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# Evaluating medical and systemic factors related to maternal and neonatal mortality at Nyakahanga Hospital in north-western Tanzania

LINDA A. WINKLER
*Department of Anthropology, Wilkes University, 84 West South St, Wilkes Barre PA 18766, USA*
E-mail: linda.winkler@wilkes.edu

**Abstract**
**Background:** This study examined maternal morbidity and mortality and neonatal mortality over a multi-year period from de-identified retrospective medical records at Nyakahanga Designated District Hospital in north-western Tanzania. The study aimed to examine factors related to maternal mortality (MMR) and morbidity in women who deliver their babies at the hospital, assess neonatal mortality of full-term infants, and analyse health care response to mother and neonate after admission.
**Methods:** Information from hospital obstetric logs was analysed and relationships explored for obstetric outcomes including maternal deaths and complications, neonatal status, and types of delivery for 55.5 months during 2009-2014.
**Results:** Results indicate that this rural hospital has achieved noteworthy improvement in their maternal mortality with MMR approximating the national average despite ongoing gaps in staffing needs. The majority of deliveries are under the age of 25 and a first or second pregnancy. Reported maternal complications are equivalent to global averages although some, i.e. uterine rupture, may be related to delays in obstetric delivery. Despite improvements in maternal mortality, neonatal mortality is elevated relative to Tanzania averages, particularly in caesarean sections. Neonatal deaths are positively related to maternal age.
**Conclusion:** Since this hospital is an emergency obstetric referral centre, obstetric clients frequently arrive after prolonged labour and foetal distress is common, partially explaining the elevated caesarean section rate and perinatal death rate. Hospital initiatives are underway to provide more rapid response in these scenarios. In addition, it is recommended that since antenatal attendance is high, initiatives be expanded to educate multiparous and older women on seeking skilled care upon onset of labour or at the sign of any complications.
**Keywords:** neonatal mortality, maternal mortality, caesarean section, uterine rupture, Tanzania

## Introduction

The last 15 years have seen impressive improvement in maternal and neonatal health outcomes across the globe through the effort of countless individuals and organizations. However, maternal mortality continues to be a problem with nearly all maternal deaths in less developed countries and 62% of the deaths of women during pregnancy occurring in Sub-Saharan Africa (UN, 2015; TMM, 2014). Neonatal mortality is also higher in Sub-Saharan Africa than in all other areas of the world (CCS-UNCF, 2014). Many of the neonatal deaths are associated with birth complications therefore intricately linked to the birth outcomes of the mother (Edmond *et al*., 2008; Bryce *et al*., 2013; Mpembeni *et al*., 2014).

There is disparity in birth outcomes in Sub-Saharan Africa between rural and urban areas with mothers from rural areas and lower socioeconomic groups more likely to have a child die. However, the underlying issues responsible for this disparity are complex. Much of Africa remains rural with less developed infrastructure, i.e. lack of paved roads, electrification, and readily available transportation (World Bank, 2015). For example, 69% of the population of Tanzania is estimated to be rural compared to 25% for Germany, 26% for Russia, and 46% for China (World Bank, 2015). In addition, women in much of Sub-Saharan Africa have lower education achievement levels (World Bank, 2015), particularly in rural areas, than their counterparts in more developed countries. Educational level is linked to greater risk of maternal and neonatal mortality (Setel *et al*., 2000; Mswia *et al*., 2003; CCS-UNCF, 2014). Poverty complicates the situation in Tanzania as the poorest pregnant women are half as likely as the wealthiest to get skilled care at birth (TDH-MIS, 2016; Shoo *et al*., 2017). As a result of these factors,

access to and use of health care resources for obstetric care remains challenging in many rural areas.

There also remain substantial differences in availability and quality of care between rural and urban environments (Mbaruku *et al*., 2003; Olsen *et al*., 2004; Dogba & Fournier, 2009; Fofie & Baffoe, 2010; Mezie-Okoye *et al*., 2012). This places constraints on women being able to access maternal care easily or quickly during delivery or in emergency obstetric situations. Since most maternal and neonatal deaths occur during the birth process (Sarker *et al*., 2010; Pembe *et al*., 2010), skilled delivery is a crucial component of reducing mortality. Late or non-compliance with referral due to pre-term complications is common among rural African communities with detrimental effects to the mother and new-born (Nyirenda, 2005; Rockers *et al*., 2009; Kilonzo *et al*., 2009; Pembe *et al*., 2010). In addition, few countries in Sub-Saharan Africa have adequate staff and Emergency Obstetric Centres (EOC) to meet the need (Dogba & Fournier, 2009). This is particularly true in rural areas where maternal deaths are greater than urban areas (Kilonzo *et al*., 2009; Mezie-Okoye *et al*., 2012). The percent of skilled professional staff in rural areas compared to urban areas of Tanzania is substantially less for delivery services (42% vs. 69%), obstructed labour (30% vs. 67%), and postpartum haemorrhage treatment (32% vs. 66%) (Olsen *et al*., 2004; Dogba & Fournier, 2009; MNPI, 2016).

Like many other Sub-Saharan African countries, Tanzania has made substantial progress combating maternal and neonatal mortality in response to high death rates and United Nations and World Health Organization initiatives (TMM, 2014). The Maternal Mortality Ratio (MMR) in Tanzania has dropped by over 50% since 2000 when it was 1100 (CCS-UNCF, 2014). Neonatal deaths as measured by neonatal mortality rate (NMR) have also dropped. In fact, Tanzania is counted as one of the top ten countries with the largest absolute declines in neonatal mortality from 1990-2013 (CCS-UNCF, 2014). Nevertheless, there have been recent concerns over indications that these downward trends have shifted back upward (TDH-MIS, 2016; Shoo *et al*., 2017).

This current paper discusses an ongoing project in Tanzania at a rural health facility, Nyakahanga Designated District Hospital (NDDH) examining maternal mortality, associated neonatal mortality, and parameters related to neonatal and maternal mortality and morbidity as part of an ongoing collaboration. This project seeks to illuminate factors which can be addressed by health care response to lower maternal and neonatal mortality. Similar to many rural hospitals in Sub-Saharan Africa, NDDH is seriously understaffed with a 60% staff gap between need and actual available staff (MNPI, 2016). Despite the staffing deficit, Nyakahanga Hospital has had ongoing initiatives in the last ten years to try to reduce maternal mortality, mirroring what is happening in Tanzania as a whole. The birth rate is 4.6% with the majority of women delivering at home as is common in rural Africa (Nyirenda, 2005; Nyakahanga Hospital, 2017). The objectives of this study were to: i) examine maternal mortality in women who deliver their babies at the hospital; ii) assess maternal complications; and (iii) analyse perinatal deaths in full-term single birth infants.

## Material and Methods

### *Study area*

Nyakahanga Designated District Hospital (NDDH) is the government district hospital located in Karagwe District of north-western Tanzania. The area is dependent on subsistence agriculture and intersected by unpaved roads. The hospital receives clients from both Karagwe and Kyerwa districts as direct admissions or referrals from other clinics, dispensaries, or hospitals, serving over 55,000 patients in 2014 (MNPI Index, 2016). The hospital is chronically understaffed. Staff numbers as of 2016 include ten medical and assistant medical officers (deficit of 55%), eight Assistant Medical Officers (deficit of 47%), seven Clinical Officers (deficit of 54%) and 102 nursing staff (deficit of 37%) (MNPI, 2016).

***Population and study design***

This study utilized a retrospective medical records research design involving obstetric labour logs of women who delivered babies at NDDH during 55.5 months from January 2009-July 2013 and January through March 2014. All deliveries were entered into the data set. Obstetric logs were unavailable for part of October through December 2009. All records were examined after client identifiers had been removed and there was no attempt to link the file entries to identifiable patients or medical charts.

***Data collection***

Data was collected over four weeks in June of 2014 and two weeks May-June of 2015. All available data were transcribed into Excel files prior to analysis. Research assistants helped in transcribing the data to the excel files. Data collected and analysed included date of admission, delivery date, age of mother, gravida, type of delivery, health status of mother after delivery, complications associated with the delivery, health status of neonate, and post-delivery status. Time of admission and time of delivery was compiled in the medical records beginning with the 2014 log entries. This additional information facilitated an analysis of the timing of hospital response and time of delivery relative to intake in the 2014 subset (N=889). The entire data set was modified to remove multiple births (twins, etc.), premature births (as identified in record), or birth defects which resulted in still-birth before analysis of perinatal death rate. In addition to the medical records, the hospital annual reports and hospital sources were consulted for summary data (MNPI, 2016).

***Data analysis***

Analysis included frequency of maternal and perinatal deaths, types of deliveries and associated perinatal death rates, and maternal complications associated with deliveries. In some cases, data entry in the labour log was incomplete or information missing. These cases were removed from analysis. Descriptive statistics were computed along with cross-tabulations using excel data statistical functions, Minitab statistical function, and SPSS statistical software. Chi-squared measure of fit was calculated to examine the relationship between type of delivery and perinatal death. When p-values were calculated, they were done to the p=.01 confidence interval. An additional subset of the obstetric records from a thirty-one month period, 2010-2013 (31 months of data, n=8391) was further analysed in reference to maternal age and in regard to neonatal mortality. The distribution of maternal age was tested with the Anderson-Darling test for normality.

The distribution of age and possible correlations between age and death of neonate were also examined by calculating the Pearson product-moment correlation coefficient. The sample is large but was not normally distributed with younger women (under age 25, see Table 1 and Figure 1 below) representing 60% of the cases. Therefore, a Spearman's rank correlation coefficient was calculated as an additional statistical measure.

***Ethical considerations***

This study was reviewed for ethical use of human subjects and approved by Nyakahanga Designated District Hospital Medical Officer in Charge and Hospital Management, Karagwe District Medical Officer, the National Institute for Medical Research of Tanzania, and Tanzania Commission for Science and Technology.

**Results**

The majority of the women who chose to deliver at the hospital (rather than at home or at a clinic) were relatively young and over 40% were primigravida. The statistical analysis of the distribution of ages confirms that the data set is not a normal distribution with 60% of population under the age of 25

and 90% under the age of 34 (Table 1).

**Table 1: Age and gravida status of women delivering at Nyakahanga Hospital**

| Gravida status | Age | | | | | |
|---|---|---|---|---|---|---|
| | <20 | 20-29 | 30-39 | 40 + | Unknown | Total/ $\bar{X}$ |
| N | 3361 | 8539 | 3063 | 260 | 157 | 15,380 |
| Deliveries | 1.2 ± | 2.34 ± | 4.75 ± | 6.55 ± | - | 2.60 |
| $\bar{x}$ ± SD | .7745 | 1.38 | 2.05 | 2.79 | | 2.31 |
| (Range) | (1-7) | (1-10) | (1-12) | (1-15) | | (1-15) |
| Primigravida | 2,934 | 3,006 | 185 | 11 | 60 | 6,196 |
| Gravida 2 | 309 | 2,442 | 231 | 11 | 31 | 3,024 |
| Gravida 3+ | 118 | 3,091 | 2,647 | 238 | 66 | 6,160 |

The distribution of age and possible correlations between age and death of neonate were also examined by calculating the Pearson product-moment correlation coefficient. The sample was not normally distributed with younger women (under age 25) representing 60% of the cases (Figure 1).

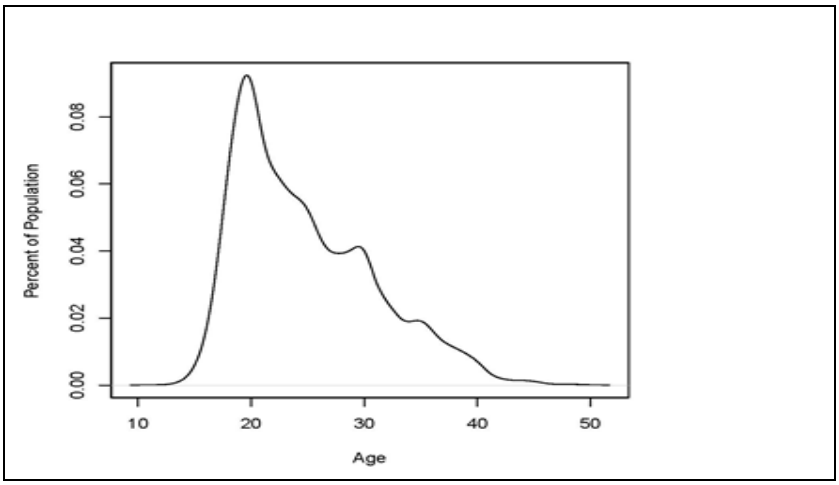


**Figure 1: Distribution of maternal age**

***Maternal mortality and maternal complications***

The analysis of maternal mortality for 2002-2014, indicates noteworthy improvement (64% drop in maternal mortality ratio (MMR) despite a 66% increase in deliveries at the hospital during this time period.

The birth register comments were analysed in order to derive a record of complications. In most cases, comments were only entered if there was a maternal or neonatal death or a caesarean section (C-section) was done (rather than a vaginal delivery). The average C-section rate is 20.6 % for 2003-2014. On a yearly basis, it has risen since 2003 (see Table 2).

**Table 2: Number of deliveries, maternal deaths and maternal mortality ratio (MMR)**

| Year | No. deliveries | Spontaneous vaginal delivery | Caesarian section | Maternal deaths | Maternal mortality ratio |
|---|---|---|---|---|---|
| 2001 | 1174 | - | - | 14 | 1192 |
| 2002 | 2037 | - | - | 24 | 1178 |
| 2003 | 2265 | 1823 | 442 | 22 | 971 |
| 2004 | 3019 | 2605 | 414 | 15 | 497 |
| 2005 | 3266 | 2736 | 530 | 21 | 643 |
| 2006 | 3060 | 2466 | 594 | 18 | 588 |
| 2007 | 3108 | 2499 | 609 | 21 | 676 |
| 2008 | 3791 | 3036 | 755 | 14 | 369 |
| 2009 | 3054 | 2403 | 651 | 15 | 491 |
| 2010 | 3484 | 2724 | 760 | 17 | 488 |
| 2011 | 3625 | 2750 | 875 | 17 | 469 |
| 2012 | 3507 | 2656 | 851 | 13 | 370 |
| 2013 | 3768 | 2983 | 786 | 15 | 398 |
| 2014 | 3544 | 2666 | 878 | 14 | 395 |

The most common complications were cephalopelvic disproportion (6.1%), obstructed labour (2.9%), foetal distress (4%), foetal malposition (1.8%), cord malposition (1.5%), ruptured uterus (0.53%), eclampsia or pre-eclampsia (0.3%) and pre or post-partum haemorrhage (0.7%). Three maternal deaths and 74 perinatal deaths at NDDH in 2009-2013 were attributed to ruptured uteri. In this sample, there were 82 reported ruptures (Table 3). Only 16% of the neonates survived. In addition, all ended in hysterectomies. This study sample also included 39 additional records marked as hysterectomies after C-sections with no additional information. Some of these may be uterine ruptures.

**Table 3: Frequencies of uterine rupture by year and gravida status**

| Variable | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 |
|---|---|---|---|---|---|---|
| Sample size | 2293 | 3317 | 3713 | 3319 | 1993 | 896 |
| Number (%) of uterine ruptures reported | 12 (0.52) | 19 (0.57) | 21 (0.56) | 14 (0.42) | 11 (0.55) | 5 (0.56) |
| Additional hysterectomies performed without explanation (potential ruptures) | 7 | 7 | 13 | 8 | 4 | 0 |
| Neonates surviving the ruptures | 3 | 0 | 4 | 1 | 5 | 0 |
| Ruptures in women with 5 or more pregnancies | 5 | 13 | 6 | 5 | 5 | 2 |
| Ruptures in women in first or second pregnancy | 3 | 3 | 9 | 2 | 2 | 1 |

In the 2014 sample, the recording of admission and delivery times in the log provided the means to assess treatment time and response. Although none were repaired within one hour, one of the uterine ruptures was repaired between 1-2 hours after arrival at the hospital and one at 4.5 hours. In two of the additional ruptures, the women laboured for 14 and 14.5 hours before surgical intervention. The prolonged labour may be a factor in their cases. Only one woman (4.5 hour delivery) appeared at risk for rupture due to three prior C-section deliveries. Only 44% of the ruptures occurred among women with five or more pregnancies in this sample. Many of the cases in this study had no previous scars with 24% in a first or second pregnancy.

***Neonatal deaths***

Although the maternal mortality ratio at Nyakahanga Hospital has substantially improved in the past 11 years, the perinatal death rate remained elevated relative to Tanzanian national indicators. Since most mothers leave the hospital within two days of delivery, the records only encompass a limited time period after birth. This measure of perinatal mortality includes all babies who died during the labour process plus babies born alive, but who died before release from the hospital. All neonates marked as premature or with life threatening birth defects (i.e. anencephaly) have been removed before determining perinatal death ratios. The perinatal mortality average for the years 2009-2014 (55.5 months) was 56 (Table 4).

**Table 4: Perinatal mortality ratio 2009-2014, 55.5 months**

| Year | No. of deliveries | No. of perinatal death | Perinatal mortality ratio |
|---|---|---|---|
| Summary | 15671 | 832 | 56 |
| 2009 (9.5 months) | 2321 | 137 | 59 |
| 2010 | 3373 | 171 | 51 |
| 2011 | 3771 | 189 | 50 |
| 2012 | 3378 | 167 | 49 |
| 2013 (7 months) | 1939 | 113 | 58 |
| 2014 (3 months) | 889 | 55 | 62 |

In this study, younger women were more likely to choose to come to the hospital to deliver. However, the risk of neonatal death increased with maternal age (Figure 2). The two were positively correlated (r = 0.2059550) in this data set. We further analysed the relationship between perinatal death and maternal age in this subset of data by removing births to women under age 15 or over age 40 due to the small sample sizes of these groups. For this adjusted data set (n=8,287), the Spearman rank correlation coefficient is 0.4824756 and it is significant at the 99% confidence level.

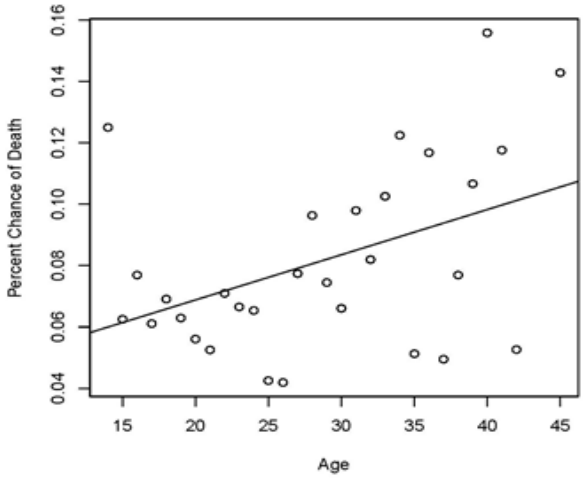


**Figure 2: Maternal age and correlation of age with neonatal death (2010-2013)**

***Caesarean sections and neonatal mortality***

Neonatal deaths were elevated in caesarean deliveries relative to vaginal deliveries: PMR = 76 or 37% of deaths even though C-sections during this time period constituted less than 24% of deliveries (Figure 5). The perinatal mortality rate (PMR) in vaginal deliveries was equal to 38. Further analysis via chi-squared analysis of fit found significant differences (0.99 CI) between deaths via vaginal delivery versus those via C-section.

**Table 5: Perinatal deaths during vaginal versus caesarian section deliveries, 2009-2014**

| Year | No. deliveries | Perinatal Deaths | Vaginal | C-Section | % of C-Sections Relative to Vaginal Deliveries |
|---|---|---|---|---|---|
| 2009 | 2,293 | 134 | 77 | 57 | 21.2% |
| 2010 | 3,317 | 181 | 92 | 89 | 21.8% |
| 2011 | 3,713 | 187 | 117 | 70 | 24.1% |
| 2012 | 3,319 | 165 | 115 | 50 | 24.3% |
| 2013 | 1,993 | 135 | 100 | 35 | 20.8% |
| 2014 | 896 | 44 | 27 | 17 | 27.2% |
| Total | 15,531 | 846 | 528 | 318 | |

## Discussion

Multiple international and national initiatives in Tanzania have targeted reduction in maternal mortality and neonatal mortality. Nyakahanga Hospital is to be commended for the substantial improvement in their maternal mortality rate in the last 13 years. It is particularly noteworthy given the ongoing deficit in health care staff, particularly doctors and nurses at the hospital. Nevertheless, this study suggests that delays in seeking skilled care by pregnant women continue to be responsible for both maternal mortality and significant numbers of neonatal deaths. This remains a primary obstacle to decreasing maternal mortality further and reducing perinatal mortality (Zeck *et al*., 2006).

Previous studies at the hospital and elsewhere in Tanzania indicate that although almost all women attend at least one antenatal clinic (Nyirenda, 2005; TDH-MIS, 2016; personal communication from hospital), a minority of women return to the hospital for delivery. Women report that they deliver at home due to social pressures and preferences, a decreasing concern with later pregnancies, privacy, higher social status because they do not require assistance for birth, and a fear of delivering surgically (Nyirenda, 2005; Ekman *et al*. 2008; Pembe *et al*., 2008). Community campaigns encourage pregnant women to return to the hospital for delivery, particularly if there are any complications or prior C-sections. Women who are younger, lower parity, or are less poor are more likely to deliver in a health facility (Nyirenda, 2005; Mrisho *et al*., 2007, TDH-MIS, 2016).

The vast majority of obstetric deliveries in this study were less than the age of 30 years and a first or second delivery. The use of skilled attendants are critical however in that hospital clinicians indicate that the majority of maternal deaths are related to late referral or arrival at the hospital after prolonged labour. The referral process takes time and prolongs emergency obstetric care even further. Many of the maternal deaths are preventable if skilled medical care is sought at the first sign of medical distress (Say *et al*., 2014). The presence of a local communication system for transport (including free ambulance) which can deliver women directly from their homes to emergency obstetric care has been shown to increase hospital deliveries and reduce stillbirths (Mucunguzi *et al*., 2014). Although some of the government health centres have ambulances, they are not available everywhere or consistently part of a referral system.

Studies elsewhere suggest that more than half of all neonatal deaths occur after home birth without a skilled attendant present and home births have higher perinatal mortality rates than those in a health facility in the presence of skilled attendants (Nyirenda, 2005; Mrisho *et al*., 2007; Rockers *et al*., 2009; Kilonzo *et al*., 2009). Hospital staff at Nyakahanga Hospital report that many women report to the facility only after attempting home birth and after experiencing distress or obstructed labour. The obstetric log does not always differentiate between an infant who died prior to arrival, died due to foetal distress, emergency referral and delayed arrival, or one who died during a planned hospital delivery. Once admitted, there may be hospital delays for C-section mothers due to time needed for assembling a surgical team and occasional need to wait for a surgical theatre to open. The emergency

nature of these referrals partially explains the elevated number of C-section deliveries compared to WHO recommended levels due to foetal distress or death prior to arrival at the hospital (WHO, 2015). It also explains differences from a study elsewhere in Tanzania which found reduced neonatal mortality with caesarean deliveries (Mbawala *et al*., 2014). As demonstrated here, the PMR is particularly elevated in older women (age 30 years or over) and in concordance with results of earlier studies, greater age and parity increases obstetric risk. These risks should be communicated to women during their antenatal check-ups (Kruk *et al*., 2010). Since most women seek antenatal care, community health messages to all women and particularly multiparous, older women are easily relayed through these clinics. As such, maternal education and messages encouraging institutional delivery are positively associated with hospital delivery (Megeda & Mmbaga, 2015). Community-based safe motherhood interventions have been shown to be effective in increasing the use of skilled birth attendant elsewhere in Tanzania (Mushi *et al*., 2010). Incorporating these types of interventions into mobile clinic programmes at Nyakahanga Hospital may result in better outcomes for mother and baby.

It is common in Tanzania for women who intend to deliver in a health facility to end up delivering at home because of a lack of transport or the high fees or cost of transport. Interviews indicate that mothers in the catchment area around Nyakahanga report numerous and similar barriers to care (Nyirenda, 2005). In particular, the lack of paved roads throughout much of the area and easily accessible transportation remains a significant barrier to travel to the hospital for delivery or transport there for emergency obstetric care. Delayed arrival at the NDDH is the result, with particular implications for poor women in communities off the main paved road. It is noteworthy that the most dramatic increase in women delivering babies at the hospital and the greatest year-to-year decrease in maternal mortality occurs from 2003-2004. This corresponds with the completion of the single tarmac road into Karagwe from the east as far as the hospital. The tarmac road facilitates travel for services once you reach it from secondary roads, particularly during the rainy seasons. Other studies have indicated that a road with regular transport to the hospital (Hunger *et al*., 2007) correlated with improved met need of treatment.

The improvement in maternal mortality rate at Nyakahanga Hospital follows concerted efforts via new techniques, ongoing staff training efforts, and community health initiatives. The obstetric ward has consistently introduced training and protocols for their nurse-midwives that emphasize safe delivery practice and intervention as needed. Posters regarding safe practice and reminders are readily visible in the delivery ward. During the time period 2002-2014, an ultrasound unit has been installed at the hospital with a doctor and technician trained to use it. This has been important in identifying uterine ruptures during labour and saving lives. However, many but not all of the ruptures are related to prolonged labour prior to arriving at the hospital. The use of labour inducing drugs or herbs has also been identified as a potential concern related to the ruptures by hospital staff. The use of herbs during labour may be relatively common in Tanzania (Dika *et al*., 2017). A study in Ghana (Fofie & Baffoe, 2010) has reported very similar findings in regards to rupture frequency. In order to emphasize the need to reduce mortality, case studies are now required for every maternal death with ward nurses included in the discussions. Additional campaigns involve ongoing job related training for the obstetrics staff.

Emergency or difficult deliveries are further complicated by a deficit in designated neonatal intervention support services available to monitor or respond to neonatal distress. There is no designated neonatal nursery, but rather, neonates are kept in the obstetric delivery area under a warming light until claimed by the mother after delivery. Oxygen can be given by nasal tube, but is designed for short term supportive use only. Since the nurse-midwives on this ward are trained for obstetric care of the mother, their primary task is responding to obstetric complications, not to neonatal complications. Staffing limitations necessitate their focus to the mothers in labour in this busy area (10-12 births a day).

The situation is further complicated by a 60% gap at Nyakahanga Hospital between need and available staff. This need is most critical for doctors and other skilled staff. As a result, doctors (including medical officers, assistant medical officers and other surgical staff) may be involved in multiple competing emergency cases at once or after assigned hours, may be on-call. The two surgical theatres can also be busy with other cases. This leads to delays in emergency obstetric cases since a team has to be assembled for each case and only a single doctor or anaesthesiologist may be available. Shortfalls in professional staff have been documented elsewhere in Tanzania with rural regions adversely affected (Olsen *et al*., 2004; Hunyinbo *et al*., 2008; Dogba & Fournier, 2009; Shoo *et al*., 2017). The presence of physicians is positively associated with increased survivorship for mother and new-born (Dogba *et al*., 2011). The deficit in staffing numbers is a major obstacle to future improvements in medical response and quality of care. Decreasing response time including quicker access to emergency C-sections is important in decreasing the elevated perinatal deaths seen during this procedure in this study.

In implications for future treatment, hospital staff have reviewed these study findings, met and discussed means to deliver babies more quickly, the need to chart the status of the foetus upon arrival in the ward, a consistent programme to monitor foetal heart rate, and possible roles for other factors in these foetal deaths. This study increased awareness of causes of neonatal and maternal death such as uterine rupture with greater attention being given to monitoring uterotonic drugs and herbal medications ingested by mothers. Nyakahanga Hospital has begun construction of a designated obstetric theatre to eliminate one obstacle to a faster response to obstetric emergencies.

In conclusion, advocacy by the United Nations and the World Health Organization have led to ongoing improvement in Millennium Development Goals (MDGs). Similar to what has occurred globally and nationwide in Tanzania, Nyakahanga Hospital has made significant progress in maternal mortality. This improvement in maternal outcomes can be attributed to multiple hospital and staff initiatives. It is noteworthy given recurrent staffing shortages at the hospital. The majority of deliveries are under the age of 25 years and a first or second pregnancy. Reported maternal complications are equivalent to global averages although some, i.e. uterine rupture, may be related to delays in obstetric delivery.

Despite improvements in maternal mortality, neonatal mortality is elevated relative to Tanzania averages, particularly in caesarean sections. Neonatal deaths are positively related to maternal age. Since this hospital is an emergency obstetric referral centre, obstetric clients frequently arrive after prolonged labour at home or other district facilities. Foetal distress is common in these scenarios partially explaining the elevated caesarean section rate and perinatal death rate. Hospital initiatives are underway to add a designated obstetric surgical theatre to provide more rapid response in these scenarios. In addition, it is recommended that since antenatal attendance is high, initiatives be continued to educate multiparous and older women on seeking skilled care upon onset of labour or at the sign of any complications.

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**Declaration of Interest**

There is no conflict of interest that could be perceived as prejudicing the impartiality of the research reported.

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