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## Association between birth attendant type and delivery site and perinatal outcomes

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### Abstract

**Objective:** To test the hypothesis that modified perinatal mortality, early neonatal mortality, and other measures of perinatal mortality are lower with facility births than with home births among deliveries conducted by traditional birth attendants (TBAs) or nurse-midwives.

**Method:** This population-based observational study used data collected prospectively for home and facility deliveries conducted by TBAs and nurse-midwives in 13 rural communities in Zambia between September 1, 2009, and December 31, 2015.

**Results:** We enrolled 48 956 pregnant women. In adjusted analysis, modified perinatal mortality (adjusted odds ratio [aOR] 0.63, 95% confidence interval [CI] 0.45–0.88), early neonatal mortality (0.48, 0.33–0.69), and fresh stillbirth/day-1 neonatal mortality (0.55, 0.38–0.80) were lower among home deliveries than among facility deliveries conducted by TBAs, but did not differ among deliveries conducted by nurse-midwives. Rates of fresh stillbirth did not differ between home and facility delivery by either TBAs (aOR 1.03, 95% CI 0.64–1.66) or nurse-midwives (1.19, 0.67–2.10).

**Conclusion:** Our findings show significant reductions in modified perinatal mortality, early neonatal mortality, and fresh stillbirth/day-1 neonatal mortality among home deliveries done by

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#### CONFLICTS OF INTEREST

The authors have no conflicts of interest.

TBAs. This may be explained by robust community structures built by our program and referral bias of complicated cases.

### Keywords

Birth attendant; Facility delivery; Home delivery; Neonatal mortality; Stillbirth; Traditional birth attendant

## 1 | INTRODUCTION

Approximately 2.6 million neonatal deaths and 2.1 million stillbirths occur globally per year, with about 98% occurring in low- and middle-income countries.<sup>1</sup> Every year around 48 million women worldwide (about 35% of deliveries) give birth without a physician, nurse, and/or midwife, with rates of 52% in Africa, 34% in Asia, and 11% in Latin America and the Caribbean.<sup>2</sup> 35% of world deliveries do not take place in a health facility.<sup>2</sup> Birth attendants are crucial during delivery for preventing maternal and perinatal mortality and morbidity; yet, in most developing countries, women only seek the assistance of a trained birth attendant or consider a health facility delivery when experiencing obstetric complications.<sup>3</sup> There is a global shortage of 350 000 midwives,<sup>4</sup> and thus, high maternal and perinatal rates will continue even though they could be prevented by a health worker with the appropriate skills.

Home births may increase mortality risks in both high- and low-income countries. A recent meta-analysis of data from sub-Saharan Africa found that perinatal mortality was 21% higher among home deliveries than facility-based deliveries.<sup>5</sup> Home births are infrequent in most high-income countries, but remain common in low-income countries. Many deaths could be prevented through simple and cost-effective interventions, such as clean delivery practices, neonatal resuscitation, exclusive breastfeeding, and thermal care,<sup>6</sup> which may be more readily available for facility births.

Training of birth attendants in newborn care in resource-poor settings improves pregnancy outcomes, including reduction in still-births,<sup>7</sup> neonatal deaths,<sup>8</sup> and perinatal deaths.<sup>7-10</sup> Recent reports from low-income countries show improvements in perinatal and neonatal outcomes with increased coverage by health services and skilled birth attendants.<sup>6,7,9,11</sup> The role of community health workers (CHWs) and traditional birth attendants (TBAs) is still under discussion; however, they may play a promising part in providing pregnant mothers with childbirth and pregnancy care, mobilizing communities, and improving perinatal outcomes<sup>7</sup> by strengthening their partnership with the primary health facilities and even delivering in health facilities, where there are shortages of more skilled providers.<sup>12</sup> According to WHO recommendations for optimizing key maternal and newborn health interventions through task shifting, TBAs (lay health workers) are recommended to provide promotion of health care, including promotion of basic newborn care and care of low birth weight infants, birth preparedness, skilled care for childbirth, exclusive breastfeeding, and kangaroo mother care for low birth weight infants, which includes most of the components of essential newborn care.<sup>13</sup> Community-based strategies combined with health systems strengthening may improve childbirth care in the rural settings, help reduce maternal and

perinatal mortality rates, and provide an effective transition to higher coverage for facility births.<sup>12</sup>

Zambia is one example of a low-resource country with limited healthcare providers, especially in rural areas. Zambia has 1956 health facilities<sup>14</sup> and only 23 376 healthcare providers,<sup>15</sup> which is far below the WHO recommendation.<sup>16</sup> While user fees for delivery have been abolished in Zambia since April 2006,<sup>17</sup> factors that influence the use of a skilled birth attendant during delivery include demographic, socioeconomic, and other family-specific characteristics, such as the distance between the nearest health facility and its provided quality care coupled with bad roads and expensive or unavailable transport, presence of a male birth attendant, and the absence of a free delivery kit.<sup>8,18</sup> Many Zambian women living in rural settings reside far from a facility where emergency obstetric care services are offered, and the impact of distance to place of delivery is as high as that of education or socioeconomic status.<sup>8</sup>

While there has been policy change in many developing countries, including Zambia, to stop the funding and training of TBAs<sup>19</sup> and women are recommended to deliver at health facilities,<sup>20</sup> many women still deliver at home and TBAs are considered essential providers of obstetric care.<sup>21</sup>

We aimed to test the hypothesis that modified perinatal mortality (fresh stillbirth plus early [7 day] neonatal mortality) and other measures of perinatal mortality (stillbirth, fresh stillbirth, day-1 mortality, fresh stillbirth plus day-1 mortality, and early neonatal mortality) are lower with facility births than with home births among deliveries conducted by TBAs or nurse-midwives.

## 2 | MATERIALS AND METHODS

This population-based observational study was done using data collected prospectively for home and facility deliveries conducted by TBAs and nurse-midwives in 13 geographically defined rural communities (clusters) located in the Kafue and Chongwe districts in Zambia between September 1, 2009, and December 31, 2015. The study was approved by the institution review boards of the University of Zambia Biomedical Research Ethics Committee, University of Alabama at Birmingham, and RTI International. All women provided written informed consent.

The Maternal Newborn Health Registry is a population-based birth registry dataset collected prospectively in Zambian rural settings, with a minimum of 300 expected births per year as part of the National Institute of Child Health and Human Development Global Network for Women's and Children's Health Research sites.<sup>22</sup> Over this period, trained study staff, known as registry administrators, registered all pregnant women residing within the study communities.

All pregnant women residing within the selected 13 communities were eligible for enrollment into the parent study. Women who resided outside these communities but who were seeking a one-off prenatal care service in these facilities were excluded from this study.

Enrolled pregnant women who did not deliver between September 2009 and December 2015 were additionally excluded.

Each community had one primary health center (PHC). All 13 of the PHCs are open 24 hours a day 7 days a week and have a nurse-midwife on duty during the day and on call during the night. As part of the national scale-up plan of Emergency Obstetrics and Neonatal Care (EmONC) services, we trained and equipped the nurse-midwives to provide basic EmONC services, including antibiotics, oxytocin, vaginal delivery services, and basic neonatal resuscitation with bag and mask. Additionally, these facilities provide prenatal, delivery, under-5, and other services. Lastly, to further strengthen the linkages between the health facilities and communities, all the TBAs in these catchment areas were trained in early identification and immediate referral of women in labor; identification of danger signs during pregnancy, labor, and postpartum; and basic neonatal resuscitation with bag and mask. All TBAs and nurse-midwives were provided with bag and mask resuscitators.

Registry administrators enrolled eligible pregnant women and initiated data collection during prenatal care visits at the clinic level and during outreach activities but, in few cases, data collection was started at the time of delivery. Data collection was continued until 42 days after birth. Recorded outcomes included macerated stillbirth, stillbirth, early (7-day) and late (28-day) neonatal mortality, live birth rates, and baseline clinical characteristics of both the mother and the newborn for all deliveries. Deliveries were also classified as either by TBAs or nurse-midwives, and at home or facility level (facility included health center or hospital deliveries). Perinatal outcomes were collected for all pregnancies. In cases where the exact birth weight was not registered, the estimated birth weight was used.

The primary outcome was the rate of modified perinatal mortality, defined as fresh stillbirth plus early neonatal mortality among facility births compared with home births conducted by TBAs or nurse-midwives. The prespecified secondary outcomes were the rates of fresh stillbirths, defined as stillbirths without signs of maceration, early neonatal mortality defined as neonatal death within the first 7 days of life, and fresh stillbirths/day-1 neonatal mortality by birth attendant type and delivery site.

A registry administrator oversaw data collection in each community and held bimonthly meetings with both skilled (nurse-midwife) and unskilled (TBA) birth attendants in their catchment area for data collection and follow up purposes (7- and 28-day neonatal outcomes). The nurse-midwife in each facility registered all pregnant women during their prenatal care visits, and subsequently registered their delivery outcomes in the government registry (i.e., Safe Motherhood Registry). For all deliveries conducted at household level by TBAs, perinatal outcomes were collected by TBAs through existing community structures (i.e., neighborhood health committees, safe motherhood action groups) and sent to the registry administrators (one per community) at either facility or community level. Data were collected using study-specific data forms following written informed consent from eligible pregnant women.

As most communities had poor health systems with a high proportion of the deliveries conducted at home assisted by TBAs,<sup>7</sup> registry administrators were involved in the

enrollment and follow-up processes related to interventions with the healthcare providers from their respective communities. To facilitate the data collection processes between the TBAs and the registry administrators, messengers were provided a bicycle by the project to visit the villages located far from the health facility on a weekly basis to collect data forms from the TBAs and deliver them to the registry administrators. The registry administrators reviewed all data for quality control and quality assurance purposes before being sent for entry.

Data were entered centrally in Lusaka, Zambia, and transmitted to the data coordinating center in the USA on a weekly basis (RTI International, Durham, NC, USA). Consistency checks of the data were performed with the help of edit reports (across and within form edits) and double keying, which were done on a monthly basis. Missing data reports were generated on a monthly basis; these reports were then given to the relevant birth attendant by the registry administrator during these meetings for monitoring and follow-up purposes.

All personnel involved in data collection were trained in Good Clinical Practice (GCP), the study protocol and data collection, including data collection tools. GCP refresher trainings were held every 3 years, per guidelines, while refresher trainings pertaining to the study protocol and data collection on an annual basis.

The statistical analyses were conducted by the data coordinating center at RTI International. An independent data monitoring board was put in place to review data for efficacy and safety, recruitment, delivery outcomes, and adverse events as part of the ongoing studies. Descriptive statistics and risk estimates were generated for each of the binary outcomes, and point and interval estimates of relative risks were generated using log-binomial models (or Poisson regression models if log-binomial models failed to converge). Generalized estimating equation (GEE)-type variance estimates were used to control for the clustering that was inherent to the data collection mechanism. One set of models that included only a term for delivery location, with adjustment for cluster through GEE, were used to generate unadjusted point and interval estimates of delivery location effect on mortality outcomes. A second set of models that adjusted for multiple birth, preterm/term birth, sex, birth weight, maternal age, parity, number of other living children, and maternal education were used to generate adjusted estimates. Data were analyzed with SAS version 9.3 (SAS Institute, Cary, NC, USA).  $P < 0.05$  was considered statistically significant.

### 3 | RESULTS

Data from 48 956 delivery outcomes were collected during the study period. Table 1 shows the demographic characteristics of the study population. Among all the pregnancies recorded within the selected catchment areas, the consent rate of eligible women was 99.98% ( $n = 48\ 956$ ), with only 13 pregnant women (0.02%) not consenting to participate. The 7-day and 28-day follow-up rate of those who consented was 98.7% ( $n = 48\ 319$ ). Overall, 12 015 (30%) mothers were between the ages 20–24 years, and most mothers ( $n = 22\ 372$  [55%]) had more than two children. The rate of prematurity was 12% ( $n = 5808$ ), and 20 444 (51%) newborns were of male sex. The proportions of deliveries that were conducted by a nurse-midwife or a TBA were 35 738 (73%) and 13 218 (27%), respectively. Across both datasets,

36 717 (75%) of deliveries took place in a health facility compared with 12 239 (25%) in home settings. Among deliveries conducted at the health facility by TBAs, 41 (3.1%) required bag and mask resuscitation, while 623 (2.2%) required resuscitation among deliveries conducted by nurse-midwives. Similarly, 116 (1.2%) newborns required bag and mask resuscitation among deliveries conducted by TBAs at home, versus only 2 (0.4%) among home deliveries by nurse-midwives.

While the unadjusted analysis showed no evidence of differences in modified perinatal mortality, fresh stillbirth, and fresh stillbirth/day-1 neonatal mortality between home and facility deliveries, early neonatal mortality was lower among home deliveries than among facility deliveries by TBAs (Table 2). After controlling for baseline clinical characteristics and cluster in the adjusted analysis, modified perinatal mortality rate (fresh stillbirth plus early neonatal mortality), early neonatal mortality, and other measures of perinatal mortality (fresh stillbirth or day-1 neonatal mortality) were lower among home deliveries than among deliveries done at the health facility by TBAs (Table 3). However, the analyses showed no evidence that facility delivery was associated with a lower rate of fresh stillbirth. Neither the unadjusted nor the adjusted analyses showed any evidence of lower modified perinatal mortality rate, fresh stillbirth, early neonatal mortality, and other measures of perinatal mortality (fresh stillbirth or day-1 neonatal mortality) among home or facility deliveries than among deliveries done at the health facility by nurse-midwives (Tables 2 and 3).

## 4 | DISCUSSION

This large, prospective, population-based study conducted in rural communities of Zambia showed that facility deliveries by TBAs or nurse-midwives did not differ in the rates of modified perinatal mortality (fresh stillbirth plus early neonatal mortality), fresh stillbirth, and most measures of perinatal mortality. However, when controlling for baseline characteristics in the adjusted analysis, home deliveries by TBAs showed significant reductions in early neonatal mortality, modified perinatal mortality, and fresh stillbirth or day-1 neonatal mortality.

This study has key strengths. First is the rigorous data collection system using standardized data forms with high consent and 7-day and 28-day follow-up rates for both home and facility deliveries. Second, our data include deliveries and perinatal outcomes at home and facility levels. Our data reinforce the need for ongoing monitoring of deliveries done at both home and facility level and audits of perinatal adverse event outcomes. Additionally, other indicators, such as quality of maternal and neonatal services, morbidities, obstetric interventions, could also be evaluated.

The study has several limitations. First, there were a lower number of deliveries done by TBAs at a facility and by nurse-midwives at home compared with their usual delivery sites. Second, data collection relied on the birth attendant's record. Another limitation is the possible inaccuracy of maternal clinical characteristics registered by TBAs. Although we controlled for clinical characteristics, data collected at the household level by TBAs might not have accurate information about referral, postnatal care (i.e., perinatal asphyxia), and delivery complications (i.e., pre-/postpartum hemorrhage, eclampsia, pre-eclampsia,

traverse/breech delivery, etc.). Lastly, we did not collect data for the number of healthcare providers in comparison to the population within each community or the health commodities available at each health facility.

A multilevel analysis found that delivery by a skilled birth attendant in Africa was associated with a higher 1-day and early (7-day) neonatal mortality.<sup>23</sup> However, while simple and cost-effective interventions are available to prevent a large portion of these deaths, they are not available in all health facilities.<sup>24,25</sup> Additionally, while many countries might see an increase in facility deliveries, many of the nurse-midwives might not have the equipment or proficiency to handle neonatal complications.

While our study findings suggest lower modified perinatal mortality, early neonatal mortality, and fresh stillbirth/day-1 neonatal mortality among home deliveries, this may be explained by robust community structures built by our program over the years and referral bias of complicated cases to nearby health facilities.

There are several possible explanations for the lack of mortality benefit among facility deliveries by skilled birth attendants. These range from lack of understanding of danger signs leading to delays in seeking care in the health facility, delays and/or lack of skills in providing appropriate management of birth complications, lack of medical supplies and equipment for neonatal care at rural health facility level, traditional beliefs of the pregnant women, and attitudes of the healthcare providers conducting the deliveries. Lastly, while our findings showed no benefit in perinatal mortality risk in health facility deliveries compared with home deliveries, it is possible that deliveries done at the health facility were at higher risk than those done at home. Our data show that more newborns were resuscitated at the health facility by both skilled and unskilled birth attendants than at home.

Mixed methods research is necessary to better understand these factors affecting neonatal outcomes and identify means to improve mortality. Facility deliveries by nurse-midwives or other skilled birth attendants remain the recommended method of delivery, which is essential for the reduction of neonatal mortality and reaching the Sustainable Development Goals.

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TABLE 1

Demographic and clinical characteristics of study participants (N = 48 956).<sup>a</sup>

Characteristic	Home deliveries by TBAs	Facility deliveries by TBAs	Home deliveries by nurse-midwife	Facility deliveries by nurse-midwife
Multiple birth	154/9402 (1.6)	12/1331 (0.9)	11/449 (2.4)	462/28 635 (1.6)
Term birth	7906/8972 (88.1)	1146/1264 (90.7)	368/430 (85.6)	23 657/27 749 (85.3)
Male sex	4805/9397 (51.1)	706/1330 (53.1)	219/449 (48.8)	14 714/28 613 (51.4)
Birth weight, g				
2500 g	9059/9398 (96.4)	1268/1330 (95.3)	434/448 (96.9)	26 728/28 625 (93.4)
1500–2499	287/9398 (3.1)	55/1330 (4.1)	14/448 (3.1)	1662/28 625 (5.8)
1000–1499	34/9398 (0.4)	5/1330 (0.4)	0/448 (0.0)	165/28 625 (0.6)
<1000	18/9398 (0.2)	2/1330 (0.2)	0/448 (0.0)	70/28 625 (0.2)
Age of mother, y				
<20	1995/9319 (21.4)	402/1325 (30.3)	94/444 (21.2)	7283/28 346 (25.7)
20–24	2844/9319 (30.5)	364/1325 (27.5)	135/444 (30.4)	8672/28 346 (30.6)
25–30	2433/9319 (26.1)	277/1325 (20.9)	115/444 (25.9)	7017/28 346 (24.8)
>30	2047/9319 (22.0)	282/1325 (21.3)	100/444 (22.5)	5374/28 346 (19.0)
Parity				
0	1823/9313 (19.6)	401/1322 (30.3)	87/444 (19.6)	8647/28 363 (30.5)
1	1865/9313 (20.0)	247/1322 (18.7)	86/444 (19.4)	5914/28 363 (20.9)
2	5625/9313 (60.4)	674/1322 (51.0)	271/444 (61.0)	13 802/28 363 (48.7)
Bag and mask ventilation				
Yes	116/9367 (1.2)	41/1329 (3.1)	2/447 (0.4)	623/28 495 (2.2)
No	9251/9367 (98.8)	1288/1329 (96.9)	445/447 (99.6)	27 872/28 495 (97.8)

Abbreviation: TBA, traditional birth attendant.

<sup>a</sup> Values are given as number/number available (percentage), unless otherwise indicated.

**TABLE 2**

Unadjusted outcomes by home and facility deliveries and birth attendant.<sup>a</sup>

Outcome	Home deliveries by TBAs <sup>b</sup>	Facility deliveries by TBAs <sup>b</sup>	OR (95% CI)	P value	Home deliveries by nurse-midwife <sup>b</sup>	Facility deliveries by nurse-midwife <sup>b</sup>	OR (95% CI)	P value
Modified perinatal mortality	138/9330 (14.8)	27/1311 (20.6)	0.80 (0.55–1.16)	0.2362	12/440 (27.3)	581/20 020 (20.7)	1.20 (0.74–1.93)	0.4578
Fresh stillbirth	64/9402 (6.8)	8/1331 (6.0)	1.26 (0.75–2.11)	0.3885	5/449 (11.1)	273/28 635 (9.5)	1.10 (0.57–2.15)	0.7693
Early neonatal mortality	74/9266 (8.0)	13/1303 (14.6)	0.57 (0.37–0.88)	0.0105	7/435 (16.1)	308/27 747 (11.1)	1.32 (0.66–2.61)	0.4326
Fresh stillbirth or day-1 neonatal mortality	105/9330 (11.3)	19/1311 (14.5)	0.85 (0.50–1.43)	0.5425	10/440 (22.7)	423/28 020 (15.1)	1.39 (0.89–2.20)	0.1512

Abbreviations: TBA, traditional birth attendant; OR, odds ratio; CI, confidence interval.

<sup>a</sup>Values are given as number/number available (percentage), unless otherwise indicated.

<sup>b</sup>Rate per 1000 women.

TABLE 3

Adjusted outcomes by home and facility deliveries and birth attendant.<sup>a</sup>

Outcome	Home deliveries by TBAs <sup>b</sup>	Facility deliveries by TBAs <sup>b</sup>	Adjusted OR (95% CI)	P value	Home deliveries by nurse-midwife <sup>b</sup>	Facility deliveries by nurse-midwife <sup>b</sup>	Adjusted OR (95% CI)	P value
Modified perinatal mortality	138/9330 (14.8)	27/1311 (20.6)	0.63 (0.45–0.88)	0.0067	12/440 (27.3)	581/20 020 (20.7)	1.07 (0.98–1.18)	0.1272
Fresh stillbirth	64/9402 (6.8)	8/1331 (6.0)	1.03 (0.64–1.66)	0.8908	5/449 (11.1)	273/28 635 (9.5)	1.19 (0.67–2.10)	0.5497
Early neonatal mortality	74/9266 (8.0)	13/1303 (14.6)	0.48 (0.33–0.69)	<0.0001	7/435 (16.1)	308/27 747 (11.1)	1.22 (0.98–1.51)	0.0739
Fresh stillbirth or day-1 neonatal mortality	105/9330 (11.3)	19/1311 (14.5)	0.55 (0.38–0.80)	0.0015	10/440 (22.7)	423/28 020 (15.1)	1.08 (0.99–1.18)	0.0900

Abbreviation: TBA, traditional birth attendant; OR, odds ratio; CI, confidence interval.

<sup>a</sup>Values are given as number/number available (percentage), unless otherwise indicated.<sup>b</sup>Rate per 1000 women.