Graduate thesis

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Caesarean Sections in Sierra Leone explored: a literature review from the last 20 years

Graduate thesis in Programme of Professional Study, Medicine
Supervisor: Josien Westendorp
Co-supervisor: Alex van Duinen
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Abstract

AIM: The aim of this study is to describe the main trends and use of caesarean section (CS) over the last 20 years in Sierra Leone. Further exploration of CS rates, indications for CS, patient outcomes, the effect of the Ebola outbreak on CS and task sharing and its effect on CS are main focus areas in this study. **METHODS:** The design of the study is a semi-systematic literature review. The main literature for the thesis was identified by conducting a systematic search in PubMed, MEDLINE, SCOPUS and Google Scholar.
Additional Demographic and Health Survey (DHS) reports and Maternal Death Surveillance and Response (MDSR) reports were included alongside the database search results. The literature retrieval resulted in 51 works of literature which were read by both authors, and sorted by main focus areas as well as sub themes. A selection of key articles for the results were based on relevancy for each focus area. **RESULTS:** The key findings of the selected articles were summarized in the results. The result section includes an overview on the findings of the literature for each focus area (CS rates, patient outcomes, indications for CS, Ebola and its effect on CS and task sharing and its effect on CS). 13 articles were used for the CS rate results, seven articles and six reports were used for the patient outcome results, three articles were used for the indications for CS results, three articles were used for the task sharing results and five were used for the Ebola section of
results. **CONCLUSION:** Findings in literature suggest there has been a development in maternal health care services in Sierra Leone over the last 20 years, resulting in increased CS rates and decreased maternal and perinatal mortality and morbidity. However, CS access is still below the recommendations, and increased investment, research and governmental commitment to improve obstetric care is needed in Sierra Leone.

Sammendrag

FORMÅL: Formålet med denne oppgaven er å beskrive trender og hovedtrekk i bruken av keisersnitt gjennom de siste 20 årene i Sierra Leone. Videre utforsking av keisersnitt-rate, indikasjoner for keisersnitt, pasientutfall, påvirkningen av ebolautbruddet på keisersnitt samt oppgaveglidning (task sharing) og dens påvirkning på keisersnitt er hovedfokusområder i denne oppgaven. **METODE:** Studiedesignet er en semi-systematisk litteratur-gjennomgang/review. Hovedparten av litteraturen for oppgaven ble funnet gjennom et systematisk databasesøk i PubMed, MEDLINE, SCOPUS og Google Scholar. Tilleggslitteratur som ble inkludert etter databasesøket er Demographic and Health Survey (DHS)-rapporter og Maternal Death Surveillance and Response (MDSR)- rapporter.
Litteraturinnhentingen resulterte i 51 tekster som ble lest av begge forfatterne, og videre sortert etter hovedfokusområder og undertemaer. Et utvalg av sentrale artikler for resultatdelen ble valgt på bakgrunn av relevans for hvert
fokusområde. **RESULTATER:** Hovedfunnene i de utvalgte artiklene ble oppsummert i resultatdelen av oppgaven. Resultatdelen inneholder en oversikt over funnene i litteraturen for hvert fokus område (keisersnitt-rate, pasientutfall, indikasjoner for keisersnitt, ebola og dets påvirkning på keisersnitt samt oppgaveglidning og dets påvirkning på keisersnitt). 13 artikler ble brukt i avsnittet om keisersnitt-rate, syv artikler og seks rapporter ble brukt for delen om pasientutfall, tre artikler for indikasjoner, tre artikler for oppgaveglidning-resultatene og fem artikler for ebola-seksjonen av resultatene. **KONKLUSJON:** Funnene i litteraturen tilsier at det har vært en utvikling i den maternelle helsetjenesten i Sierra Leone de siste 20 årene. Dette har resultert i økt keisersnitt-rate og synkende dødelighet og sykelighet, både maternell og perinatal. Likevel er tilgangen på keisersnitt fremdeles lavere enn anbefalt, og videre forskning samt investering og engasjement fra myndighetenes side er nødvendig for å forbedre obstetrisk omsorg i landet.

Introduction

The World Health Organization (WHO) estimated 295 000 maternal deaths globally and sub-Saharan Africa alone accounted for roughly 66% of these[1]. This area suffers from one of the world's highest maternal mortality ratio (MMR) of 546 maternal deaths per 100 000 live births[1]. In comparison, there were three maternal deaths per 100 000 live births in Norway in the same period[2]. The lifetime risk of maternal mortality is estimated at one in 36 in sub-Saharan Africa[1], contrasting sharply with one in 22 600 in Norway[2]. Access to safe caesarean section (CS) in low-income countries is one of the main approaches to reduce maternal mortality and morbidity[3].

With the aim of reducing maternal mortality globally, the United Nations (UN) established the Sustainable Development Goals (SDGs) in 2015. The target of SDG 3.1 is to reduce global MMR to less than 70 per 100 000 live births by 2030[4]. In addition, all countries should reduce MMR to less than 140 per 100 000 live births[4]. To achieve this goal, actions need to be taken to ensure access to quality obstetric care and safe CS when indicated.

CS is an obstetric operative procedure performed for maternal or foetal indications. These are among others haemorrhage, obstructed labour, foetal distress and eclampsia[5]. In situations like these, a CS may be life saving for mother and child[5,6]. WHO states that CS should be provided to women when medically indicated[6] as the procedure significantly reduces maternal and perinatal mortality[7]. However, CS rates above 20% is not associated with reduced maternal and perinatal mortality[8]. In 1985, the WHO expert panel proposed a CS rate of 10-15% at population-level as optimal, and concluded that CS rates higher than 10% had no impact on reductions in maternal and neonatal mortality[6,9].

The number of CS has significantly increased in both developed and developing countries over the last 20 years[8,10]. High-income countries account for the largest increase in CS rates globally, and a major proportion of these are not medically indicated[11]. Data show that almost one in five women in the world give birth by CS[11], but there are great disparities between countries. Many countries have a much higher population CS rate than the recommended 10%. For instance, in 2015 in Latin America and Caribbean the average CS

rate was 44.3%[8]. Even though CS rates are also increasing in developing countries, many countries have CS rates that are still below the recommended 10%. In the west and central parts of Africa, the overall CS rate was 4.1%[8]. This indicates that many women in need of a CS in low-income countries, still do not have access to it.

Sierra Leone, a low-income country located in West Africa, has one of the world's highest estimated MMR of 717 maternal deaths per 100 000 live births[12]. The country has been impacted by the civil war (1991-2002) and the Ebola Virus Disease (EVD) outbreak which lasted from 2014 to 2016[13]. These events affected the functioning of the health care system and consequently impacted the MMR and CS rate. The national CS rate was estimated 4% in 2019, making it one of the lowest in the world[12,14-16]. CS constitutes of 21% of all surgical procedures in Sierra Leone, and overall numbers from 2012 show that there is an unmet need of more than 90% for all surgical care in Sierra Leone[14]. Although the use of CS has increased, the rate of 4%[12] is still far below 10%, which indicate that not all Sierra Leonean women in need of a CS are receiving one[6,12].

The Ministry of Health and Sanitation in Sierra Leone (MoHS) and its partners implemented multiple strategies in response to this unmet surgical need and these high mortality levels among mothers and children[15]. In 2010, MoHS introduced the Free Health Care Initiative (FHCI) for pregnant and lactating women and children younger than five years[17]. The purpose of this initiative was to provide better health care services free of costs to these vulnerable groups[17]. To increase access to surgical care and thus cover more of the surgical need in Sierra Leone, the non-profit organization CapaCare together with MoHS initiated a surgical training programme in 2011[18]. Through this programme, Medical Doctors (MDs) and Community Health Officers (CHOs) are trained to manage the most common life-threatening emergency surgical and obstetrical conditions at district hospitals. After graduating these students become Surgical Assistant Community Health Officer (SACHOs) and they are currently performing a substantial volume of CSs in the country[19]. Furthermore, to obtain reliable data on maternal deaths in Sierra Leone, the MoHS introduced the Maternal Death Surveillance and Response (MDSR) system in 2015[20]. The purpose was to identify and investigate every maternal death occurring in the country, and thus be able to propose interventions to prevent future deaths and reduce maternal mortality[15,20].

One of the main approaches to reduce maternal mortality and morbidity is access to safe CS[3]. According to the DHS reports from Sierra Leone, the estimated CS rate has increased from 1.5% in 2008 to 4% in 2019[12,21]. Furthermore, there has been an increase in number of deliveries taking place at health facilities and deliveries assisted by a skilled birth attendant[12,21]. These data show a positive development in both maternal health care (MHC) services and CS rates in the country. However, there is a need for further interventions to reach the recommended CS rate of 10% and to achieve the SDG 3.1 by 2030[4,6].

Aim

The aim of this study is to describe the main trends and use of CS over the last 20 years in Sierra Leone. In these trends we zoom in on the impact of the EVD outbreak and the task sharing programme on CS rates and maternal mortality.

Method

This literature review aims to assess CS in Sierra Leone over the past 20 years. Our research question is:

- What is known about CS in Sierra Leone? A literature review from the last 20 years

Structure and main focus areas

Within this research question we envisioned certain areas to focus our research. The choice of focus areas was made based on an assumption on what themes could provide a relevant and interesting take on CS in Sierra Leone, as well as what areas were of particular interest to the authors. The authors made suggestions on focus areas and decided on the particular five after guidance by our supervisor. We used the template for systematic reviews on the Prospero website for the initial planning of the thesis (see appendix 1). We chose the following main focus areas:

CS rates
Patient outcome
Ebola (and impact on CS)

Task sharing (and impact on CS)

Indications (for CS)

Gathering background information

The first search conducted aimed to provide background information in Sierra Leone in general, not only limited to CS. A non-systematic search was conducted in PubMed, MEDLINE and Google Scholar on different topics; Sierra Leone and the Ebola outbreak, Sierra Leone and Task sharing, Sierra Leone and Caesarean Section, as well as maternal health in Sub-Saharan Africa. Articles from this search were gathered in an Excel file and sorted by year published, title, overall theme (CS rate, Ebola, Task Sharing, Patient Outcome and Other). This resulted in 90 articles. These articles were read fully by both authors, and the content later was discussed between the authors to achieve a shared understanding of the situation in Sierra Leone, and further explore how the thesis could provide a relevant overview of CS in Sierra Leone.

Search strategy

This thesis is a semi-systematic literature review. The main literature for the thesis was identified by conducting a systematic search in PubMed, MEDLINE, SCOPUS and Google Scholar. All types of literature from the search were included for this review, including, but not limited to, articles, reports, master theses and grey literature. There were no exclusion criteria except articles published, or containing data from, before the year 2000. The advanced search with filter on publication date was applied in SCOPUS, but not in PubMed, MEDLINE and Google Scholar, thus articles that did not meet the timeframe criteria were excluded by the authors manually. The search was limited to English literature.

Inclusion criteria were articles containing both “Sierra Leone” AND “Caesarean Section”, either by MeSH terms, synonyms or title-abstract-keywords.

All articles found in the searches were added to an Excel database containing columns for title of article, year published, hyperlink to article, tentative main focus area of article, as well as which database(s) the articles were found in. The list was cross-checked by both

authors after adding all literature, and duplicates and articles older than 20 years were removed. See appendix 2 for details of each database search strategy.

Additional literature

In addition to the database search, seven reports were included for our results. These were the Demographic and Health Surveys (DHS) of Sierra Leone from 2008, 2013 and 2019 and the Maternal Death and Surveillance Reports (MDSR) from 2016, 2017, 2018 and 2019.

Reviewing the literature

The final literature list after our systematic literature search, was read fully by both authors, separately taking notes from each article before discussion of all the articles together. The DHS reports and the MDSR reports were read partly. This included the chapters about maternal health and the method and introduction sections. Search terms “caesarean” “caesarean” and “c-section” were also used to locate the pages with relevant information on the topic. The remaining parts of the reports were skim-read.

After both authors read through all 51 articles, theses and reports separately, one or more keyword to each article, thesis and report was chosen to represent the content. Keywords were chosen by both authors together after discussion of the content of each article. Then the articles were sorted according to which main focus area they represent. For every main focus area found, all articles are presented in the result section. If more than one focus area was represented in the article, the most relevant focus area was chosen as main focus area, and the other focus areas were mentioned separately as other focus areas. For example, articles with keywords such as “maternal mortality”, “perinatal mortality”, “neonatal mortality” and “surgical site infections” were put in a table under the main focus area of “patient outcome”. If the article also contained information on indications to a lesser extent, this article was sorted by the main theme “patient outcome” and “indications” as other focus areas. This was done in order to sort articles according to which focus areas they could provide information on. Each article was sorted by main focus area and other focus area according to the keywords. The DHS reports, theses and MDSR reports were also sorted by keywords and main focus area.

For every focus area all articles that were included are stated in the beginning of each result section. Although all articles, theses and reports were sorted by main focus area and other focus areas, not all were used in the result section. Articles with data rated less relevant by both authors were not used in the result section. Some articles were also used in several result sections, when the article contained information on more than one focus area. See table 1 below in result section for an overview of final literature list which were used in the result part of the thesis, sorted by which focus area and other focus areas they represent.

Results

Literature retrieval

In the final list of literature, 51 works, there were three DHS reports, four MDSR reports, three master theses from NTNU, two from medical students and one from a midwife. The remaining were articles. See flowchart below for illustration of the literature retrieval process.

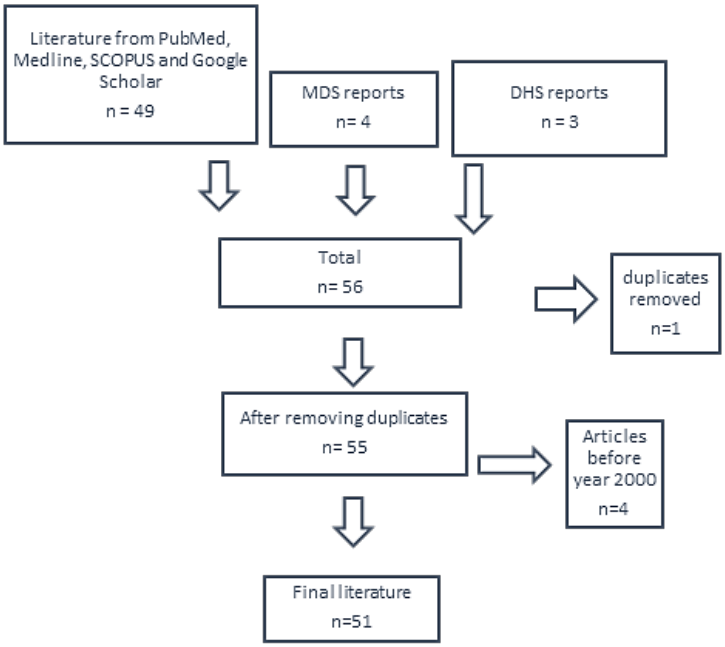

Figure 1 *Flowchart representing the main literature retrieval.*

Database results

See Appendix 2 for details on the search strategy for each database. The PubMed search resulted in 36 articles, where two were duplicates and five were older than 20 years, which resulted in a total of 30 articles after excluding those.

The MEDLINE search provided an initial 36 results – where five were older than the year 2000 and 2 were duplicates, a total of 30 articles, identical to the ones found in PubMed, were used.

The SCOPUS search resulted in 41 articles. One article published in 2002 was excluded after the search was conducted because the data analysed in the study was from 1992-1994, and two were duplicates, a total of 39 articles were included from SCOPUS, where 11 were not found in other databases.

The Google Scholar search resulted in a total of 14 articles and theses. Of the 14, three were not found in the other searches in MEDLINE, SCOPUS and PubMed. These three were all master theses from NTNU and were borrowed through ORIA (NTNU main theses from medical students) and from our supervisor, AvD (master thesis midwife).

Literature review

After reviewing the literature, the main focus areas remained the same as in the Prospero plan (see appendix 1). The table below shows the main focus area chosen for the articles included in our result section, as well as the other focus areas.

Main focus area	**Other focus areas**	**Article**
CS rates	Outcomes	Chu *et al* (2012)[22]
	Outcomes Indications	Holmer *et al* (2019)[15]
		Bolkan *et al* (2015)[23]

		Oyerinde *et al* (2011)[24]
		Groen *et al* (2013)[25]
		Rød *et al* (2013)[26]
		Lonnée *et al* (2021)[27]
		Husby *et al* (2019)[28]
	Outcomes	(DHS Report 2008[21]), 2013[29], 2019[12]
Indications		*No articles labelled with indications as main focus area. Three articles labelled with indications as other focus area.*
(Patient) outcomes	Indications for CS CS rates	van Duinen *et al* (2020)[30]
		van Duinen *et al* (2020)[31]
		Chu *et al* (2014)[32]
		Di Gerrano F *et al* (2020)[33]
		MDSR (2016)[34], (2017)[35], (2018)[36], (2019)[37]
Task sharing	Indications for CS	van Duinen *et al* (2019)[38]
		Bolkan *et al* (2017)[18]
		Waalewijn *et al* (2017)[39]
Ebola		Jones *et al* (2016)[40]
		Brolin *et al* (2016)[41]
		Quaglio *et al* (2019)[42]
	CS rates	Drevin *et al* (2019)[43]
		Bolkan *et al* (2018)[13]

Table 1 *Main focus area and other focus areas of articles in result section*

Caesarean Section Rates

There were 22 articles, theses and reports which were sorted with CS rate as main focus area, 13 were included for results (11 as main focus area, two as other focus area). How the calculations of the CS rates were done, varied. Some articles used numbers from CS rates found in other articles and the DHS reports. Some studies are nationwide, while one is from 9 districts[24], and one is from 58/60 facilities performing CS[23]. Appendix 3 provides a table with an overview of the articles which included data on CS rates from different years, and details on the calculations the study provided. The rates found in these articles and reports are shown in figure 2 below. One article was excluded from the table and figure, a study from Medecins Sans Frontieres (MSF), which only provided data from one facility run by MSF in Sierra Leone, where the CS rate was 16.8 % in 2010-2011[22]. Table 2 provides information on the studies used for figure 2.

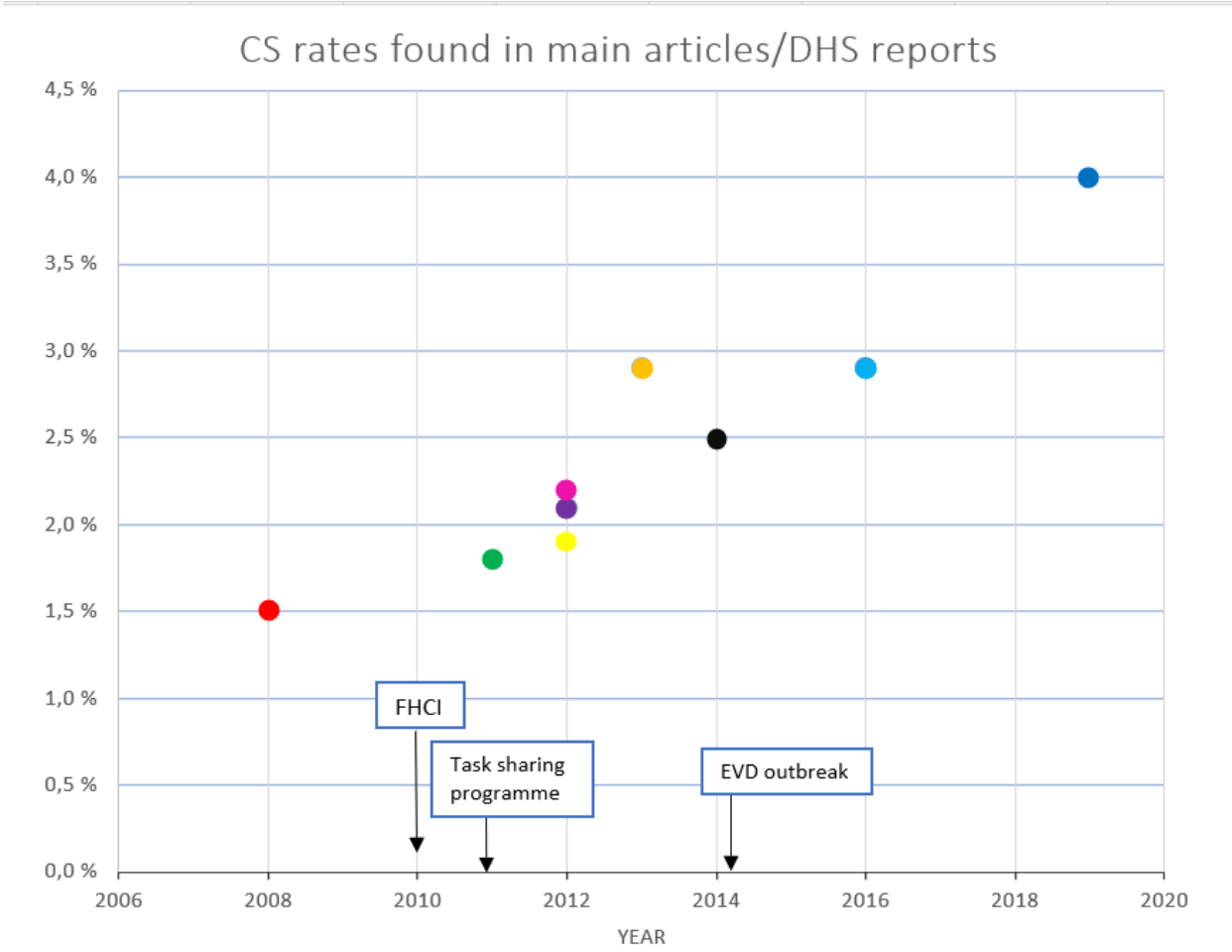

Figure 2 *CS rates over the last 20 years found in literature*

DHS 2008[21]	Oyerinde et al 2011[24]	Groen et al 2013[25]	Bolkan et al 2013[23], Drevin et al 2019[43]	Rød et al 2013[26]	DHS 2013[29], Husby et al 2019[28]	Brolin et al 2016[41]	Holmer et al 2019[15], Lonnée et al 2021[27], van Duinen et al 2020[30]	DHS 2019[12]

Table 2 *Literature of CS rates found in figure 2*

The DHS reports use population samples that aim to represent national numbers from the age group 15-49 in Sierra Leone[12,21,29]. The 2008 report found a national CS rate of 1.5 %[21]. In 2013, the DHS report found a national CS rate of 2.9 %[29]. This rate has been referred to in several articles and studies (see Appendix 3). The 2019 DHS report found a CS rate of 4 % in the 5 years preceding the publishing of the report[12].

In addition to providing data on national CS rates, the reports also provide rates in different age groups, by wealth indicators and regions in Sierra Leone. Some of the key findings from these reports are placed in table 3 below:

	DHS 2008[21]	DHS 2013[29]	DHS 2019[12]
Nationwide CS rate	1.5 %	2.9 %	4 %
CS rate in urban areas	3.2 %	4.9 %	6.5 %
CS rate in rural areas	0.9 %	2.2 %	2.9 %
CS rate in the highest wealth quintile	4.9 %	6.0 %	8.7 %
CS rate in the lowest wealth quintile	0.7 %	1.8 %	2.8 %
CS rate among women with Secondary or higher education (above	5.5 %	4.6 %	6.9 % (more than secondary)

secondary only for 2019 report)			
CS rate among women with no education	0.8 %	2.3 %	3.3 %

Table 3 *Characteristics of CS rates as found in DHS reports*

Indications for CS

The literature search resulted in five articles which were sorted with indication as main focus area, none of them were included for results. Three articles sorted with indications as other focus areas were included. A prospective observational study conducted by van Duinen and his colleagues, assessed indications for CS, and maternal and perinatal outcomes in CSs performed by Associate Clinicians (ACs) and MDs[30,38]. Data on women undergoing CS were collected from nine hospitals between October 2016 and May 2017[30]. In total, 1274 CSs were included in the study[30]. The three most frequent indications for CS were prolonged or obstructed labour (37.8%, n=481), previous CS (12.9%, n=164) and antepartum haemorrhage (11.8%, n=150), including abruptio placentae and placenta previa[30]. Eclampsia or pre-eclampsia accounted for 5.4% (n=69), breech presentation for 5.1% (n=65), foetal distress for 4.9% (n=62) and uterine rupture for 4.3% (n=55)[30]. Of the 7.0% (n=89) of CSs performed on foetal indication, 62 were performed for foetal distress, 13 for umbilical cord prolapse, 11 for premature rupture of membranes, two for oligohydramnios and one for polyhydramnios[30]. Of the 1274 CSs, 86.3% (n=1099) were performed as emergency surgery[30].

One study from 2019 assessed all CSs and reported in-facility maternal deaths in 2016[15]. All facilities performing CSs were visited and numbers of CSs performed in each facility were gathered[15]. Data on in-facility maternal deaths were retrieved from the MDSR database[15]. There were 99 deaths in 6748 CSs performed, and of these the three most common indications for CS were obstructed labour (42%, n=42), eclampsia or pre-eclampsia (25%, n=25) and haemorrhage (22%, n=22)[15]. There were no CSs performed for foetal distress[15]. The incidence of uterine rupture (22%) was high among the women who died from CS[15].

Patient outcomes

In the final list of literature, 13 articles and reports were sorted with patient outcome as main focus area. Four articles and four MDSR reports were included for the results. In addition, two DHS reports and two articles sorted with CS rate as main focus area and patient outcome as other focus area were included for the outcome results. Two of the included studies elaborated on surgical site infections post CS.

Maternal mortality

The overall MMR was estimated by the DHS report from 2013 to be 1165 per 100 000 live births[29], 717 per 100 000 live births in 2019[12].

The MDSR reports include data on MMR as well as characteristics on the maternal deaths[34]. Because of the low number of registered maternal deaths in the MDSR report from 2016, it estimated a likely underreporting of 70-80 % of maternal deaths[34]. From the data on the maternal deaths that were reported with data on delivery mode, 29.9 % were after CSs[34].

In 2017, the MDSR report showed a decrease in registered maternal deaths, unclear whether because of actual decrease in maternal deaths, or further underreporting[35]. Nevertheless, the registered deaths including mode of delivery found 25 % of deaths to be after a CS[35]. The 2017 report also noted that Sierra Leone has a very high rate of uterine rupture (7%)[35].

In 2018, the MDSR showed a small increase of reporting of maternal deaths compared to 2017[36], and of the reported deaths with information on delivery mode, 24 % were after CS[36].

The MDSR report from 2019 found that there was a small decrease in reporting of maternal deaths compared to in 2018[37], and the percentage of deaths after CS where data on delivery mode was available, was 21 %[37].

One study from 2019 which assessed all CSs and reported in-facility maternal deaths in 2016 is also mentioned in the indication section. This was the first study to provide nationally

representative numbers on maternal mortality following CS[15]. The study found that the in-facility maternal mortality after CS was 1.5 %[15]. Of all registered maternal deaths in facilities, 18 % occurred during or after CS[15].

MSF conducted a prospective study between 2010 and 2011, and included studies of CS in MSF-supported or MSF hospitals with emergency obstetric care programs in several countries, including one from Bo, Sierra Leone[22]. Here, of the 338 women who underwent CS, seven died, a perioperative mortality rate related to CS of 1.2 %[22].

Stillbirth, perinatal and neonatal mortality

In 2020 a study of all patients undergoing CS between October 2016 and May 2017 in nine hospitals was published[30]. The aim of the study was to look at indications for CS and factors that contributed to high perinatal mortality[30]. The study did a follow up on the patients, and used data perioperatively, when patients were discharged from the hospital, and at a follow up visit 30 days after discharge[30]. This study found an exceptionally high rate of perinatal mortality, and also looked at factors of the CS associated with high mortalities[30]. The study included a total of 1376 babies. Of these, 208 were stillbirths[30]. These were either classified as prepartum (n=53) when the foetus showed signs of death occurring before start of delivery, and intrapartum (n=155)[30]. The perinatal mortality included stillbirths and neonatal deaths. This particular study found a stillbirth rate of 15.1 % and an overall perinatal mortality rate of 19.0 %[30]. The study also noted that abruptio placentae, prolonged and obstructed labour, and uterine rupture were the indications associated with the highest perinatal mortality (23.4 %, 19.2 % and 17.2 %, respectively)[30].

Another study investigated travel time from location before delivery and facility where CS was conducted, and compared modelled travel times with patient-reported travel time[31]. This study was part of the multicentre prospective study that looked at perinatal mortality after CS[30]. The results showed that modelled travel times were significantly lower than the patient-reported ones, but also concluded that all measures of travel time, both modelled and patient-reported, when over two hours, were associated with higher perinatal mortality[31]. This study found an overall perinatal mortality ratio of 219 per 1000 births, and elective CS were excluded from the analysis[31].

The MSF study from 2010-2011 also provided numbers for neonatal outcomes for the MSF program in Bo, Sierra Leone, in Gondoma Referral Center[22]. The study found an early neonatal mortality rate of 21 % in that particular hospital, and also pointed out that many non-MSF supported hospitals and patients outside the area utilized hospital there[22].

Surgical Site Infections (SSI)

Two articles specifically focused on post-operative infections after CS. One study was a multi-country study from MSF, published in 2014[32]. This study gathered data from emergency obstetric programs supported by MSF in Aug 2010-Jan 2011[32]. The data was not specifically analyzed from Sierra Leone, but were numbers from the four hospitals in DRC, Burundi and Sierra Leone altogether. The findings were an overall surgical site infection incidence of 7.3 % for all the hospitals included[32]. For Sierra Leone specifically, one hospital in Bo (Gondoma Referral Center) was included. Of the 338 women undergoing CS, 25 got a post-operative infection (7%)[32]. For all the countries' facilities included in this study, most infections were superficial (91.4 %), 56.0 % were treated with antibiotics only, while 30.1 % had to do an opening of the wound[32]. Young age of the mother, premature rupture of membrane, and neonatal death correlated with a higher risk of SSI[32].

A newer case-control study on infections, published in 2020, was conducted in a hospital in Freetown, Sierra Leone[33]. This study was conducted from May '18 to April 19, and looked at SSI rates and risk factors for getting a post-CS infection[33]. A total of 1016 patients who underwent a CS were included, where 254 constituted the SSI patients, and the remaining were controls[33]. The SSI rate was 10.9 % and 5.3% of the confirmed cases died from the SSI[33]. Here, in this study, only 35.5 % of the infections were classified as superficial, while 38.2 % were deep and 26.3 % was organ/space[33]. Fewer patients than in the MSF study mentioned in the previous paragraph were treated with antibiotics only (31.9 % vs 56.0%)[32,33]. The study found some common risk factors for getting an SSI. One risk factor was premature rupture of membranes, a result also presented in the study from MSF[32,33]. Others included abnormal BMI, both low and high, long decision-incision time, previous CS and missing post CS antibiotics[33].

Task sharing and its impact on CS in Sierra Leone

Three articles out of a total of four containing information on task sharing were included. One study from 2017 evaluated maternal mortality and productivity of SACHOs after completing the 3-year surgical training programme (STP)[18]. The study gathered data from operations performed by SACHOs between 2011 and 2016[18]. The trainees and SACHOS performed a total of 27 216 surgical procedures in the five-year period, where 2944 were performed by SACHOS who had completed the STP[18]. Of these procedures, 1290 (43.8 %) were CS[18]**.** Given that the trend from the study period continued, the study calculated that 60 SACHOS would perform 4578 CSs annually[18]. Mortality from CS performed by trainees under indirect supervision was 0.7 %, compared to a maternal mortality rate of 1.2 % for the procedures that the trainees observed[18]. The maternal mortality rate for CS performed by fully trained SACHOS was 0.4%[18].

A different study, also published in 2017, assessed the learning curve of the training of associate clinicians (ACs) in Sierra Leone, where the 50 first CS performed by trainees were included for analysis[39]. The study was a prospective study that used operation logbooks from 2011 to 2016 for their analysis, and found that operation time was reduced significantly for the first 15 operations performed; operation time averaged 72 min for the first five, then on average 12 min faster for the next five, and then 9 min faster for the next five[39]. After 15 operations, the reduction in operation time was minor and not statistically significant[39]. Other outcomes were also analysed form the logbooks of this study, which also found an MMR of 1.0%[39]. SSI rates were on average 3.7 % of the analysed operations (984 out of 1174 had data on SSI), and were more common in the first 15 CS performed by the ACs[39]. SSIs are described further above, in the results section on patient outcomes.

In 2019, another study looking into task sharing was published, assessing maternal and neonatal outcomes of CS performed by ACs through task sharing, compared with MDs[38]. The study was conducted between October 2016 and May 2017, where patients were followed up for 30 days. The primary outcome of this study was maternal mortality, while secondary outcomes were perinatal events (stillbirth, perinatal and neonatal death), and maternal morbidity (blood loss, reoperation and readmission, wound infection and postoperative pain)[38]. Nine hospitals were included in this prospective study, these were all the hospitals in

Sierra Leone where both ACs and MDs performed CS[38]. 1282 CS were included for the study, where 444 were performed by ACs and 838 were performed by a doctor[38]. MMR was 0.2 % for the CS performed by ACs and 1.8 % for doctors[38]. For secondary outcomes, the stillbirth rate was 12.7 % and 16.4 % for the CS performed by ACs and doctors, respectively[38]. The study did not find any significant difference in fresh vs macerated stillbirth, neonatal and perinatal deaths between the two groups[38]. Other findings in the 2019 study were that CS performed by ACs were done quicker (7 min on average) compared to the CS performed by doctors[38]. ACs patients who underwent CS were twice as likely to be readmitted, but other outcomes such as postoperative infections, more than 600 ml blood loss, reoperation, length of hospital stay and postoperative abdominal pain did not pose any significant differences[38].

Impact of Ebola outbreak on CS utilization

Seven articles were sorted with Ebola as main focus area, five were included for results. One study from 2016 looked at the impact of the EVD outbreak on the availability, uptake and outcome of routine MHC in Sierra Leone[40]. The data were assessed 12 months prior to, and 10 months during, the EVD outbreak. All facilities providing comprehensive (n=13) or basic (n=67) emergency obstetric care (EmOC) across the 13 districts were included[40]. There was a 34% increase in facility MMR and a 24% increase in stillbirth rate after onset of the EVD outbreak[40]. The increase was significant at CEmOC level, but not at BEmOC level[40]. There was also reported a decrease in number of deliveries at CEmOC level, which was associated with an 14% increase in the overall CS rate[40].

Drevin et al. reviewed why surgical staff continued to perform CSs during the EVD outbreak[43]. The study documents experiences of 15 CS providers from all four administrative areas[43]. They reported that obstetric emergencies were highly prioritised, and elective surgery was postponed[43]. The surgical staff also reported an increase in pregnancy complications and more cases of obstructed labour requiring CS[43]. This is supported by data demonstrating a decrease of 4%-65% in delivery rates at the study sites[43]. The support of international actors helped to maintain surgical capacity and CS services[43]. They provided rapid EVD tests, protective equipment and ambulances[43]. In addition, skilled surgical staff were essential to maintain CS provision during the outbreak[43]. Participants in this study

reported a strong internal motivation to perform their medical duty and a feeling of responsibility for the community[43].

A study from 2018 evaluated changes in provisions of surgery at 40 hospitals during the first year of the EVD outbreak[13]. There was a 45% increase in weekly median CSs performed at governmental hospitals ($P < 0.001$), while the CSs performed at private non-profit hospitals decreased by 43% ($P < 0.001$)[13]. CSs represented fewer than 30% of the total volume of surgical procedures before the outbreak, and increased to more than 50% during the peak of the epidemic[13]. An opposite trend was observed for inguinal hernia repair, which decreased from 20% of all surgical procedures to 10% during the peak of the outbreak in the end of 2014[13]. Despite the decrease in CSs in private non-profit hospitals, the volume of CSs did not change during the EVD outbreak[13].

One study published in 2019, collected data from a governmental hospital in Pujehun, a rural district in Sierra Leone, and evaluated utilization of maternal and child health (MCH) services before, during and after the EVD outbreak[42]. During the outbreak, the Pujehun hospital maintained the same volume of CSs and deliveries as before the outbreak[42].

Brolin et al. documented the number of in-hospital deliveries and CSs in all health facilities offering emergency obstetrics before and during the EVD outbreak[41]. In total, 32 facilities were visited and data were collected in the period January 2014 to May 2015[41]. The number of CSs decreased by approximately 20% during the outbreak[41]. There were great disparities within the country, with a decrease in CSs by almost 20% and 50% in the Northern and Southern provinces during the outbreak peak[41]. In the Eastern province, the number of CSs decreased by 20% during the outbreak peak, but then increased by 10% during the outbreak slow-down at the beginning of 2015[41]. In the Western province, there was also a slight increase in CSs performed during the outbreak compared to the pre-outbreak period[41]. There was a significant association between the decrease in number of CSs and the number of EVD cases for all provinces[41]. In governmental facilities, the number of CSs decreased by 5% in the outbreak peak and increased by 5% in the outbreak slow-down[41]. The number of CSs performed in private non-profit hospitals decreased by 49% and 58% during the

outbreak peak and slow-down respectively[41]. The facilities that remained open, performed the same proportion of CSs and deliveries after the onset of the outbreak as before[41].

Discussion

A total of 27 articles, theses and reports were selected for the result section to assess findings in literature of each focus area. In the discussion, findings from these articles and papers are further evaluated and investigated. The structure of the discussion is the same as in the result section, where each main focus area is discussed separately in the same order as in the results.

CS rate

The CS rate over the last 20 years has shown a slow but steady increase in Sierra Leone, with an annual increase of growth rate of 8% between 2012-2016 according to a nationally representative study looking into CS rates and mortality[15].

A study published recently in 2021 evaluated the surgical workforce and unmet need for surgery in Sierra Leone between 2012 and 2017[44]. The study found that despite an increase in both surgical workforce and number of annual surgical procedures, the population growth was faster, and the unmet need for surgery therefore remained high – at 92.7%[44]. Even though the access to surgery is still very low in Sierra Leone, obstetric surgery was found to be particularly increasing, and the study found an increase in CS of 62% in the period[44]. Thus, the overall surgical need may not be an accurate depiction of caesarean sections in Sierra Leone in itself – as also seen in the increasing overall rate from 1.5 to 4%[12,21]. The increase in obstetric surgery could be a consequence of the FHCI as well as implementation of a task sharing programme[44]. An increase in ANC visits has been seen after the FHCI implementation in 2010[45]. Therefore, the FHCI probably played a role in the number of ANC visits and in-facility deliveries increasing, and therefore also possibly the CS rate increasing.

The overall CS rate is low in Sierra Leone, but there are great variations between geographical and socioeconomical groups in the country. Looking at the rates among the poorest and richest wealth quintile from the three DHS reports, there are still major differences in the rates. However, in 2008, the richest quintile had a 7-fold higher

rate than the poorest quintile[21], while in 2013 and 2019, the richest quintile had a rate 3.3 and 3.1 times higher than the poorest quintile, respectively[12,29]. In addition, the CS rate in the more rural parts of Sierra Leone has also relatively increased from 2008 to 2013 and 2019[12,21,29]. This reduction in rate differences could also be partially explained by initiation of FHCI in Sierra Leone, providing financial aid for population groups that previously could not afford health care services. With the findings in literature, it is evident that the reasons behind the different CS rates and disparities between geographical and socioeconomic groups is complicated. However, it seems that although the surgical unmet need in Sierra Leone in general has not changed considerably over the last years[44], the use of obstetric surgery and CS has increased. The CS rate is still far below the recommended 10-15%[6], but it seems as though obstetric surgery is a growing focus point for the health sector in Sierra Leone when trying to combat the high maternal and perinatal mortality rates. Factors such as more widely use of ANC, better distribution of surgical workforce through task-sharing, and economical support through the FHCI, is slowly increasing the CS rate to a more acceptable number that hopefully will continue reducing the maternal mortality rate in Sierra Leone.

Indications for CS

One of the studies included in this review reported that the three most frequent indications for CS were obstructed labour, previous CS and antepartum haemorrhage[30]. Prolonged or obstructed labour accounted for almost 40% of the CSs performed[30] and are associated with maternal and foetal mortality and morbidity[46]. The possible reason for the high incidence of obstructed labour might be poor ANC follow up, long travel time to a health facility and poor use of partographs during labour[30,47-54].

ANC follow up might be important in order to identify risk factors and reduce the incidence of obstructed labour in Sierra Leone. The association between ANC visits and obstructed labour are supported by findings in studies conducted in Northwest Ethiopia[47] and Southwest Ethiopia[54]. The trend in seeking ANC is positive in Sierra Leone, and it seems that access to and usage of ANC services is increasing[12]. This is an important step in the right direction to prevent maternal deaths by identifying and managing obstetric complications.

Although increased utilization of ANC services is important, the quality of ANC services is also crucial.

Long distance to a health facility may also explain the high incidence of obstructed labour as indication for CS in Sierra Leone. This is supported by studies in Northwest Ethiopia[47] and Central Ethiopia[51], which found a significant association between longer travel time and obstructed labour. The three delays model proposes that maternal mortality is associated with delays in (1) decision to seek care, (2) reaching a health facility and (3) receiving adequate care[55,56]. Improvement of road and infrastructure, as well as the referral system, would contribute to timely diagnosis and intervention, and thereby prevent poor outcome in case of obstructed labour. To improve the referral system, the National Emergency Medical Service (NEMS) was implemented in 2018[57]. In May 2019, the NEMS became operative at national level with 80 ambulances, 450 certified paramedics and 450 certified drivers[57]. According to data collected between December 2018 and March 2020, a total of 35 493 missions have been handled by the NEMS[57]. Of these, 49% were obstetric and gynaecological missions[57]. The implementation of the NEMS probably has contributed to the decrease in maternal mortality and morbidity, and increase in CS rate, but further studies are needed to assess specific outcomes.

Most of the CSs were performed as emergency surgery on maternal indication[15]. Only 7% of the CSs were done on foetal indication[15]. This is lower than previous findings in other low-income countries[58]. Presence of abnormal foetal heart rate was associated with obstructed labour in a study of risk factors for obstructed labour in Eastern Uganda[59]. In a study from Sierra Leone, a partograph was used for 30% of the CSs and for 50% in the group with obstructed labour[30]. When a partograph was used in the group with obstructed labour, there was reduced odds for perinatal death[30]. Use of partographs has been shown to reduce the incidence of prolonged or obstructed labour[53]. It does not require expensive technology and is therefore an affordable and simple way to monitor labour in low resource settings[60]. Based on these numbers of use of partographs in Sierra Leone, there is still a need for more monitoring during labour to assess the wellbeing of mother and foetus. It can contribute to identification and diagnosis of pathological labour[53], thus preventing maternal and perinatal mortality.

The two other most frequent indications for CS were previous CS and antepartum haemorrhage[30]. These findings are consistent with a study from MSF[22] and a systematic review[61] that reported these as the most common indications for CS in sub-Saharan Africa. Unnecessary CSs should be avoided, and women undergoing CS must be counselled about the risks of complications in future pregnancies. Antepartum haemorrhage must be identified early so that CS can be performed in time.

Few data are available on indications for CS and the extent of obstructed labour in Sierra Leone. Future studies should assess risk factors for obstructed labour and decision making among health care workers providing CS. This information can be used to prevent maternal and perinatal mortality in case of obstructed labour and evaluate if CSs are performed on the right indications.

Patient outcomes

Maternal mortality following CS in Sierra Leone is exceptionally high[15]. The article of van Duinen and colleagues shows that perinatal mortality following CS is also remarkably high, 19%[30]. Maternal mortality following CS was in the first nationally representative study estimated to be 15 per 1000[15]. For comparison, a systematic review and meta-analysis from 2019 from 67 low and middle income countries (LMICs), found an overall risk of maternal death following CS to be of 7.6 per 1000 CS, and 10.9 per 1000 in Sub-Saharan Africa[62]. The study also pointed out that the maternal mortality after CS in high-income countries, such as the UK, is 0.08 per 1000[62].

The overall MMR in Sierra Leone is one of the highest in the world[12]. Because the maternal mortality in itself is so high, it might not be surprising that the maternal mortality following CS is also high[15]. Literature suggests that there are specific factors regarding CS in Sierra Leone that might contribute to the high mortality rate following CS, both maternal and perinatal. As described in the study of van Duinen and colleagues[30], the most common indications for CS were prolonged/obstructed labour, as well as abruptio placenta and previous CS[30]. Prolonged and obstructed labour, abruptio placentae and uterine rupture was associated with the highest perinatal mortality in the same study, and uterine rupture had a perinatal mortality rate of over 81%[30]. The MDSR reports also note the high percentage of

uterine rupture in women in Sierra Leone compared to other countries, a possible consequence of obstructed and prolonged labour that could be fatal and contribute to the high maternal mortality[37]. One can speculate how many deaths could be avoided if access to emergency obstetric care including CS was optimal and well within the WHO recommendations of 10-15%[6].

In addition to overall access to more CS, the circumstances and effectiveness of referral to clinics performing CS are also crucial. MSF conducted a multi-country study from Sub-Saharan Africa, including Sierra Leone, which points to lack of basic and emergency obstetric care at all health centres as a risk for high mortality rates, along with poor referral services[22]. Their clinic was a centre to which many other clinics and hospitals referred their patients, and the early neonatal mortality was also higher here, 21%, compared to 12% when only referred from MSF-supported clinics[22]. The findings suggest the care pre-delivery is crucial for patient outcome, and that correct and timely referral is necessary to avoid high mortality rates. This is in line with the study on travel time and perinatal mortality from van Duinen et al from 2020 where the findings underline specifically the risk of poor outcomes when travel time exceeds two hours[31]. As mentioned, uterine rupture accounts for a relatively large of the CS indications, as well as the high perinatal and maternal mortality[30]. A large portion of the patients who die during or after CS have had haemorrhage and need for blood transfusions[15]. A possibility is that the travel time and late presentation cause these patients to be already critically ill when admitted for a CS. One can conclude that lack access to more hospitals performing CS, late presentation to such hospitals, as well as poor obstetric care pre-delivery are factors contributing to the high maternal and perinatal mortality rates in Sierra Leone.

In addition to factors regarding access to CS, factors in the facilities performing these surgeries also have an impact on patient outcome. One study investigating anaesthesia practices in Sierra Leone found that of the 36 hospitals included, only 50% had access to ECG, and only between 50-75% had a functioning blood bank[27]. As a big portion of the patients who die during or after CS are admitted with haemorrhage as indication for CS and receive blood tranfusions[15], one could assume that the lack of for instance enough blood for transfusion could be an in-facility factor contributing to the poor outcomes.

Furthermore, access to quality obstetric services and skilled health care workers, also in rural areas, are crucial to reduce maternal and perinatal mortality. To ensure this, health personnel should receive training in managing obstetric complications and assisted vaginal delivery. In case of prolonged or obstructed labour, assisted vaginal delivery by use of forceps or vacuum extraction, are alternatives to CS.

The most recent case-control study on post-operative infections following CS found a mortality rate of 5.3% in the patients who got an infection after CS[33]. The same study found a 2.5 times increased risk for getting an infection when missing postoperative antibiotic doses[33]. Lack of monitoring equipment, qualified staff and life-saving treatments such as blood transfusions and antibiotics could contribute to the high mortality.

Task sharing

Studies investigating task sharing and CS in Sierra Leone conclude that task sharing is safe and effective[18,38]. From the studies published about task sharing, the finding is that the maternal mortality following CS is lower in the AC/SACHO group than in the MD group[18,38]. MMR was 0.4% for CS performed by fully trained SACHOS in one study[18], and 0.2% in a newer study[38]. Both these mortality rates were lower than for the CSs performed by MDs[18,38]. The article from Bolkan et al from 2017 commented on this, stating that the difference in rates may be a result of case mix, where the supervisors and trainers possibly took on more high-risk and difficult patients[18]. However, the article also noted that none of the rates were higher than MMR found in previous studies of maternal mortality following CS in Sierra Leone[18]. The more recent article from van Duinen and colleagues found that the indications for CS were slightly different in the two groups[38]. ACs were found to more frequently operate on twin pregnancies and on multiparous women, whereas MDs operated more frequently out of office hours, as emergencies and in combination with additional procedures such as hysterectomies[38]. The study of van Duinen et al emphasizes that they did not adjust for possible confounders as differences between the women undergoing CS in the AC group vs the MD group because of a low number of events such as maternal death when calculating the maternal mortality[38]. This could indicate that the selection of patients for the ACs and doctors is slightly different, and may contribute to the lower mortality rate in the AC group because they possibly take on less high-risk patients. Therefore, this finding could

suggest that an accurate selection of patients for the surgeons is necessary for the CSs to maintain the outcomes found in the study. To further optimize task sharing, more in-depth research of the clinical decision making and case sorting for the ACs and MDs performing CS would be interesting. Nevertheless, the data in these studies all show that the mortality rate is not higher, more often lower, in the AC group[18,38]. This could also mean that the selection and process of task sharing is already established in a way that sort the particular need for a doctor vs SACHO/AC in a safe way, and that sorting the more complicated cases to the doctors with more clinical experience may be beneficial for the outcome.

A study by Waalewijn et al looking into the learning curve and effectiveness of a task sharing programme found that operation time was reduced significantly within the first 15 operations for ACs, as well were SSI[39]. As found in other studies, SSI have a direct association with operation time in general[63], and this is found for the ACs as well, which could imply that the cause of this is the reduction in operation time.

Another aspect of task sharing worth mentioning, is the contribution of ACs performing CS particularly in areas with sparse access, like rural districts[44]. The article of Minde et al published in 2021, found an increase of surgeries performed by ACs especially in rural areas since 2017, compared to 2012[44]. This underlines the importance of surgical task sharing as a mean to tackle the unequal distribution of surgical providers in Sierra Leone[44]. The study found that ACs between 2012 and 2017 performed a large portion of obstetric surgery, while the number performed by specialists only increased slightly[44].

From the studies we retrieved about task sharing and CS in Sierra Leone, none have findings that suggest task sharing is in any way less safe than when done by doctors, and the calculations in the studies also imply that the contributions of ACs/SACHOS performing CS can be great, with the possible contribution of over 4500 CS annually[18]. However, there are some differences in patient groups and outcomes of the CS between the doctors and ACs, such as patient characteristics[38]. Further investigation into the clinical decision making that explain these findings could be the next steps in looking into task sharing and CS.

EVD outbreak

One study reported an increase in maternal and perinatal mortality[40], and another study noted an increase in pregnancy complications and more cases of obstructed labour requiring CS[43]. This may be a result of failures to detect maternal complications early, as the routine MHC services ceased during the outbreak[40]. Lack of personal protective equipment (PPE) for healthcare workers and fear of infection could also have resulted in poorer quality of care[40]. This is supported by findings in a report by Volunteers Service Overseas (VSO), where a midwife reported that the level of care they offered was reduced because of fear of contracting EVD and lack of PPE[64].

Women's fear of infection and low confidence in the health system may have led to delays in seeking health care in a health facility. This may explain the decrease in number of deliveries, CSs and ANC visits[64]. The decrease in number of deliveries at CEmOC level was associated with an 14% increase in the overall CS rate, indicating that CS continued to be available during the epidemic[40]. These findings may imply that there was mainly reduced utilization of health services that contributed to a decrease in number of institutional deliveries and CSs, rather than provision of these services. Similar findings are reported in studies conducted in the neighbouring countries, Liberia[65,66] and Guinea[67,68], which were also impacted by the EVD outbreak.

Most of the decline in CSs occurred early in the outbreak and was mainly a result of the closing of private non-profit hospitals[41]. Several private non-profit hospitals, including the Gondoma Referral Centre run by MSF were converted into Ebola Treatment Units, thus ceasing the surgical capacity[41]. This private non-profit hospital located in Bo district, Southern province, performed an average of 12 CSs weekly before the outbreak[41]. The large decrease in CS volume by almost 50% in the Southern province can probably be explained by closure of this key health facility. The facilities that remained open during the outbreak, maintained the same CS volume[41]. This study also found that there was a higher volume of CSs in the first part of 2014, probably due to increased capacity in the governmental sector[41]. In the absence of the EVD outbreak, one can speculate whether this progress would have continued.

The increase in weekly median performed CSs in the governmental sector could be explained by the changes in type of surgeries performed during the epidemic[13]. The proportion of CSs increased, while the proportion of inguinal hernia repair decreased[13], implying that the governmental hospitals adapted adequately in terms of being able to prioritize life-saving obstetric procedures over non-acute surgeries. These results are supported by previous findings, where participants reported that elective surgery was postponed and obstetric emergencies were highly prioritized[43].

Several factors may have contributed to maintain surgical capacity and CS services during the outbreak. The support of international actors was important, with provision of rapid EVD tests, PPEs and ambulances[43]. Improvement of the referral system may have increased CS volumes at public hospitals as patients were transported from closed private facilities[43]. Ambulances were redirected to obstetric emergencies at these were made the highest priority[43]. Health personnel also reported a moral duty to continue to work despite their fears and loss of colleagues[43,64]. Additionally, there was reported a significant association between the decrease in number of CSs and the number of EVD cases[41]. This may explain why Pujehun hospital, which was one of the least affected areas, was able to maintain the same volume of CSs and deliveries as before the outbreak[42,69].

Although health systems in the country showed some degree of resilience, healthcare workers reported of not being prepared for the EVD outbreak[64]. In the initial phase, health facilities developed their own methods and procedures to cope with the outbreak[64]. Training in Infection Prevention and Control (IPC) were provided from some International Non-Governmental Organizations (INGOs) and the Government, but the amount of training and access to enough PPE varied between facilities[64]. This insinuates that there are disparities within facilities in terms of preparedness in the event of an epidemic, and there is a need for further development of resilient health systems in the country.

Factors contributing to increased CS rate

Several aspects of CS have been discussed in this review, and factors contributing to the increase in CS rate have been investigated through the findings in literature. The three delay model, states factors that contribute to (1) delay in the decision to seek care, (2) delay at

arrival at a health facility and (3) delay in provision of adequate care[56]. Findings in literature discussed in this review indicate that interventions for all three of these factors exist. The FHCI could have an effect on the delay in the decision to seek health care, and the NEMS could improve the arrival time to hospitals, thus preventing delays in reaching a health facility. Task sharing could contribute to a lesser delay in provision of adequate care, as it increases the number of health care personnel who are competent to perform CS. The combination of these interventions may have led to the increase in CS rate in Sierra Leone.

Strengths and limitations

The aim of the thesis was to provide an overview of literature findings on caesarean section Sierra Leone. Strengths of our thesis include broad search terms and research question, which lead to our literature review providing input on a variety of aspects regarding CS in Sierra Leone. Including all forms of literature let us utilize the DHS reports, MDSR reports, main theses from NTNU, among others. This provides a wide perspective on our research question, and allowed us to enlightened the topic from many angles. Our thesis contains both quantitative and qualitative results and a variety of research methods from different articles, which could contribute to a more nuanced overview, including results on patient experience in Sierra Leone and results from patient-interviews. Another strength is that our database searches were done systematically, which strengthens the validity of our article retrieval, and our methodology is transparent regarding search terms. However, our study also has several limitations. The review in itself is not fully a systematic review, and lack any form of meta-analysis of results, and there was no systematic strategy for choosing what results to include, thus there is risk of the authors favouring certain studies and articles over others when comparing and finding data. The search terms have been followed similarly for each database. However, reports (DHS and MDSR) which were not covered in the database searches, were included in the thesis. Thus, there is a risk of selection bias towards these reports. In addition, there is also risk of the authors favouring certain articles from the database searches. There is therefore a possibility for certain literature being valued more in the review than others.

Conclusions

There has been a development in maternal health care services in Sierra Leone over the last 20 years, resulting in increased CS rates and decreased maternal and perinatal mortality and morbidity. The country has for many years had a shortage of health personnel and was greatly impacted by the EVD outbreak. Yet, the health system showed some degree of resilience and health facilities that remained open maintained the same CS volume during the epidemic. Implementation of the task sharing programme has provided surgical staff with training in managing obstetric emergencies with promising results. The CS rate is still far below the recommended ten percent and there are large disparities between wealth quintiles and geographic areas. Therefore, increased investment and governmental commitment to improve obstetric care and focus on women's health is needed. Improvement of the referral system, continuing of the task sharing programme and increased awareness and handling of pregnancy complications among women and healthcare workers, are important to ensure access to timely and safe CSs in order to decrease maternal mortality in Sierra Leone.

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We would also like to thank our supervisors, Alex van Duinen and Josien Westendorp, for helping us make a new thesis on short notice due to covid-19, and for great guidance through the work process.

Appendix 1

Prospero layout

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*Fields that have an **asterisk (*)** next to them means that they **must be answered. Word limits** are provided for each section. You will be unable to submit the form if the word limits are exceeded for any section. Registrant means the person filling out the form.*

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Give the title of the review in English

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3. * Anticipated or actual start date.

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Provide any other relevant information about the stage of the review here.

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Ingrid Ingels

Email salutation (e.g. "Dr Smith" or "Joanne") for correspondence:

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Details of the individuals, organizations, groups, companies or other legal entities who have funded or sponsored the review.

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State the funder, grant or award number and the date of award

13. * Conflicts of interest.

List actual or perceived conflicts of interest (financial or academic).

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15. * Review question.

State the review question(s) clearly and precisely. It may be appropriate to break very broad questions down into a series of related more specific questions. Questions may be framed or refined using PI(E)COS or similar where relevant.

The Development of Cesarean Sections in Sierra Leone over the last twenty years, since the year 2000. The focus areas are:

- CS population ratein this time period?
- Data on patient outcome in the last 20 years; how has this changed?
- Has the indications for CS changed over time?
- Has the Ebola outbreak influenced the rates of CS, patient outcomes or complications?
- How has the task sharing program of CapaCare affected the CS rates, patient outcomes and rate of complications in Sierra Leone?

We emphasize that these questions are our focus areas, but that changes may occur depending on information we are able to retreive from articles etc, and what we find during our research.

16. * Searches.

State the sources that will be searched (e.g. Medline). Give the search dates, and any restrictions (e.g. language or publication date). Do NOT enter the full search strategy (it may be provided as a link or attachment below.)

PubMed, helsebiblioteket, Oria, Google Scholar, snow balling of key articles, african journals online and

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17. URL to search strategy.

Upload a file with your search strategy, or an example of a search strategy for a specific database, (including the keywords) in pdf or word format. In doing so you are consenting to the file being made publicly accessible. Or provide a URL or link to the strategy. Do NOT provide links to your search **results**.

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18. * Condition or domain being studied.

Give a short description of the disease, condition or healthcare domain being studied in your systematic review.

Cesarean Sections in Sierra leone.

19. * Participants/population.

Specify the participants or populations being studied in the review. The preferred format includes details of both inclusion and exclusion criteria.

Women undergoing CS in Sierra Leone

20. * Intervention(s), exposure(s).

Give full and clear descriptions or definitions of the interventions or the exposures to be reviewed. The preferred format includes details of both inclusion and exclusion criteria.

- This review aims to get an overview of Cesarean Sections in Sierra Leone, (with focus areas such as CS rates, patient outcomes and complications). The aim is to also look at how access to surgical care has had an effect on the rates of CS, if the Ebola outbreak had any effect on the different rates etc.

21. * Comparator(s)/control.

Where relevant, give details of the alternatives against which the intervention/exposure will be compared (e.g. another intervention or a non-exposed control group). The preferred format includes details of both inclusion and exclusion criteria.

-

22. * Types of study to be included.

Give details of the study designs (e.g. RCT) that are eligible for inclusion in the review. The preferred format includes both inclusion and exclusion criteria. If there are no restrictions on the types of study, this should be stated.

RCT, cohort studies, case-control studies, literature reviews, population studies, meta-analyses and systematic reviews, case reports, grey literature, reports (e.g from WHO and the Ministry of Health in Sierra Leone)

23. Context.

Give summary details of the setting or other relevant characteristics, which help define the inclusion or

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exclusion criteria.

The aim of this study is to create an overview of CS in Sierra Leone, and to look at main trends of CS, i.e CS rates, maternal mortality and complications of CS over the last twenty years.

24. * Main outcome(s).

Give the pre-specified main (most important) outcomes of the review, including details of how the outcome is defined and measured and when these measurement are made, if these are part of the review inclusion criteria.

Main focus areas are:

- CS patient outcomes
- CS complication rates

Measures of effect

Please specify the effect measure(s) for you main outcome(s) e.g. relative risks, odds ratios, risk difference, and/or 'number needed to treat.

-

25. * Additional outcome(s).

List the pre-specified additional outcomes of the review, with a similar level of detail to that required for main outcomes. Where there are no additional outcomes please state 'None' or 'Not applicable' as appropriate to the review

If during the research period, other relevant changes of CS are discovered, these may be mentioned in the article.

Measures of effect

Please specify the effect measure(s) for you additional outcome(s) e.g. relative risks, odds ratios, risk difference, and/or 'number needed to treat.

-

26. * Data extraction (selection and coding).

Describe how studies will be selected for inclusion. State what data will be extracted or obtained. State how this will be done and recorded.

-

27. * Risk of bias (quality) assessment.

State which characteristics of the studies will be assessed and/or any formal risk of bias/quality assessment tools that will be used.

-

28. * Strategy for data synthesis.

Describe the methods you plan to use to synthesise data. This **must not be generic text** but should be **specific to your review** and describe how the proposed approach will be applied to your data. If meta-analysis is planned, describe the models to be used, methods to explore statistical heterogeneity, and software package to be used.

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29. * Analysis of subgroups or subsets.

State any planned investigation of 'subgroups'. Be clear and specific about which type of study or participant will be included in each group or covariate investigated. State the planned analytic approach.

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30. * Type and method of review.

Select the type of review, review method and health area from the lists below.

Type of review

Cost effectiveness
No

Diagnostic
No

Epidemiologic
Yes

Individual patient data (IPD) meta-analysis
No

Intervention
No

Living systematic review
No

Meta-analysis
No

Methodology
No

Narrative synthesis
No

Network meta-analysis
No

Pre-clinical
No

Prevention
No

Prognostic
No

Prospective meta-analysis (PMA)
No

Review of reviews
No

Service delivery
No

Synthesis of qualitative studies

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No

Systematic review
Yes

Other
Yes

Health area of the review

Alcohol/substance misuse/abuse
No

Blood and immune system
No

Cancer
No

Cardiovascular
No

Care of the elderly
No

Child health
No

Complementary therapies
No

COVID-19
No

Crime and justice
No

Dental
No

Digestive system
No

Ear, nose and throat
No

Education
No

Endocrine and metabolic disorders
No

Eye disorders
No

General interest
No

Genetics
No

Health inequalities/health equity
No

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Infections and infestations
No

International development
No

Mental health and behavioural conditions
No

Musculoskeletal
No

Neurological
No

Nursing
No

Obstetrics and gynaecology
Yes

Oral health
No

Palliative care
No

Perioperative care
No

Physiotherapy
No

Pregnancy and childbirth
No

Public health (including social determinants of health)
No

Rehabilitation
No

Respiratory disorders
No

Service delivery
No

Skin disorders
No

Social care
No

Surgery
No

Tropical Medicine
No

Urological
No

Wounds, injuries and accidents

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No

Violence and abuse
No

31. Language.

Select each language individually to add it to the list below, use the bin icon to remove any added in error.
English

There is an English language summary.

32. * Country.

Select the country in which the review is being carried out. For multi-national collaborations select all the countries involved.

Norway

33. Other registration details.

Name any other organisation where the systematic review title or protocol is registered (e.g. Campbell, or The Joanna Briggs Institute) together with any unique identification number assigned by them. If extracted data will be stored and made available through a repository such as the Systematic Review Data Repository (SRDR), details and a link should be included here. If none, leave blank.

34. Reference and/or URL for published protocol.

If the protocol for this review is published provide details (authors, title and journal details, preferably in Vancouver format)

Add web link to the published protocol.

Or, upload your published protocol here in pdf format. Note that the upload will be publicly accessible.

No I do not make this file publicly available until the review is complete

Please note that the information required in the PROSPERO registration form must be completed in full even if access to a protocol is given.

35. Dissemination plans.

Do you intend to publish the review on completion?

Yes

Give brief details of plans for communicating review findings.?

36. Keywords.

Give words or phrases that best describe the review. Separate keywords with a semicolon or new line. Keywords help PROSPERO users find your review (keywords do not appear in the public record but are included in searches). Be as specific and precise as possible. Avoid acronyms and abbreviations unless these are in wide use.

CS, Cesarean sections, Sierra Leone,

37. Details of any existing review of the same topic by the same authors.

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If you are registering an update of an existing review give details of the earlier versions and include a full bibliographic reference, if available.

38. * Current review status.

Update review status when the review is completed and when it is published.New registrations must be ongoing so this field is not editable for initial submission.
Please provide anticipated publication date

Review_Ongoing

39. Any additional information.

Provide any other information relevant to the registration of this review.

40. Details of final report/publication(s) or preprints if available.

Leave empty until publication details are available OR you have a link to a preprint (NOTE: this field is not editable for initial submission). List authors, title and journal details preferably in Vancouver format.

Give the link to the published review or preprint.

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Appendix 2

Search strategy

PubMed

Two searches were generated in PubMed, one using MeSH-terms for Sierra Leone AND Caesarean Section, and one using title-abstract-keyword terms for Sierra Leone AND Caesarean section. For the title-abstract-keyword search, the following synonyms and phrases for CS were included: Cesarean section*[tiab] OR caesarean section*[tiab] OR C-section*[tiab] OR cesarean delivery*[tiab] OR caesarean delivery*[tiab].

a. MeSH terms

#1 Caesarean Section	"Cesarean Section"[Mesh]
#2 Sierra Leone	"Sierra Leone"[Mesh]

b. Tiab-terms

#1 Caesarean Section	Cesarean section*[tiab] OR caesarean section*[tiab] OR C-section*[tiab] OR cesarean delivery*[tiab] OR caesarean delivery*[tiab]
#2 Sierra Leone	Sierre Leone*[tiab]

The two searches were combined.

MEDLINE

The search strategy for MEDLINE was:

Advanced search – all fields:

1. sierra leone.af.
2. (caesarean OR caesarean OR c-section*).af.
3. #1 and #2

Scopus

The search strategy in SCOPUS was:

TITLE-ABS-KEY(sierra AND leone) AND TITLE-ABS-KEY(caesarean OR cesarean OR c-section*) AND (EXCLUDE(PUBYEAR, 1998) OR EXCLUDE(PUBYEAR, 1997) OR EXCLUDE(PUBYEAR , 1994) OR EXCLUDE(PUBYEAR, 1986).

Google Scholar

Google scholar does not have the option to add synonyms with “OR” between them, therefore, we conducted multiple searches in Google Scholar using just one of the words for Caesarean section together with Sierra Leone. Google scholar does not have the ability to search from title and abstracts, only either title or full text. We chose to search in title only to exclude articles with very little information on Caesarean Section. Our searches were therefore:

intitle:“caesarean section” and intitle:”sierra leone”
intitle:”cesarean section” and intitle:”sierra leone”
intitle:”Caesarean” and intitle:”sierra leone”
intitle:”cesarean” and intitle:”sierra leone”
intitle:”C-section” and intitle:”sierra leone”

Appendix 3

CS rates

Table 1 shows the article from which the different CS rates in figure 2 were found. Also, a separate column was made for additional information, i.e. how the calculations were made or if the rates were retrieved from another article.

Year	CS rate	Article	Note
2008	1,50 %	DHS report 2008[21]	Nationwide CS rate
2011	1,80 %	Oyerinde et al. (2011), The status of maternal and newborn care services in Sierra Leone 8 years after ceasefire.[24]	Data from 9 Districts
2012	2,10 %	Drevin et al. (2019), ”For this one, let me take the risk”: why surgical staff continued to perform caesarean sections during the 2014–2016 Ebola epidemic in Sierra Leone.[43]	Data from Bolkan et al, Rates of caesarean section and total volume of surgery in Sierra Leone: a retrospective survey.
2012	1,90 %	Groen et al. (2013), Female health and family planning in Sierra Leone.[25]	75 clusters, defined as ”enumeration areas”, the smallest administrative units in Sierra Leone were randomly chosen with a chance proportionate to population size. Each district as well as rural and urban areas was stratified to achieve a representative sample of the population.
2012	2,10 %	Bolkan et al. (2013), Rates of caesarean section and total volume of surgery in Sierra Leone: a retrospective survey.[23]	Data from 58/60 facilities performing surgery
2012	2,20 %	Rød et al. (2013), Caesarean sections in Sierra Leone after introduction of Free Health Care Services for pregnant and lactating women.[26]	Main thesis, NTNU
2013	2,90 %	DHS report 2013[29]	Nationwide CS rate
2013	2,90 %	Husby et al. (2019), Caesarean birth experiences. A qualitative study from Sierra Leone.[28]	Data from DHS report 2013
2014	2,50 %	Brolin et al. (2016) The Impact of the West Africa Ebola Outbreak on Obstetric Health Care in Sierra Leone.[41]	
2016	2,90 %	Holmer et al. (2019), The rate and perioperative mortality of caesarean section in Sierra Leone.[15]	
2016	2,90 %	van Duinen et al. (2020), Perinatal outcomes of cesarean deliveries in Sierra Leone: A prospective multicenter observational study.[30]	Data from Holmer et al. The rate and perioperative mortality of caesarean section in Sierra Leone.
2016	2,90 %	Lonnée et al.(2021), A survey of anaesthesia practices at all hospitals performing caesarean sections in Sierra Leone.[27]	Data from Holmer et al. The rate and perioperative mortality of caesarean section in Sierra Leone.
2019	4,00 %	DHS report 2019	Nationwide CS rate

Appendix 3 Table 1 CS rates retrieved from articles

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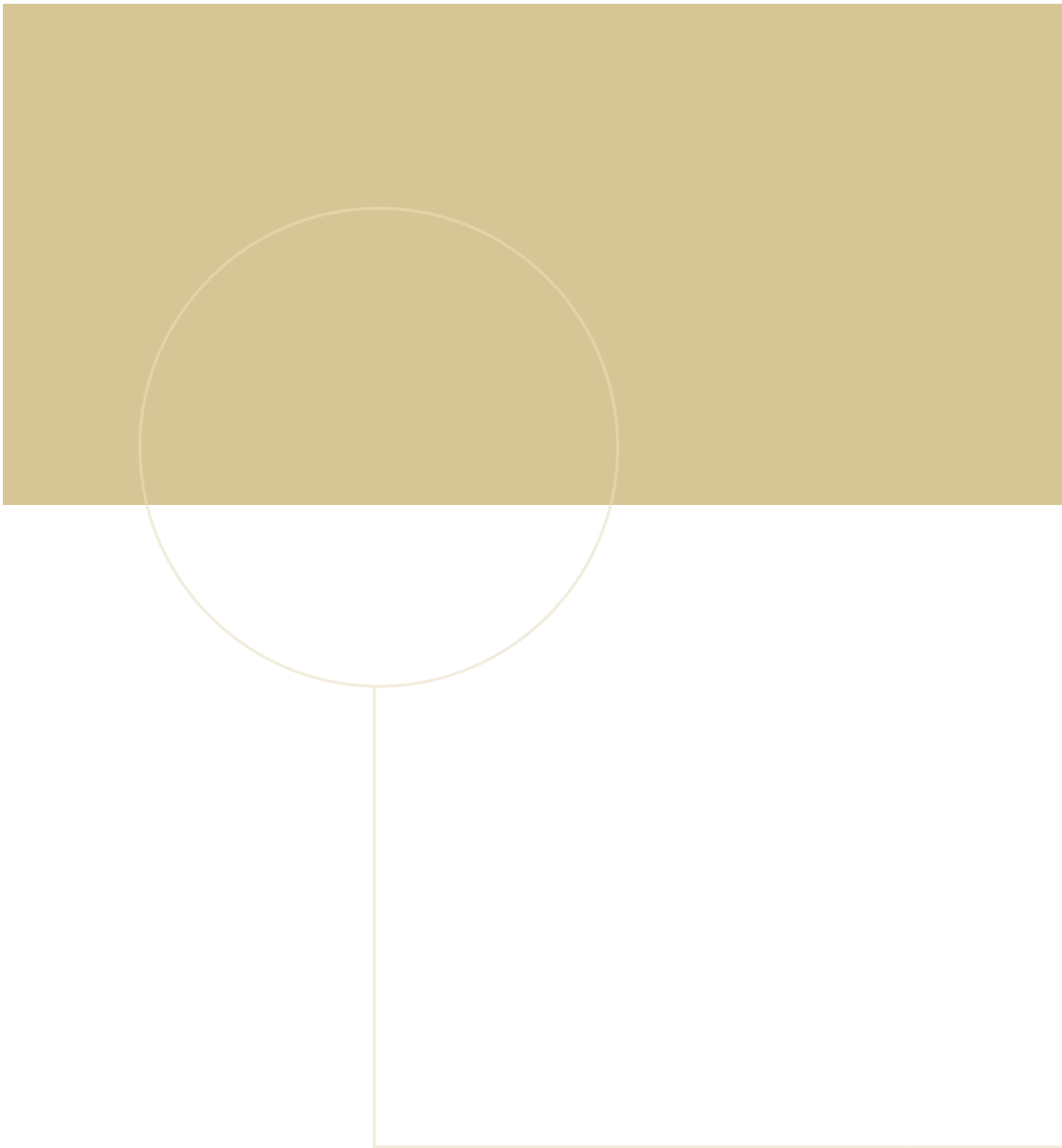

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