ndiyo ni aina gani ya mataizo alikumbana nayo?

1. Uvunjaji wa sheria	**2**. Ugomvi (Ubakaji) n.k.	TDRGTR
3. Alikuwa akiugua (taja ugonjwa) …………………	**4**. Alikuwa anazembea katika uwajibikaji(kuvunjika kwa familia, kupoteza kazi n.k.)	
5. NK		

MWISHO WA MAHOJAINO

MSHUKURU MHOJIWA KWA USHIRIKIANO

Verbal autopy questionaire

11. Maoni ya mhojaji na jinsi alivyouona usaili

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Certify correct on:							**By:**			**CCB**

Short Coding Lists for the Cause of Deaths

alg1	full_name	description
***** Not coded *****	*** Not coded ***	*** Not coded ***
1.0.0 Unspecified communicable disease	Unspecified communicable diseases	
1.1.0 Unspec. Acute febrile illness	Unspecified Acute febrile illness	
1.1.0 Unspec. Acute febrile illness	Acute febrile illness inclu. malaria	
1.1.0 Unspec. Acute febrile illness	Acute febrile illness with anaemia	Acute febrile illness incl. malaria
1.1.0 Unspec. Acute febrile illness	Chronic febrile illness > 4 weeks	Chr. febrile illness (fever >= 4wks)
1.1.0 Unspec. Acute febrile illness	Acute febrile illness 1-4 weeks	Acute febrile illness incl. malaria
1.1.0 Unspec. Acute febrile illness	Acute fever with anaemia	Acute febrile illness incl. malaria
1.1.0 Unspec. Acute febrile illness	Acute febrile illness with seizures	Acute febrile illness with seizures
1.1.1 Malaria	Malaria	
1.1.1 Malaria	Malaria (confirmed)	Acute febrile illness incl. malaria
1.1.1 Malaria	Cerebral malaria (confirmed)	Acute febrile illness incl. malaria
1.1.2 Meningitis	Meningitis	
1.1.2 Meningitis	Meningitis	Meningitis
1.1.9 All other spec. acute febrile illness	All other specified acute febrile illness	
1.1.9 All other spec. acute febrile illness	Acute febrile illness <= 7 days	Acute febrile illness incl. malaria
1.1.9 All other spec. acute febrile illness	Fever + malnutrition	Fever + malnutrition
1.2.0 Unspecified Acute Respiratory infections	Unspecified Acute respiratory infections	
1.2.1 Pneumonia	Pneumonia	
1.2.1 Pneumonia	Acute respiratory infections	
1.2.1 Pneumonia	Pneumonia	Pneumonia
1.2.9 All other specified acute respiratory infections	All other specified acute respiratory infections	
1.3.0 Hepatitis	hepatitis	
1.3.0 Hepatitis	Viral Hepatitis	Liver disease
1.4.0 Unspecified TB/AIDS	Unspecified TB/AIDS	
1.4.0 Unspecified TB/AIDS	PTB & AIDS	AIDS
1.4.1 Pulmonary Tuberculosis	Pulmonary Tuberculosis	
1.4.1 Pulmonary Tuberculosis	Pulmonary TB	Pulmonary TB
1.4.1 Pulmonary Tuberculosis	Pulmonary TB (confirmed)	Pulmonary TB
1.4.1 Pulmonary Tuberculosis	Pleural effusion	Other respiratory
1.4.2 AIDS	AIDS	
1.4.2 AIDS	AIDS	AIDS
1.4.2 AIDS	Family History of HIV	Family History of HIV
1.4.3 AIDS + Pulmonary Tuberculosis	AIDS + Pulmonary Tuberculosis	
1.4.9 All other forms of tuberculosis	All other forms of tuberculosis	

1.4.9 All other forms of tuberculosis	Pulmonary TB (not confirmed)	Pulmonary TB
1.4.9 All other forms of tuberculosis	Pulmonary TB (suspected)	Pulmonary TB
1.4.9 All other forms of tuberculosis	Extra pulmonary TB	Other
1.4.9 All other forms of tuberculosis	Extra pulmonary TB & AIDS	AIDS
1.5.0 Diarrhoeal diseases	Unspecified diarrhoeal diseases	
1.5.0 Diarrhoeal diseases	Diarrhoeal disease (acute)	Acute diarrhoeal disease
1.5.0 Diarrhoeal diseases	Diarrhoeal disease (chronic)	Chronic diarrhoeal disease
1.5.0 Diarrhoeal diseases	Chronic diarrhoea, chronic cough +/- fever > 4 wks	Chronic cough, chronic diarrhoea
1.5.0 Diarrhoeal diseases	Acute or chronic diarrhoea with anaemia	Chronic diarrhoeal disease +/- anaemia malnutritio
1.5.0 Diarrhoeal diseases	Acute or chronic diarrhoea with malnutrition	Chronic diarrhoeal disease +/- anaemia malnutritio
1.5.0 Diarrhoeal diseases	Diarrhoeal diseases	
1.5.9 All other specified diarrhoeal diseases	Cholera	Acute diarrhoeal disease
1.5.9 All other specified diarrhoeal diseases	Amoebiasis	Chronic diarrhoeal disease
1.5.9 All other specified diarrhoeal diseases	Acute diarrhoeal disease (bloody)	Acute diarrhoeal disease (bloody)
1.5.9 All other specified diarrhoeal diseases	Chronic diarrhoeal disease (bloody)	Chronic diarrhoeal disease (bloody)
1.5.9 All other specified diarrhoeal diseases	All other specified diarrhoeal diseases	
1.6.0 Tetanus	Tetanus	
1.6.0 Tetanus	Tetanus	Tetanus
1.6.0 Tetanus	Tetanus	
1.7.0 Rabies	Rabies	
1.7.0 Rabies	Rabies	Rabies
1.9.0 All other spec. communicable diseases	All other specified communicable diseases	
1.9.0 All other spec. communicable diseases	Foodbourne intoxications	Acute diarrhoeal disease
1.9.0 All other spec. communicable diseases	Other bacterial diseases including typhoid	Other
1.9.0 All other spec. communicable diseases	Leprosy	Other
1.9.0 All other spec. communicable diseases	Septicaemia	Septicaemia
1.9.0 All other spec. communicable diseases	Sexually transmitted diseases	Other
1.9.0 All other spec. communicable diseases	Abcess etc.	Other
1.9.0 All other spec. communicable diseases	Chicken pox	Other
1.9.0 All other spec. communicable diseases	Herpes zoster	Other
1.9.0 All other spec. communicable diseases	Helminthiasis	Other
1.9.0 All other spec. communicable diseases	Other respiratory disease	Other respiratory
1.9.0 All other spec. communicable diseases	Influenza	Pneumonia
1.9.0 All other spec. communicable diseases	Bronchitis/Emphysema	Bronchitis/Emphysema
1.9.0 All other spec. communicable diseases	Lung abcess	Other respiratory
1.9.0 All other spec. communicable diseases	Appendicitis	Acute abdominal problem
1.9.0 All other spec. communicable diseases	Peritonitis	Acute abdominal problem
1.9.0 All other spec. communicable diseases	Cystitis/UTI	Genito-urinary diseases

1.9.0 All other spec. communicable diseases	Inflammatory diseases of female pelvic organs	Genito-urinary diseases
10.0.0 Still Birth	Still Birth	
10.0.0 Still Birth	Stillbirth	Perinatal
11.0.0 Birth injury and/or asphyxia	Birth injury and/or asphyxia	
12.0.0 Prematurity and/or low birth weight	Prematurity and/or low birth weight	
12.0.0 Prematurity and/or low birth weight	Premature	Premature
13.0.0 Congenital abnormalities	Congenital abnormalities	
13.0.0 Congenital abnormalities	Congenital malformation	Congenital malformation
13.0.0 Congenital abnormalities	Congenital abnormalities	
14.0.0 All other perinatal causes	All other perinatal causes	
14.0.0 All other perinatal causes	Perinatal death	Perinatal
14.0.0 All other perinatal causes	Twin	Twin
15.0.0 Neonatal tetanus	Neonatal tetanus	
18.0.0 Malnutrition	Malnutrition	
18.0.0 Malnutrition	Anaemia/malnutrition	Malnutrition
18.0.0 Malnutrition	Malnutrition	Malnutrition
18.0.0 Malnutrition	Malnutrition	
19.0.0 Measles	Measles	
19.0.0 Measles	Measles	Measles
2.0.0 Unspec. direct maternal causes	Unspecified direct maternal causes	
2.0.0 Unspec. direct maternal causes	Maternal death	Maternal
2.0.0 Unspec. direct maternal causes	Oedema etc. in childbirth etc.	Maternal
2.1.0 Abortion	Unspecified Abortion	
2.1.0 Abortion	Pregnancy with abortive outcome	Maternal
2.1.9 Specified Abortion	Specified Abortion	
2.2.0 Eclampsia	Eclampsia	
2.3.0 Ante/postpartum haemorrhage	Unspecified Ante/postpartum haemorrhage	
2.3.0 Ante/postpartum haemorrhage	Antepartum haemorrhage	Maternal
2.3.9 Specified Ante/postpartum haemorrhage	Placenta praevia	Maternal
2.3.9 Specified Ante/postpartum haemorrhage	Postpartum haemorrhage	Maternal
2.3.9 Specified Ante/postpartum haemorrhage	Specified Ante/postpartum haemorrhage	
2.4.0 Obstructed labour	Obstructed labour	
2.5.0 Puerperal sepsis	Puerperal sepsis	
2.5.0 Puerperal sepsis	Complications within puerperium	Maternal
2.9.0 Other spec. direct maternal causes	Other specified direct maternal causes	
2.9.0 Other spec. direct maternal causes	Ectopic pregnancy	Maternal
2.9.0 Other spec. direct maternal causes	Other obstetric complications	Maternal
2.9.0 Other spec. direct maternal causes	Complications of labour and delivery	Maternal
20.0.0 All other specified diseases	All other specified diseases	
3.0.0 Unspecified non-communicable causes	Dysfunctional uterine bleeding	Other

3.0.0 Unspecified non-communicable causes	Unspecified non-communicable causes	
3.1.0 Unspecified cardiovascular disorders	Unspecified cardiovascular disorders	
3.1.0 Unspecified cardiovascular disorders	Other heart disease	Other heart disease
3.1.1 Hypertension	Hypertension	
3.1.1 Hypertension	Hypertensive diseases	Other heart disease
3.1.2 Congestive Cardiac Failure	Congestive Cardiac Failure	
3.1.2 Congestive Cardiac Failure	Anaemia/heart failure	Anaemia
3.1.2 Congestive Cardiac Failure	Heart failure	Chronic heart failure
3.1.3 Ischaemic Heart Disease	Ischaemic Heart Disease	
3.1.4 Cerebrovascular Disease	Cerebrovascular Disease	
3.1.4 Cerebrovascular Disease	Stroke	Stroke
3.1.9 All other spec. cardiovascular disorders	All other specified cardiovascular disorders	
3.1.9 All other spec. cardiovascular disorders	Acute and chronic rheumatic heart disease	Other heart disease
3.1.9 All other spec. cardiovascular disorders	Other forms of heart disease	Other heart disease
3.1.9 All other spec. cardiovascular disorders	Pericardial effusion	Other heart disease
3.2.0 Chronic Obstructive Pulmonary Disease	Chronic Obstructive Pulmonary Disease	
3.2.0 Chronic Obstructive Pulmonary Disease	Asthma - Acute severe asthma	Asthma
3.3.0 Unpecified liver diseases	Unspecified liver diseases	
3.3.1 Liver cirrhosis	Liver cirrhosis	
3.3.1 Liver cirrhosis	Diseases of the liver	Liver disease
3.3.1 Liver cirrhosis	Portal hypertension	Liver disease
3.3.9 All other specifed liver diseases	All other specified liver diseases	
3.4.0 Acute abdominal conditions	Unspecified Acute abdominal conditions	
3.4.0 Acute abdominal conditions	Severe abdo pain, but diagnosis uncertain	Acute abdominal problem
3.4.0 Acute abdominal conditions	Acute abdominal conditions	
3.4.9 All other specified acute abdominal conditions	All other specified acute abdominal conditions	
3.5.0 Diabetes	Diabetes	
3.5.0 Diabetes	Diabetes	Diabetes
3.5.0 Diabetes	Diabetes/hypertension	Diabetes
3.6.0 Unspecified neoplasms	Unspecified neoplasms	
3.6.1 Carcinoma breast	Carcinoma breast	
3.6.1 Carcinoma breast	CA breast (C50)	Cancer
3.6.2 Carcinoma cervix/uterus	Carcinoma cervix/uterus	
3.6.2 Carcinoma cervix/uterus	CA female genital tract (C51)	Cancer
3.6.3 Hepatoma	Hepatoma	
3.6.3 Hepatoma	CA liver (C22)	Cancer
3.6.4 Carcinoma of gastrointestinal tract	Carcinoma of gastrointestinal tract	
3.6.4 Carcinoma of gastrointestinal tract	CA oesophagus (C15)	Cancer
3.6.4 Carcinoma of gastrointestinal tract	CA stomach (C16)	Cancer

3.6.5 Carcinoma of the lung	Carcinoma of the lung	
3.6.5 Carcinoma of the lung	CA bronchus and lung (C34)	Cancer
3.6.9 All other specified neoplasms	All other specified neoplasms	
3.6.9 All other specified neoplasms	Other cancer	Cancer
3.6.9 All other specified neoplasms	CA lip, oral cavity, pharanyx (C14)	Cancer
3.6.9 All other specified neoplasms	CA larynx (C32)	Cancer
3.6.9 All other specified neoplasms	CA skin (C44)	Cancer
3.6.9 All other specified neoplasms	Kaposi's sarcoma (C46)	Cancer
3.6.9 All other specified neoplasms	CA urinary tract (C64)	Cancer
3.6.9 All other specified neoplasms	Lymphomas/leukaemia (C81)	Cancer
3.6.9 All other specified neoplasms	Hyperplasia of prostate	Genito-urinary diseases
3.7.0 Renal disorders	Unspecified Renal disorders	
3.7.0 Renal disorders	Genito-urinary disease	Genito-urinary diseases
3.7.0 Renal disorders	Disease of the urinary system	Genito-urinary diseases
3.7.0 Renal disorders	Renal failure	Genito-urinary diseases
3.7.9 Specified renal disorders	Nephrotic syndrome	Genito-urinary diseases
3.7.9 Specified renal disorders	Specified Renal disorders	
3.8.0 Central Nervous System disorders	Unspecified Central Nervous System disorders	
3.8.0 Central Nervous System disorders	Nervous system disorders	Other nervous system disorders
3.8.0 Central Nervous System disorders	Other nervous system disorders	Other nervous system disorders
3.8.1 Epilepsy	Epilepsy	Epilepsy
3.8.1 Epilepsy	Epilepsy	
3.8.9 All other specified CNS disorders	Polyneuropathies etc.	Other nervous system disorders
3.8.9 All other specified CNS disorders	Paraplegia	Other nervous system disorders
3.8.9 All other specified CNS disorders	Other disorders of the nervous system	Other nervous system disorders
3.8.9 All other specified CNS disorders	All other specified CNS disorders	
3.9.0 All other specified noncommunicable diseases	All other specified non-communicable diseases	
3.9.0 All other specified noncommunicable diseases	Mood affective disorders	Other nervous system disorders
3.9.0 All other specified noncommunicable diseases	Disease of digestive system	Other digestive system disorders
3.9.0 All other specified noncommunicable diseases	Gastric and duodenal ulcer	Other digestive system disorders
3.9.0 All other specified noncommunicable diseases	Diseases of the skin	Other
3.9.0 All other specified noncommunicable diseases	Stevens-Johnson Syndrome	Other
3.9.0 All other specified noncommunicable diseases	Connective tissue disorders	Other
3.9.0 All other specified noncommunicable diseases	Genital or rectal prolapse	Genito-urinary diseases
3.9.0 All other specified noncommunicable diseases	Fistula involving female genital tract	Genito-urinary diseases
4.1.0 Anaemia		
4.1.0 Anaemia	Anaemia	Anaemia

4.1.0 Anaemia	Sickle cell disease	Anaemia
4.9.0 All other spec. symptoms, signs and syndromes	All other specified symptoms, signs and syndromes	
4.9.0 All other spec. symptoms, signs and syndromes	Alone	
4.9.0 All other spec. symptoms, signs and syndromes	Blind Person	
4.9.0 All other spec. symptoms, signs and syndromes	Chronic cough	Chronic cough
4.9.0 All other spec. symptoms, signs and syndromes	Other blood diseases	Anaemia
4.9.0 All other spec. symptoms, signs and syndromes	Disorders of other endocrine glands	Other
4.9.0 All other spec. symptoms, signs and syndromes	Severe headache	Other nervous system disorders
4.9.0 All other spec. symptoms, signs and syndromes	Grand parents	
4.9.0 All other spec. symptoms, signs and syndromes	HAEMOP	Pumonary TB
4.9.0 All other spec. symptoms, signs and syndromes	Hernia - intestinal obstruction	Acute abdominal problem
4.9.0 All other spec. symptoms, signs and syndromes	Intestinal obstruction	Acute abdominal problem
4.9.0 All other spec. symptoms, signs and syndromes	Vomitting major symptom - no fever	Acute abdominal problem
4.9.0 All other spec. symptoms, signs and syndromes	Mother	
4.9.0 All other spec. symptoms, signs and syndromes	Hydrocoele	Genito-urinary diseases
4.9.0 All other spec. symptoms, signs and syndromes	Old age	Old age
4.9.0 All other spec. symptoms, signs and syndromes	Poverty	Poverty
4.9.0 All other spec. symptoms, signs and syndromes	Was in Prison	
4.9.0 All other spec. symptoms, signs and syndromes	Ascites	Liver disease
4.9.0 All other spec. symptoms, signs and syndromes	Lymphadenopathy	Other
4.9.0 All other spec. symptoms, signs and syndromes	Shock	Other
4.9.0 All other spec. symptoms, signs and syndromes	Acute blood loss	Acute blood loss
4.9.0 All other spec. symptoms, signs and syndromes	Other oedema	Oedema - uncertain cause
4.9.0 All other spec. symptoms, signs and syndromes	Ulcer	Other
5.0.0 Unspecified external causes	Fractures	Injuries (intentional/unintentional)
5.0.0 Unspecified external causes	Head injury	Injuries (intentional/unintentional)
5.0.0 Unspecified external causes	Uvulectomy/traditional surgical proc. or therapy	Injuries (intentional/unintentional)
5.0.0 Unspecified external causes	Falls	Injuries (intentional/unintentional)
5.0.0 Unspecified external causes	Exposure to mech. forces incl. foreign bodies	Injuries (intentional/unintentional)
5.0.0 Unspecified external causes	Exposure to smoke, fire, flames, hot liquids etc	Injuries (intentional/unintentional)
5.0.0 Unspecified external causes	Exposure to forces of nature	Injuries (intentional/unintentional)
5.0.0 Unspecified external causes	Alcohol related	Injuries

		(intentional/unintentional)
5.0.0 Unspecified external causes	Complications of medical or surgical care	Injuries (intentional/unintentional)
5.0.0 Unspecified external causes	Sequelae of external causes of mortality	Injuries (intentional/unintentional)
5.0.0 Unspecified external causes	Unspecified external causes	
5.1.0 Unspecified unintentional injuries	Unspecified unintentional injuries	
5.1.0 Unspecified unintentional injuries	Event of undetermined intent	Injuries (intentional/unintentional)
5.1.1 Road traffic accident	Road traffic accident	
5.1.1 Road traffic accident	Transport accidents	Injuries (intentional/unintentional)
5.1.2 Accidental poisoning	Accidental poisoning	
5.1.2 Accidental poisoning	Contact with venomous animals-insects-plants	Injuries (intentional/unintentional)
5.1.2 Accidental poisoning	Accidental poisoning	Injuries (intentional/unintentional)
5.1.3 Other specified unintentional injuries	All Other specified unintentional injuries	
5.1.3 Other specified unintentional injuries	Accidental drowning	Injuries (intentional/unintentional)
5.1.3 Other specified unintentional injuries	Accidental suffocation and strangulation in bed	Injuries (intentional/unintentional)
5.1.3 Other specified unintentional injuries	Exposure to electric current	Injuries (intentional/unintentional)
5.1.3 Other specified unintentional injuries	Assault	Injuries (intentional/unintentional)
5.1.3 Other specified unintentional injuries	Rape	Injuries (intentional/unintentional)
5.2.0 Intentional injuries	Intentional injuries	
5.2.1 Homicidal injuries	Homicidal injuries	
5.2.2 Suicidal injuries	Suicidal injuries	
5.2.2 Suicidal injuries	Intentional self harm	Injuries (intentional/unintentional)
6.0.0 Undetermined	Undetermined	
6.0.0 Undetermined	Sudden death	Sudden death
6.0.0 Undetermined	Uncertain	Uncertain
bad code	bad code	bad code

Improving Newborn Survival in Southern Tanzania

Health Facility Survey 2009

A1:District/ Wilaya: ___________________________
A3:Facility Name/ Jina la Kituo:______________________
A4:Facility Level/ Ngazi ya kituo:
Hospital Hospitali / Health Centre Kituo cha afya / Dispensary Zahanati
A5:For Hospitals only: Ward: Labour/ RCH clinic/Outpatient department
A6:Facility Type/ Mmiliki wa kituo: Private Binafsi/Government Serikali / NGO (inclu Mission) Shirika lisilo la kiserikali {ikihusisha mission}
GPS Co-ordinates/ Vipimo vya GPS ____
A7:Longitude
A8:Latitude
A9:Surveyor ID/ Namba ya utambulisho ya Mhojaji: ___
A10:Date/ Tarehe: __ / __ / __

1. Facility Staffing and Training Module:
Watumishi kituoni na Mafunzo;

To be administered to the Health facility in-charge.
Health workers who work in the facility *(including part-time and volunteer workers)* /wafanyakazi wanaofanyakazi kwenye kituo *(wanaofanya kazi kwa muda na wanaojitolea)*
F0=Staff number

F1:Qualification Taaluma F2= specify	F3:Main task Majukumu makuu	F4: Usual duties relating to MCH. Include(a) ANC (b)intrapartum(c) sick newborns (d)postnatal(e) vaccination (f)prescribing(g) other[text field] Kazi za Kawaida zinazohusisha huduma za Mama na Mtoto, (a) Klinic ya Mama wajawazito (b) huduma za kujifungua, (c) Matibabu kwa watoto wachanga wagonjwa, (e) chanjo.(f) kuandika dawa (g) nyingine.kwakila moja andika (1)Ndio (2) hapana	F5:Year started work in facility (YYYY) Mwaka wa kuanza kazi katika kituo	F6:Employed or volunteer Ameajiriwa au anajitolea	F7:Present in the health facility on survey day (1) Yes, (2) No (3) NA Yupo kwenye kituo siku kwanza ya usaili(1) ndio (2) hapana (3) Haihusiki	F8:Training in the past 1 year (1) Yes, (2) No(3)don't know / Mafunzo katika mwaka mmoja uliopita(1) Ndio (2) Hapana (3)Sijui						
						F9a:Safe Motherhood Uzazi salama	F9b:Family Planning Uzazi wa mpango	F9c: PMTCT / Kuzuia Maambukizi ya UKIMWI kutoka kwa mama kwenda kwa mtoto	F9d:m Breastfeeding Unyonyeshaji	F9e: Focused antenatal care	F9f: Essential Newborn Care/F9g:Kangaroo Mother Care	F9h IMCI

Annex

Drop-down list:
1. Medical Officer (MD) 1.Daktari
2. Assistant medical Officer (AMO) 2.Daktari Msaidizi
3. Clinical Officer3.Afisa Tabibu
4. Assistant Clinical Officers/ Rural Medical Assistant/Clinical Assistant4.Afisa Tabibu Msaidizi,Mganga msaidizi,Tabibu Msaidizi
5. Registered nurse / Nursing officer5.Muuguzi Aliyesajiliwa / Afisa Muuguzi
6. Enrolled nurse (medical attendants, Nurse PHN B, Nurse Midwife B) 6.Muuguzi Aliyeorodheshwa / Muuguzi PHN B
7. MCHA
8. Laboratory technologist
9. Laboratory assistant
10. Laboratory attendant
11. Pharmacist
12. Pharmaceutical assistant
13. Pharmacy assistant
14. Village Health workers
15. Traditional birth attendants
16. Trained traditional birth attendants
17. Others (specify)

2. Facility Services Module:
Kipengele cha Huduma za Kituo

To be administered to the Health facility in-charge.
Itumike kwenye usaili wa mkuu wa kituo
Are the following services provided in this facility?./Je, huduma zifuatazo zinapatikana katika kituo hiki?
S1) Antenatal care (1) Yes (2) No
Huduma za mama mjamzito (1) Ndiyo (2) Hapana
S2 Delivery (1) Yes (2) No
Kuzalisha (1) Ndiyo (2) Hapana
S3) Postnatal checkup (mother) (1) Yes (2) No
Uchunguzi wa mama baada ya kujifungua (1) Ndiyo (2) Hapana
S4) Postnatal check up (baby)
Uchunguzi wa mtoto baada ya kuzaliwa (1) Yes (2) No
S5 Caesarean section (1) Yes (2) No Kuzaa
Kujifungua kwa njia ya upasuaji (1) Ndiyo (2) Hapana
S6) Assisted delivery (breech, vacuum extraction, etc) (1)Yes, (2) N0
Kujifungua kwa kusaidiwa (1) Ndiyo (2) Hapana
S7) Management of sick newborns (1) Yes (2) No
Matibabu ya watoto mchanga (1) Ndiyo (2) Hapana
S8) Management of Preterm and Low birth weight 1) Yes (2) No
Huduma kwa watoto waliozaliwa kabla ya umri wao (njiti) na wenye uzito mdogo (
S9) Neonatal Resuscitation (1) Yes (2) No
Kuokoa maisha ya mtoto mchanga Ndio (2) Hapana
S10) Vaccination (1) Yes (2) No
Chanjo (1) Ndiyo (2) Hapana
S11) Family planning (1) Yes (2) No
Uzazi wa mpango (1) Ndiyo (2) Hapana
S12) Blood transfusion (1) Yes (2) No
Kuongezewa damu (1) Ndiyo (2) hapana
S13) Take blood to measure haemoglobin (1) Yes (2) No
Kipimo cha wingi wa damu (1) Ndiyo (2) Hapana
S14) Take blood to do Malaria test (1) Yes (2) No
Kipimo cha malaria (1) ndiyo (2) hapana
S15) Take blood to do Blood grouping and RH status (1) Yes (2) No
Kipimo cha kundi la damu (1) Ndiyo (2) Hapana
S16) STI treatment services (1) Yes (2) No
Huduma za matibabu ya magonjwa ya zinaa (1) Ndiyo (2) Hapana
S17) Take blood to do Blood culture/ kutoa damu kwa ajili ya culture (1) Yes/ndiyo (2) No/hapana
S18) Take blood to test Blood Glucose/ kutoa damu kwa ajili ya kupima uwingi wa sukari (1) Yes/ndiyo (2) No/hapana
S19) Take blood to measure Serum Bilirubin/kutoa damu kwa ajili ya kupima bilirubin kwenye damu (1) Yes/ndiyo (2) No/hapana

SKIP IF S1 A = NO :
S20. How many days in a week are antenatal services provided at this health facility? --------- Days/week
Siku ngapi katika wiki huduma za mama wajawazito zinatolewa hapa kituoni? ___________siku/wiki
SKIP IF S1 B = NO :
Are delivery services available at the following times in the facility / Je, huduma za uzalishaji zinapatikana hapa kituoni kwenye nyakati zifuatazo?
21. At night / Usiku (1)Yes, Ndiyo (2) N0 Hapana

22. At weekends and public holidays / Jumamosi, Jumapili na siku za sikukuu za kitaifa (1)Yes, Ndiyo (2) N0 Hapana

SKIP IF S1 E = NO:

Are on-call services for care of complicated deliveries available at the following times in the facility / Je huduma za dharula kwa wagonjwa wenye matatizo wakati wa uzazi zinapatikana katika nyakati zifuatazo?

23. At night / Usiku (1)Yes, Ndiyo (2) N0 Hapana

24. At weekends and public holidays / Jumamosi, Jumapili na siku za sikukuu za kitaifa (1)Yes, Ndiyo (2) N0 Hapana

SKIP IF S1 D = NO:

Are on-call services for caesarean section available at the following times in the facility / Je huduma za zamu kwa ajili ya uzalishaji kwa upasuaji zinapatikana katikai nyakati zifuatazo?

25. At night / Usiku (1)Yes, Ndiyo (2) N0 Hapana

26. At weekends and public holidays / Jumamosi, Jumapili na siku za sikukuu za kitaifa (1)Yes, Ndiyo (2) N0 Hapana

SKIP IF S1 J = NO:

Are on-call services for blood transfusion available at the following times in the facility / Je huduma za zamu kwa ajili ya kuongeza damu zinapatikana nyakati zifuatazo?

27. At night / Usiku (1)Yes, Ndiyo (2) N0 Hapana

28. At weekends and public holidays / Jumamosi, Jumapili na siku za sikukuu za kitaifa (1) Yes, Ndiyo (2) N0 Hapana

SKIP IF S1 A = NO

Which of the following services are offered during the routine antenatal care services? Je, ni Huduma zipi za akina mama wajawazito kati ya zifuatazo hutolewa katika kituo hiki?

For each item options are: 1. always offered / 2. Not available
Kwa kila kipengele kifuatacho, majibu ni 1. Hutolewa 2. Haitolewi kabisa
S29a: Measure height/ Kupima urefu
b: Weighing / Kupima uzito
c: Measuring blood pressure / Kupima Shinikizo la damu
d: Urine testing for protein and urinalysis/ Kupima mkojo
e Tetanus vaccination / Chanjo ya pepopunda
f:Checking of Hemoglobin / Kupima kiwango cha damu
g:PMTCT/ Kutoa huduma ya kuzuia maambukizi ya ukimwi toka kwa mama kwenda kwa mtoto
h:VDRL/ RPR testing/ kipimo cha kaswende
i:Treatment for sexual transmitted diseases/ Matibabu ya magonjwa ya zinaa (kaswende,, kisonono, vaginosis, and others)

j:Family planning counseling / Ushauri kuhusu uzazi wa mpango
k:Prevention of malaria during pregnancy through IPTp/ Uzuiaji wa maambukizi ya malaria wakati wa ujauzito IPTp

l:Prevention of malaria during pregnancy through promotion of bed nets / offering discount vouchers / Kuzuia maambukizi ya malaria kipindi cha ujauzito kwa kuhimiza matumizi ya vyandarua au kutoa hati punguzo.
m:Birth preparation counselling / Ushauri juu ya maandalizi kabla ya kujifungua
n :Information on pregnancy danger signs and what to do / Kutoa elimu juu ya viashiria vya hatari wakati wa ujauzito na nini cha kufanya.
O: Information on essential newborn care / Kutoa elimu juu ya huduma muhimu za afya ya watoto wachanga na nini cha kufanya

3. Equipment, infrastructure and education materials Module / Kipengele cha Vifaa,Miundombinu na Elimu

To be administered to the in-charge of the Reproductive and Child Health:
Iulizwe kwa mkuu wa kitengo cha huduma za uzazi na watoto(RCH in-charge) kituoni
Basic infrastructure for maternal and newborn section:
Probe for the presence and ask to see each of the following (Absent if not seen): For infrastructure to be regarded as "functioning", whenever possible, either test for it's operational or judge whether it is operational by its physical appearance:
Uliza moja moja kwa kutaja, ukiulizia uwepo na kuomba kuona kila moja ya vifaa vifuatavyo (Vifaa ambavyo hutaviona, vihesabiwe kama havipo). Ili kifaa kihesabiwe kama kinafanya kazi, ni lazima ujaribu kukitumia au uamue kwa kuangalia kwa macho kwa baadhi ya vifaa usivyoweza kujaribisha.

	Basic infrastructure / Kifaa	Present on day of survey (Seen by interviewer) (1)Yes, (2) N0 Je, kifaa kilikuwepo siku ya usaili (kimeonwa na mhojaji) (1) Ndiyo (2) Hapana	Functioning (determined by interviewer) (1) Yes, (2) No Je, Kinafanya kazi (kadri ya mhojaji) (1) Ndiyo (2) Hapana
E1	Examination room or area providing client privacy / Chumba cha kuwaona wagonjwa kwa faragha		
E2	Examination couch for gynaecological examinations / Kitanda cha kupimia magonjwa ya akina mama		
E3	Storage area or cupboard for drugs and other supplies / Sehemu au kabati la kuhifadhia dawa na mahitaji mengine		
E4	Toilet facilities or latrines for patient use / Vyoo kwa ajili ya matumizi ya wagonjwa		
E5	Delivery or labour room/area / Chumba cha kujifungulia mama wajawazito		
E6	Refrigerator / Jokofu If yes/kama ndiyo: a) Temperature of fridge on day of survey (celcius) a) Andika nyuzi joto ya jokofu siku ya usaili		
E7	Hand washing facility (clean water, soap) / Sehemu ya kunawia mikono (maji masafi, sabuni)		
E8	Telephone or radio transmitter for clinic use / Simu au Redio ya upepo		
E9	Means of transport for obstetric emergency referral (including access to municipal vehicle/ambulance off site) / Njia ya usafiri kwa ajili ya rufaa ya wagonjwa wa uzazi		
E10	Electricity / Umeme		

Basic equipment for maternal and newborn section:
Sehemu ya vifaa vya muhimu kwa ajili ya mama wajawazito na watoto wachanga*:*
Probe for the presence and ask to see each of the following (Absent if not seen): For equipment to be regarded as "functioning", take what the staff member says / Uliza moja moja kwa kutaja ukiulizia uwepo na kuomba kuona kila moja ya vifaa vifuatavyo (Vifaa ambavyo hutaviona, vihesabiwe kama havipo). Ili kifaa kihesabiwe kama kinafanya kazi, ni lazima ujaribu kukitumia

	Basic equipments / Kifaa	Present on the day of survey (seen by interviewer)Je, kifaa kilikuwepo siku ya usaili (1)Yes Ndiyo (2) No Hapana	Functioning (reported by staff) Je, kifaa Kinafanya kazi (1) Yes (2) No Hapanaa
E11	Blood pressure machine / Mashine ya kupimia msukumo wa damu (BP)		
E12	Weighing scale for adults / Mizani ya wakubwa		
E13	Infant weighing scale / Mizani ya watoto		
E14	Stethoscope		
E15	Fetoscope		
E16	Means of sterilizing equipments / Njia ya kuuwa vijidudu kwenye vifaa (sterilization)		
E17	Clinical thermometer / KIpima joto		
E18	Manual Vacuum Aspirator (MVA) / Mashine ya kusafisha mimba zilizoharibika(MVA)		
E19	Speculum		
E20	Vacuum extractor / Mashine ya kuvuta mtoto		
E21	Scissors / Mikasi		
E22	Needle holders/ Kishikia sindano		

E23	Adult Ambu-bag/ Ambu bag ya wakubwa		
E24	Newborn ambubag /Ambu bag ya watoto		
E25	Oxygen cylinder/ Mtungi wa oxygen		
E26	Suction machine /		
E27	Tubes for suction machine - adult		
E28	Tubes for suction machine - children		
E29	Forceps		
E30	Yellow box (for sharps disposal) / Box la njano kwa ajili ya vifaa vyenye ncha kali		
E31	Red bin(for wet infectious material disposal, e.g. blood, placenta, blood infusion bag)/ Pipa jekundu kwaajili ya taka hatarishi		

Educational material for maternal and newborn services:
Probe for the presence and ask to see each of the following (Absent if not seen): Multiple answers are allowed for the type of materials and the places where the materials were found.
Vifaa vya kuelimisha Huduma za mama mjamzito na Mtoto mchanga.:
Uliza moja moja kwa kutaja ukiulizia uwepo na kuomba kuona kila moja ya vifaa vya mafunzo vifuatavyo (Vifaa ambavyo hutaviona, vihesabiwe kama havipo). Jibu zaidi ya moja linaruhusiwa kwa aina ya kifaa cha mafunzo na mahali ambapo kifaa kimekutwa

	Education materials Kifaa cha mafunzo kwa ajili ya	Staff reported they have #	Seen by intervirewer on day of the survey / Je, kifaa kimeonwa siku ya usaili (1)Yes / Ndiyo (2) N0 / Hapana #	Type of materials / Aina ya kifaa cha mafunzo: 0=Poster / Posta 1=Handwritten Flipchart / chati 2=Card / kadi 3=others (specify) / Vingine (taja) A+B	Places found / Sehemu ambazo vifaa vipo 0=posted on the wall / Ukutani 1=lying on the table / mezani 2=kept in the store / stoo 3=others (specify) / Pengine (taja) C+D
E32	Warning signs of pregnancy complications / Maelekezo Viashiria vya ujauzito wenye matatizo				
E33	Antenatal nutrition instructions / Maelekezo ya lishe kwa wajawazito				
E34	Post-partum/neonatal care instructions / Maelekezo baada ya kujifungua na kwa ajili ya watoto wachanga				
E35	Breast-feeding instructions / Maelekezo kuhusu unyonyeshaji				
E36	Family planning instructions / Maelekezo kuhusu Uzazi wa mpango				

4. Supplies and Record Review Module

Ask facility in-chargefor access to MTUHA records

Maternal and newborn statistics / Takwimu za Mama wajawazito na Watoto wachanga.

For each of the following record, ask the health facility staff if you can look at the document and record the answer from the record. Write "999" if you did not see the record.

Kwa kila rekodi zifuatavyo, mwombe mhudumu wa afyaa kuonyesha na andika rekodi unayoikuta kwenye takwimu. Andika "999" kama haukuona rekodi husika.

	Number of sick newborns under one month (MTUHA 5) treated in/ namba ya watoto wachanga chini ya mwezi mmoja waliotibiwa katika vipindi vifuatavyo:	Number/namba
R1 a	January 2008	
R1 b	February 2008	
R1 c	March 2008	
R1d	April 2008	
R1 e	May 2008	
R1 f	June 2008	
R1 g	July 2008	
R1 h	August 2008	
R1 i	September 2008	
R1 j	October 2008	
R1 k	November 2008	
R1L	December 2008	

	Record/Register/Rekodi/rejista	Number/namba
R2	Number of women attending ANC in 2008 (summary in MTUHA 2 table 40 A)/namba ya akina mama waliohudhuria klinik ya akina mama wajawazito kwa mwaka 2008 (mhutasari katika MTUHA 2(jedwali 40 A)	
R3	Number of deliveries in the health facility 2008 (summary in MTUHA 2 table 41A)/namba ya akina mama waliojifungua kwa mwaka 2008 mhutasari katika MTUHA 2 jedwali 41A	
R4	Number of assisted delivery (e.g. vacuum extraction) in this facility in 2008? (MTUHA 2 table 41A)/ Jumla ya akina mama wangapi walijifungua kwa kusaidiwa kama vile kujifungua mtoto kwa kuvutwa na mashine (vacuum extraction) katika kituo hiki cha huduma ya afya mwaka 2008? (MTUHA 2 jedwali 41A)	
R5	Number of caesarean sections in this facility in 2008(MTUHA 2 jedwali 41A) / Jumla ya akina mama wangapi walijifungua kwa operesheni (caesarean section) katika kituo hiki cha huduma ya afya mwaka 2008(MTUHA 2 jedwali 41A*)*	
R6	Number of live births in 2008 (MTUHA 2 table 41C &D)/namba ya watoto waliozaliwa hai kwa mwaka 2008 (MTUHA 2 jedwali 41 C&D)	
R7	Number of maternal deaths in 2008(MTUHA 2 table 41B)? Jumla ya akina mama wangapi walikufa kwa sababu za uzazi (maternal death) katika mwaka 2008? (MTUHA 2 jedwali 41B)	

For R5-R12, answers should be those given by the staff/Kwa maswali R5-R12, majibu yaliyotolewa na wahudumu wa afya

R8. What is the total number of delivery beds for maternal and newborns in this facility (Beds used before, during and after delivery? [MTUHA 10 F002]) Je, kuna vitanda vingapi kwa ajili ya huduma za uzazi katika jituo hiki cha huduma ya afya (vitanda vinavyotumika kabla ya kujifungua, wakati wa kujifungua na baada ya kujifungua?[MTUHA 10 F002]) *(Number)*

R9. What was the number of perinatal deaths in 2008(MTUHA 2 table 41C)? / Jumla ya mimba ngapi ziliharibika baada ya miezi Saba na kupelekea kifo cha mtoto mchanga (MTUHA 2 jedwali 41C)? *(Namba)…………………………………………*

R10. What is the average number of inpatient hours for women who have a vaginal delivery? / Wakina mama wanaojifungua kwa njia ya kawaida hupumzishwa kwa wastani wa masaa managapi kabla ya kuruhusiwa? *(Namba)……………………………… hours*

R11. What is average number of inpatient days for women who deliver by cesarean section? / Nini wastani wa siku ambazo akina mama wanaojifungua kwa njia ya operesheni (caesarean section) hulazwa wodini? *(Namba)………………………………………*

R12. What is the average number of inpatient days for women who have an assisted delivery? / Nini wastani wa siku ambazo akina mama wanaojifungua kwa njia ya kusaidiwa kwa mfano kuvutwa na mashine hulazwa wodini? *(Namba……………………………………)*

Maternal and newborn service guidelines / Miongozo {Guidelines} na Takwimu za mama wajawazito na Watoto wachanga:

R13. Did the facility say they have a copy of MOH guidelines for antenatal care (FANC) available? / Je, kituo kina nakala ya mwongozo wa wizara ya afya kuhusu huduma za mama wajawazito siku ya usaili?
(1)Yes, Ndiyo (2) N0 Hapana
SKIP IF R13=NO
R14. Ask for the copy / mwongozo ulionekana
Seen / Umeonekana =0, Not seen / Haujaonekana =1

R15. Did the facility say that have a copy of MOH guidelines for postnatal care of mothers and newborns? / Je, kituo kina mwongozo wa wizara ya afya kwa ajili ya huduma za watoto wacahnga na akina mama wajawazito baada ya kujifungua?
(1)Yes, Ndiyo (2) N0 Hapana
SKIP IF R15=NO
R16. Ask for the copy / mwongozo ulionekana
Seen / Umeonekana =0, Not seen / Haujaonekana =1

Supplies for maternal and newborn section:

Probe for the presence and ask to see each of the following (Absent if not seen): Ask for MTUHA number 4(Leja) to find out stock out

Uliza moja moja kwa kutaja ukiulizia uwepo na kuomba kuona kila moja ya vifaa vifuatavyo (Vifaa ambavyo hutaviona, vihesabiwe kama havipo. Omba kuangalia leja ya madawa MTUHA namba 4 ili kuangalia habari kuhusu ukosekanaji wa baadhi ya vifaa:

		#	a
	Basic supplies/Vifaa muhimu	Present (seen by interviewer) on day of the survey (1)Yes, (2) N0/ Kifaa kilikuwepo siku ya usaili (kadri ya mhojaji) (1) ndiyo (2) hapana	Stock out between July 1st and December 31st 2008. Check in MTUHA 4 (1)Yes, (2) N0, (3) NA/Ukosekanaji wa dawa katika miezi 6 iliyopita.Tazama katika MTUHA 4 (1) ndiyo (2) hapana (3) haihusiki
R17	Examination Gloves		
R18	Disposable syringes and needles - adult		
R19	Disposable syringes and needles - neonate		
R20	giving set (blood)		
R21	Giving set (other fluids)		
R22	Intravenous canula sizes 16(kijivu), 18 (kijani)or 20(njano)		
R23	Intravenous caunla size 24(bluu)		
R24	Blank partographs/ partograph zisiyojazwa		
R25	Blank antenatal client cards/kadi za klinik zisizojazwa		
R26	Cord ligatures		
R27	Suture needles		
R28	Protective clothing for staff(aprons)		
R29	Complete Suture kits		
R30	Syphilis tests kits		
R31	HIV tests kits		
R32	Urine dipsticks		
R33	Male Condoms/ kondomu za kiume		
R34	Female condoms/ kondomu za kike		
R35	Intrauterine contraceptive devices(IUCD)/kitanzi		

Essential drugs for maternal and newborn section:
Probe for the presence and ask to see each of the following (Absent if not seen): Ask for MTUHA number 4(Ledger) to find out stock outs for highlighted drugs.
Dawa za muhimu kwa mama na mtoto mchanga.*Uliza moja moja kwa kutaja ukiulizia uwepo na kuomba kuona kila moja ya vifaa vifuatavyo (Vifaa ambavyo hutaviona, vihesabiwe kama havipo. Omba kuangalia leja ya madawa MTUHA namba 4 ili kuangalia habari kuhusu ukosekanaji wa dawa*

	Essential drugs/Dawa muhimu	Present (seen by interviewer) on day of the survey (1)Yes, (2) N0/ Dawa ilikuwepo siku ya usaili (kadri ya mhojaji) (1) ndiyo (2) hapana	Stock out between July 1st and December 31st 2008 as shown in MTUHA 4 (1)Yes, (2) N0/Ukosekanaji wa dawa katika miezi 6 iliyopita.Tazama katika MTUHA 4 (1) ndiyo (2) hapana (3) haihusiki
R36	General anaesthetic agent (e.g. Ketamine, Nitrous Oxide)		
R37	Diazepam (injections)		
R38	Diazepam (Oral)		
R39	Local anaesthetic agent (e.g. Lodocaine)		
R40	Pethidine		
R41	Penicillin (injections)		
R42	Penicillin (oral)		
R43	Ampicillin (injection)		
R44	Ampicillin (oral)		
R45	Ciprofloxacin (injection)		
R46	Ciprofloxacin (oral)		
R47	Ceftriaxone		
R48	Gentamycin		
R49	Chloramphenical (injection)		
R50	Chloramphenical (oral)		
R51	Cotrimoxazole		
R52	Quinine (injection)		
R53	Quinine (oral)		
R54	Coartem (injection)		
R55	Coartem (oral)		
R56	Ferrous Sulphate		
R57	Folic acid		
R58	Hydralazine (injection)		
R59	Methyldopa		
R60	Magnesium Sulfate		
R61	Contraceptives (injection)		
R62	Contraceptives (oral)		
R63	Tetanus Toxoid injection		
R64	BCG vaccine		
R65	OPV vaccine		
R66	Ergometrine		
R67	Oxytocin		
R68	Antiseptic (e.g. spirit, Savlon, etc)		
R69	Normal saline		
R70	Ringer's lactate		
R71	Sp for IPTp		
R72	10% Dextrose		
R73	5% Dextrose		
R74	Metronidazole (injection)		
R75	Metronidazole (oral)		
R76	Naso-gstric tube size 6 to 8 (NGT)		
R77	Misoprostol		
R78	Phenobarbitone injection		

5. Services supervision module
Kipengele cha usimamizi wa huduma

To be administered to the Health facility in-charge
Uhojaji ufanyike kwa Mkuu wa kituo.
M1. How many times has the CHMT come for general supervision in the facility in the past 6 months? *Number of times /* Ni mara ngapi katika miezi 6 iliyopita kituo chenu kimepata ukaguzi wa jumla kutoka wilayani? Andika namba
…………………………………………………………

M2. Write how many times have been documented in the MTUHA Book 2, Table 6? Number of times if missing write 999 / Andika mara ngapi imeandikwa kwenye waraka wa MTUHA kitabu 2, jedwali la 6. Andika Namba kama haijaandikwa andika 999………………………………………………
M3. When was the last maternal and newborn services supervision done? (Date) DD/MM/YYYY (Check MTUHA Book 2, Table 6) / Je, ni lini ilikuwa mara ya mwisho ya ukaguzi wa huduma ya mama na watoto wachanga kufanyika? Tarehe angalia MTUHA kitabu 2 jedwali la 6
……………………………………………
SKIPM4-M6 IF M3 = never (01/01/01)
M4. During the last maternal and newborn services who came for maternal and newborn services to this facility? / Wakati wa ukaguzi wa huduma ya mama na watoto wachanga kwa mara ya mwisho, nani alifika kwa ukaguzi? (jibu zaidi ya moja linaruhusiwa)
District Medical Officer/ Mganga mkuu wa wilaya
District Health Officer / Afisa afya wa wilaya
District Maternal and Child Health Coordinator/ Msimamizi wa wilaya wa huduma za mama na watoto
Others (specify) Wengine (taja)   Specify = M4a
M5. During the last supervision did the Supervisor(s) use a checklist for assessing staff performance on maternal and newborn services provision during his/her visit? / Wakati wa ukaguzi wa mwisho mkaguzi alitumia checklist kuangalia uwezo wa ufanyaji kazi wa wafanyakazi wa kitengo cha mama na watoto wachanga?
(1)Yes, Ndiyo (2) N0, Hapana (3) don't know, Sijui

SKIP IF M5=no, hapana or don't know, sijui
M6. Was copy of the checklist left in the facility? / Kama M5 ni ndiyo, kopi ya checklist imeachwa kituoni? (1)Yes, Ndiyo (2) N0, Hapana (3) sijui

M7. Which of the following was/were done by supervisor (s) when he/she/they came for supervision last time?/ Kipi kati ya vifuatavyo kilifanywa na mkaguzi mara ya mwisho alipokuja kukagua? (1)Yes, ndio (2) N0 Hapana
Checked records or reports / kukagua ripoti na rekodi
Observed work / kuangalia kazi
Provided feedback / kutoa mrejesho
Gave praise / kutoa sifa
Provided updates / kutoa taarifa mpya
Discussed problems / kuzungumzia matatizo
Others (specify) / mengineyo (Fafanua)

6. Usual MCH procedures module
Kipengele cha Huduma za mama na mtoto

To be administered to a group of maternal and newborn services staff (These include all staff working in the RCH clinic: Clinicians, Nurse Midwives, Public Health Nurses MCHAs, health Officers)
Iulizwe kwa wafanyakazi wa idara ya huduma za mama na watoto wachanga kwa pamoja kama mahojiano ya kikundi (Hii inajumuisha wafanyakazi wote wanaofanya kazi katika idara hii: waganga, manesi, maafisa afya, nk)
Katika jedwali hapa chini, oredhesha vifupisho vya majina ya wote watakaoshiriki katika mahojiano

P0 = # participants
P0a = initials
P0b=qualifications

Table of participants for group interview / Orodha ya washiriki	
Participant's initials / Vifupisho vya majina	Qualification Sifa/Taaluma

We would like to know about the usual obstetic care available in this facility/tungependa kujua kuhusu huduma ya uzazi katika kituo hiki cha huduma ya afya
SKIP P1-P15 if S1B=No
Huduma za Mama wajawazito na Watoto wachanga.:
P1. When was the last time that any of you attended a delivery in this facility? (Give date) DD/MM/YY
P1. Ni lini mara ya mwisho mmoja wenu alimuhudumia mama aliyekuwa anajifungua hapa kituoni? Toa tarehe
P2. When was the most recent delivery in the community attended by a member of staff from this facility? (Give date) DD/MM/YY
P2. Ni, lini kwa mara ya mwisho mmoja wenu kutoka kituo hiki alimuhudumia mama aliyekuwa anajifungua nyumbani/nje ya kituo cha huduma ya afya? *Andika tarehe.kama haijawahi kufanyika andika 01.01.2001*
P3. After normal delivery, do you usually ask a client to return to the health facility? (1)Yes, (2) N0 P3. Baada ya kujifungua kwa kawaida, huwa mnamshauri mama kurudi kituoni? (1)Ndiyo (2) Hapana
KIP IF P3=NO
P4. When should she return? / Kama S31 ni ndiyo, lini anatakiwa kurudi?

Specify ___________days or _________weeks — P4 = #
777=only if she is ill / in case of problem — P4a= days/weeks
888=other - specify: — P4b= don't know-specify
999= don't know

Taja siku___________ ama wiki___________
777=Kama tu ni mgonjwa/au kama kuna tatizo
888=Nyingine taja.
999 = sijui

P5. When was the last time you used the partograph during the delivery? (Give date) DD/MM/YY
P5.Lini ilikuwa mara yako ya mwisho kutumia Partograph wakati wa kuzalisha? { taja tarehe}

P6. Is a partograph used during labour /Je, Partograph hutumika wakati wa uchungu?
always / Hutumika mara zote
during most normal deliveries / Mara nyingi
during some deliveries/wakati wa baadhi ya deliveries
only if needed / Pale tu inapohitajika
don't use? /Haitumiki

P7. Do you measure blood pressure during labour / Mnapima msukumo wa damu wakati wa uchungu?
always / Hutumika mara zote
during most normal deliveries / Mara nyingi
during some deliveries
only if needed / Pale tu inapohitajika
don't use? /Haitumiki

P8. Do you record the fetal heart beat during labour / Mnapima mapigo ya moyo ya mtoto wakati wa uchungu?
always / Hutumika mara zote
during most normal deliveries / Mara nyingi
during some deliveries/wakati wa baadhi ya deliveries
only if needed / Pale tu inapohitajika
don't use? /Haitupimi

P9. Do you use measures of infection prevention during deliveries (e.g. sterile instruments, gloves) / Huwa mnachukua hatua kuzuia maambukizi wakati wa kujifungua? {Mfano, vifaa visafi, gloves}?
always / Hutumika mara zote
during most normal deliveries / Mara nyingi
during some deliveries/ wakati wa baadhi ya deliveries

only if needed / Pale tu inapohitajika
Don't use? /Haituchukui
SKIP 9a-c IF P9=e

P9a which of the following personal protective equipment do you have available to use (multiple answers allowed):
Surgical gloves/ gloves fupi
Gauntlet gloves/ gloves ndefu
Goggles/ Safety glasses/ mawani
Face shield

P9b which of the following sterilization techniques do you have available in this facility (multiple answers allowed)?
Chlorine solution (JIK)
Other chemical sterilization (e.g. formaldehyde, glutaraldehyde)
Autoclave(Sterilizer)
Dry heat oven
Boiling
P10. Do you do active management of the third stage of labour e.g. injecting oxytocin or ergometrin / Je Mnafanya hatua ya tatu ya kujifungua (third stage of labour) kwa mfano kuchoma Oxytocin au Ergometrine?
always / Hutumika mara zote
during most normal deliveries / Mara nyingi
during some deliveries/wakati ya baadhi ya deliveries
only if needed / Pale tu inapohitajika
don't use? /Haitumiki

P11. Do you do cord traction in the active management of the third stage of labour / Mnafanya cord traction wakati wa hatua ya tatu ya kujifungua (third stage of labour)?
always / Hutumika mara zote
during most normal deliveries / Mara nyingi
during some deliveries/wakati wa baadi ya deliveries
only if needed / Pale tu inapohitajika
don't use? /Haitufanyi

P12. Do you give the baby to the mother and encourage her to breastfeed immediately after delivery / Mnampa mama mtoto na kumhimiza amnyonyeshe baada ya kujifungua?
always / Hutumika mara zote
after most normal deliveries / Mara nyingi
after some deliveries/wakati wa baadhi ya deliveries
Do not encourage mother to breastfeed immediately

P13. Do you weigh the baby after delivery / Mnampima mtoto uzito baada ya kuzaliwa?
always / tunapima mara zote
during most normal deliveries / Mara nyingi
during some deliveries/wakati wa baadhi ya deliveries
don't do/hatufanyi

P14. Do you apply eye ointment to the baby to prevent ophtalmia neonatorum / Huwa mnamuwekea mtoto dawa ya macho baada ya kuzaliwa kuzuia ophtalmia neonatorum{ugonjwa wa macho}?
always / Hufanyika mara zote
during most normal deliveries / Mara nyingi
during some deliveries/wakati wa baadhi ya deliveries
only if needed / Pale tu inapohitajika
don't do/hatufanyi

P15. Do you dry and wrap the baby after delivery / Huwa mna mkausha na Kumfunika mtoto baada ya kuzaliwa?
always / tunafanya mara zote
during most normal deliveries / Mara nyingi
during some deliveries/wakati wa baadhi ya deliveries
only if needed / Pale tu inapohitajika
don't do/hatufanyi

We also would like to ask about any emergency obstetric patients you have encountered and care you have performed in this health facility.
Tungependa kuuliza kuhusu Huduma za dharura wakati wa kujifungua ambazo mmezitoa katika kituo hiki.
P16. When was the last time that you encountered a woman with postpartum haemorrhage? (Give date) DD/MM/YY or don't know or never ………………………
P16.Ni, lini mara ya mwisho kwa mmoja wenu katika kituo hiki kumwona mama aliyetoka damu nyingi baada ya kujifungua (PPH)? Andika tarehe. *kama haijawahi kutokea andika 01.01.200*
…………………………………………………1

P17. When was the last time that you encountered a woman with obstructed labour? (Give date) DD/MM/YY or don't know or never ....

P17.Ni, lini mara ya mwisho kwa mmoja wenu katika kituo hiki kumwona mama aliyepata uchungu kwa muda mrefu? Andika tarehe. *kama haijawahi kutokea andika 01.01.2001*

...

P18. When was the last time that you encountered a woman with puerperal sepsis? (Give date) DD/MM/YY or don' t know or never ....

P18. Ni, lini mara ya mwisho kwa mmoja wenu katika kituo hiki kumwona mama mwenye uambukizo baada ya kujifungua (puerperal sepsis)? Andika tarehe. *kama haijawahi kutokea andika 01.01.2001*

P19. When was the last time that you encountered a woman with eclampsia? (Give date) DD/MM/YY or don't know or never ....

P19. Ni, lini mara ya mwisho kwa mmoja wenu katika kituo hiki kumwona mama aliyepata kifafa cha mimba? Andika tarehe. *kama haijawahi kutokea andika 01.01.2001*

...

P20. When was the last time that you encountered a woman with complications resulting from incomplete or unsafe abortions? (Give date) DD/MM/YY or don't know or never ....

P20. Ni, lini mara ya mwisho kwa mmoja wenu katika kituo hiki kumwona mama amepata matatizo baada ya kuharibu mimba kwa njia isiyo salama au mimba isiyomalizika kutoka? Andika tarehe. *kama haijawahi kutokea andika 01.01.2001*

..

P21. When was the last time you did a manual removal of the placenta?
(Give date) DD/MM/YY or don't know or never ....

P21.Lini ilikuwa mara ya mwisho kutoa kondo la nyuma kwa mikono{bila kutumia machine}
Taja tarehe] DD/MM/YY au sijui au haijawahifanyika..

P22. When was the last time you performed an assisted vaginal delivery / vacuum extraction? (Give date) DD/MM/YY or don't know or never ....

P22.Lini ilikuwa mara ya mwisho kusaidia kuzaa kwa njia ya kawaida au vacuum extraction?
Taja tarehe] DD/MM/YY au sijui au haijawahifanyika..

P23. When was the last time you gave a women parental sedatives (magnesium sulfate or diazepam) because of hypertensive disorders?
(Give date) DD/MM/YY or don't know or never ....

P23.Lini ilikuwa mara ya mwisho kumpatia mama dawa za usingizi {kama magnesium sulphate,diazepam} kwa sababu ya matatizo ya shinikizo la damu?
Taja tarehe] DD/MM/YY au sijui au haijawahifanyika..

P24. When was the last time you treated a women with sepsis with iv antibiotics? (Give date) DD/MM/YY or don't know or never ....

P24.Lini ilikuwa mara ya mwisho kumtibu mama mwenye uambukizo kwenye damu kwa kumchoma sindano ya antibiotic kwenye mshipa? Taja tarehe] DD/MM/YY au sijui au haijawahifanyika..

P25. When was the last time you did a removal of retained products of abortion (Manual Vacuum Aspiration (MVA) or dilatation and curettage [D&C])?
(Give date) DD/MM/YY or don't know or never ....

P25.Lini ilikuwa mara ya mwisho ulitoa mabaki tumboni (retained products) baada ya utoaji mimba kufanyika {Manual Vacuum Aspiration {MVA} au Dilatation na curettage}?
Taja tarehe] DD/MM/YY au sijui au haijawahifanyika..

P26. When was the last time you did a newborns resuscitation?
(Give date) DD/MM/YY or don't know or never ....

P26.Lini ilikuwa mara ya mwisho kufanya resuscitation kwa mtoto mchanga?
Taja tarehe] DD/MM/YY au sijui au haijawahifanyika..

Referral of obstetric emergencies/ Rufaa kwa huduma za dharura wakati wa kujifungua.

P27. Which of the following conditions are usually referred from your health facility: *Probe one by one for each of the options:* Ni hali zipi kati ya zifuatavyo zanapatiwa rufaa kutoka katika kituo hiki cha huduma ya afya? *Uliza kwa kuzitaja moja moja kwa kila hal*

Previous bad obstetric history e.g. abdominal scars, stillbirth/Historia mbaya ya uzazi au makovu tumboni au historia ya mtoto kufa kabla ya kuzaliwa
(1) Yes/ndiyo, (2) No/hapana

Hypertension or headache or swelling or fits / Shinikizo la damu au kichwa kuuma au degedege au kuvimba

(1) Yes/ndiyo, (2) No/hapana

Anemia or pallor or fatigue or breathlessness / Upungufu wa damu au kuchoka au kuishiwa pumzi
(1) Yes/ndiyo, (2) No/hapana

Cessation of fetal movement / Mtoto kuacha kucheza
(1) Yes/ndiyo, (2) *No/hapana*

Abnormal position of fetus / Mtoto kulala vibaya
(1) Yes/ndiyo, (2) *No/hapana*

Sepsis or foul smelling discharge or postpartum abdominal pain / Tumbo kuuma baada ya uzazi au kutoka maji yenye harufu mbaya
(1) Yes/ndiyo, (2) *No/hapa*

Light bleeding / Kutoka matone ya damu
(1) Yes/ndiyo, (2) *No/hapana*
Heavy bleeding / Kutoka damu nyingi njia ya uzazi (APH)
(1) Yes/ndiyo, (2) *No/hapana*
Multiple pregnancy or large abdomen or 5th pregnancy or more Mapacha au tumbo kubwa au mimba zaidi ya ya tano
1) Yes/ndiyo, (2) *No/hapana*
Obstructed or prolonged labor ("sun set two times") / uchungu wa muda mrefu
(1) Yes/ndiyo, (2) *No/hapana*
Older woman having first pregnancy or very young mother or very short mother/akina mama wenye umri mkubwa ambao wana uja uzito wa kwanza au akina mama wenye umri mdogo au akina mama wafupi wa kimo (1) Yes/ndiyo (2) No/Hapana
Other - specify: / Mengineyo (taja)
(1) Yes (ndiyo), (2) *No (Hapa)*

P28. Which is the nearest referral facility for an obstetric emergency case / Ni kituo gani cha karibu cha rufaa kwa dharura ya uzazi? (give facility name)………
P29. When was the last time an obstetric emergency patient was referred from this facility? / Ni, lini ilikua mara ya mwisho kwa mgonjwa wa dharula ya uzazi kupewa rufaa kutoka kwenye kituo hiki? (Give date Andika tarehe) DD/MM/YY or don't know or never ………………………
SKIP P30 and P31 if P29=never
P30. Which means of transport was used to go to the referral facility for the last obstetric emergency patient / Njia gani ya usafiri ilitumika mara ya mwisho kumpeleka mgonjwa wa dharura ya uzazi kwenye kituo cha rufaa? (allow multiple answers)(majibu zaidi ya moja yanaruhusiwa)
Walking / kutembea
Bicycle / baiskeli
Motorcycle / pikipiki
Facility vehicle / gari la kituo
Hired vehicle / gari la kukodi
Government ambulance/gari ya wagonjwa la serikali
Public transport (bus, dalladlla)/usafiri wa public
Plane / ndege

P31. Who accompanied an emergency referral patient to the referral facility during the last obstetric emergency / Nani alimsindikiza mgonjwa wa mwisho mwenye dharura ya uzazi kwenye kituo cha rufaa? (Multiple answers allowed)
Nurse or Midwife / nesi or mkunga
other health personnel in the health facility / mfanyakazi wa afya kutoka kituo hiki
Family member / mwana familia
None / hakuna
others (Specify)/mengineyo (taja)