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SYSTEMATIC REVIEW AND META-ANALYSIS

Obstetrics

Cesarean birth decision-to-delivery interval in sub-Saharan Africa: A systematic review and meta-analysis

Peter M. Nthumba[1,2,3*], Immaculate K. Barasa[1], Sri H. Malapati[4], Moses O. Odhiambo[1,3], Nenkai M. Nthumba[3,5]

[1] AIC Kijabe Hospital, Kijabe, Kenya
[2] Department of Plastic Surgery, Vanderbilt University Medical Centre, Nashville, TN, USA
[3] EACH Research
[4] Medical School, University of California Los Angeles, California, USA
[5] Department of Women Studies, University of Nairobi, Nairobi, Kenya

Correspondence: nthumba@gmail.com

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Abstract

Background: Globally, in 2017, 810 women died daily from pregnancy- or childbirth-related preventable complications. Of these deaths, 94% occurred in resource-poor countries, with the highest maternal and perinatal mortality occurring in sub-Saharan Africa (SSA). We conducted a systematic review and meta-analysis of studies on the decision-to-delivery interval (DDI) from the SSA to determine the mean DDI, establish the maternal and neonatal outcomes reported, and evaluate the obstacles to achieving the gold standard DDI of ≤30 minutes.

Methods: We performed a systematic literature review and meta-analysis of eligible studies between January 1995 and December 2022, in seven databases and grey literature. Studies of any design were included if they reported obstetric emergencies delivered by cesarean birth and had information on the DDI. Three independent reviewers applied eligibility criteria, assessed the risk of bias, and extracted data. The authors performed meta-analysis of mean DDI on studies with adequate data.

Results: Thirty-nine studies with 41 datasets (12,835 participants), qualified for inclusion. In these studies, only 6.34% of cesarean deliveries were performed in under 30 minutes. A meta-analysis of 27 datasets found an overall DDI mean of 2.81 hours (168.8 minutes, 95%CI 151.5 to 186.2)). The pooled perinatal and maternal case fatality rates for the included studies were 61.2 in 1000 and 444.1 in 100,000 CDs, respectively.

Conclusion: This review and meta-analysis found unacceptably high mean DDI, and perinatal and maternal mortality following cesarean delivery in SSA.

Keywords: emergency cesarean section, decision-to-delivery interval, decision-to-incision interval, maternal mortality, perinatal mortality, sub-Saharan Africa

Introduction

In 2017, the World Health Organization (WHO) estimated that 810 women died daily from pregnancy or childbirth-related preventable complications globally. 94% of these deaths occurred in low and middle-income countries (LMICs) (1). In 2020, WHO reported that a woman died from pregnancy or childbirth-related complications every two minutes (2). Although maternal mortality rates (MMR) have fallen globally, the sub-Sahara African (SSA) region continues to struggle with the highest maternal morbidities and mortalities, accounting for 70% of the total global maternal deaths in 2020, with 545 maternal deaths for every 100,000 births (2,3). Although access to reproductive health services and emergency obstetric

care (which could prevent up to 67% of maternal deaths and 40% of intrapartum-related neonatal deaths) may be considered a basic human right in high-income countries (HICs), this is a luxury for many in LMICs, reflected in the high perinatal and maternal morbidities and mortalities (4,5).

Individuals and healthcare institutions within HICs identified communication and poor teamwork across disciplines involved in emergency obstetric care as the primary drivers of adverse maternal and neonatal outcomes (6-9). HICs proposed emergency obstetric drills to build multidisciplinary communication and teamwork (6,8,10) and cesarean delivery (CD) urgency stratification (11-13) to help teams speak a common language. Further, professional and regulatory bodies in HICs adopted the 30-minute decision-to-delivery interval (DDI) limit for emergency cesarean deliveries, creating a gold standard for emergency surgical deliveries (14). Dikete et al. conducted a review of sub-Sahara African literature on CDs and concluded that 'the risks incurred by the mother and fetus during a cesarean birth are significantly greater than during a vaginal delivery, and that therefore, cesarean delivery was not a tool for reducing maternal and perinatal mortality in this setting (15). Indeed, the risk of a woman dying from a maternal cause in LMICs is 23 to 50 times higher than for a woman in an HIC (16,17). Further, in 2017, SSA neonatal mortality contributed to 38% of the global neonatal mortality (3).

These realities point to the urgent need for strategies to improve cesarean delivery outcomes in SSA. This urgency is further highlighted by statistics that indicate that CDs may account for up to 80% of the surgical workload in some institutions in SSA (18). We conducted a systematic review and meta-analysis of sub-Sahara African studies on emergency cesarean delivery with DDI as an outcome measure to determine the extent to which a DDI of 30 minutes or less has been achieved in SSA studies, establish the impact of the DDI on maternal and neonatal outcomes, and evaluate the obstacles to achieving the gold standard DDI. We also collated comments on the obstacles to the realization of an acceptable DDI from included studies.

Methods

Study design

The authors conducted a systematic review and meta-analysis of the mean DDI of emergency CD studies in sub-Sahara Africa with DDI as the primary outcome measure. We also abstracted data on maternal and/ or perinatal morbidities and mortalities, as well as reports on the challenges encountered in attempts to achieve the DDI gold standard in the included studies.

Search strategy

A compound search strategy using a comprehensive list of search terms that included exploded Medical Subject Headings (MESH terms) with the following search terms: 'decision to delivery interval', 'decision-to-delivery interval', 'decision to incision', 'decision-to-incision', 'DDI', 'DTI', 'emergency cesarean section or delivery', and 'sub-Saharan Africa', including all the countries within the sub-Sahara Africa region, with synonyms for each search concept, was used to search PubMed, Medline, Embase, AJOL, and Bioline databases. We also searched grey literature using similar phrases and keywords.

Inclusion and exclusion criteria

All studies conducted in SSA and published in English between January 1995 and December 2022, that reported the decision-to-delivery interval (DDI), or decision-to-incision (DTI) of CD conducted on obstetric emergencies were eligible. Studies were also included if they reported on either DDI or DTI, but only provided data on perinatal and/or maternal outcomes following cesarean delivery. Studies reporting on CD, but that did not include DDI or DTI as an outcome, were excluded.

Data extraction and quality control

Three independent reviewers applied eligibility criteria, extracted data and assessed the risk of bias. Any discrepancies were discussed amongst the reviewers and agreed on. These reviewers also abstracted data on perinatal and maternal mortality, as secondary outcome measures. In addition, the authors reviewed obstacles and challenges to achieving a desirable DDI, as reported in the included studies, and grouped these into themes identifying obstacles. Data that were not reported was assumed to be 'zero' for purposes of analysis. The authors performed a risk of bias assessment of the studies included in the meta-analysis using the ROBINS-E tool (19).

We conducted a systematic review of literature and meta-analysis of included studies, according to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) and the Meta-analysis of Observational Studies in Epidemiology (MOOSE) guidelines (20,21). Descriptive statistics were reported for data for which meta-analysis could not be performed. The study was registered with PROSPERO (CRD42023394874).

Data analysis

We used STATA version 18 (StataCorp LLC, College Station, TX), to calculate the meta-analysis of the DDI means of all the included studies. Where the DDI was reported as a median, the authors calculated the sample mean and standard deviation from the reported median using the webpage: https://smcgrath.shinyapps.io/estmeansd/. The webpage com-

bines the quantile estimation (QE) method and the Box-Cox (BC) method of McGrath et al (22), with the Method for Unknown Non-Normal Distributions (MLN) approach of Cai et al. (23). A random effects model assuming a different underlying effect for each study was used to calculate pooled means, along with 95% confidence intervals, using STATA version 17 (StataCorp LLC, College Station, TX). We used the Shapiro-Wilk Test to test for mean DDI normality.

The studies by Onah et al. (24) and Tucker et al. (25), although reported as single studies, were split into two each for purposes of analysis in this meta-analysis. While Onah et al. compared data from two hospitals, Tucker et al. reported a before-and-after study, hence each generating two sets of separate data.

Statements from studies that included obstacles that prevented them from meeting the desired DDI were collected into an EXCEL® sheet, from which themes were developed. Themes were abstracted directly from these statements, and the total number of times an obstacle was mentioned determined its positioning in the hierarchy of challenges.

Results

The literature search identified 1180 papers, of which 43 were eligible for full-text screening. 39 papers, (of which 2 had 2 different datasets each, totaling 41 datasets), with a total of 12,835 parturient women undergoing emergency CDs, were included in the final quantitative synthesis. However, only 25 (with 27 datasets) of these had sufficient data to be included in the meta-analysis (24-46). Of the included studies, 14 had insufficient data on DDI means and were excluded from the meta-analysis. However, they contributed robustly to the qualitative component of the review (47-60). The studies by Onah et al. and Tucker et al. were reported as two separate studies each, for purposes of analysis, as explained in the methodology.

All the included studies were observational (17 retrospective, and 23 prospective, and one ambidirectional). While only 15 studies (25-26,28,33-34,39-41,47-48,51,58,61) reported maternal mortality, 82.5% of the included studies reported perinatal mortality. Maternal and neonatal outcomes were not reported in six studies (27,29,42,44,56,59). Of 24 studies that reported an Apgar score (3853 patients), 21% had an Apgar score of <7 at 5 minutes; there was no correlation between a 5-minute Apgar score of <7, and perinatal mortality, as reported by the studies. The studies were from 12 countries; 3 countries contributed over 50% of the studies: 15 (37.5%) from Nigeria, 5 each from Kenya and Ethiopia. Orji et al. reported an audit of the outcomes of CDs following uterine rupture; this study (47), along with five others,

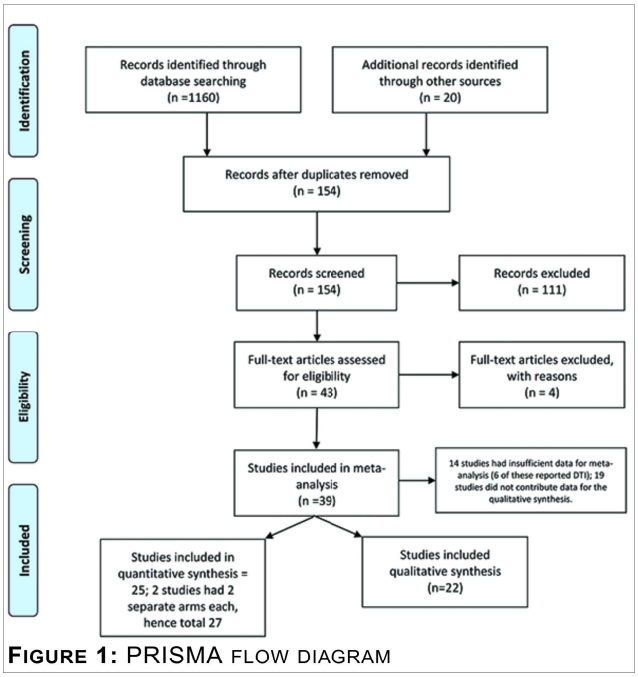

FIGURE 1: PRISMA FLOW DIAGRAM

were excluded from the meta-analysis, as they reported DTI as the primary outcome (25,48,51,53,61) (**Table 1**). Six of the included studies were theses (28,31,50,52,54,57); five other theses could not be accessed for data abstraction (**Figure 1**).

The Shapiro-Wilk W test for normal data gave a test statistic of 0.865, with a p-value of 0.002, indicating that the study DDI means were skewed. The 25 studies (with 27 datasets) included in the meta-analysis had an overall low risk of bias on assessment using the ROBINS-E tool (19,62) (**Figure 2**)

Synthesis of results

The 39 included studies (with 41 datasets) were from twelve countries; of the total 12,835 patients, only 6.34% (841) had their CDs performed in under 30 minutes. A meta-analysis of 27 studies (8118 parturient women) that had sufficient data found an overall DDI mean of 2.81 hours (168.8 minutes, 95%CI (151.5 to 186.2)); only 6.34% (556) of these patients had a DDI of ≤30 minutes (**Figure 3**).

The pooled perinatal and maternal case fatality rates (CFRs) for the included studies were 61.2 in 1000 and 444.1 in 100,000 CDs, respectively. While only 15 studies reported maternal mortality, 82.5% of the included studies reported perinatal mortality. There was no mention of the outcome of mothers and babies in the remaining studies. Of the 24 studies that reported an Apgar score (3853 patients), 21% had an Apgar score of <7 at 5 minutes. Twenty-five studies reported the causes of CD delays; approximately 90% of these were institutional; the rest were direct patient-attributable causes, involving delays in the consenting process (**Figure 4**).

Table 1: Results of included studies

Study Identification	Year	Country	Center	Study design	Total	DDI<30	5-minute Apgar score <7	PNM	MM	DDI and PNM/MM
Bello 2015[1]	2015	Nigeria	Single	Prospective	235	5	.	12	.	
Chukwudi 2014[2]	2014	Nigeria	Single	Retrospective	352	20	.	0	.	X
Shorunmu 2015[3]	2015	Nigeria	Single	Retrospective	577	0	18	42	15	√
†Inyang-Etoh EC 2010[4]	2010	Nigeria	Single	Prospective	150	0	.	11	.	√
†Mwangi 2012[5]	2012	Kenya	Single	Retrospective	502	27	20	51	.	X
†Kamotho 2018[6]	2018	Kenya	Single	Retrospective	330	10	.	24	1	.
†Habib 2010[7]	2010	Kenya	Two	Cross-sectional	251	1	14	7	.	X
†Buowari 2018[8]	2018	Nigeria	Single	Retrospective	522	22	.	0	.	.
†Orji 2002[9]	2002	Nigeria	Single	Retrospective	102	6	.	182	5	X
‡Onah 2009a[10]	2009	Nigeria	Single - UNTH	Prospective	164	0	.	14	.	X
‡Onah 2009b[10]	2009	Nigeria	Single - NH	Prospective	60	0	.	0	.	.
Adewunmi 2014[11]	2014	Nigeria	Single	Prospective	359	0	.	.	.	.
Yakasai 2011[12]	2011	Nigeria	Single	Prospective	350	43	8	22	1	X
Onuoha 2015a[13]	2015	Ghana	Single	Prospective	581	0	.	39	0	X
Onuoha 2015b[13]	2015	Ghana	Single	Prospective	574	1	.	27	3	X
†Harfouche 2015[14]	2015	Malawi	Single	Prospective	513	0	.	39	.	.
Hirani 2017[15]	2017	Tanzania	Single	Cross-sectional	598	73	.	7	.	X
†Orji 2007[16]	2007	Nigeria	Single	Cross-sectional	50	3	.	8	1	.
Temesgen 2020[17]	2020	Ethiopia	Single	Prospective	163	32	.	4	1	X
Hughes 2020[18]	2020	Uganda	Single	Retrospective	344	0	.	48	3	X
Njekwa S 2014[19]	2014	Zambia	Single	Cross-sectional	216	0	34	13	.	.
Onwudiegwu U 1999[20]	1999	Nigeria	Single	Prospective	134	0	.	28	4	√
Oppong 2014[21]	2014	Ghana	Single	Retrospective	495	8	148	26	.	√
Degu Ayele 2021[22]	2021	Ethiopia	Single	Retrospective	510	89	.	.	.	X
Kitaw 2021a[23]	2021	Ethiopia	Single	Cross-sectional	325	66	.	.	.	.
Kitaw 2021b[24]	2021	Ethiopia	Single	Prospective	182	26	46	3	.	.
Ayeni 2021[25]	2021	Nigeria	Single	Cross-sectional	205	0	.	15	.	√
Owonikoko 2018[26]	2018	Nigeria	Single	Retrospective	232	2	.	33	.	X
Igwe 2021[27]	2021	Nigeria	Single	Retrospective	522	6	447	18	.	X
‡Tucker 2021a[28]	2021	Sierra Leone	Single	Retrospective	213	18	.	10	11	.
‡Tucker 2021b[28]	2021	Sierra Leone	Single	Retrospective	327	129	.	12	8	.
†Mungai 2021[29]	2021	Kenya	Single	Prospective	130	4	13	14	.	.
†Kanario 2021[30]	2021	Kenya	Single	Ambidirectional	419	4	.	6	2	√
Nakintu 2016[31]	2016	Uganda	Single	Cross-sectional	297	2	40	1	.	X
Andisha 2019[32]	2019	South Africa	Single	Retrospective	153	8	2	0	0	X
†Kumoyo 2015[33]	2015	Zambia	Single	Cross-sectional	355	1	.	.	.	.
†Tebeu 2022[34]	2022	Cameroon	Four	Prospective	165	33	.	.	.	.
le Riche 2005[35]	2005	South Africa	Single	Prospective	178	28	22	.	.	.
†Niyitegeka 2017[36]	2017	Rwanda	Three	Retrospective	338	50	.	13	.	.
†Fesseha 2011[37]	2011	Ethiopia	National	Retrospective	267	97	.	74	2	.
Khumalo 2022[38]	2022	South Africa	Single	Retrospective	395	0	36	3	.	.

†Insufficient data, excluded from meta-analysis. ‡Onah compared data from two hospitals; ‡Tucker reported a before-and-after study. Each generated two complete sets of separate data. '.' stands data not reported, presumed zero, for purposes of analysis

FIGURE 2: ROBINS-E RISK OF BIAS ASSESSMENT

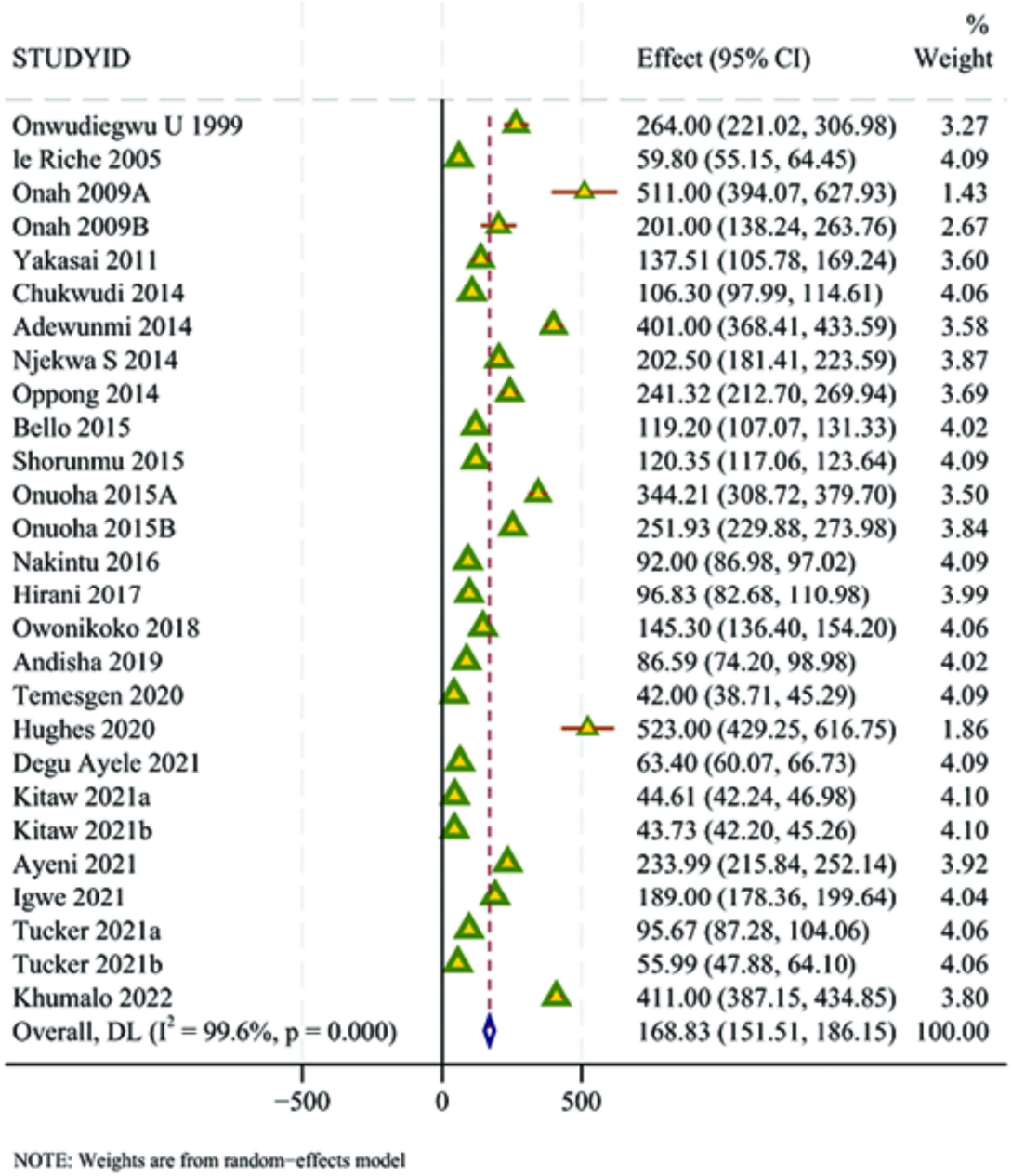

FIGURE 3: META-ANALYSIS OF THE DECISION-TO-DELIVERY INTERVAL MEANS

This review found high perinatal and maternal CFRs following CD in SSA; the perinatal mortality rate was almost two times that reported in SSA (61.2 in 1000 CD, compared to 34.7 in 1000 total births, while the maternal mortality rate was near-equivalent (444.1 in 100,000 CDs, compared to 534 in 100,000 live births (63,64). Perinatal and maternal mortalities may have been underestimated in our analysis because studies that did not report on these statistics were assumed to have had no mortalities, which may not have been the case. While maternal and perinatal outcomes in SSA are worse following CDs than vaginal deliveries (65), emergency CDs result in even poorer outcomes when compared to elective CDs (17). In this review, for every 200 CDs performed, approximately 16 babies and one mother died. These statistics are extremely worrisome, especially considering that CDs are intended to be life-saving for both the baby and mother (66); no wonder Dikete et al. observed that a 'CD is not a tool for reducing maternal and perinatal mortality' in SSA (15). These sentiments indicate the need for urgent action to make this right and use CDs as life-saving and life-giving tools, as intended.

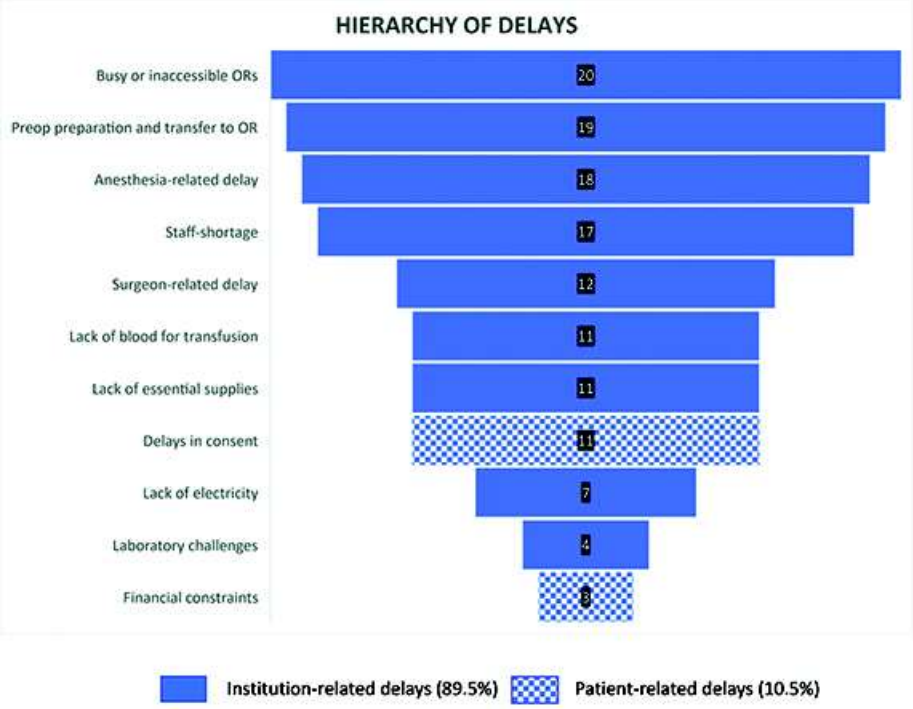

FIGURE 4: HIERARCHY OF CAUSES OF DDI DELAYS IN SUB-SAHARA AFRICA

It was not possible to perform a meta-analysis on DDI data outcomes because only two papers (41,47) reported perinatal outcomes stratified by DDI; none stratified maternal outcomes by the DDIs. It was notable though, that in general, DDIs of more than 60 minutes resulted in adverse neonatal outcomes. Amongst studies reporting DDIs, a DDI<30 minutes was achieved in only 6.34% of total CDs performed. Most studies did not achieve a DDI<30 minutes even for the direst obstetric emergencies. The mean DDI for included studies was 168.8 minutes 95% CI (151.5 to 186.2); at 2.81 hours, this is more than five times the gold standard of 30 minutes. Many authors reported that with the hurdles faced in the SSA region, a DDI of <30 minutes was an unreasonable goal.

This review identified multiple causes of delays in achieving safe CDs in SSA, which present serious challenges to achieving safe CDs. Nevertheless, in identifying these problems, these authors make it possible for solutions that could improve maternal and perinatal outcomes to be crafted, and so make CD safe. Out-of-pocket payments required before CDs were identified as a major hindrance to good outcomes in two studies. The patient/family was also required to purchase essential supplies and pay for blood screening before hospital admission. Lack of money and prehospital delays were the only hurdles not under the direct control of health care institutions (55,67-70). However, governments can en act laws that prohibit health care institutions from withholding emergency medical and surgical care, as is the case in Kenya (71). The government should also be required to ensure that CD-capable hospitals are CD-ready, with the necessary resources.

Emergency cesarean delivery

Cesarean delivery, the most performed major surgical procedure in SSA (18,72), is an important indicator of the quality of emergency obstetric care provided by an institution. When performed judiciously, CD is a critical tool for averting complications during labor and delivery (73). Emergent CD is required in situations in which prompt delivery is needed to reduce risk to the mother, fetus, or both (74,75). Although lifesaving, CD increases maternal and newborn risks and costs, especially in resource-constrained settings (15,73,76). Maternal and neonatal complication rates are higher in emergency CDs than in elective CDs. In LMICs, emergency CDs may be associated with a 10-fold increase in the odds of surgical site infection, compared with elective procedures (17). In South Africa, mothers who undergo CD may have three times the mortality rates of vaginal delivery (65). Additionally, the proportion of mothers dying after CD in LMICs is 100 times higher than that in HICs (77). This review reported that one maternal death occurred for every 200 CDs.

Emergency CDs are major surgical interventions that in LMICs are often performed under intense stress, in generally high-risk patients, and frequently by underqualified, poorly trained, and poorly motivated staff (65).

Safe obstetric anesthesia in SSA is a critical component of safe surgery. This study found that anesthesia-related delays in the current review were among the top causes of CD delays. Consistent with this finding, Bishop et al. found that 10% of post-CD deaths in their study were related to anesthesia (17), while Leung et al. identified training in teamwork and communication, availability of anesthetists, and operating room (OR) as the main factors needed to achieve quick CDS in Hong Kong (78). These same factors were identified as causes of delays in achieving short DDIs in this review. Multidisciplinary team practice for emergency CD is therefore both rational and prudent from a quality improvement perspective (8,10). Chang et al. proposed multidisciplinary four-level triage categories, based on the Lucas classification for the degree of urgency for cesarean delivery (11), to delineate the communication and action plan for CDs based on acuity and coded by colors, along with the staff that needs to be informed, and when, at each level of urgency (79). Significant reductions in the decision-to-incision time after the introduction of color-coded cesarean delivery urgency classification have been reported (11-13). Obstetric drills in the SSA are the subject of a subsequent manuscript.

Decision-to-incision and decision-to-delivery interval

Lipman et al. divided the tasks needed to perform an emergency CD into three categories: tasks to be completed initially, tasks to be completed once the decision to move from the labor ward to the OR has been made, and tasks to be completed upon entering the OR (8). Once the decision to perform a CD has been made, a team of providers is immediately mobilized; this team must communicate effectively and efficiently, provide timely safe care to the expectant mother and her newborn (80). The 8th Edition of the Guidelines for Perinatal Care (2017) recommends that the "decision-to-incision interval should be based on the timing that best incorporates maternal and fetal risks and benefits" and that "it is reasonable to tailor the time to delivery based on local circumstances and logistics". This requires effective communication between the obstetrics, anesthesia, and pediatric specialties, and the OR staff (81).

To ensure the provision of safe maternal and perinatal care in HICs, professional and regulatory bodies have adopted the 30-minute DDI limit for emergency CD, albeit in the absence of supporting evidence (14). Tolcher et al. found that the 30-minute DDI rule was not achieved in a substantial proportion of cases included in their review, although there was no convincing evidence to suggest that neonatal morbidity was worse when the DDI was more than 30 minutes either (74), a finding also reported elsewhere (82-84). Furthermore, achieving the DDI <30 minutes is a tall order that many believe is difficult to achieve, irrespective of resource setting (78,85). Paradoxically, some authors have reported poorer neonatal outcomes for babies delivered under 30 minutes, with many attributing this to the fact that emergent CDs performed for fetal distress are more likely to have poor Apgar scores at 5 minutes (74,86-87). Following a quality improvement program, De Regt et al. reduced their DTI time. They concluded that indication-based standards that address an institution's staff and structural capacity are needed to evaluate the DTI. These authors identified five areas for improvement to help achieve a DTI<30 minutes: situation (indication and urgency), staff (availability of OR nurses, surgeons, and anesthesiologists), facility (OR availability), scheduling (time of day and volume of cases), and patient (preparedness to apprehend and accept CD) (88).

In this review, 18 studies did not report on the relationship between DDI and perinatal outcomes (25,27,29,31,33,35,44-45,51,54-55,57,59-61), whereas 12 studies did not find any associations (24,28,32,38-42,46,50,52). A further 12 studies found a positive association between prolonged DDI and perinatal morbidity and mortality (26,30,34,36-37,43,47-49,53,56,58) with DDI >60 minutes in general, resulting in poorer outcomes. Bello et al. reported that patients and relatives were required to purchase their own OR supplies when a decision for CD was made, leading to DDI delays (35). Several authors reported frustration at not being able to run a full-time emergency obstetric service, despite working at resourced hospitals (32,34,48-49). Orji et al. reported their experience with 102 uterine ruptures in which only 6 had a DDI <30 minutes; however, there were no maternal or fetal deaths in these patients (47). Adekanle et al. noted that despite an institutionally high CD rate, there was no corresponding reduction in perinatal deaths (89).

Even when the diversity of healthcare across SSA is considered, poor maternal and perinatal outcomes demand action (90). This action could include a standardization of CD protocols and institutionalized referral systems with state monitoring (50). Given the heterogeneity of indications for CD, and the lack of data to support a DDI <30 minutes for every emergent CD, it would appear reasonable to adopt the proposal made by some authors: that the DDI of 30 minutes be maintained for a defined group of maternal and fetal indications, rather than for all emergent CDs (27,34,37,49,81,84). Fuhrmann et al. reported their experience in Denmark, where emergency CD DDIs are stratified by indication: DDI <15 minutes where there is an immediate maternal or neonatal threat, while a 60-minute DDI is indicated for urgent CDs in which there is no maternal or neonatal threat (91). Furthermore, several authors from SSA have concluded that it is impossible to achieve a DDI<30 minutes in their settings, given the systemic delays, and the lack of evidence for improved perinatal

or maternal outcomes with expedited CDs (32,34-35). Landry et al. audited CD record-keeping across a range of referral facilities in five LMICs and identified the following shortcomings: lack of documentation from referring facilities, inadequate use of the partograph, non-standardized terminology for CD indications, and poor documentation of the DDI (92). These deficiencies lead to poor inter- and intra-professional and institutional communication and are likely to lead to delays in the provision of care, resulting in poor maternal and/or perinatal outcomes. Although CD audit tools, if well-implemented, can improve decision-making and harmonize practice among care providers, specific standardized tools appropriate for the resource environment would be more effective and sustainable in the long term. Standardization of terminology and programs will make it easy for adoption, credentialing, and scaling up (93-94).

Strengths and limitations

The elevated mean DDI and unacceptable high perinatal and maternal CFRs following CD, reported in this review, demand an urgent need for innovative solutions to improve maternal and perinatal outcomes in SSA. This review collected, analyzed, and developed themes perceived by authors as the drivers of delays to the provision of lifesaving CDs, thereby providing institutional and government administrators the basis for introducing the changes required to improve outcomes. All included studies in this systematic review were of low quality. Besides mean DDIs, there was insufficient data to perform any other analyses. Data that were not reported was assumed to be 'zero' for purposes of analysis; we recognize that this may potentially have led to the finding of lower perinatal and maternal mortalities, by using higher denominators. Additionally, although the mean DDI was not normally distributed, the study findings are based on the assumptions of a normally distributed effect size.

Conclusions and implications

This review found a prolonged DDI (2.81 hours), and high perinatal and maternal mortalities following CD in SSA. Given the varied, multiple causes of DDI delays reported in this review, as well as the fact that 90% of the delays were caused by institutional inefficiencies, the authors recommend that healthcare institutions providing CD in SSA audit their institutional processes to reduce the DDI, as well as reducing the attendant complications.

Author contributions

PMN, IKB, and NMN contributed to the concept and design of the manuscript. PMN, SHM, and MOO analyzed the data, interpreted it, and drafted the manuscript. SHM, MOO, IKB, and NMN revised the manuscript. All the authors approved the submitted manuscript version.

Conflict of interest

The authors have no conflicts of interest to declare.

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Patient Consent Statement

Not applicable.

References

1. World Health Organization. Maternal mortality [Internet]. 2024 [cited 2024 May 6]. Available from: https://www.who.int/news-room/fact-sheets/detail/maternal-mortality
2. Trends in maternal mortality 2000 to 2020: estimates by WHO, UNICEF, UNFPA, World Bank Group and UNDESA/Population Division. Geneva: World Health Organization; 2023. Licence: CC BY-NC-SA 3.0 IGO
3. African Union Commission. 2014 Status Report on Maternal, Newborn, & Child Health. 2014 [cited 2024 May 6]; Available from: www.au.int
4. Manasyan A, Saleem S, Koso-Thomas M, et al. Assessment of obstetric and neonatal health services in developing country health facilities. *Am J Perinatol*. 2013;30(9):787-794. doi:10.1055/s-0032-1333409
5. van den Broek N, Ameh C, Madaj B, et al. Effects of emergency obstetric care training on maternal and perinatal outcomes: a stepped wedge cluster randomised trial in South Africa. *BMJ Glob Health*. 2019;4(6):e001670. Published 2019 Nov 10. doi:10.1136/bmjgh-2019-001670
6. Sentinel event alert issue 30--July 21, 2004. Preventing infant death and injury during delivery. *Adv Neonatal Care*. 2004;4(4):180-181.
7. Sorensen SS. Emergency drills in obstetrics: reducing risk of perinatal death or permanent injury. *JONAS Healthc Law Ethics Regul*. 2007;9(1):9-18. doi:10.1097/01.NHL.0000262488.31030.8d
8. Lipman SS, Carvalho B, Cohen SE, Druzin ML, Daniels K. Response times for emergency cesarean delivery: use of simulation drills to assess and improve obstetric team performance. *J Perinatol*. 2013;33(4):259-263. doi:10.1038/jp.2012.98
9. Draycott T, Sibanda T, Owen L, et al. Does training in obstetric emergencies improve neonatal outcome?. *BJOG*. 2006;113(2):177-182. doi:10.1111/j.1471-0528.2006.00800.x

10. Black RS, Brocklehurst P. A systematic review of training in acute obstetric emergencies. *BJOG*. 2003;110(9):837-841.
11. Lucas DN, Yentis SM, Kinsella SM, et al. Urgency of caesarean section: a new classification. *J R Soc Med*. 2000;93(7):346-350. doi:10.1177/014107680009300703
12. Huissoud C, du Mesnildot P, Sayegh I, et al. La mise en oeuvre des codes "couleur" réduit le délai décision-naissance des césariennes urgentes [Color-codes implementation shortens the decision-to-delivery interval of emergency C-sections]. *J Gynecol Obstet Biol Reprod (Paris)*. 2009;38(1):51-59. doi:10.1016/j.jgyn.2008.09.011
13. Dupuis O, Sayegh I, Decullier E, et al. Red, orange and green Caesarean sections: a new communication tool for on-call obstetricians. *Eur J Obstet Gynecol Reprod Biol*. 2008;140(2):206-211. doi:10.1016/j.ejogrb.2008.04.003
14. Tomlinson JH, Lucas DN. Decision-to-delivery interval: Is 30 min the magic time? What is the evidence? Does it work?. *Best Pract Res Clin Anaesthesiol*. 2017;31(1):49-56. doi:10.1016/j.bpa.2017.04.001
15. Dikete M, Coppieters Y, Trigaux P, Englert Y, Simon P, Zhang W. An analysis of the practices of caesarean section in sub-Saharan Africa: A summary of the literature. Archives Community Med Public Health. 2019 Aug;5:077-86.
16. World Health Organization. Time to respond: a report on the global implementation of maternal death surveillance and response (MDSR) [Internet]. 2016 [cited 2024 May 6]. Available from: https://www.who.int/publications/i/item/9789241511230
17. Bishop D, Dyer RA, Maswime S, et al. Maternal and neonatal outcomes after caesarean delivery in the African Surgical Outcomes Study: a 7-day prospective observational cohort study [published correction appears in Lancet Glob Health. 2019 Aug;7(8):e1019]. *Lancet Glob Health*. 2019;7(4):e513-e522. doi:10.1016/S2214-109X(19)30036-1
18. Sway A, Nthumba P, Solomkin J, et al. Burden of surgical site infection following cesarean section in sub-Saharan Africa: a narrative review. *Int J Womens Health*. 2019;11:309-318. Published 2019 May 9. doi:10.2147/IJWH.S182362
19. ROBINS-E Development group (Higgins J, Morgan R, Rooney A, Taylor K, Thayer K, Silva R, Lemeris C, Akl A, Arroyave W, Bateson T, Berkman N, Demers P, Forastiere F, Glenn B, Hróbjartsson A, Kirrane E, LaKind J, Luben T, Lunn R, McAleenan A.) *McGuinness, Risk Of Bias In Non-randomized Studies of -Exposure (ROBINS-E)* (2022)
20. Moher D, Liberati A, Tetzlaff J, Altman DG; PRISMA Group. Preferred reporting items for systematic reviews and meta-analyses: the PRISMA statement. *PLoS Med*. 2009;6(7):e1000097. doi:10.1371/journal.pmed.1000097
21. Stroup DF, Berlin JA, Morton SC, et al. Meta-analysis of observational studies in epidemiology: a proposal for reporting. Meta-analysis Of Observational Studies in Epidemiology (MOOSE) group. *JAMA*. 2000;283(15):2008-2012. doi:10.1001/jama.283.15.2008
22. McGrath S, Katzenschlager S, Zimmer AJ, Seitel A, Steele R, Benedetti A. Standard error estimation in meta-analysis of studies reporting
23. medians. *Stat Methods Med Res*. 2023;32(2):373-388. doi:10.1177/09622802221139233
24. Cai S, Zhou J, Pan J. Estimating the sample mean and standard deviation from order statistics and sample size in meta-analysis. *Stat Methods Med Res*. 2021;30(12):2701-2719. doi:10.1177/09622802211047348
25. Onah HE, Ibeziako N, Umezulike AC, Effetie ER, Ogbuokiri CM. Decision - delivery interval and perinatal outcome in emergency caesarean sections. *J Obstet Gynaecol*. 2005;25(4):342-346. doi:10.1080/01443610500119671
26. Tucker L, Frühauf A, Dumbuya I, et al. Reducing Decision to Incision Time Interval for Emergency Cesarean Sections: 24 Months' Experience from Rural Sierra Leone. *Int J Environ Res Public Health*. 2021;18(16):8581. Published 2021 Aug 13. doi:10.3390/ijerph18168581
27. Onwudiegwu U, Makinde ON, Ezechi OC, Adeyemi A. Decision-caesarean delivery interval in a Nigerian university hospital: implications for maternal morbidity and mortality. *J Obstet Gynaecol*. 1999;19(1):30-33. doi:10.1080/01443619965912
28. le Riche H, Hall D. Non-elective Caesarean section: how long do we take to deliver?. *J Trop Pediatr*. 2005;51(2):78-81. doi:10.1093/tropej/fmh082
29. Yakasai DIA, Zaria A. Decision to Delivery Interval for Emergency Caesarean Section and Fetomaternal Outcome at Aminu Kano Yeaching Hospital Kano, Nigeria. 2011;60.
30. Adewunmi AA, Rabiu KA, Tayo TA, et al. Decision-Delivery Interval and Perinatal Outcome in Emergency Caesarean Section:A University Teaching Hospital Experience. *West Afr J Med*. 2014;33(4):252-257.
31. Oppong SA, Tuuli MG, Seffah JD, Adanu RM. Is there a safe limit of delay for emergency caesarean section in Ghana? Results of analysis of early perinatal outcome. *Ghana Med J*. 2014;48(1):24-30. doi:10.4314/gmj.v48i1.4
32. Samutumwa N. Immediate fatal outcomes of Caesarean sections done for fetal distress at term at University Teaching Hospital Lusaka Zambia (Doctoral dissertation).
33. Chukwudi OE, Okonkwo CA. Decision - delivery interval and perinatal outcome of emergency caesarean sections at a tertiary institution. *Pak J Med Sci*. 2014;30(5):946-950. doi:10.12669/pjms.305.5470
34. Onuoha O, Ramaswamy R, Srofenyoh EK, Kim SM, Owen MD. The effects of resource improvement on decision-to-delivery times for cesarean deliveries in a Ghanaian regional hospital. *Int J Gynaecol Obstet*. 2015;130(3):274-278. doi:10.1016/j.ijgo.2015.03.032

35. Shorunmu TO, Nathaniel GV, Oloyede OA, Adefuye PO, Ayodeji AB, Ukweduan IM, Olusegun OO. The impact of decision–delivery interval on maternal and fetal outcome: a three-year experience in a tertiary hospital. Tropical Journal of Obstetrics and Gynaecology. 2015;32(1):46-54.
36. Bello FA, Tsele TA, Oluwasola TO. Decision-to-delivery intervals and perinatal outcomes following emergency cesarean delivery in a Nigerian tertiary hospital. *Int J Gynaecol Obstet*. 2015;130(3):279-283. doi:10.1016/j.ijgo.2015.03.036
37. Nakintu E, Murokora D. Emergency caesarean sections: decision to delivery interval and obstetric outcomes in Nsambya hospital, Uganda-A Cross Sectional Study. J Gynecol. 2016;1(4):122
38. Hirani BA, Mchome BL, Mazuguni NS, Mahande MJ. The decision delivery interval in emergency caesarean section and its associated maternal and fetal outcomes at a referral hospital in northern Tanzania: a cross-sectional study. *BMC Pregnancy Childbirth*. 2017;17(1):411. Published 2017 Dec 7. doi:10.1186/s12884-017-1608-x
39. Owonikoko K, Olabinjo A, Bello-Ajao H, Adeniran M, Ajibola T. Determinants of Decision to Delivery Interval (DDI) in Emergency Caesarean Sections in Ladoke Akintola University of Technology Teaching Hospital Ogbomoso, Nigeria. Clin Mother Child Health. 15: 294. surgeries was. 2018:152-2.
40. Cronjé L, Andisha E. Evaluating the decision-to-delivery interval in category 1 emergency caesarean sections at a tertiary referral hospital. South African Journal of Obstetrics and Gynaecology. 2019 Dec 1;25(3):95-9.
41. Hughes NJ, Namagembe I, Nakimuli A, et al. Decision-to-delivery interval of emergency cesarean section in Uganda: a retrospective cohort study. *BMC Pregnancy Childbirth*. 2020;20(1):324. Published 2020 May 27. doi:10.1186/s12884-020-03010-x
42. Temesgen MM, Gebregzi AH, Kasahun HG, Ahmed SA, Woldegerima YB. Evaluation of decision to delivery time interval and its effect on feto-maternal outcomes and associated factors in category-1 emergency caesarean section deliveries: prospective cohort study. *BMC Pregnancy Childbirth*. 2020;20(1):164. Published 2020 Mar 17. doi:10.1186/s12884-020-2828-z
43. Degu Ayele A, Getnet Kassa B, Nibret Mihretie G, Yenealem Beyene F. Decision to Delivery Interval, Fetal Outcomes and Its Factors Among Emergency Caesarean Section Deliveries at South Gondar Zone Hospitals, Northwest Ethiopia: Retrospective Cross-Sectional Study, 2020. *Int J Womens Health*. 2021;13:395-403. Published 2021 Apr 28. doi:10.2147/IJWH.S295348
44. Ayeni OM, Aboyeji AP, Ijaiya MA, Adesina KT, Fawole AA, Adeniran AS. Determinants of the decision-to-delivery interval and the effect on perinatal outcome after emergency caesarean delivery: a cross-sectional study. *Malawi Med J*. 2021;33(1):28-36. doi:10.4314/mmj.v33i1.5
45. Kitaw TM, Limenh SK, Chekole FA, Getie SA, Gemeda BN, Engda AS. Decision to delivery interval and associated factors for emergency cesarean section: a cross-sectional study. *BMC Pregnancy Childbirth*. 2021;21(1):224. Published 2021 Mar 20. doi:10.1186/s12884-021-03706-8
46. Kitaw TM, Tsegaw Taye B, Tadese M, Getaneh T. Effect of decision to delivery interval on perinatal outcomes during emergency cesarean deliveries in Ethiopia: A prospective cohort study. *PLoS One*. 2021;16(11):e0258742. Published 2021 Nov 8. doi:10.1371/journal.pone.0258742
47. IGWE PC, EGEDE JO, OGAH EO, ANIKWE CC, NWALI MI, LAWANI LO. Association and Determinants of Decision-Delivery Interval of Emergency Caesarean Sections and Perinatal Outcome in a Tertiary Institution. Journal of Clinical & Diagnostic Research. 2021 Mar 1;15(3).
48. Orji EO, Fasubaa OB, Onwudiegwu U, Dare FO, Ogunniyi SO. Decision-intervention interval in ruptured uteri in Ile-Ife, Nigeria. *East Afr Med J*. 2002;79(9):496-498. doi:10.4314/eamj.v79i9.9123
49. Orji EO, Ojofeitimi EO, Adeyimi AB, Esimai AO, Adejuyigbe E, Owolabi OO. Time-motion study of obstetric emergencies in a teaching hospital. Turkish-German Gynecol Assoc. 2007;14(27):1.
50. Inyang-Etoh EC. Decision-delivery interval for emergency Caesarean section and perinatal outcome in the University of Calabar Teaching Hospital Calabar, Nigeria. Tropical Journal of Obstetrics and Gynaecology. 2010;27(2):63-8.
51. Habib HA. Emergency caesarean section turnaround time and its effect on maternal and newborn health outcomes at University of Nairobi teaching hospitals (Doctoral dissertation, University of Nairobi).
52. Fesseha N, Getachew A, Hiluf M, Gebrehiwot Y, Bailey P. A national review of cesarean delivery in Ethiopia. *Int J Gynaecol Obstet*. 2011;115(1):106-111. doi:10.1016/j.ijgo.2011.07.011
53. Mwangi LW. A clinical audit of emergency caesarean deliveries at Kenyatta National Hospital (Doctoral dissertation, University of Nairobi, Kenya).
54. Harfouche M, Hosseinipour M, Kaliti S, Wilkinson J. Quality Indicators and Outcomes of Emergency Caesarean Deliveries at a District-level Maternity Hospital. *Afr J Reprod Health*. 2015;19(3):61-67.
55. Kumoyo M. Decision delivery interval for emergency caesarean sections at the University Teaching Hospital, Lusaka (Doctoral dissertation, The University of Zambia).
56. Niyitegeka J, Nshimirimana G, Silverstein A, et al. Longer travel time to district hospital worsens neonatal outcomes: a retrospective cross-sectional study of the effect of delays in receiving emergency cesarean section in Rwanda. *BMC Pregnancy Childbirth*. 2017;17(1):242. Published 2017 Jul 25. doi:10.1186/s12884-017-1426-1
57. Buowari DY, Ebirim LN. Audit of decision to delivery interval in a low resource setting. Jos Journal of Medicine. 2018 Sep 4;12(1):50-6.
58. Mungai RW. Predictors of Decision to Delivery Interval And outcomes of Caesarean Sections at

Kenyatta National Hospital (Doctoral dissertation, University of Nairobi).
59. Kanario P, Mburugu P, Kabuga S, Wangari L, Wanjiku L, Luchemo P, Simba J, Nyariki CM, Thuo R, Makworo D, Lusweti B. Decision to delivery interval of emergency caesarean section and associated maternal and neonatal outcomes in a county hospital in Kenya. East African Medical Journal. 2021 Jul 1;98(7).
60. Tebeu PM, Tchamte CN, Kamgaing N, Antaon JSS, Mawamba YN. Determinants of the decision to incision interval in case of emergency caesarean section in Yaoundé' hospitals. *Afr Health Sci*. 2022;22(2):511-517. doi:10.4314/ahs.v22i2.59
61. Khumalo M, Leonard T, Scribante J, Perrie H. A Retrospective Review of Decision to Delivery Time Interval for Foetal Distress at a Central Hospital. *Int J Womens Health*. 2022;14:1723-1732. Published 2022 Dec 14. doi:10.2147/IJWH.S382518
62. Kamotho D, Pertet AM, Ogwayo I. Decision to incision interval for emergency caesarean section and postoperative outcomes in a resource limited rural Kenyan public hospital. Int J Reprod Contraception, Obstet Gynecol. 2018 Jul 1;7(7):2573.
63. McGuinness LA, Higgins JPT. Risk-of-bias VISualization (robvis): An R package and Shiny web app for visualizing risk-of-bias assessments. *Res Synth Methods*. 2021;12(1):55-61. doi:10.1002/jrsm.1411
64. Akombi BJ, Renzaho AM. Perinatal Mortality in Sub-Saharan Africa: A Meta-Analysis of Demographic and Health Surveys. *Ann Glob Health*. 2019;85(1):106. Published 2019 Jul 12. doi:10.5334/aogh.2348
65. WHO, UNICEF, UNFPA, World Bank Group, and UNDESA/Population Division. Trends in Maternal Mortality 2000 to 2020. Geneva, World Health Organization, 2023
66. Gebhardt GS, Fawcus S, Moodley J, Farina Z; National Committee for Confidential Enquiries into Maternal Deaths in South Africa. Maternal death and caesarean section in South Africa: Results from the 2011-2013 Saving Mothers Report of the National Committee for Confidential Enquiries into Maternal Deaths. *S Afr Med J*. 2015;105(4):287-291. doi:10.7196/samj.9351
67. Shah A, Fawole B, M'imunya JM, et al. Cesarean delivery outcomes from the WHO global survey on maternal and perinatal health in Africa. *Int J Gynaecol Obstet*. 2009;107(3):191-197. doi:10.1016/j.ijgo.2009.08.013
68. Nwolise CH, Hussein J, Kanguru L, Bell J, Patel P. The effectiveness of community-based loan funds for transport during obstetric emergencies in developing countries: a systematic review. *Health Policy Plan*. 2015;30(7):946-955. doi:10.1093/heapol/czu084
69. Miller S, Abalos E, Chamillard M, et al. Beyond too little, too late and too much, too soon: a pathway towards evidence-based, respectful maternity care worldwide. *Lancet*. 2016;388(10056):2176-2192. doi:10.1016/S0140-6736(16)31472-6
70. Pirkle CM, Fournier P, Tourigny C, Sangaré K, Haddad S. Emergency obstetrical complications in a rural African setting (Kayes, Mali): the link between travel time and in-hospital maternal mortality. *Matern Child Health J*. 2011;15(7):1081-1087. doi:10.1007/s10995-010-0655-y
71. Mucunguzi S, Wamani H, Lochoro P, Tylleskar T. Effects of improved access to transportation on emergency obstetric care outcomes in Uganda. *Afr J Reprod Health*. 2014;18(3):87-94.
72. Republic of Kenya. Kenya Gazette Supplement Acts, 2017. The Health Act, 2017. 2017 Jun 23;
73. Biccard BM, Madiba TE, Kluyts HL, et al. Perioperative patient outcomes in the African Surgical Outcomes Study: a 7-day prospective observational cohort study. *Lancet*. 2018;391(10130):1589-1598. doi:10.1016/S0140-6736(18)30001-1
74. Shah A, Fawole B, M'imunya JM, et al. Cesarean delivery outcomes from the WHO global survey on maternal and perinatal health in Africa. *Int J Gynaecol Obstet*. 2009;107(3):191-197. doi:10.1016/j.ijgo.2009.08.013
75. Tolcher MC, Johnson RL, El-Nashar SA, West CP. Decision-to-incision time and neonatal outcomes: a systematic review and meta-analysis. *Obstet Gynecol*. 2014;123(3):536-548. doi:10.1097/AOG.0000000000000132
76. Schauberger CW. Decision-to-incision times and maternal and infant outcomes. *Obstet Gynecol*. 2006;108(5):1298. doi:10.1097/01.AOG.0000244982.46510.a4
77. Keag OE, Norman JE, Stock SJ. Long-term risks and benefits associated with cesarean delivery for mother, baby, and subsequent pregnancies: Systematic review and meta-analysis. *PLoS Med*. 2018;15(1):e1002494. Published 2018 Jan 23. doi:10.1371/journal.pmed.1002494
78. Sobhy S, Arroyo-Manzano D, Murugesu N, et al. Maternal and perinatal mortality and complications associated with caesarean section in low-income and middle-income countries: a systematic review and meta-analysis. *Lancet*. 2019;393(10184):1973-1982. doi:10.1016/S0140-6736(18)32386-9
79. Leung TY, Lao TT. Timing of caesarean section according to urgency. *Best Pract Res Clin Obstet Gynaecol*. 2013;27(2):251-267. doi:10.1016/j.bpobgyn.2012.09.005
80. Chang OH, Levy B, Lytle H, et al. Implementation of the Alliance for Innovation on Maternal Health Program to Reduce Maternal Mortality in Malawi. *Obstet Gynecol*. 2019;133(3):507-514. doi:10.1097/AOG.0000000000003108
81. Chang HY, Gavin N, Nguyen TA, Sheffield JS, Szymanski L. A multidisciplinary approach to peripartum triaging of patients to the operating room. J Clin Anesth Manag. 2018;3(2):112-25.
82. Practice AComm on F and NAComm on O. Guidelines for Perinatal Care. Guidelines for Perinatal Care [Internet]. 2017 Sep 17 [cited 2024 May 7]; Available from: https://publications.aap.org/aapbooks/book/522/Guidelines-for-Perinatal-Care

83. Grobman WA, Bailit J, Sandoval G, et al. The Association of Decision-to-Incision Time for Cesarean Delivery with Maternal and Neonatal Outcomes. *Am J Perinatol*. 2018;35(3):247-253. doi:10.1055/s-0037-1606641
84. Bloom SL, Leveno KJ, Spong CY, et al. Decision-to-incision times and maternal and infant outcomes. *Obstet Gynecol*. 2006;108(1):6-11. doi:10.1097/01.AOG.0000224693.07785.14
85. Boehm FH. Decision to incision: time to reconsider. *Am J Obstet Gynecol*. 2012;206(2):97-98. doi:10.1016/j.ajog.2011.09.009
86. Nageotte MP, Vander Wal B. Achievement of the 30-minute standard in obstetrics-can it be done?. *Am J Obstet Gynecol*. 2012;206(2):104-107. doi:10.1016/j.ajog.2011.09.008
87. Chauhan SP, Roach H, Naef RW 2nd, Magann EF, Morrison JC, Martin JN Jr. Cesarean section for suspected fetal distress. Does the decision-incision time make a difference?. *J Reprod Med*. 1997;42(6):347-352
88. Pearson GA, Kelly B, Russell R, Dutton S, Kurinczuk JJ, MacKenzie IZ. Target decision to delivery intervals for emergency caesarean section based on neonatal outcomes and three year follow-up. *Eur J Obstet Gynecol Reprod Biol*. 2011;159(2):276-281. doi:10.1016/j.ejogrb.2011.07.044
89. de Regt RH, Marks K, Joseph DL, Malmgren JA. Time from decision to incision for cesarean deliveries at a community hospital. *Obstet Gynecol*. 2009;113(3):625-629. doi:10.1097/AOG.0b013e31819970b8
90. Adekanle DA, Adeyemi AS, Fasanu AO. Caesarean section at a tertiary institution in Southwestern Nigeria—A 6-year audit. Open Journal of Obstetrics and Gynecology 2013;03:357-61
91. Dare AJ. Making caesarean section safer for African mothers. *Lancet Glob Health*. 2019;7(4):e402-e403. doi:10.1016/S2214-109X(19)30054-3
92. Fuhrmann L, Pedersen TH, Atke A, Møller AM, Østergaard D. Multidisciplinary team training reduces the decision-to-delivery interval for emergency Caesarean section. *Acta Anaesthesiol Scand*. 2015;59(10):1287-1295. doi:10.1111/aas.12572
93. Landry E, Pett C, Fiorentino R, Ruminjo J, Mattison C. Assessing the quality of record keeping for cesarean deliveries: results from a multicenter retrospective record review in five low-income countries. *BMC Pregnancy Childbirth*. 2014;14:139. Published 2014 Apr 12. doi:10.1186/1471-2393-14-139
94. Ennen CS, Satin AJ. Training and assessment in obstetrics: the role of simulation. *Best Pract Res Clin Obstet Gynaecol*. 2010;24(6):747-758. doi:10.1016/j.bpobgyn.2010.03.003
95. Noblot E, Raia-Barjat T, Lajeunesse C, et al. Training program for the management of two obstetric emergencies within a French perinatal care network. *Eur J Obstet Gynecol Reprod Biol*. 2015;189:101-105. doi:10.1016/j.ejogrb.2015.03.019