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A prospective study of maternal, fetal, and neonatal outcomes in the setting of cesarean section in low- and middle-income countries

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Conflict of Interest

Data and presentation of information has not been influenced by the personal or financial relationship of the authors with other people or organizations. Authors have no financial or otherwise competing interests to disclose.

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Abstract

Introduction—Cesarean section (CS) rates are increasing globally with an unclear effect on pregnancy outcomes. The study objective was to quantify maternal and perinatal morbidity and mortality in low- and middle-income countries associated with CS compared to vaginal delivery (VD) both within and across sites.

Material and methods—A prospective population-based study including home and facility births in 337,153 women with a VD and 47,308 women with a CS from 2010 to 2015 was performed in Guatemala, India, Kenya, Pakistan, Zambia, and Democratic Republic of Congo. Women were enrolled during pregnancy; delivery and 6-week follow-up data were collected.

Results—Across all sites, CS rates increased from 8.6 to 15.2%, but remained low in African sites. Younger, nulliparous women were more likely to have a CS, as were women with higher education and those delivering a 1500–2499g infant. Across all sites, maternal and neonatal mortality was higher, and stillbirths lower, in pregnancies delivered by CS. Antepartum and postpartum complications as well as obstetric interventions and treatments were more common among women who underwent CS. In stratified analyses, all outcomes were worse in women with a CS compared to VD in African compared to non-African sites.

Conclusions—CS rates increased across all sites during the study period, but at more pronounced rates in the non-African sites. CS was associated with reducedpostpartum hemorrhage and lower rates of stillbirths in the non-African sites. In the African sites, CS was associated with an increase in all adverse outcomes. Further studies are necessary to better understand the increase in adverse outcomes with CS in the African sites.

Keywords

cesarean section; low- and middle-income countries; maternal morbidity; maternal mortality; neonatal morbidity; neonatal mortality

Introduction

The World Health Organization (WHO) has asserted that improving availability, accessibility, quality, and use of healthcare services is essential to reducing maternal mortality during pregnancy, labor, and delivery (1). This requires universal access to comprehensive emergency obstetrical care (EmOC), defined as a health service organization's capability to provide antibiotics, uterotonics, magnesium sulfate, blood transfusion, and employ skilled providers who can perform manual placental extraction, remove retained products of conception, perform operative vaginal delivery, neonatal resuscitation, and cesarean section (CS) (1). Per the WHO, CS, at a rate of around 5 – 15%, is considered essential treatment for antepartum hemorrhage, dysfunctional labor, hypertensive disease, and fetal distress in order to prevent maternal, neonatal, and fetal morbidity and mortality (1).

CS rates are increasing globally. The average global CS rate has increased by 150% over the past 25 years, and is currently at 18.6% with an average rate of increase of 4.4% per year (2). Understanding how pregnancy outcomes are affected by delivery method in low and middle-income countries (LMIC) is important to ensure that the intervention is, on balance, beneficial (3). Research has shown that the relative risks of maternal mortality, neonatal respiratory morbidity, hysterectomy, ureter and bladder injury, fetal death, placental previa, and uterine rupture in a future pregnancy are increased with CS as compared to vaginal delivery (VD) (4). It has been suggested that research on health outcomes related to CS and testing of interventions to reduce unnecessary CS are essential (5). Thus, the objective of this study was to quantify maternal and perinatal morbidity and mortality in LMIC associated with CS compared to VD, both within and across study sites.

Material and methods

This analysis was conducted using data from a prospective study conducted in communities at seven sites in six low-income countries on births from January 1, 2010 through December, 2015 (Chimaltenango, Guatemala; Nagpur District and Karnataka District, India; western Kenya; Thatta District, Pakistan; Lusaka, Zambia; and Equateur, the Democratic Republic of the Congo) (the Democratic Republic of the Congo site initiated enrollment in 2014). These seven sites are in the Global Network for Women's and Children's Health Research (GN), a network of institutions which conducts research aimed at improving maternal and newborn outcomes. The Eunice Kennedy Shriver National Institute of Child Health and Human Development (NICHD) in the USA funds the GN.

The GN's prospective registry, the Maternal and Newborn Health Registry (MNHR), includes outcomes from rural or semi-urban geographical areas. Each site includes between six and 24 distinct communities. The methods of the MNHR have been published (6). In general, each community represents the catchment area of a primary healthcare center, and about 300 to 500 births take place annually in each locale. Beginning in 2008, the study investigators at each site initiated an ongoing, prospective maternal and newborn health registry of pregnant women for each community. The objective is to enroll pregnant women by 20 weeks' gestation and to obtain data on pregnancy outcomes for all deliveries of registered women, regardless of birth location (i.e., home, health clinic or hospital). Each community employs a registry administrator who identifies and tracks pregnancies and their outcomes in coordination with community elders, birth attendants, and other health care workers.

The primary purpose of the MNHR is to quantify and analyze trends in pregnancy outcomes in defined low-resource geographic areas over time in order to provide population-based statistics on pregnancy outcomes, including stillbirths, neonatal and maternal mortality and morbidity. The analysis presented here utilizes the MNHR to determine maternal and fetal outcomes in the setting of CS and to compare these outcomes to a reference population, also from the registry, that underwent VD, both within and across study sites. VD includes both spontaneous and assisted vaginal deliveries. The rates of the latter remained stable at less than 1% of all deliveries during the course of the study.

Other covariates were defined in accordance with the WHO definitions, described elsewhere (7). Gestational age at delivery was classified as term (>37 weeks gestation) or preterm (<37 weeks) for all deliveries, based on gestational age from last menstrual period and estimated due date. Infants originally classified as term or preterm with implausible birth weights for that classification were reclassified. Birth weight was the weight of the live birth or stillbirth taken at delivery or as soon as possible after delivery. Within the registry, stillbirth is defined as the death of a fetus at 20 weeks gestational age or later, with the fetus showing no signs of life at birth, such as gasping, breathing, heartbeat, or movement. Postpartum hemorrhage (PPH) is defined as blood loss of 1000 mL or more from the genital tract after delivery through six weeks postpartum.

Data were collected and entered into research computers at each study site and transmitted through secure methods to a central data-coordinating center (RTI International). All analyses were done with SAS version 9.4 (SAS Institute, Cary, NC, USA). Analyses included descriptive statistics. Relative risks were computed using log binomial generalized linear models with generalized estimating equations accounting for study clusters. In addition, because the results suggested that CS rates were different by birth weight, Cochran-Mantel-Haenszel tests stratified by site were performed to control for birth weight, as average birth weights vary by country within the registry.

The appropriate institutional review boards/ethics research committees of the participating institutions and the ministries of health of the respective countries approved the MNHR. Prior to initiation of the study, approval was sought from the participating communities. Individual informed consent for study participation is requested and obtained from each study participant. A Data Monitoring Committee, appointed by the NICHD, oversees and reviews the study semi-annually.

Results

Altogether, 384,461 women were screened and enrolled, 47,308 who had a CS and 337,153 who had a VD. Figure 1 illustrates CS rates over time within the GN. While in the Central American and south Asian sites, the CS rates approximately doubled over the five years of data collection, there was little or no change in CS rates in Zambia, and in Kenya the CS rate increased from <1% to 2%. There are only two years of data (2014–2015) for the Democratic Republic of Congo.

Table 1 shows the maternal characteristics of women experiencing CS versus VD within the GN. All characteristics were significantly different at $p<0.05$. Women more likely to undergo CS were younger, nulliparous and more educated.

Table 2 presents infant characteristics including gestational age and birth weight by delivery method. The test of differences are adjusted for GN site, to account for the fact that birth weights in African countries tend to be higher than those in south Asia. Babies in the birth weight range of 1500–2499g were more likely to be delivered by CS, while babies who weighed >2500g were more likely to have been delivered vaginally.

Table 3A presents the relationship of antepartum complications, including obstructed labor/prolonged labor/failure to progress, antepartum hemorrhage, hypertensive disease, and malpresentation to delivery method. Additionally, there was a comparison of women with no recorded antepartum complications who underwent CS versus VD. Each of the antepartum complications evaluated was more likely to be present in pregnancies delivered by CS than those delivered vaginally. Women without one of these antepartum complications were more likely to deliver vaginally. Because Table 3A suggested that antepartum complications in the setting of CS were more common in African sites than in the other sites within the GN, African and non-African sites were compared in Table 3B. Each of the antepartum complications evaluated had a higher relative risk of a CS in the African sites compared to the other sites studied.

Table 4A shows how postpartum complications and procedures were related to delivery method. Postpartum infection, maternal death, the use of dilation and curettage, hysterectomy, and unplanned hospitalization, were all more common after CS than VD, although PPH was not. When the outcome of PPH related to CS was evaluated on a regional basis (Table 4B), hemorrhage associated with CS was more common in the African sites, while PPH was less common in the non-African sites. In the African sites, all adverse maternal outcomes were more common in the setting of CS than in other sites. While adverse outcomes were up to fifteen times more common after CS than VD in the African sites, in the other settings they were about twice as likely to occur.

Table 5A shows an assessment of interventions commonly performed during and after delivery, and how prevalent those obstetric treatments were in the setting of CS versus VD. These interventions include prophylactic antibiotics, preterm corticosteroid administration, uterotonic utilization, blood transfusion, and magnesium sulfate administration. With the exception of uterotonics, all interventions were used at least twice as often in the setting of CS as compared to VD. In the setting of CS, the African sites were found to utilize all interventions at higher rates than sites in other regions (Table 5B).

Table 6A focuses on perinatal outcomes in the setting of CS versus VD. Overall, stillbirth was less common in the setting of CS, but neonatal mortality was more common. Table 6B, which separates outcomes by region, shows that this was not the trend in sub-Saharan Africa. In the African sites, stillbirth was five times more common in women undergoing CS than VD (RR 5.6, 95% CI 4.3, 7.1) and neonatal mortality three times (3.2, 95% CI 2.4, 4.2) more likely. (Table 6B) In comparison, at non-African sites, the RR for stillbirth in women with CS vs VD was less (0.6, 95% CI 0.5, 0.6), with little difference in the neonatal mortality.

Discussion

The study objective was to quantify maternal and perinatal morbidity and mortality in LMIC associated with CS compared to VD, both within and across sites. In summary, we found that younger, nulliparous women were more likely to have a CS, as were women with higher education and those delivering a 1500–2499g infant. Across all sites, maternal and neonatal mortality was higher, and stillbirths lower, in pregnancies delivered by CS. Antepartum and

postpartum complications as well as obstetric interventions and treatments were more common among women who underwent CS. In stratified analyses, all outcomes were worse in women with a CS compared to VD in African compared to non-African sites. PPH was lower among women undergoing CS in non-African sites.

Our analysis found that young, nulliparous, and more educated women were most likely to undergo CS. These findings are also consistent with previous publications that demonstrate that young, nulliparous patients are at increased risk of CS, which may be attributable to cephalopelvic disproportion and obstructed labor (8). The concern is that some women may become pregnant before their pelvises are fully developed, putting them at increased risk of dysfunctional labor that requires cesarean delivery (9). An analysis of nearly 80,000 adolescents supported this assertion as it showed that extremely young adolescents (< 15 years old), were more likely than older women (20 – 24 years old) to undergo CS when the indication for CS was cephalopelvic disproportion (10). The finding that less educated women have lower rates of CS suggests that, if education is used as a proxy for socioeconomic status, that poorer, less educated women may have less access to facility delivery and CS, or that care differs in the facilities poor women have access to as compared to richer women. For example, studies performed in Latin America found differences in CS rates in public versus private hospitals and attributed the differences to provider behavior instead of access to care (11, 12).

The finding that CS is more common in infants weighing in the 1500 – 2499g range may be explained by the fact that smaller fetuses might be more likely to have a malpresentation, to be growth restricted, to be delivered in the context of hypertensive disorders that require preterm delivery, or have another condition requiring CS, such as placental abruption. All antepartum complications were more common in pregnancies delivered by CS as compared to those delivered vaginally. Vaginal delivery was significantly more common in pregnancies where no major antepartum complication was present (>90% of deliveries in all sites except Pakistan), suggesting that the majority of CS in the GN were performed for clinical indications. These antepartum complications may have contributed to the decision to perform CS. If the complications in the African sites are used as a proxy measure for indication, they are comparable to other major studies on indication for CS in the region (13).

Across all sites, maternal and neonatal mortality was higher in pregnancies delivered by CS, which is supported by the experience of other LMIC (14). However, stillbirth rates and PPH were lower among women undergoing CS in non-African sites. It was a surprising finding that PPH was reduced in the setting of CS in non-African sites, but there is some plausibility to this finding. A recent Lancet publication noted that the rate of CS performed prior to the onset of labor is increasing (15). Data from the USA has shown that potential short-term maternal benefits of planned cesarean delivery compared with a planned vaginal delivery included a decreased risk of PPH and transfusion (16). Regarding stillbirth, ninety-eight percent of stillbirths occur in LMIC, occurring at a rate of over 2.5 million per year, making stillbirth one of the most common adverse perinatal outcomes (17). If CS is associated with fewer stillbirths in the non-African sites, this suggests that CS may offer benefit for this outcome as well.

Antepartum and postpartum complications, as well as obstetric interventions and treatments, were more common among women who underwent CS. This may be due to the fact that many of the vaginal deliveries in the GN occurred outside facilities, often in the home setting, where subsequent interventions would be less likely. Women with antepartum complications or complicated labors would likely be transferred to a facility where CS might possibly ensue. While some interventions such as prophylactic antibiotic administration are generally beneficial, other interventions such as dilation and curettage and hysterectomy might have been performed in response to morbidities sustained by the performance of a poor quality CS. Blood transfusion and uterotonic use were also more common in women undergoing CS. With respect to antibiotic administration, which we consider a sign of high quality care, while rates above 95% were observed with CS, the finding of antibiotic treatment in 45% of vaginal deliveries raises concern. It is not clear whether this represents prophylactic administration of medications or treatment of a postpartum infection; the latter would suggest very high rates of infection in our study sites. Many providers in LMIC administer prophylactic antibiotics after vaginal delivery, which likely accounts for this finding, but it does not represent standard of care per WHO recommendations (18). This is an area that warrants further research.

In stratified analyses, all outcomes were worse in women with a CS compared to VD in African compared to non-African sites. For example, when the African sites were compared to the other sites in the GN, maternal mortality appears to be ten times more common in the setting of CS, suggesting that these women may be presenting for care in a significantly worse state, or that the quality of CS in the African sites, as compared to the other sites, is far inferior. This finding potentially supports the WHO's assertion that quality of care is of primary importance to improving outcomes, not just increasing access and utilization of healthcare services (19). If women are presenting for care at more advanced stages of labor and in higher acuity situations, this raises the point that improved community and provider education regarding abnormal progress in labor may also be important to improve outcomes in these settings. Healthcare providers not knowing if the fetus was alive when the CS was performed may explain the higher rate of stillbirth in the African sites. If the providers knew the fetus was dead, there may have been obstetric or maternal indications such as obstructed labor or hemorrhage that required expedited delivery by CS to prevent further maternal morbidity and mortality.

Several other issues merit discussion. First, since CS rates of at least 2% are thought to be required to reduce maternal mortality and CS rates of 10% to 15% are required to have a significant impact on stillbirths, it is clear that there is a large unmet need for CS, especially in the African sites (20, 21). Evidence from Uganda suggests that increasing access to CS is highly cost effective and additional evidence from across Africa suggests that increasing CS rates will reduce maternal and infant mortality (22). The low rates of assisted vaginal delivery across sites likely represent another unmet obstetrical need. Assisted vaginal delivery with vacuum or forceps may reduce the risk of delivery of an asphyxiated fetus, thereby preventing a stillbirth or neonatal death. Where neither CS nor assisted vaginal delivery is available, as often appears to be the case in the African sites, craniotomy and vaginal delivery, especially in the face of obstructed labor and stillbirth, may be life-saving for the mother. This procedure was not reported at any of our site hospitals during the study

period. Furthermore, one limitation is that we did not collect data on uterine rupture, data which would contribute to our understanding of the unmet need for CS in many of our sites. Clearly, the issue of unmet obstetrical need is a crucial issue that bears further investigation.

This study has a number of limitations including the fact that many of the deliveries occurred at home with either a family member or a traditional birth attendant present. Additionally, for many deliveries occurring in a clinic or hospital, medical records were often incomplete. While trained registry administrators interviewed the women and caregivers and reviewed the medical records within 48 hours of delivery, determining the amount of blood loss or length of labor was often problematic. Recall bias may have occurred. Additionally, while our registry collects data on pregnancy complications, it did not specifically collect information on indication for CS, or timing of the CS with regards to onset of labor. It is generally unknown if stillbirths were diagnosed prior to the CS or were only diagnosed at delivery. Each of these issues indicates the importance of collecting more detailed information on the events leading up to and during CS so that audits can be performed to determine if CS are performed for appropriate indications and how associated pregnancy outcomes are affected. Each hospital should consider performing CS audits to evaluate appropriateness and safety of the procedures.

The strengths of this study include its large sample size, varied sites on three continents, data collected prospectively, and pre-specified outcomes that were defined similarly at all sites. In summary, CS is rapidly becoming an increasingly common surgery around the globe, and rates are increasing within the GN as well (23). This analysis shows that in LMIC, CS is an essential but complex healthcare service. The data suggest that in some locations, CS is associated with reduced stillbirth and PPH, but also is associated with adverse postpartum outcomes including severe morbidity and death and additional treatments and interventions. The WHO has asserted that women should deliver in facilities with skilled birth attendants in order to improve outcomes, but acknowledges that those outcomes may not improve unless high quality care is provided. As the global health community supports the medicalization of childbirth, it must provide resources and guidelines to promote safe CS so that the most benefit and least harm will occur from increasing utilization of this procedure.

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Abbreviations

CS	cesarean section
GN	Global Network for Women’s and Children’s Health Research
LMIC	low and middle-income countries
MNHR	Maternal and Newborn Health Registry

NICHD	*Eunice Kennedy Shriver* National Institute of Child Health and Human Development
PPH	postpartum hemorrhage
VD	vaginal delivery
WHO	World Health Organization

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Key Message

Cesarean section was associated with reduced postpartum hemorrhage and stillbirth in Latin American and South Asian sites, while adverse pregnancy outcomes were worse after cesarean section in African sites.

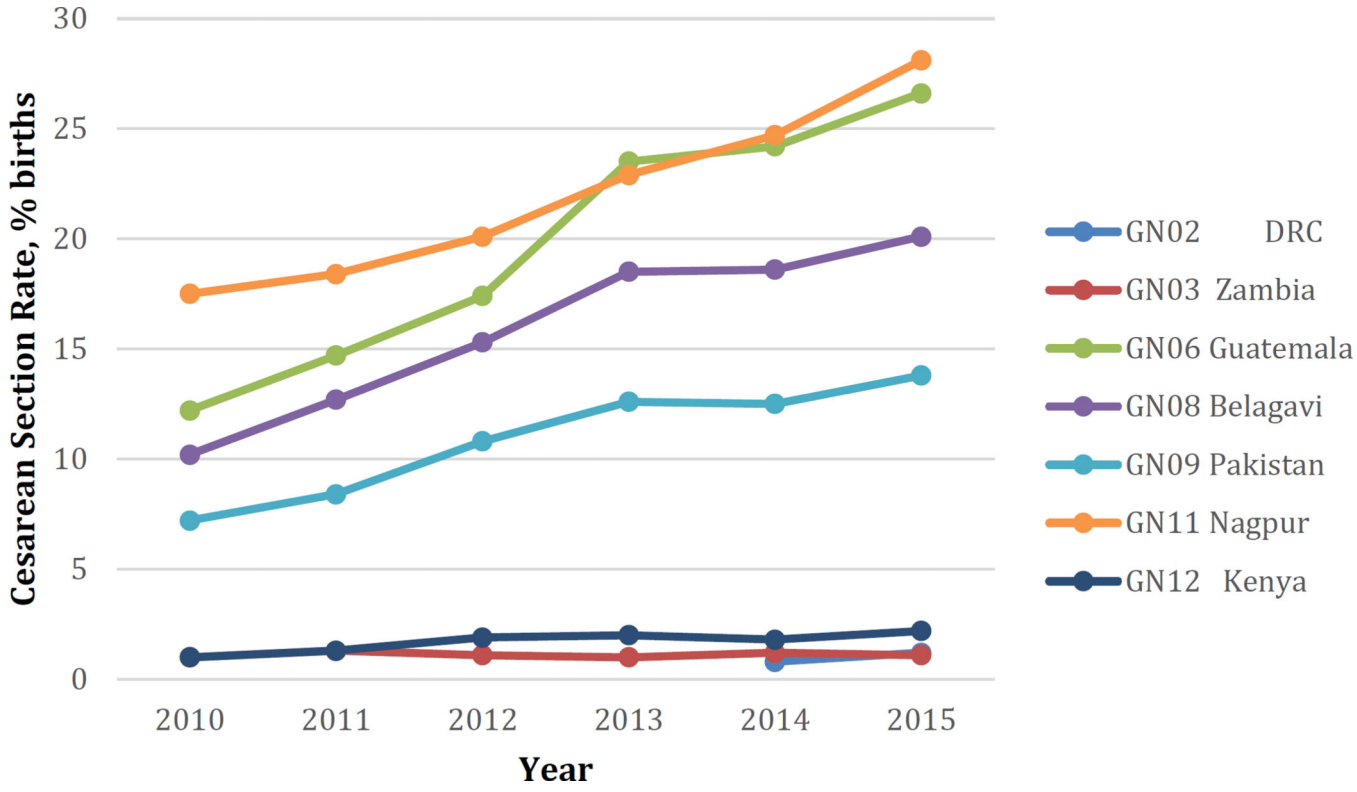

Figure 1.
Cesarean section rates at Global Network sites, 2010–2015.

Table 1

Characteristics of women experiencing cesarean vs. vaginal delivery, 2010 – 2015.

Characteristic	Cesarean	Vaginal
Deliveries, N	47,308	337,153
Maternal age, N (%)	47,277	336,707
< 20	4,193 (8.9)	41,533 (12.3)
20–35	41,559 (87.9)	280,743 (83.4)
> 35	1,525 (3.2)	14,431 (4.3)
Parity, N (%)	46,780	335,036
0	22,435 (48.0)	101,462 (30.3)
1–2	19,497 (41.7)	141,587 (42.3)
≥3	4,848 (10.4)	91,987 (27.5)
Education, N (%)	47,203	336,100
No formal education	7,021 (14.9)	91,082 (27.1)
Primary	11,775 (24.9)	114,557 (34.1)
Secondary	20,780 (44.0)	111,899 (33.3)
University+	7,627 (16.2)	18,562 (5.5)

Table 2

Birth outcomes of women experiencing cesarean vs. vaginal delivery, 2010–2015.

Characteristic	Cesarean	Vaginal	P-value[a]
Births, N	48,219	339,980	
Gestational age, N (%)	46,978	325,720	0.9308
Preterm	5,613 (11.9)	42,284 (13.0)	
Term	41,365 (88.1)	283,436 (87.0)	
Birth weight, N (%)	48,166	339,334	<.0001
< 1000g	101 (0.2)	1,823 (0.5)	
1000–1499g	494 (1.0)	3,736 (1.1)	
1500–2499g	7,670 (15.9)	40,445 (11.9)	
≥2500g	39,901 (82.8)	293,330 (86.4)	

[a]Cochran-Mantel-Haenszel test adjusting for site.

Table 3

A. Antepartum complications in women experiencing cesarean section or vaginal delivery by country, 2010 – 2015.

Characteristic	DRC		Zambia		Kenya		Guatemala		Belgaum		Nagpur		Pakistan		Total	
	CS	VD	CS	VD	CS	VD	CS	VD	CS	VD	CS	VD	CS	VD	CS	VD
Deliveries, N	128	13,321	460	40,858	852	50,094	10,643	40,113	15,181	85,182	12,699	45,298	7,345	62,287	47,308	337,153
OL/PL/FTP, %	85.8	1.2	56.0	3.0	73.8	7.6	17.8	3.5	53.6	2.0	39.1	2.0	53.0	12.1	42.0	5.0
Antepartum hemorrhage, %	9.4	0.6	5.7	1.0	12.4	1.8	2.1	0.9	1.5	0.5	0.8	0.3	6.6	3.6	2.5	1.4
Hypertensive disease, %	2.4	0.1	9.5	0.8	7.6	1.3	11.1	2.3	8.2	1.5	5.7	1.2	10.4	5.1	8.5	2.0
Malpresentation, %	25.0	0.6	18.9	0.7	25.6	1.1	13.0	0.6	7.8	0.3	10.0	0.4	13.9	2.4	11.0	0.9
No specified complications, %	9.5	98.2	26.5	95.7	15.0	90.4	60.5	93.2	34.4	96.0	48.1	96.4	31.9	80.5	43.1	92.1

B. Antepartum complications in women experiencing cesarean section or vaginal delivery in African vs. non-African sites, 2010 – 2015.

Characteristic	African Sites			Other Sites		
	CS	VD	RR (95% CI)	CS	VD	RR 95% CI)
Deliveries, N	1,440	104,273		45,868	232,880	
OL/PL/FRP, %	69.2	5.0	40.1 (28.9, 55.7)	41.2	5.0	6.0 (5.2, 7.1)
Antepartum hemorrhage, %	10.0	1.3	7.5 (5.5, 10.3)	2.2	1.4	1.7 (1.6, 1.8)
Hypertensive disease, %	7.7	0.9	8.0 (6.2, 10.4)	8.5	2.6	2.7 (2.4, 3.0)
Malpresentation, %	23.4	0.9	26.2 (20.1, 34.1)	10.6	0.9	4.6 (4.2, 5.1)
No specified complications, %	18.2	93.4	0.02 (0.01, 0.02)	43.9	91.5	0.14 (0.12, 0.17)

DRC, Democratic Republic of Congo; CS, cesarean section; VD, vaginal delivery, OL/PL/FTP, obstructed labor/prolonged labor/failure to progress.

CS, cesarean section; VD, vaginal delivery; RR, relative risk; CI, confidence interval; OL/PL/FTP, obstructed labor/prolonged labor/failure to progress; RR, relative risk; CI, confidence interval.

Table 4

A. Postpartum morbidity and mortality in women experiencing cesarean section or vaginal delivery by country, 2010 – 2015.

Characteristic	DRC		Zambia		Kenya		Guatemala		Belgaum		Nagpur		Pakistan		Total	
	CS	VD	CS	VD	CS	VD	CS	VD	CS	VD	CS	VD	CS	VD	CS	VD
Deliveries, N	128	13,321	460	40,858	852	50,094	10,643	40,113	15,181	85,182	12,699	45,298	7,345	62,287	47,308	337,153
Postpartum hemorrhage, %	7.1	1.3	2.2	0.9	8.1	5.1	2.3	2.3	0.5	0.7	0.2	0.3	3.1	5.2	1.4	2.4
Postpartum infection, %	3.3	0.2	0.2	0.0	5.9	0.7	0.8	0.4	0.6	0.2	0.1	0.1	4.0	1.9	1.1	0.6
Dilation and curettage, %	0.0	0.1	2.9	0.2	16.6	7.5	0.1	1.0	5.8	5.0	21.4	14.5	1.7	1.0	8.5	5.2
Hysterectomy, %	5.6	0.0	0.8	0.1	0.4	0.2	0.4	0.1	0.1	0.0	0.0	0.1	0.3	0.0	0.3	0.1
Unplanned hospitalization, %	15.2	0.8	8.9	0.6	7.6	0.7	24.9	7.5	11.5	5.3	3.9	1.3	2.9	1.1	12.5	2.7
Maternal mortality < 42 days, rate/100,000 deliveries	6299	196	1319	82	825	74	114	83	145	76	103	44	563	177	232	96

B. Postpartum morbidity and mortality in women experiencing cesarean section or vaginal delivery in African vs. non-African sites, 2010 – 2015.

Characteristic	African Sites			Other Sites		
	CS	VD	RR (95% CI)	CS	VD	RR (95% CI)
Deliveries, N	1,440	104,273		45,868	232,880	
Postpartum hemorrhage, %	6.1	3.0	1.9 (0.9, 4.0)	1.2	2.1	0.8 (0.7, 0.9)
Postpartum infection, %	3.9	0.4	8.7 (4.4, 17.2)	1.0	0.6	1.6 (1.4, 1.8)
Dilation and curettage, %	11.0	3.8	3.3 (2.2, 4.9)	8.4	5.8	1.2 (1.0, 1.6)
Hysterectomy, %	1.7	0.1	15.0 (6.6, 33.9)	0.2	0.0	2.5 (1.9, 3.2)
Unplanned hospitalization, %	9.8	0.7	13.3 (9.7, 18.3)	12.6	3.9	2.3 (2.1, 2.6)
Maternal mortality < 42 days, rate/100,000 deliveries	1469	93	13.6 (9.3, 19.9)	193	98	1.9 (1.6, 2.2)

DRC, Democratic Republic of Congo; CS, cesarean section; VD, vaginal delivery.

CS, cesarean section; VD, vaginal delivery; RR, relative risk; CI, confidence interval.

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Table 5

A. Interventions and treatments received by women experiencing cesarean section or vaginal delivery by country, 2010 – 2015.

Characteristic	DRC		Zambia		Kenya		Guatemala		Belgaum		Nagpur		Pakistan		Total	
	CS	VD	CS	VD	CS	VD	CS	VD	CS	VD	CS	VD	CS	VD	CS	VD
Deliveries, N	128	13,321	460	40,858	852	50,094	10,643	40,113	15,181	85,182	12,699	45,298	7,345	62,287	47,308	337,153
Antibiotics, %	89.8	6.8	55.8	1.5	72.2	8.7	92.8	12.9	98.4	88.0	97.8	86.1	95.0	50.5	95.6	46.4
Corticosteroids, %	23.2	0.5	6.0	2.5	6.2	0.8	5.6	2.0	4.9	4.3	7.2	2.9	6.8	5.9	6.0	3.1
Blood Transfusion, %	17.3	0.3	4.6	0.2	9.6	0.6	1.2	0.4	2.4	1.0	3.0	0.7	43.6	3.8	8.5	1.2
Uterotonics, %	79.2	42.0	61.2	62.7	73.7	50.1	69.2	37.6	65.0	82.3	71.6	77.6	80.4	68.1	70.2	64.2
Magnesium sulfate, %	0.0	0.0	2.9	0.1	13.7	0.8	8.4	1.5	7.3	0.5	3.4	0.7	2.0	0.7	5.7	0.7

B. Interventions and treatments received by women experiencing cesarean section or vaginal delivery in African vs. non-African sites, 2010 – 2015.

Characteristic	African Sites			Other Sites		
	CS	VD	RR (95% CI)	CS	VD	RR (95% CI)
Deliveries, N	1,440	104,273		45,868	232,880	
Antibiotics, %	68.9	6.0	32.6 (21.7, 49.1)	96.4	64.3	21.0 (9.8, 44.6)
Corticosteroids, %	8.3	1.3	6.6 (3.3, 13.3)	6.0	4.0	1.5 (1.2, 1.9)
Blood Transfusion, %	8.8	0.4	18.1 (14.0, 23.3)	8.5	1.5	3.3 (2.9, 3.8)
Uterotonics, %	70.5	52.7	2.2 (1.3, 3.6)	70.2	69.2	1.0 (0.8, 1.3)
Magnesium sulfate, %	9.2	0.4	17.6 (13.7, 22.5)	5.6	0.8	3.1 (2.6, 3.7)

DRC, Democratic Republic of Congo; CS, cesarean section; VD, vaginal delivery.

CS, cesarean section; VD, vaginal delivery. RR, relative risk; CI, confidence interval.

Table 6

A. Perinatal mortality in women experiencing cesarean section or vaginal delivery by country, 2010 – 2015.

Characteristic	DRC		Zambia		Kenya		Guatemala		Belgaum		Nagpur		Pakistan		Total	
	CS	VD	CS	VD	CS	VD	CS	VD	CS	VD	CS	VD	CS	VD	CS	VD
Deliveries, N	128	13,321	460	40,858	852	50,094	10,643	40,113	15,181	85,182	12,699	45,298	7,345	62,287	47,308	337,153
Stillbirths, rate/1000	345.3	33.7	55.0	18.2	100.2	19.9	12.5	20.8	10.4	27.2	10.3	26.4	34.9	48.3	17.8	28.3
Neonatal mortality, rate/1000	87.9	24.2	58.8	15.8	37.3	13.8	33.9	21.1	22.8	23.9	19.1	22.5	54.3	48.7	29.8	25.4

B. Perinatal mortality in women experiencing cesarean section or vaginal delivery in African vs. non-African sites, 2010 – 2015.

Characteristic	African Sites			Other Sites		
	CS	VD	RR (95% CI)	CS	VD	RR (95% CI)
Deliveries, N	1,440	104,273		45,868	232,880	
Stillbirths, rate/1000	107.8	21.0	5.6 (4.3, 7.1)	14.8	31.6	0.6 (0.5, 0.6)
Neonatal mortality rate/1000	47.8	15.9	3.2 (2.4, 4.2)	29.3	29.7	1.1 (1.0, 1.2)

DRC, Democratic Republic of Congo; CS, cesarean section; VD, vaginal delivery.

CS, cesarean section; VD, vaginal delivery. RR, relative risk; CI, confidence interval.