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Maternal and newborn outcomes at a tertiary care hospital in Lusaka, Zambia, 2008– 2012

Bellington Vwalika[1,2,3], **Marie C.D. Stoner**[4], **Mulindi Mwanahamuntu**[1,2], **K. Cherry Liu**[3], **Eugene Kaunda**[1], **Getrude G. Tshuma**[1,2], **Somwe W. Somwe**[5,6], **Yusuf Ahmed**[1,2], **Elizabeth M. Stringer**[3], **Jeffrey S.A. Stringer**[3], and **Benjamin H. Chi**[2,3,*]

[1]Department of Obstetrics and Gynaecology, University Teaching Hospital, Lusaka, Zambia

[2]Department of Obstetrics and Gynaecology, University of Zambia School of Medicine, Lusaka, Zambia

[3]Department of Obstetrics and Gynecology, University of North Carolina School of Medicine, Chapel Hill, NC, USA

[4]Department of Epidemiology, University of North Carolina Gillings School of Global Public Health, Chapel Hill, NC, USA

[5]Department of Paediatrics, University Teaching Hospital, Lusaka, Zambia

[6]Department of Paediatrics, University of Zambia School of Medicine, Lusaka, Zambia

Abstract

Objective—To measure key obstetric and neonatal outcomes recorded at a tertiary hospital in Zambia over a 5-year period.

Methods—A retrospective analysis was conducted among women who had delivered at the University Teaching Hospital in Lusaka, between January 1, 2008, and December 31, 2012. Data were extracted from electronic medical records. The main outcomes were maternal mortality, cesarean delivery, prenatal or intrapartum hemorrhage, stillbirth, a 5-minute Apgar score of less than 7, and admission to the neonatal intensive care unit.

Results—A total of 62 470 deliveries were recorded. Rates of maternal mortality, cesarean delivery, and hemorrhage during pregnancy all declined over time. Decreased admissions to the neonatal intensive care unit were observed; however, the rate spiked temporarily in late 2011 and early 2012 before returning to previous levels. The proportion of stillbirths remained stable over time but reports of a 5-minute Apgar score of less than 7 rose.

*Correspondence : Benjamin H. Chi, Department of Obstetrics and Gynecology, University of North Carolina School of Medicine, Campus Box 7577, MBRB 4300C, Chapel Hill, NC 27599-7577, USA. bchi@med.unc.edu.

Conflict of interest

The authors have no conflicts of interest.

Author contributions

BV and BHC designed the analysis, interpreted the data, and wrote the paper. MCDS and KCL managed the observational database, conducted the statistical analysis, interpreted the data, and critically revised the manuscript. MM, EK, GGT, SWS, YA, EMS, and JSAS supported data collection, contributed to the analysis plan, interpreted study findings, and critically revised the manuscript. All authors have reviewed and approved the submitted version; all have agreed to address any questions that might arise about the accuracy or integrity of the present study.

Conclusion—Routinely collected obstetric and neonatal data could aid ongoing program monitoring and should be used to guide quality improvement activities.

Keywords

Africa; Hospital; Obstetric outcomes; Pregnancy; Prenatal care; Trends; Zambia

1 INTRODUCTION

Similar to other Sub-Saharan African countries, the health risks faced by pregnant women and newborns in Zambia are unacceptably high. A Zambian woman has a one in 37 lifetime risk of dying from complications of childbirth [1]. Despite substantial reductions over the past two decades, the national maternal mortality rate was 315 per 100 000 live births in 2013 [2]. This rate is 17 times higher than that of North America [2]. Newborns in Zambia are also at high risk of morbidity and mortality [3]. Although substantial investments have been made to accelerate progress for both mothers and their offspring [4], such efforts must rely on strong health systems that—given the ubiquity of childbirth—must extend from the largest city to the most remote region of the country.

Decentralized maternal and child health services have greatly expanded coverage; however, hospitals remain the cornerstone of pregnancy related care. High-level obstetric services, such as cesarean delivery and blood transfusion, must be available in emergency referral situations but these facilities are often overburdened and understaffed. As hospitals in Africa seek to improve the quality of their services, monitoring of clinical outcomes becomes a critical tool for evaluating health systems and assessing progress [5–7]. Nonetheless, few hospitals are currently equipped to perform such activities routinely [8–10]. Most government registers are designed for low-risk obstetrics and might not capture the nuances of clinical diagnosis and management. Medical complications are often underdiagnosed and inadequately treated, tending to be reported only when “near misses” or deaths occur. In addition, poor maternal and newborn outcomes are often recorded in separate, unlinked registers, which might present challenges for comprehensive review and quality improvement efforts.

The aim of the present study was to describe trends in key obstetric and neonatal outcomes recorded at a tertiary care facility in Zambia over a 5-year period.

2 MATERIALS AND METHODS

A retrospective analysis was conducted among women who delivered at the University Teaching Hospital (UTH) in Lusaka, Zambia, between January 1, 2008, and December 31, 2012. The present study was approved by the ethical review committees at the University of Zambia (Lusaka, Zambia) and the University of North Carolina (Chapel Hill, NC, USA). Individual informed consent was not sought because the data were collected as part of routine medical care.

Located in Zambia’s capital city, UTH serves a primary catchment population of approximately 2 million. This facility is the province’s only tertiary care center and, in this

capacity, UTH receives a high volume of transfers; however, it also provides primary-level care for individuals who live in neighboring communities. The 17-bed labor ward offers 24-hour coverage by midwives, doctors in training, and qualified obstetrician–gynecologists. With three operating theatres, including one dedicated to obstetrics, UTH was the main facility providing cesarean delivery in the Lusaka public sector during the present study period. The UTH neonatal intensive care unit (NICU) is located 150 m from the delivery ward and is staffed by specialist pediatricians and a dedicated nursing team. Patients who are referred to UTH from primary care facilities are provided health services free of charge. Individuals who seek care at UTH without a formal referral (i.e. self-referrals) incur a one-time fee equivalent to US$15.

The present study used observational data from the Zambia Electronic Perinatal Record System (ZEPRS), which collects detailed medical information about prenatal, intrapartum, and newborn care across the Lusaka public health sector [11]. This system has been implemented across 25 health centers, including 13 with delivery facilities [11]. The ZEPRS application employs real-time data entry at the point of care. A unique identification number is automatically generated for all neonates on delivery and is linked with the mother's medical record. Data are uploaded on a central server and their quality regularly assessed.

The present study included women with pregnancy information recorded in ZEPRS who had delivered at UTH. This cohort was compared with a group of women who had delivered at primary care facilities in Lusaka. Demographic characteristics assessed included medical history, obstetric history, and pregnancy outcomes. At the time of enrollment, fetuses with an estimated gestational age of less than 20 weeks were dated according to the mother's last menstrual period. For those with an estimated gestational age of at least 20 weeks, a simple algorithm was implemented that considered the last menstrual period and fundal height at clinical examination [11]. If the results obtained by these two methods were more than 3 weeks apart, gestational age was determined from fundal height alone.

Maternal outcome measures included maternal mortality, cesarean delivery, and prenatal or intrapartum hemorrhage. Adverse neonatal outcomes included stillbirth, a low 5-minute Apgar score (<7), and NICU admission. Stillbirth was defined as the delivery of a non-viable fetus at a gestational age of 28 weeks or older. This event was further subclassified as "fresh" (suggestive of intrapartum demise) or "macerated" (suggestive of prenatal demise) on the basis of degenerative skin changes on physical examination at birth [12,13].

The data were analyzed using SAS version 9.3 (SAS Institute, Cary, NC, USA). The data were divided into 3-month windows from the first quarter to the fourth quarter of each year. Point estimates with 95% confidence intervals were calculated for each outcome of interest. Graphical representations were generated of the observed percentages over time. The time trend was then modeled using two separate approaches: a LOESS curve (a non-parametric method that fits simple models to localized data subsets without imposing a predefined structure) and a linear regression line (to determine the relationship between quarter and each outcome of interest). $P<0.05$ was considered statistically significant.

3 RESULTS

The cohort flow is outlined in Figure 1. A total of 323 115 women sought pregnancy-related care in Lusaka and had health information entered into ZEPRS during the present study period. Of these women, 232 578 (72.0%) had both prenatal and delivery information available. The analysis cohort comprised the 62 470 deliveries that occurred at UTH. Most of the women who delivered at UTH had received all of their prenatal care from other sites in Lusaka (n=55 099 [88.2%]).

Table 1 compares the characteristics of the women who delivered at UTH with those of the women who delivered at other sites in Lusaka (n=170 108). Only marginal differences were noted across the numerous demographic and medical characteristics assessed. Although the comparisons were statistically significant—probably owing to the large sample sizes—the incremental differences did not seem to be clinically meaningful. By contrast, important differences were noted in medical history, reflecting the role of UTH as Zambia's sole tertiary care center. For example, women who delivered at UTH reported higher rates of previous stillbirth, preterm birth, and preconception hypertension than did those who delivered elsewhere. As shown in Tables 1 and 2, large between-group differences were found for both maternal and neonatal outcomes, with higher rates of maternal mortality, stillbirth, low 5-minute Apgar score, and early neonatal death recorded at UTH than at the other sites (P<0.01 for all comparisons).

Figure 2 shows that only minor fluctuations in the quarterly number of deliveries and newborns were detected at UTH over the 5-year observation period. Trends in maternal outcomes are presented in Figure 3. General declines in maternal mortality ratio, cesarean delivery, and hemorrhage during pregnancy were observed over time. Among the neonatal outcomes (Figure 4), a general decline was detected in NICU admissions, although the rate seemed to spike temporarily in late 2011 and early 2012 before returning to previous levels. Similar improvements in the rates of stillbirth or a low 5-minute Apgar score were not observed. Indeed, there appeared to be a general rise over time in the proportion of newborns with a 5-minute Apgar score of less than 7.

4 DISCUSSION

The present study documented temporal trends in maternal and neonatal outcomes at a tertiary care hospital in an urban African setting. The rates of complications recorded at UTH reflected the high burden of disease managed at such referral centers. Important declines in several key indicators, including maternal mortality and pregnancy related hemorrhage, were observed from 2008 to 2012. These positive findings coincided with increased investments in clinical training and health infrastructure at UTH.

The data analyzed in the present study were obtained from an electronic medical record system (ZEPRS). Use of such systems has increased in Sub-Saharan Africa, across a broad range of disciplines and healthcare settings [14]. These platforms have the capacity to collect large amounts of patient-level information in a standardized way and at volumes otherwise impossible for registers or paper-based files. Integrated into quality improvement

methodologies, such routinely collected data can be used by frontline providers to identify bottlenecks, design interventions, and evaluate performance [15]. The importance of such systems might be greater in secondary or tertiary care settings than in primary care facilities. A systematic review of 27 studies found that quality improvement initiatives in hospitals had slower achievement and more limited maintenance of performance targets than in health centers, possibly owing to the complexity of the care provided, limited engagement of health providers, and high staff turnover [16].

The key maternal and neonatal outcomes assessed in the present study were broken down into 3-month windows. A striking characteristic of the analysis was the high degree of variability observed from one quarter to another. Such variation was detected not only among rare events, such as maternal mortality, but also among frequent outcomes, such as cesarean delivery. The observed fluctuations emphasized the importance of ongoing monitoring and evaluation activities at the programmatic level. The findings also highlighted the need for such data to inform clinical studies and implementation research, as key incidence and prevalence outcomes can change over time.

Few studies have reported on obstetric outcomes in an urban tertiary care hospital in Africa. The declines in maternal mortality recorded at UTH were consistent with cross-sectional surveys in Zambia [17,18]. The reported maternal mortality ratio at UTH (215 per 100 000 live births) was lower than both the 2013–2014 Demographic and Health Survey (398 per 100 000 live births) [18] and the Global Burden of Disease Study (315 per 100 000 live births) [2]. The accessibility of institutional delivery, coupled with low rates of home delivery in Lusaka, probably contributed to the lower estimate reported for UTH. At 6.0%, the rate of stillbirth in the present study was substantially higher than rates previously reported in Lusaka [19] and other parts of Zambia [20]. Nearly all complications of pregnancy were recorded at much higher rates at UTH than at the other facilities in Lusaka, a reflection of local referral patterns. The spike in NICU admissions observed over a 6-month period in 2011–2012 coincided with an increasing trend for a 5-minute Apgar score of less than 7. A review of the labor ward registers at UTH uncovered an increase in the diagnosis of “preterm birth with asphyxia” during this time frame; however, this finding could not be verified because the hospital’s NICU registers from 2011–2012 were lost. This situation highlighted the difficulties in analyzing and interpreting retrospective data and emphasized the importance of ongoing programmatic monitoring.

Several factors probably contributed to the temporal trends detected in the present study. First, the observation window overlapped with that of the Medical Education Partnership Initiative, which sought to enhance obstetric and neonatal clinical training at UTH [21]. Jointly funded by the Fogarty International Center and the US President’s Emergency Plan for AIDS Relief, the Medical Education Partnership Initiative supported increased faculty supervision, structured skills-building exercises (e.g. teaching simulations), and regular perinatal audits. This initiative might have exerted a direct and positive impact on clinical outcomes, while providing enhanced ascertainment of negative outcomes (e.g. low Apgar scores). Second, incremental improvements in health infrastructure could have contributed to improved outcomes. Increasing investments in blood transfusion services probably played an important part in reducing maternal mortality. Increased government resources were also

allocated to clinical staff and emergency transportation via ambulances (personal communication, G. Tshuma, March 2016). Third, the shifting dynamics of patient referrals in Lusaka might have played an important part in the observed trends. The Levy Mwanawasa General Hospital opened in August 2011 as Lusaka's secondary-level public hospital and so probably diverted a proportion of complicated obstetric cases from UTH. Finally, the per-person gross national income in Zambia rose from $1160 in 2008 to $1650 in 2012 [22]. In 2011, the World Bank reclassified Zambia as a lower middle-income country [23]. These secular changes across Zambia—and certainly in Lusaka—might have led to increased health service utilization in the private health sector rather than in public facilities such as UTH.

The analytical approach used in the present study was not novel; however, it enabled the description of a robust framework for future obstetric research. Monitoring outcomes that reflect the quality of care delivered at UTH could have an important role in program improvement. Fresh stillbirths and postpartum hemorrhage are two examples of such outcomes that might be used to track preventable adverse pregnancy outcomes over time. With the availability of sophisticated medical records, process indicators (e.g. time to emergency cesarean delivery) could also be tracked to monitor performance. Classification of cesarean delivery according to the 10-category Robson system [24] could be conducted to help characterize local needs and priorities for obstetric care. This approach might be particularly interesting given the temporal fluctuations in cesarean delivery observed in the present study.

Limitations of the present study must be acknowledged. First, the findings reflected the clinical care provided in an African tertiary facility. However, even within UTH, there are different source populations that represent differing levels of obstetric risk and the composition of each group may change over time. Inclusion of referral status—or objective assessment of obstetric risk—could greatly enhance future analyses. Second, similar to other observational databases [25], ZEPRS faces problems with missing data. This deficit could lead to bias; however, these missing data were probably random (i.e. non-differential) suggesting that the longitudinal comparisons were sound. Third, the analysis focused only on health outcomes that could be objectively measured and easily ascertained. Important conditions, such as preterm delivery and severe morbidities (e.g. "near misses") were not included owing to the inherent challenges to accurate diagnoses. Similarly, data on specific clinical practices could provide insight into the quality of care; however, such process indicators were not readily available. Fourth, the clinical care that precipitated or resulted from these health outcomes was not routinely described. Routine review of such process data could help to identify barriers to optimal care and to chart progress made in addressing them [26]. Finally, although there were several initiatives at UTH over the present study period, there were insufficient data about their timing or implementation to measure impact. Nevertheless, the analysis highlighted the potential of ZEPRS for implementation research, including interrupted time-series evaluations.

In summary, temporal variations across numerous clinical indicators were detected over a 5-year observation period in an African tertiary care setting. Monitoring frameworks such as

ZEPRS can play a valuable part in quality improvement activities, particularly where disease burden is great and clinical management is complicated.

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References

1. UNICEF. [Accessed October 2, 2016] Country profile: Zambia. http://www.unicef.org/infobycountry/zambia_statistics.html - 25
2. Kassebaum NJ, Bertozzi-Villa A, Coggeshall MS, Shackelford KA, Steiner C, Heuton KR, et al. Global, regional, and national levels and causes of maternal mortality during 1990–2013: a systematic analysis for the Global Burden of Disease Study 2013. Lancet. 2014; 384(9947):980–1004. [PubMed: 24797575]
3. Wang H, Liddell CA, Coates MM, Mooney MD, Levitz CE, Schumacher AE, et al. Global, regional, and national levels of neonatal, infant, and under-5 mortality during 1990–2013: a systematic analysis for the Global Burden of Disease Study 2013. Lancet. 2014; 384(9947):957–979. [PubMed: 24797572]
4. [Accessed on June 14, 2016] Saving mothers, giving life: Zambia. http://savingmothersgivinglife.org/our-work/zambia.aspx
5. AbouZahr C, Boerma T. Health information systems: the foundations of public health. Bull World Health Organ. 2005; 83(8):578–583. [PubMed: 16184276]
6. Mutale W, Chintu N, Amoroso C, Awoonor-Williams K, Phillips J, Baynes C, et al. Improving health information systems for decision making across five sub-Saharan African countries: Implementation strategies from the African Health Initiative. BMC Health Serv Res. 2013; 13(Suppl 2):S9. [PubMed: 23819699]
7. McNatt Z, Linnander E, Endeshaw A, Tatek D, Conteh D, Bradley EH. A national system for monitoring the performance of hospitals in Ethiopia. Bull World Health Organ. 2015; 93(10):719–726. [PubMed: 26600614]
8. Garrib A, Stoops N, McKenzie A, Dlamini L, Govender T, Rohde J, et al. An evaluation of the District Health Information System in rural South Africa. S Afr Med J. 2008; 98(7):549–552. [PubMed: 18785397]
9. Mate KS, Bennett B, Mphatswe W, Barker P, Rollins N. Challenges for routine health system data management in a large public programme to prevent mother-to-child HIV transmission in South Africa. PLoS One. 2009; 4(5):e5483. [PubMed: 19434234]
10. Mphatswe W, Mate KS, Bennett B, Ngidi H, Reddy J, Barker PM, et al. Improving public health information: a data quality intervention in KwaZulu-Natal, South Africa. Bull World Health Organ. 2012; 90(3):176–182. [PubMed: 22461712]
11. Chi BH, Vwalika B, Killam WP, et al. Implementation of the Zambia electronic perinatal record system for comprehensive prenatal and delivery care. Int J Gynecol Obstet. 2011; 113(2):131–136.
12. McClure EM, Nalubamba-Phiri M, Goldenberg RL. Stillbirth in developing countries. Int J Gynecol Obstet. 2006; 94(2):82–90.
13. Lawn J, Shibuya K, Stein C. No cry at birth: global estimates of intrapartum stillbirths and intrapartum-related neonatal deaths. Bull World Health Organ. 2005; 83(6):409–417. [PubMed: 15976891]
14. Akanbi MO, Ocheke AN, Agaba PA, Daniyam CA, Agaba EI, Okeke EN, et al. Use of Electronic Health Records in sub-Saharan Africa: Progress and challenges. J Med Trop. 2012; 14(1):1–6. [PubMed: 25243111]
15. Ramaswamy R, Iracane S, Srofenyoh E, Bryce F, Floyd L, Kallam B, et al. Transforming Maternal and Neonatal Outcomes in Tertiary Hospitals in Ghana: An Integrated Approach for Systems Change. J Obstet Gynaecol Can. 2015; 37(10):905–914. [PubMed: 26606708]

16. Franco LM, Marquez L. Effectiveness of collaborative improvement: evidence from 27 applications in 12 less-developed and middle-income countries. BMJ quality & safety. 2011; 20(8):658–665.
17. Central Statistical Office [Zambia], Central Board of Health [Zambia], ORC Macro. Zambia Demographic and Health Survey 2007. Calverton, Maryland, USA: Central Statistical Office, Central Board of Health, and ORC Macro; 2009.
18. Central Statistical Office [Zambia], Central Board of Health [Zambia], ORC Macro. Zambia Demographic and Health Survey 2013–2014. Calverton, Maryland, USA: Central Statistical Office, Central Board of Health, and ORC Macro; 2015.
19. Stringer EM, Vwalika B, Killam WP, Giganti MJ, Mbewe R, Chi BH, et al. Determinants of stillbirth in Zambia. Obstet Gynecol. 2011; 117(5):1151–1159. [PubMed: 21508755]
20. McClure EM, Saleem S, Goudar SS, Moore JL, Garces A, Esamai F, et al. Stillbirth rates in low-middle income countries 2010 – 2013: a population-based, multi-country study from the Global Network. Reproductive health. 2015; 12(Suppl 2):S7.
21. Mullan F, Frehywot S, Omaswa F, Sewankambo N, Talib Z, Chen C, et al. The Medical Education Partnership Initiative: PEPFAR's effort to boost health worker education to strengthen health systems. Health affairs. 2012; 31(7):1561–1572. [PubMed: 22778346]
22. World Bank. [Accessed June 14, 2016] Data: GNI per capita, Atlas method. http://data.worldbank.org/indicator/NY.GNP.PCAP.CD
23. World Bank. [Accessed October 31, 2016] World Bank Country and Lending Groups. https://datahelpdesk.worldbank.org/knowledgebase/articles/906519
24. Betran AP, Vindevoghel N, Souza JP, Gulmezoglu AM, Torloni MR. A systematic review of the Robson classification for caesarean section: what works, doesn't work and how to improve it. PLoS One. 2014; 9(6):e97769. [PubMed: 24892928]
25. Kiragga AN, Castelnuovo B, Schaefer P, Muwonge T, Easterbrook PJ. Quality of data collection in a large HIV observational clinic database in sub-Saharan Africa: implications for clinical research and audit of care. J Int AIDS Soc. 2011; 14:3. [PubMed: 21251327]
26. Srofenyoh E, Ivester T, Engmann C, Olufolabi A, Bookman L, Owen M. Advancing obstetric and neonatal care in a regional hospital in Ghana via continuous quality improvement. Int J Gynecol Obstet. 2012; 116(1):17–21.

Synopsis

Declines in several adverse pregnancy outcomes—including maternal mortality—were observed in a tertiary care setting in Lusaka, Zambia, from 2008 to 2012.

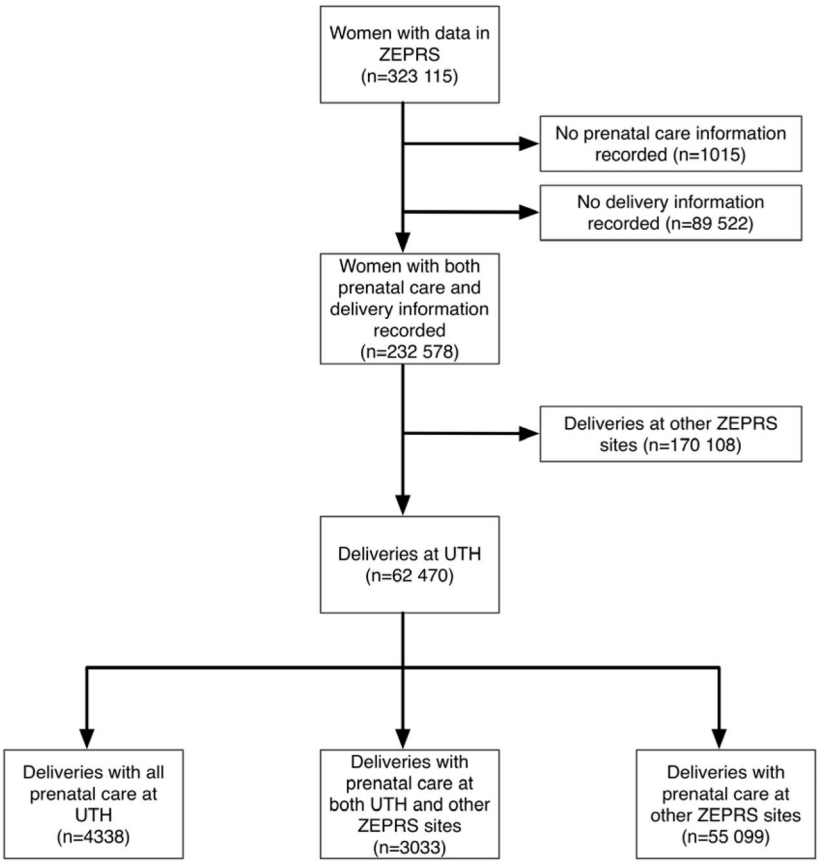
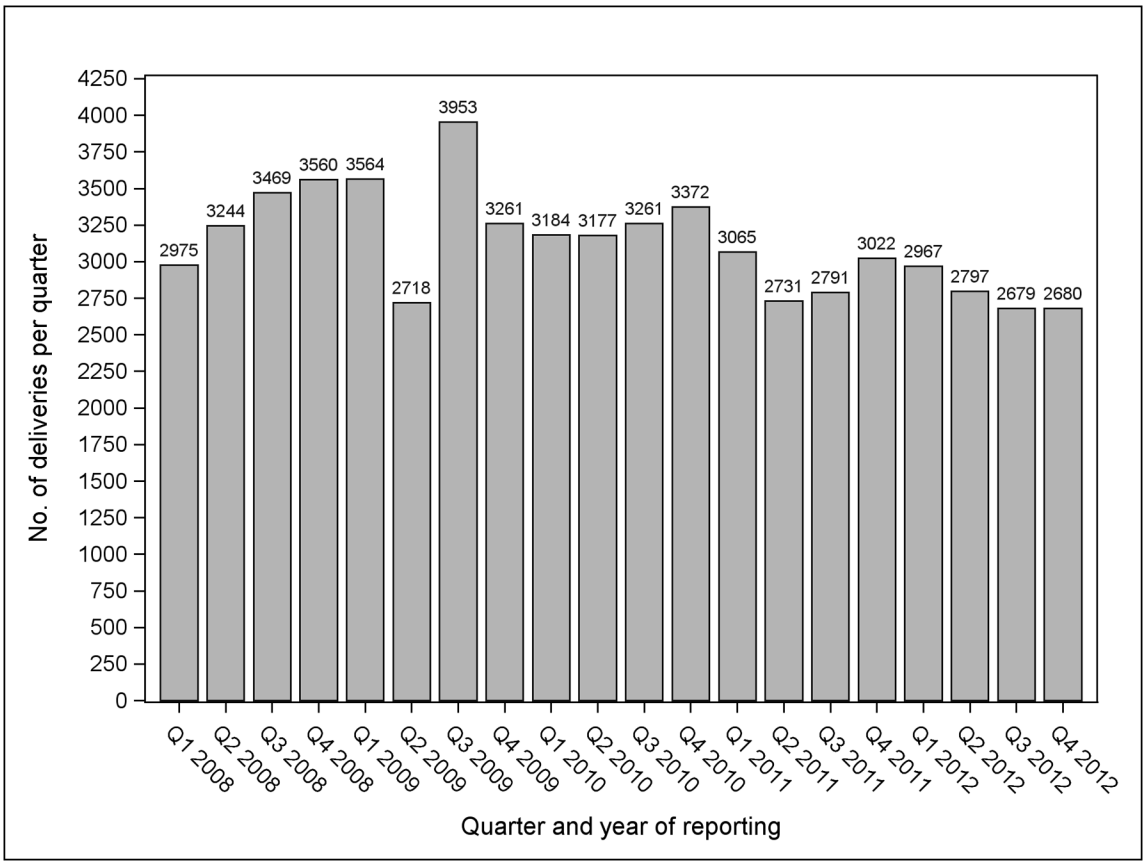


Figure 1.

Flow of women who delivered in the Lusaka public-health sector between January 1, 2008, and December 31, 2012, and who had their prenatal care and delivery information recorded in the ZEPRS. Abbreviations: ZEPRS, Zambia Electronic Perinatal Record System; UTH, University Teaching Hospital.



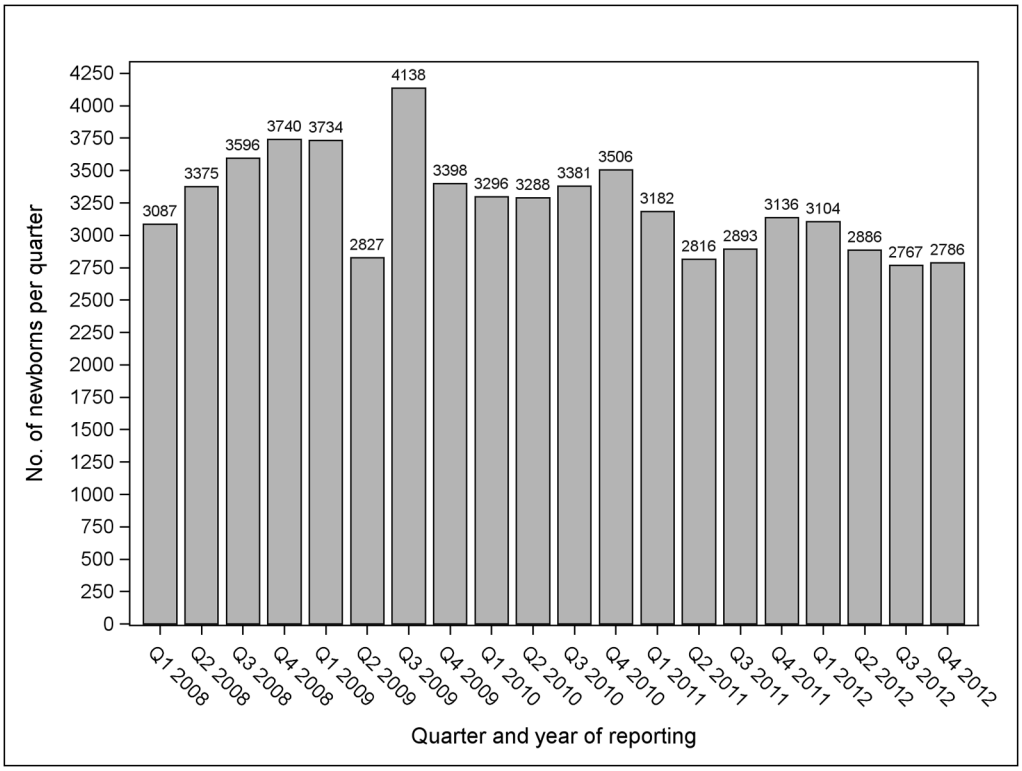
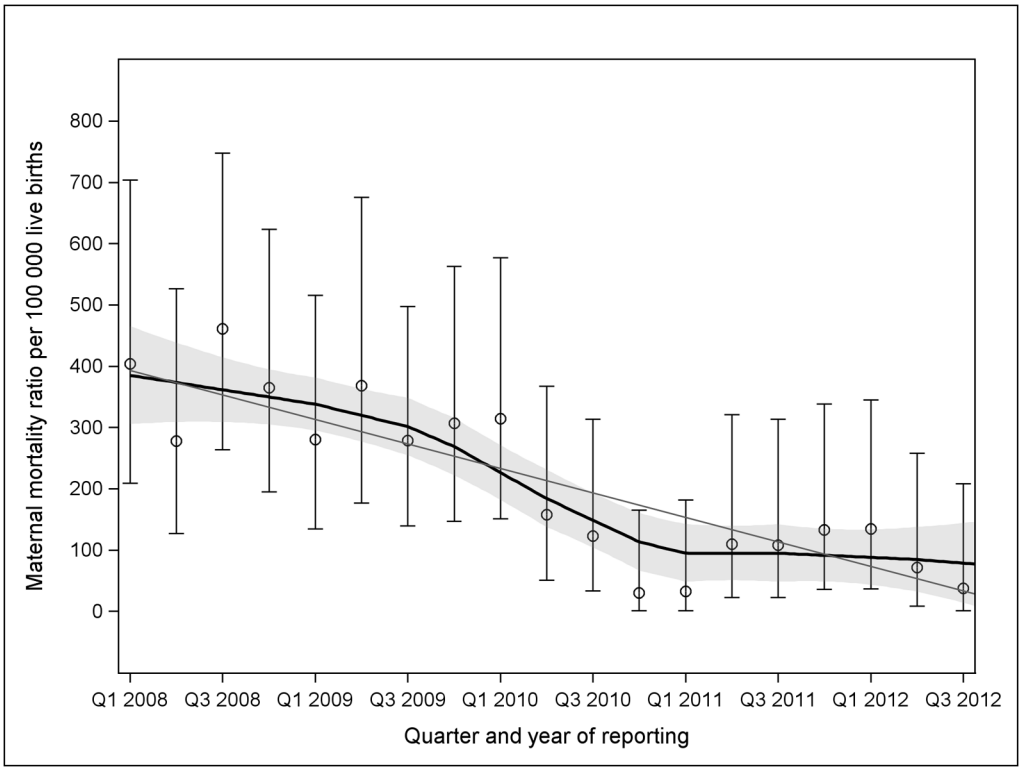
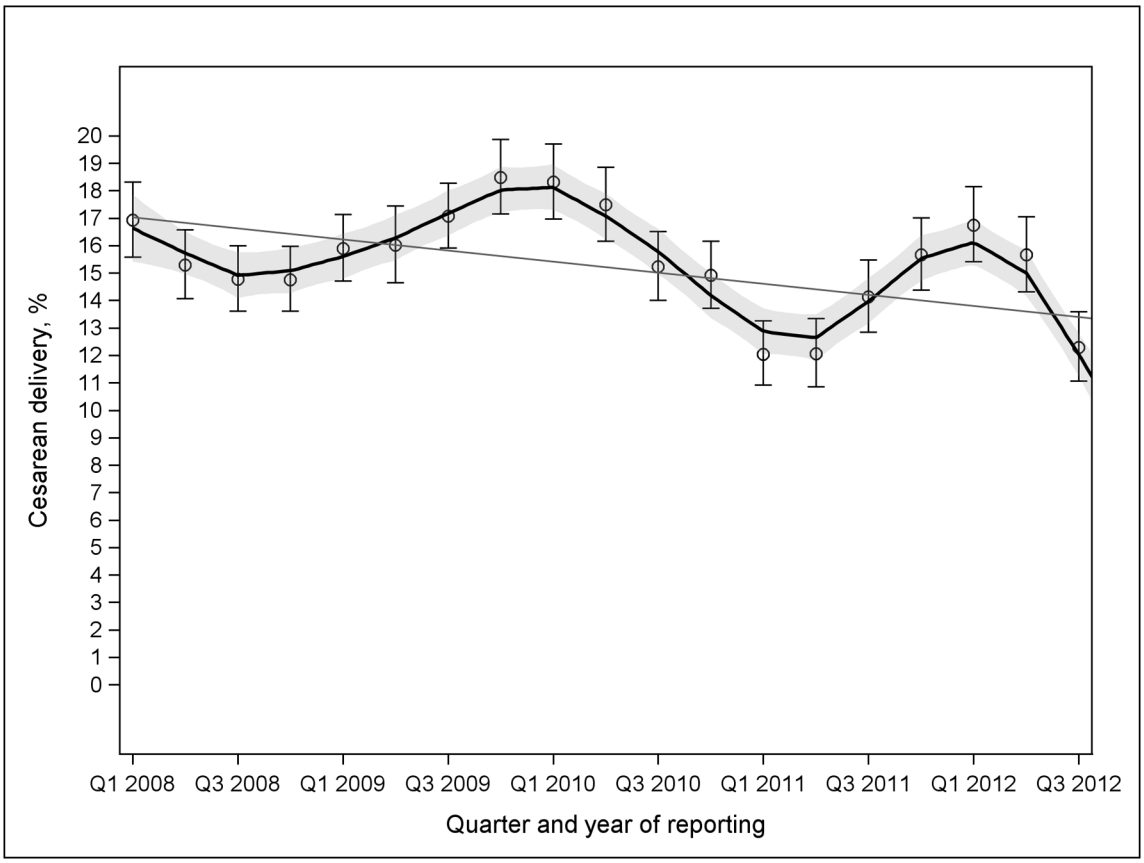


Figure 2.

Histograms depicting (A) the number of deliveries and (B) the number of newborns recorded per quarter (Q1–Q4) at the University Teaching Hospital in Lusaka, Zambia, between January 1, 2008, and December 31, 2012.





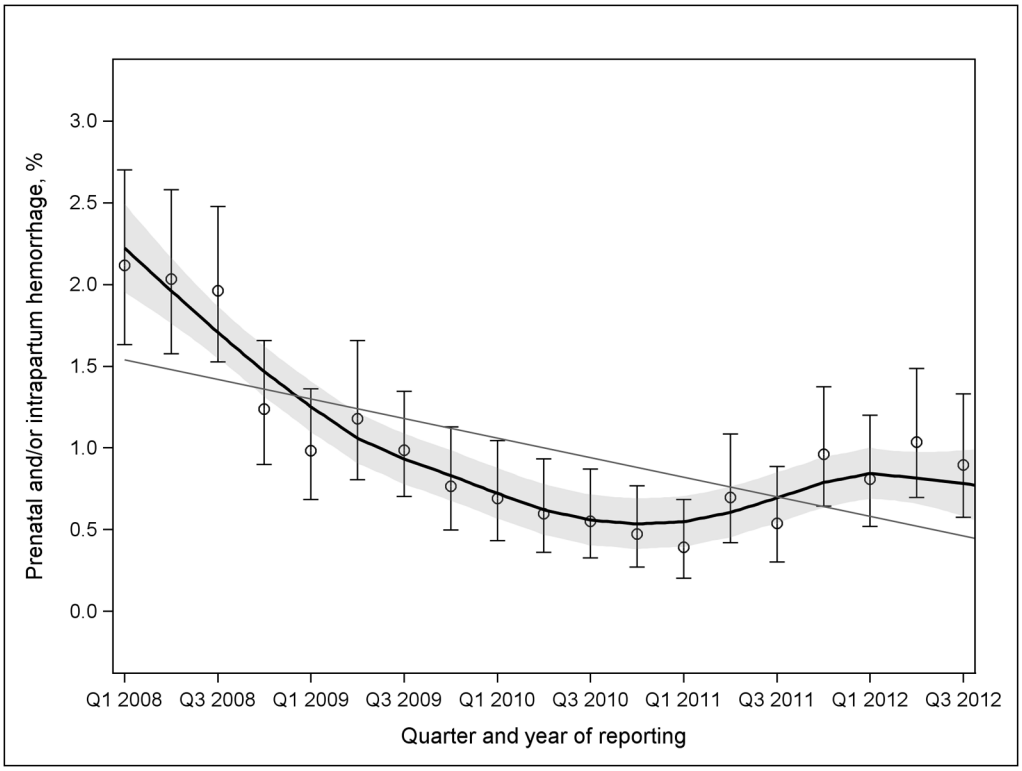
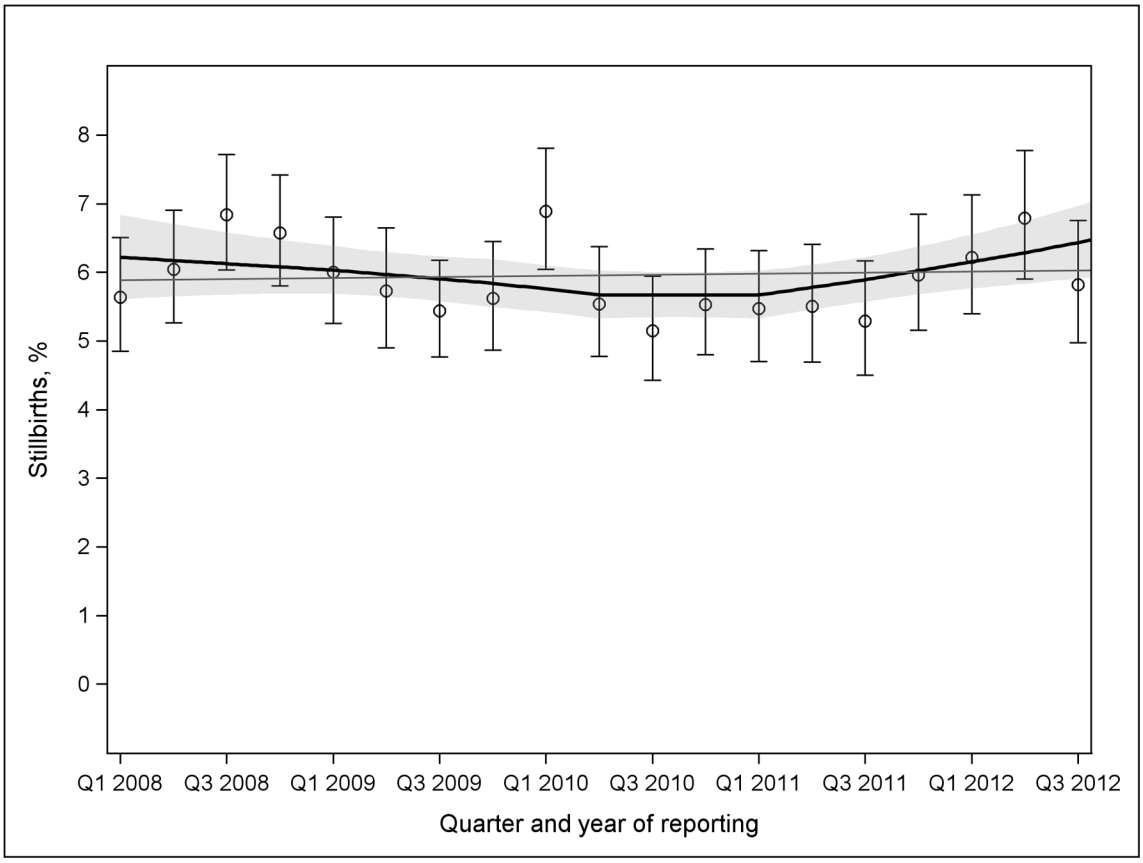
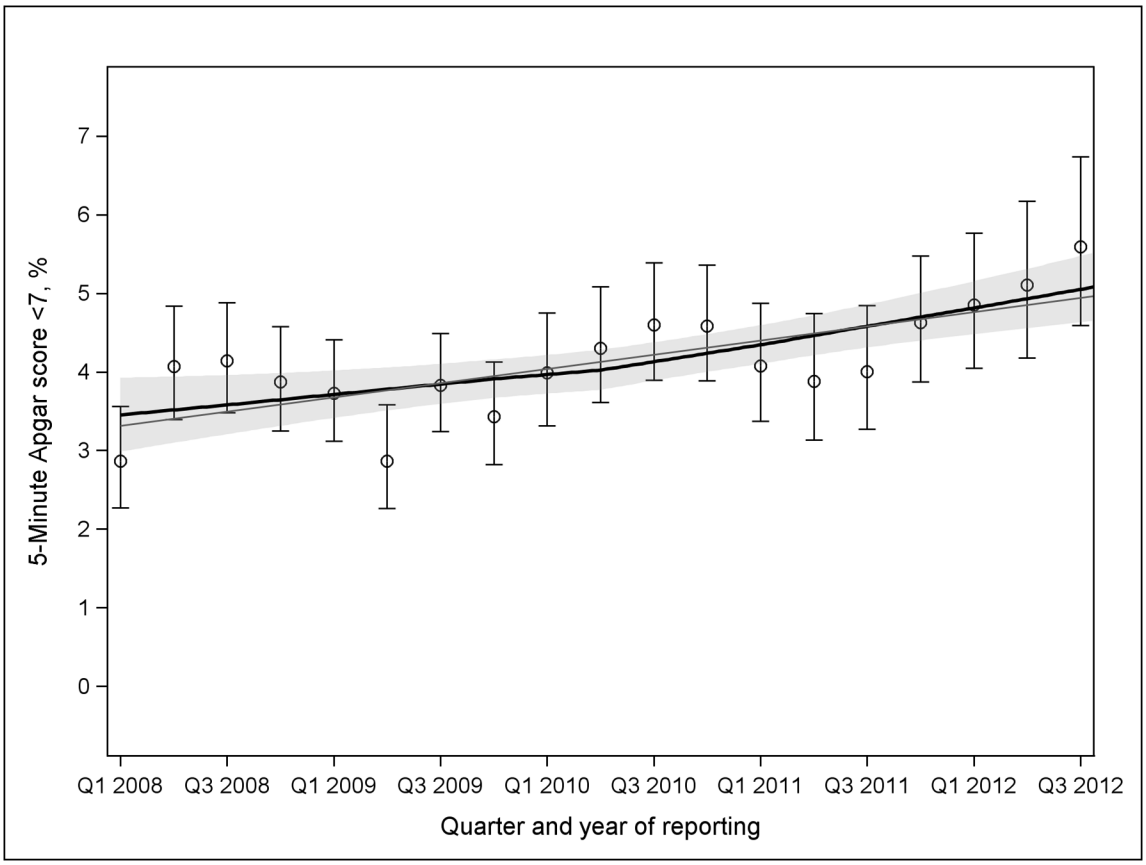


Figure 3.

Maternal outcomes among women who delivered at the University Teaching Hospital in Lusaka, Zambia, between January 1, 2008, and December 31, 2012. Outcomes assessed per quarter (Q1–Q4) of each year were (A) maternal mortality ratio, (B) cesarean delivery, and (C) prenatal and/or intrapartum hemorrhage. Error bars show 95% confidence intervals. Thick black line represents the LOESS nonparametric curve and the grey shading represents its 95% confidence interval. The thin black line is the fitted linear regression line.





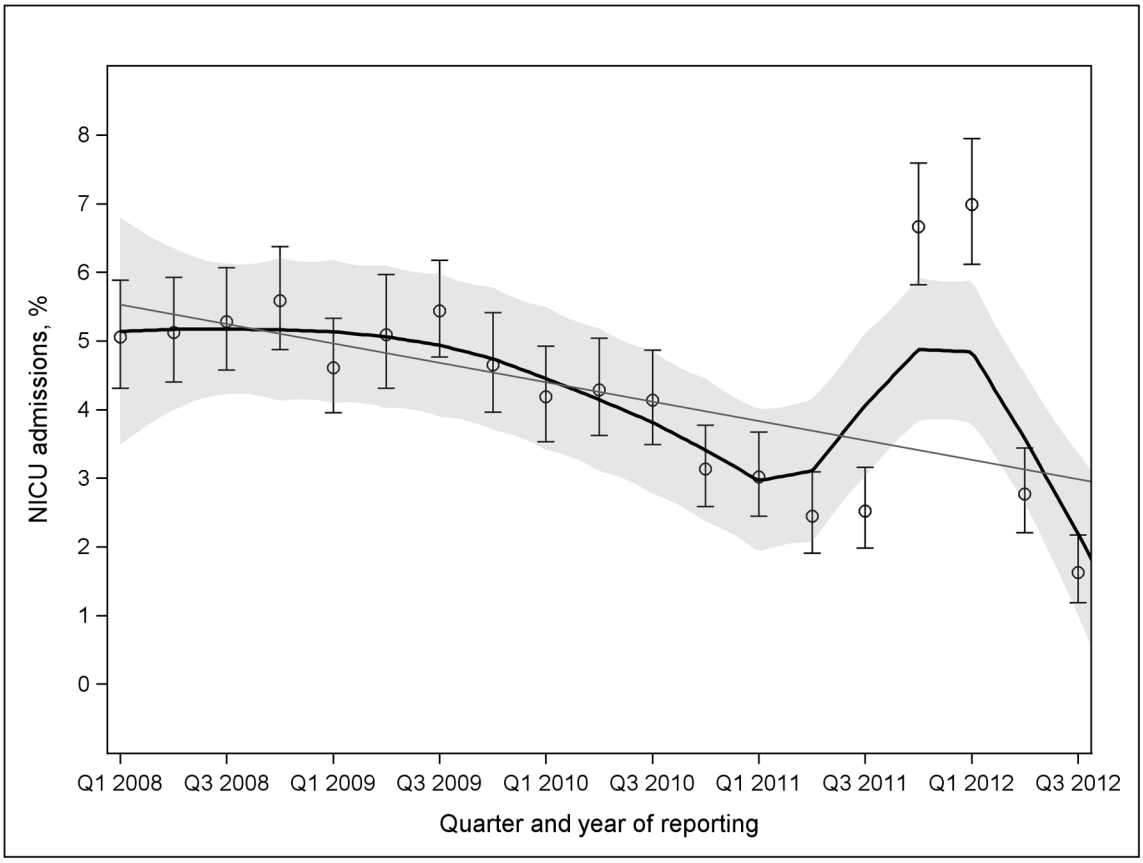


Figure 4.

Neonatal outcomes among deliveries at the University Teaching Hospital in Lusaka, Zambia, between January 1, 2008, and December 31, 2012. Outcomes assessed per quarter (Q1–Q4) each year were (A) stillbirths, (B) a 5-minute Apgar score of less than 7, and (C) admission to the NICU. Error bars show 95% confidence intervals. Thick black line represents the LOESS nonparametric curve and the grey shading represents its 95% confidence interval. The thin black line is the fitted linear regression line. Abbreviation: NICU, neonatal intensive care unit.

Table 1

Maternal characteristics.[a,b]

Characteristic [c]	Delivered at UTH (n=62 470) [d]	Delivered at other sites in Lusaka (n=170 108) [d]
Maternal age, y	26 (21–31)	24 (21–29)
<15	406 (0.7)	520 (0.3)
15–19	11 414 (18.5)	30 081 (17.8)
20–24	15 992 (25.9)	55 142 (32.6)
25–29	15 227 (24.7)	46 040 (27.2)
30–34	11 720 (19.0)	26 680 (15.8)
35–39	5409 (8.8)	8970 (5.3)
≥40	1505 (2.4)	1654 (1.0)
Parity	1 (0–2)	1 (0–2)
Fetal gestational age at first prenatal care visit, wk [e]	21 (17–26)	22 (19–26)
Maternal body mass index [f]	24.0 (21.8–27.3)	23.2 (21.3–25.7)
Previous stillbirth	1312 (2.1)	1815 (1.1)
Previous preterm delivery	1834 (2.9)	3507 (2.1)
Documented history of hypertension before conception	1218 (2.7)	1232 (1.0)
Documented history of diabetes mellitus before conception	123 (0.3)	103 (0.1)
Baseline hemoglobin level, g/L [g]	117 (108–126)	116 (107–126)
≥100	29 065 (90.4)	75 390 (90.4)
80–90	2631 (8.2)	7115 (8.5)
<80	450 (1.4)	864 (1.1)
Baseline syphilis serology by rapid plasma reagin test		
Non-reactive	40 870 (65.4)	112 296 (66.0)
Reactive and no documentation of treatment	416 (0.7)	1318 (0.8)
Reactive and documentation of treatment	965 (1.5)	3031 (1.8)
Status unknown	20 219 (32.4)	53 463 (31.4)
HIV infection status		
Uninfected	45 540 (72.9)	129 032 (75.9)
Infected	13 737 (22.0)	36 062 (21.2)
Unknown	3193 (5.1)	5014 (2.9)
Hypertension during prenatal care or delivery		
No	48 841 (85.4)	144 220 (94.9)
Yes	8372 (14.6)	7822 (5.1)
Mode of delivery		
Vaginal	51 028 (82.0)	167 792 (99.9)
Cesarean	9481 (15.2)	0 (0.0%)
Forceps or assisted breach	1721 (2.8)	209 (0.1)
Maternal mortality ratio per 100 000 live births [h]	215	126
Clinic(s) visited for prenatal care		

Characteristic [c]	Delivered at UTH (n=62 470) [d]	Delivered at other sites in Lusaka (n=170 108) [d]
None at UTH	55 099 (88.2)	169 177 (99.4)
All at UTH	4338 (6.9)	272 (0.2)
At both UTH and other sites in Lusaka	3033 (4.9)	659 (0.4)

Abbreviation: UTH, University Teaching Hospital.

[a] Values are given as median (interquartile range) or number (percentage), unless indicated otherwise.

[b] The cohort comprised Zambian women who had delivered at UTH in Lusaka and Zambian women who had delivered at other primary care facilities in Lusaka between January 1, 2008, and December 31, 2012. Data were extracted from Zambia Electronic Perinatal Record System.

[c] Missing data for specific variables included maternal age (n=1818), estimated gestational age at first visit (n=31 373), BMI (n=76 384), history of hypertension (n=69 782), history of diabetes mellitus (n=68 290), baseline hemoglobin level (n=117 063), hypertension during prenatal care or delivery (n=23 323), and mode of delivery (n=2177).

[d] χ^2 for categorical measures and Wilcoxon test for continuous measures; $P<0.01$ for all comparisons.

[e] Data available for 52 986 women in the UTH group and 148 219 women in the non-UTH group.

[f] Calculated as weight in kilograms divided by the square of height in meters; data available for 40 115 women in the UTH group and 116 079 women in the non-UTH group.

[g] Data available for 32 146 women in the UTH group and 83 369 women in the non-UTH group.

[h] Recorded deaths were 131 of 61 069 in the UTH group and 214 of 169 884 in the non-UTH group.

Table 2

Neonatal characteristics.[a,b]

Characteristic	Delivered at UTH (n=66 395)[c]	Delivered at other sites in Lusaka (n=176 154)[c]
Estimated gestational age at delivery, wk [d]	38 (35–40)	38 (35–40)
<28	1705 (3.1)	1847 (1.2)
28 to <32	3954 (7.2)	7725 (5.2)
32 to <37	15 820 (28.8)	51 519 (34.5)
37 to <42	27 944 (50.8)	77 239 (51.7)
≥42	5558 (10.1)	11 095 (7.4)
Birth weight, g [e]	2960 (2530–3300)	3000 (2700–3300)
<1500	2666 (4.2)	852 (0.5)
1500 to <2500	10 707 (16.9)	14 418 (8.4)
2500 to <3500	39 588 (62.4)	129 404 (76.0)
3500 to <4000	8729 (13.8)	22 449 (13.2)
≥4000	1735 (2.7)	3182 (1.9)
Stillbirth		
All	3867 (6.0)	1662 (1.0)
Fresh	2102 (3.2)	935 (0.5)
Macerated	1765 (2.7)	727 (0.4)
Admissions to neonatal intensive care unit	2774 (4.3)	191 (0.1)
5-Minute Apgar score		
<7	2325 (4.1)	418 (0.3)
≥7	54 201 (95.9)	146 335 (99.7)
Neonatal death, d		
<1	1059 (1.6)	67 (<0.1)
<7	1222 (1.9)	83 (<0.1)

Abbreviation: UTH, University Teaching Hospital.

[a] Values are given as median (interquartile range) or number (percentage).

[b] The cohort comprised Zambian women who had delivered at UTH in Lusaka and Zambian women who had delivered at other primary care facilities in Lusaka between January 1, 2008, and December 31, 2012. Data were extracted from Zambia Electronic Perinatal Record System.

[c] χ^2 for categorical measures and Wilcoxon test for continuous measures; $P<0.01$ for all comparisons.

[d] Missing data for specific variable included estimated gestational age at delivery (n=32 076); birth weight (n=2752); and 5-minute Apgar score (n=33 203).

[d] Data available for 54 981 newborns in the UTH group and 149 425 newborns in the non-UTH group.

[e] Data available for 63 425 newborns in the UTH group and 170 305 newborns in the non-UTH group.