


Research Articles

No difference in perinatal mortality between home and facility delivery in rural Tanzania: a prospective community-based study

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Background

Facility-based delivery with skilled birth attendants in an enabling environment is recommended for life-saving and for improving maternal and newborn health outcomes. Inconsistent results exist regarding the protective effects of facility delivery on maternal and perinatal mortality in developing countries. The primary objective of this study was to investigate the association between place of delivery and maternal and perinatal mortality. A secondary objective was to examine the association between place of delivery and maternal complications during pregnancy, labor and delivery, and 48 hours postpartum.

Methods

This community-based prospective study recruited a cohort of 1719 women in their third trimester of pregnancy through a door-to-door survey in randomly selected wards in rural Geita Northwest Tanzania between September 2016 and December 2017. A total of 1385 eligible mother-infant pairs were followed to seven days post-delivery.

Results

Half of the women delivered at a health facility (52.23%). A limited number of maternal deaths (n=7) were observed; 3 of these occurred at health facilities. No association was found between place of delivery and perinatal mortality (adjusted odds ratio, aOR=1.60, 95% confidence interval, CI=0.65-3.80). The prevalence of maternal complications during pregnancy, labor and delivery, and 48 hours postpartum were 6.14%, 8.74%, and 12.56%, respectively. A higher proportion of women who delivered at health facilities reported complications during labor and delivery (13.26% vs 3.78%) and 48 hours postnatally (14.78% vs 10.14%) than women who delivered at home.

Conclusions

Health facility delivery was not associated with reduced perinatal mortality. A higher proportion of women who delivered at health facilities reported complications during labour and delivery. Controlling for maternal complications attenuated the association between place of delivery and perinatal mortality. Many health facilities in rural Geita Tanzania remain ill-equipped to deal with unpredictable complications during childbirth. Improving staff training, access to essential drugs and equipment, and quality care could reduce perinatal mortality.

From 2000 to 2017, the maternal mortality ratio (MMR) was reduced by 38% globally from 342 to 211 per 100,000 live births.¹ However, in sub-Saharan Africa, it has remained high at 533 maternal deaths per 100,000^{1,2} with Tanzania reporting a MMR of 524 per 100,000 in 2017 [<https://data.worldbank.org/indicator/SH.STA.MMRT?locations=TZ>]. Globally, under-five mortality has been reduced

by 58% over the past 25 years and in Tanzania, it has been reduced by two-thirds from 166 to 54 per 1,000 live births.³ An increasing proportion of under-five mortality is now attributable to neonatal deaths, from 41% in 2000 to 47% in 2017,³ the majority of which occur within the first week of life. In 2015, there were over 2.5 million stillbirths worldwide. Most of these (98%) were in low and middle-income

countries (LMICs) and about a half occurred during the intrapartum period.^{3–5} In Tanzania, approximately 46,000 stillbirths were reported in 2016; 47% took place during the intrapartum period.⁶ More than 75% of maternal and newborn deaths in sub-Saharan Africa are due to preventable causes such as complications during pregnancy, labour, delivery, or in the immediate postpartum period, and infections.⁷ It has been estimated that increased coverage and quality antenatal care, skilled care at birth, provision of emergency obstetric services, postnatal care and care of small and sick newborns could avert up to 54% of maternal deaths, 71% of newborn deaths and 33% of stillbirths worldwide by 2025.^{8,9}

The Every Woman, Every Child global strategy emphasizes access to essential high quality health services from pre-pregnancy through adolescence.⁸ Facility-based delivery with skilled birth attendants in an enabling environment is recommended for life-saving and improving maternal and newborn outcomes.^{8–10} In Tanzania, skilled birth attendants are only available in health facilities. Therefore, encouraging women to deliver in health facilities is arguably the most pragmatic approach to improving maternal and pregnancy outcomes.

Inconsistent findings exist regarding the effects of place of delivery on maternal and perinatal mortality in developing countries.^{11–23} Some studies have reported a higher risk of maternal mortality among pregnant women who deliver at health facilities.^{12,14,20} In contrast, a secondary analysis of two cluster randomised controlled trials by Gabrysch et al showed no reduction of maternal mortality with health facility delivery.²³ Studies investigating perinatal mortality have reported no difference in risk between infants delivered at health facilities or at home,^{11,13,15,19,21} whereas others have reported a higher risk of perinatal mortality for home deliveries^{16,17} and still others have reported a higher risk of perinatal mortality among health facility deliveries.^{14,22,24} These discrepancies could be due to methodological differences among the studies. For example, studies using demographic and health surveys data that are typically obtained from women who gave birth 2–5 years preceding the completion of the survey may suffer recall and reporting biases.²¹ Further, studies that are health facility-based may be affected by selection bias. Failure to control for complications during pregnancy, labor and delivery, and in the immediate postpartum period, which are associated with pregnancy outcomes, could also contribute to inconsistencies in the findings.^{25,26}

In Tanzania, 70% of population resides in rural settings and urban/rural disparities have been reported in maternal and child health care.^{27,28} Rural communities are disadvantaged due to uneven distribution of skilled personnel, shortages of essential supplies and drugs, lack of medical equipment, and poor infrastructure.^{6,29,30} Further, early initiation of antenatal care is low and delivery with the assistance of an unskilled birth attendant at home are commonly practiced in rural settings.^{28,31}

To address methodological issues of concern (e.g., recall, reporting and participant selection biases, confounding variables), we conducted a prospective community-based study. Our primary objective was to investigate the associations between place of delivery and maternal and perina-

tal mortality in rural Geita district, Northwest Tanzania. A number of factors have been associated with mortality in newborn babies³²; however, in this study, we focused only on maternal complications during pregnancy, labour, delivery and 48 hours postpartum. A secondary objective was to examine the association between place of delivery and maternal complications during pregnancy, labor and delivery, and 48 hours postpartum.

METHODS

STUDY SETTING AND DESIGN

In Tanzania, preventative services in the community provide the first level maternal and child health care. The second level is delivered at dispensaries where uncomplicated delivery services are provided. Health centers provide basic emergency obstetric and newborn care, and in some cases comprehensive emergency obstetric care. The penultimate level is the district hospital, which provides basic and comprehensive emergency obstetric and newborn care. The highest level of care is provided at regional/referral hospitals. In rural settings, most women deliver at dispensaries or health centers, which may be inadequately staffed with skilled personnel, and face shortage of supplies, essential drugs, and the equipment necessary to perform caesarean sections during obstetric emergencies.^{29,30,33}

Geita is a primarily rural area. It has a district hospital, five health centers and 38 dispensaries. Medical doctors are available at the district hospital and in two health centers to assist with complicated deliveries. Other health facilities are staffed with clinical officers/assistants, nurses, midwives, and medical attendants some of whom have specialized training in childbirth. In this area, approximately half of women deliver at health facilities.²⁸

This community-based prospective study recruited a cohort of women in their third trimester of pregnancy in rural Geita Northwest Tanzania between September 2016 and December 2017. Participants were recruited at the village level through a door-to-door survey that was conducted in 11 (out of 35) randomly selected wards in rural Geita. A simple random sample technique was used to select wards; all wards in Geita were listed alphabetically and numbered from 01 to 35; based on these two-digit numbers, a random numbers table was used to select eleven wards.

Local community health workers and village leaders assisted in identifying and contacting all potential participants. Nurses and medical interns who were not involved in providing health services to the women conducted the door-to-door survey and post-delivery follow-up interviews. The door-to-door survey captured information on obstetric history and socio-demographic characteristics.

For women who delivered at health facilities, data on labor and delivery complications and maternal and perinatal mortality were extracted from medical records and a home visit was conducted within seven days post-delivery. Women who delivered at home phoned the research team to inform them of the delivery and a home visit was arranged. During these visits, information was collected on labor, delivery and postnatal complications, and perinatal outcomes in the first 48 hours after delivery. To minimize bias, we

obtained additional data from traditional birth attendants (TBAs), local community health workers and extracted data from medical records.³⁴

This study was carried out in accordance with the Code of Ethics of the World Medical Association (Declaration of Helsinki). It was approved by ethics review boards of the Catholic University of Health and Allied Sciences/Bugando Medical Centre (CREC/098/2015) and the University of Calgary (REB16-0183). Women over 18 years of age provided written informed consent; women younger than 18 years provided written assent and written informed consent were obtained from their legal guardians.

PARTICIPANTS

Women in their third trimester based on reported last menstruation period who resided in rural Geita and did not plan to change residence for at least 6 months post-survey were recruited. Those with a history of caesarean section or a pre-existing chronic disease such as heart disease, diabetes, and cancer, which could influence a woman's choice of place of delivery were not included as participants. A total of 1714 women agreed to participate and 1431 were followed to seven days post-delivery; 1385 woman-infant pairs were included in the final analyses after exclusion of participants who gave birth to multiples or for whom we did not have complete data (see Figure 1).

PLACE OF DELIVERY

Place of delivery was considered as a proxy for the quality of care received during childbirth. It was defined as either a health facility (i.e., hospital, health center, or dispensary) or home (i.e., any place other than a health facility). To reduce potential bias in reporting place of delivery, three data sources were used: the participant's response; information from a person who assisted with the delivery (e.g., skilled birth attendant, TBA), and the medical file/antenatal card of women who sought postnatal care. For participants who delivered at health facilities, information on referrals was extracted from the medical file.

MATERNAL AND PERINATAL MORTALITY

Maternal and perinatal mortality were the outcomes of interest. Maternal mortality was defined as the death of a woman during labor or delivery or within 48 hours of termination of pregnancy from any cause related to the pregnancy or its management. Perinatal mortality was defined as a pregnancy loss occurring within the third trimester, at delivery (i.e., stillbirth), or within seven days after delivery. For perinatal death, we examined whether mortality was either stillbirth or early neonatal death. For participants who delivered at the health facilities, medical records were used to confirm mortality of women and their newborns. For home deliveries, self-reports from respective mothers, close relatives, and persons who assisted with the delivery (relative or TBA) were considered.

COVARIATES

Covariates included maternal age, height, educational level,

parity, history of stillbirth and miscarriage, use of antenatal care services and complications during pregnancy, labor, delivery, and within 48 hours post-delivery. Pregnancy complications consisted of bleeding, symptoms of hypertension, infection or jaundice (Appendix 1). Complications during labor and delivery and within 48 hours post-delivery included premature rupture of the membrane (PROM), prolonged/obstructed labor, retained placenta, severe bleeding, malpresentation, and symptoms of hypertension, infection and jaundice.

SAMPLE SIZE ESTIMATION AND STATISTICAL ANALYSIS

As this was a community-based study, our aim was to recruit most of the eligible pregnant women who lived in the randomly selected wards. Our sample size was based on total deliveries for Geita district in 2015 ($n=36,101$). We estimated approximately 10,000 (28%) pregnant women would reside in the selected wards with at least 20% ($n=2,000$) in their third trimester of pregnancy. The study reached 1,805 (~90%) pregnant women in the selected wards, 1,719 of whom participated in the door-to-door survey. All pregnant women who were approached, met our inclusion criteria, and consented were recruited.

Differences in sociodemographic characteristics between study participants and those lost to follow-up were examined using chi-squared tests; age differences were examined using a student *t* test. Among study participants, the MMR was estimated as the number of maternal deaths per 100,000 live births. To obtain a measure of the perinatal mortality rate, stillbirths and early neonatal deaths were considered. The perinatal mortality rate was the sum of stillbirths and early neonatal mortality divided by total births per 1,000 births. Generalized linear models for the binomial family and robust error estimation were used to examine associations between place of delivery and perinatal mortality. An odds ratio with 95% confidence intervals was the measure of association. A maximum likelihood approach was used to determine if maternal age, height, parity, education level and use of antenatal care confounded the association between place of delivery and perinatal mortality. Only factors that were significant ($P < 0.05$) were included in the adjusted model. Adjusted odds ratios took into account complications during pregnancy, labor, delivery, and 48 hours postpartum. Goodness of fit was checked using link test. Group differences in complications during pregnancy, labor, delivery and 48 hours postpartum were investigated by place of delivery. Association between complications and perinatal mortality were also investigated. A sensitivity analysis that considered place of delivery including the district hospital, health centers, dispensaries and home, was conducted using generalized linear models for the binomial family and robust error estimation. STATA version 15 was used to conduct the analyses.³⁵

RESULTS

Participants and those lost to follow-up differed only on risk parity; 56.55% of the women lost to follow-up were in the high-risk parity group (i.e., parity zero or more than four) (Table 1). Among participants, approximately one half

Table 1. Baseline characteristics of study participants and those lost to follow up

| Baseline characteristics | | Study participantsN=1385 | | | Lost to follow upN=290 | | P-value | |
|--------------------------|-----------------|--------------------------|------|-------|------------------------|-----|---------|-------|
| | | Mean (SD) | N | % | Mean (SD) | n | | % |
| Maternal age in years | | 25.86 (6.63) | | | 25.22 (6.50) | | 0.13 | |
| Height | < 150 cm | | 131 | 9.46 | | 27 | 9.31 | 0.94 |
| | ≥150 cm | | 1254 | 90.54 | | 263 | 90.69 | |
| Education level | None | | 316 | 22.82 | | 65 | 22.41 | 0.08 |
| | Primary & above | | 1069 | 77.18 | | 225 | 77.59 | |
| Marital status | Not married | | 75 | 5.42 | | 16 | 5.52 | 0.95 |
| | Married | | 1310 | 94.58 | | 274 | 94.48 | |
| Parity | *Low Risk | | 788 | 56.90 | | 126 | 43.45 | <0.01 |
| | **High Risk | | 597 | 43.10 | | 164 | 56.55 | |
| History of stillbirth | Yes | | 59 | 4.26 | | 14 | 4.83 | 0.67 |
| | No | | 1326 | 95.74 | | 276 | 95.17 | |
| History of miscarriage | Yes | | 205 | 14.80 | | 39 | 13.45 | 0.55 |
| | No | | 1180 | 85.20 | | 251 | 86.55 | |

*Low risk includes parity one to four

**High risk includes parity zero or more than four

SD – standard deviation

delivered at health facilities (52.23%; 95% confidence interval (CI) = 49.64-54.90); 8.43% delivered at the district hospital; 56.76% delivered at health centers and 34.81% delivered at dispensaries). There was no difference in age between women who delivered at health facilities or at home. Most women reported at least primary education; a higher proportion of women with no schooling delivered at home (Table 2). A higher proportion of women with short stature

also delivered at home. Most of the women reported attending antenatal care at least once; however, a higher proportion of women who never attended antenatal care delivered at home. Only 1% of women reported referral during labor either from home or from a lower level of health facility to a health center or the district hospital.

Table 2. Participant characteristics by place of delivery

| Characteristics | | Overall (N=1385) | | | Health facility (N=724) | | | Home (N=661) | | | P - value |
|--------------------------------|----------------|------------------|------|-------|-------------------------|-----|-------|---------------|-----|-------|-----------|
| | | Mean (SD) | N | % | Mean (SD) | n | % | Mean (SD) | N | % | |
| Maternal age in years | | 25.86 (6.62) | | | 25.95 (6.58) | | | 25.75 (6.68) | | | 0.58 |
| Height | <150 cm | | 131 | 9.46 | | 57 | 7.87 | | 74 | 11.20 | |
| Height | ≥ 150 cm | | 1254 | 90.54 | | 667 | 92.13 | | 587 | 88.80 | 0.04 |
| Education level | None | | 316 | 22.82 | | 129 | 17.82 | | 187 | 28.29 | <0.01 |
| | Primary &above | | 1069 | 77.18 | | 595 | 82.18 | | 474 | 71.71 | |
| Marital status | Married | | 1310 | 94.58 | | 687 | 94.89 | | 623 | 94.25 | 0.60 |
| | Not married | | 75 | 5.42 | | 37 | 5.11 | | 38 | 5.75 | |
| Parity | *Low Risk | | 788 | 56.90 | | 420 | 58.01 | | 368 | 55.67 | 0.38 |
| | **High Risk | | 597 | 43.10 | | 304 | 41.99 | | 293 | 44.33 | |
| History of stillbirth | Yes | | 59 | 4.26 | | 36 | 4.97 | | 23 | 3.48 | 0.17 |
| | No | | 1326 | 95.74 | | 688 | 95.03 | | 638 | 96.52 | |
| History of miscarriage | Yes | | 205 | 14.80 | | 100 | 13.81 | | 105 | 15.89 | 0.28 |
| | No | | 1180 | 85.20 | | 624 | 86.19 | | 556 | 84.11 | |
| Use of antenatal care services | At least once | | 1299 | 93.79 | | 693 | 95.72 | | 606 | 91.68 | <0.01 |
| | Never gone | | 86 | 6.21 | | 31 | 4.28 | | 55 | 8.32 | |

*Low risk includes parity one to four
**High risk includes parity zero and more than four
SD – standard deviation

Table 3. Association between place of delivery and perinatal mortality

| Crude & adjusted models | Crude odds ratio (cOR) | | *Adjusted odds ratio (aOR) | |
|--|------------------------|------------|----------------------------|------------|
| | OR | 95% CI | aOR | 95% CI |
| Perinatal mortality (all deliveries) | | | | |
| Home/community | Reference | | Reference | |
| Health facility | 2.43 | 1.07-5.54 | 1.64 | 0.67-3.99 |
| Perinatal mortality by level of health facilities | | | | |
| Home/community | Reference | | Reference | |
| Dispensary | 1 | 0.26-3.82 | 0.84 | 0.21-3.38 |
| Health centre | 2.22 | 0.89-5.57 | 1.65 | 0.62-4.40 |
| Hospital | 10.39 | 3.63-29.73 | 4.05 | 1.03-15.86 |
| Perinatal mortality excluding hospital deliveries | | | | |
| Home/community | Reference | | Reference | |
| Health facility (62 hospital births excluded) | 1.76 | 0.73-4.23 | 1.38 | 0.51-3.77 |

*Adjusted for labor, delivery, and 48 hours postnatally complications, while maternal age, height, parity, education level, and use of antenatal care clinic were not significant hence removed from the model

CI – confidence interval

MATERNAL MORTALITY, STILLBIRTH, AND EARLY NEONATAL MORTALITY

Seven maternal deaths were recorded up to 48 hours post-delivery. The estimated MMR was 511 maternal deaths per 100,000 live births (95% CI = 468-557). A total of 29 perinatal deaths occurred up to seven days after delivery, 15 (51.72%) were stillbirths, and 14 (48.28%) were early neonatal deaths. The perinatal mortality rate was 21 per 1,000 births (95% CI: 13, 32). The estimated stillbirth rate was 11 per 1,000 deliveries (95% CI = 6-20); the early neonatal mortality rate was 11 per 1,000 live births.

PLACE OF DELIVERY AND MATERNAL AND PERINATAL MORTALITY

Maternal mortality was a rare event (3 at health facilities and 4 at home); therefore, because of insufficient power, the association between maternal mortality and place of delivery was not examined. Unadjusted analysis revealed that neonates born in health facilities had 2.43 increased odds of experiencing perinatal death compared to neonates born at home (Table 3). Maternal age, height, parity, education level, and use of antenatal care services did not confound the association between place of delivery and perinatal mortality (not shown in Table 3). An adjusted model that included maternal complications during labor, delivery, and 48 hours post-delivery attenuated the crude positive association; although infants born in health facilities were at 1.64 increased odds of perinatal death compared to those born at home.

MATERNAL COMPLICATIONS: PREGNANCY, LABOR, DELIVERY, 48 HOURS POST-DELIVERY

Prevalence of pregnancy complications was 6.14% (Table 4). No difference in pregnancy complications was found by place of delivery ($P=0.92$). Prevalence of labor and delivery complications was 8.74%; higher prevalence was observed among women who delivered at health facilities compared to home (13.26% vs 3.78%, $P<0.01$); for premature rupture of the membrane (PROM) (4.85% vs 1.06%), prolonged/obstructed labor (11.05% vs 2.27%), and malpresentation (1.80% vs 0.30%). The prevalence of reported maternal complications within 48 hours after delivery was 12.56% with higher prevalence among women who gave birth at health facilities compared home (14.78% vs 10.14%, $P<0.01$). Women who delivered at health facilities reported a higher prevalence of symptoms of hypertension (12.71% vs 6.81) and severe bleeding (3.45% vs. 0.61).

MATERNAL COMPLICATIONS AND PERINATAL MORTALITY

The presence of any complication during pregnancy, labor, delivery, or 48 hours post-delivery was associated with poorer perinatal outcomes. Among women who experienced complications during pregnancy, the prevalence of stillbirth, early neonatal death, and perinatal death were 26.67%, 35.71%, and 31.71%, respectively (Table 5). Almost half of women who reported labor and delivery complication experienced stillbirth, early neonatal death, or perinatal death. Prolonged labor and PROM were the most common complications associated with stillbirth.

Table 4. Reported complications during pregnancy, labor and delivery, and 48 hours postnatally

| Type of complication | Overall (N=1385) | | Health facility (N=724) | | Home (N=661) | | P - value |
|--------------------------------|------------------|-------|-------------------------|-------|--------------|-------|-----------|
| | n | % | n | % | n | % | |
| During pregnancy | | | | | | | |
| Any pregnancy complication | 85 | 6.14 | 44 | 6.08 | 41 | 6.20 | 0.92 |
| Bleeding | 20 | 1.44 | 9 | 1.24 | 11 | 1.66 | 0.51 |
| Symptoms of hypertension | 3 | 0.22 | 3 | 0.41 | 0 | 0 | 0.25 |
| Symptoms of infection | 64 | 4.62 | 33 | 4.56 | 31 | 4.69 | 0.91 |
| Jaundice | 24 | 1.73 | 12 | 1.66 | 12 | 1.82 | 0.82 |
| During labour & delivery | | | | | | | |
| Any labour complication | 121 | 8.74 | 96 | 13.26 | 25 | 3.78 | <0.01 |
| PROM | 42 | 3.03 | 35 | 4.85 | 7 | 1.06 | <0.01 |
| Prolonged/obstructed Labor | 95 | 6.86 | 80 | 11.05 | 15 | 2.27 | <0.01 |
| Malpresentation | 15 | 1.08 | 13 | 1.80 | 2 | 0.30 | <0.01 |
| Retained placenta | 16 | 1.11 | 10 | 1.38 | 6 | 0.91 | 0.41 |
| Symptoms of infection | 17 | 1.23 | 13 | 1.80 | 4 | 0.61 | 0.04 |
| Symptoms of hypertension | 8 | 0.58 | 6 | 0.83 | 2 | 0.30 | 0.20 |
| 48 hours post delivery | | | | | | | |
| Any complication post-delivery | 174 | 12.56 | 107 | 14.78 | 67 | 10.14 | 0.01 |
| Jaundice | 13 | 0.94 | 8 | 0.01 | 5 | 0.01 | 0.50 |
| Symptoms of hypertension | 137 | 9.89 | 92 | 12.71 | 45 | 6.81 | <0.01 |
| Symptoms of infection | 72 | 5.20 | 41 | 5.66 | 31 | 4.69 | 0.42 |
| Severe bleeding | 29 | 2.09 | 25 | 3.45 | 4 | 0.61 | <0.01 |

*PROM – Premature rupture of the membrane

SENSITIVITY ANALYSES

As quality of care provided across the facilities could differ, sensitivity analyses were conducted to investigate whether type of health facility (i.e., district hospital, health centre, or dispensary) influenced the association between place of delivery and perinatal outcome. Of the 29 perinatal deaths observed, a higher prevalence was found for deliveries at the district hospital (11.29%, 7/62) compared to health centres (2.65%, 11/415), dispensaries (1.21%, 3/247), and home (1.21%, 8/661). The crude odds ratio (OR) of perinatal death was higher for deliveries at the district hospital and health centers compared to dispensaries and home (Table 3). After adjusting for complications (during pregnancy, labor and delivery, and postnatally), the odds of perinatal death remained significantly higher for the district hospital. As complicated pregnancies are likely referred to the district hospital as per existing health system referral guidelines, we examined whether excluding women who gave birth at the district hospital influenced perinatal outcome by place of delivery. The crude and adjusted models revealed no association between place of delivery and perinatal outcome. In addition, as pregnant women who attend facilities for delivery and those who stay home for delivery may not be comparable due to risk of complications or death, we conducted stratified analyses to determine if the presence or absence of maternal complications modified the association between place of delivery and perinatal mortality. Results

revealed no significant associations between place of delivery and perinatal mortality among women with complications (OR=1.37, 0.28-6.74) or those without complications (OR=1.87, 0.69-5.08).

DISCUSSION

In this rural setting, almost half of pregnant women gave birth at home without the assistance of skilled birth attendants. Maternal mortality was a rare event and because of the low number, we were unable to estimate the association with place of delivery. The odds of perinatal mortality did not differ between home and health facility delivery, after adjusting for maternal complications. Finally, among women who delivered at health facilities a higher prevalence of delivery and postnatal complications were reported, which could be associated with pregnancy outcomes.

In Tanzania, the Ministry of Health and Social Welfare has set a target of 90% of all women delivering at health facilities by 2020.³⁶ Skilled birth attendants are available in most of these facilities; hence, facility delivery is recommended for all pregnant women. Nationwide in 2015/16, 63% of women in Tanzania delivered at health facilities; however, only 54% of women living in rural areas did so,²⁸ which was consistent with our finding that 52% of pregnant women delivered at health facilities. These data indicate that home delivery is still commonly practiced in rural settings in Tanzania and that the government target of 90%

Table 5. Women who reported maternal complications by perinatal mortality

| Maternal complications | Stillbirth | | Early neonatal deaths | | Perinatal deaths | |
|-----------------------------------|------------|-------|-----------------------|-------|------------------|-------|
| | (n=15) | | (n=14) | | (n=29) | |
| | n | % | n | % | n | % |
| During pregnancy | | | | | | |
| Any pregnancy complication | 4 | 26.67 | 5 | 35.71 | 9 | 31.01 |
| Bleeding | 1 | 6.67 | 1 | 7.14 | 2 | 6.90 |
| Symptoms of infection | 1 | 6.67 | 1 | 6.67 | 2 | 6.90 |
| Symptoms of hypertension | 2 | 13.33 | 3 | 21.43 | 5 | 17.24 |
| Labor and delivery | | | | | | |
| Any labor & delivery complication | 7 | 46.67 | 6 | 42.86 | 13 | 44.83 |
| PROM | 4 | 26.67 | 3 | 21.43 | 7 | 24.14 |
| Prolonged labor/obstructed | 6 | 40.00 | 5 | 35.71 | 11 | 37.93 |
| Malpresentation | 1 | 6.67 | 1 | 7.14 | 2 | 6.90 |
| Retained placenta | - | - | 1 | 7.14 | 1 | 3.45 |
| Symptoms of infection | 1 | 6.67 | 1 | 7.14 | 2 | 6.90 |
| 48 hours post-delivery | | | | | | |
| Any post-delivery complication | | | 6 | 42.86 | 10 | 34.48 |
| Severe bleeding | - | - | 3 | 21.43 | 5 | 17.24 |
| Symptoms of infection | - | - | 2 | 14.29 | 5 | 17.24 |
| Symptoms of hypertension | - | - | 3 | 21.43 | 5 | 17.24 |

*PROM: Premature rupture of the membrane

may be unattainable.

Our recent qualitative study conducted in Geita revealed that perceived risk, sociocultural issues, accessibility to childbirth services, economic constraints and factors related to quality of health services influenced women's choice of where they deliver,³⁷ which is consistent with previous research.^{38–42} We also found that women who delivered at health facilities were more likely to have at least a primary education, a potential self-selection bias. Women with a higher level of education may be more aware of potential complications associated with childbirth, which could influence their decision as to where they deliver.^{38,43} Factors that influence women's decisions on where they deliver may vary among communities and countries, therefore, health and community-based interventions to increase use of health facilities for childbirth need to take into account the local social, cultural and environmental context.

Our findings did not support a protective association between facility-based delivery and perinatal mortality, after adjusting for maternal complications. This finding is consistent with other studies in LMICs.^{13,15,18–21} Chinkhumba et al. in a meta-analysis reported no significant difference in perinatal mortality rates between women who delivered at a health facility compared to those who delivered at home based on a random effects approach.²⁰ Studies have also reported a higher risk of perinatal mortality among facility deliveries.^{12,14,24} A recent population-based study in Kenya reported an increased risk of perinatal mortality among facility deliveries.²⁴ This increased risk was associated with deliveries that took place in hospitals and appeared to be

due to selection bias; women with pregnancy complications seeking care at the hospitals. Consistent with our sensitivity analysis, no difference in perinatal mortality were found between health centres, dispensaries and home deliveries after adjusting for maternal complications.²⁴ Research has also reported protective effects for facility delivery.^{11,16,17} A study in Uganda reported a reduction in neonatal mortality rates among women who delivered at health facilities compared to home.¹⁶ The discrepancies among these studies could be due to various factors including differences in level of childbirth care utilization, quality of childbirth care, and policies related to provision of maternal and child health services across countries. In addition, methodological issues including study design (i.e., cross-sectional, case control, prospective and retrospective cohort) and study setting (community-based versus facility-based), can introduce selection and recall bias.

Tanzania is faced with several challenges including uneven distribution of skilled birth attendants, and shortages of equipment, essential supplies and drugs for the provision of quality childbirth care.^{29,30,33} Less than 5% of health facilities in Tanzania are adequately equipped for cesarean section and newborn emergency care.³⁵ Further, suboptimal infrastructure such as poor roads, a limited number of the ambulances, and lack of communication between health facilities could delay timely provision of life saving care during obstetric emergencies.⁴⁴ These challenges could attenuate the protective effect of health facility delivery on maternal and perinatal outcomes.

We found that a higher proportion of women with com-

plications during labor, delivery and 48 hours postpartum delivered at health facilities. This suggests a potential self-selection bias, which is consistent with other studies that found that women who experienced problems such as PROM and prolonged labor were more likely to seek care at health facilities or be referred by TBAs.^{14,22,25} First time mothers who are at higher risk for complications and women who are anxious about childbirth due to a previous negative experience may also be more likely to choose to deliver at health facilities.^{41,44,45} In addition, women who considered themselves low risk may have sought facility care only after experiencing complications at home, which could be associated with an increased risk of perinatal mortality.^{46,47} Women who attend health facilities also have a higher probability of intervention during labor and delivery including caesarean section or forceps or vacuum delivery, which could be associated with complications such as postpartum bleeding and a higher risk of infection.^{48,49} Our stratification analysis also revealed that the district hospital had the highest prevalence of perinatal mortality, which could be associated with referral of higher risk woman, delays among women experiencing problems in reaching hospital or delays in receiving the appropriate care. At present, however, we do not have sufficient data identify specific factors associated with the higher prevalence of perinatal mortality among infants delivered at the district hospital. Future research is needed to guide interventions that would improve pregnancy outcomes.

This study addressed many of the methodological challenges of previous studies including participant selection, and recall and reporting bias. It was a prospective community-based population study conducted in rural Tanzania that recruit the majority of pregnant women in their third trimester from randomly selected wards over a specific time period. Accurate data on maternal and perinatal mortality and maternal complications was maximized as time between delivery and the home visit was no more than seven days. We acknowledge, however, that this study has some limitations. First, women with a history or caesarean section or a pre-existing chronic disease such as diabetes or cancer were excluded. These women may be at higher risk of both maternal mortality and perinatal mortality. Therefore, both the MMR and the perinatal mortality rate we reported may have been underestimated. Further, as these women were at higher risk, they may be more likely to attend health facilities for delivery, which could have affected the MMR and perinatal mortality rates associated with health facility delivery. Maternal complications were captured through self-reports, which could have failed to identify conditions that do not have specific symptoms, leading to an under estimation especially among women who delivered at home. The possibility of selection bias due to loss to follow-up cannot be ruled out; however, there were few differences in the baseline characteristics between participants and those lost to follow-up. Delays in seeking, reaching, and receiving care have been reported to be associated with adverse pregnancy outcomes such as perinatal and maternal mortality.^{48,49} These were not adjusted for and could have influenced the study findings. These limitations could have attenuated the power of the study to detect differences in maternal and perinatal mortality between home and facility

deliveries; hence, the study findings should be interpreted with caution.

CONCLUSIONS

In conclusion, there was no difference in perinatal mortality among women who delivered at the health facility compared with women who delivered at home in this rural community of Tanzania. A higher proportion of women who delivered at health facilities reported complications during labour and delivery. When we controlled for complications, perinatal mortality was slightly higher among women who delivered at the health facilities. Many health facilities in rural Geita Tanzania remain ill-equipped to deal with unpredictable complications during childbirth and improving staff training, access to essential drugs and equipment, and quality care could prevent more perinatal deaths among women who utilise health facility during childbirth. Providing women and health providers in the community and at health care facilities with more knowledge about maternal complications could increase early recognition of complications during pregnancy, labor, delivery and postpartum, and birth preparedness planning and ultimately improve maternal and perinatal outcomes. Improving our understanding of factors associated with the relatively high levels of perinatal mortality among women who deliver in health facilities could guide focused interventions for improved pregnancy outcomes.

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Authorship contribution: ETK conceptualized the idea, supervised the collection of the household surveys during pregnancy and delivery, conducted the data analysis, and wrote the initial version of the manuscript. MTM, JH SK, RSS and DD assisted with the design of the study, provided input on the data analysis, and critically reviewed the manuscript. ETK and DD secured funding for the conduct of the study.

Competing interests: The authors completed the Unified Competing Interest form at www.icmje.org/coi_disclosure.pdf (available upon request from the corresponding author), and declare no conflicts of interest.

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SUPPLEMENTARY MATERIALS

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