Student thesis

NTNU
Norwegian University of Science and Technology
Faculty of Medicine and Health Sciences

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Student thesis in Medicine
Supervisor: Josien Westendorp
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Kunnskap for en bedre verden

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Abstract

Background: Caesarean section (CS) is a life saving procedure, but should only be performed when medically necessary. Even though the CS rate in Sierra Leone is 4.1%, and much lower than the recommended rate of 10-15% from The World Health Organisation (WHO), it is still important to evaluate the use of CS in the country. The WHO recommends using the Robson Classification when evaluating the use of CS.

Objectives: The objective of the study was to complete an obstetrical mapping and classification of CS according to the Robson Classification at eight hospitals in order to evaluate the use of CS in Sierra Leone.

Method: The study was a retrospective, descriptive study of a convenience sample of eight of the hospitals performing CS in Sierra Leone. Data necessary to assign a Robson-group was collected for all delivering women during January, May, September and October 2021 at the eight hospitals, in total 4771 women were included. Additional data that allows better evaluation of the use of CS were also collected; indication for CS, stillbirths, maternal mortality and CS provider.

Results: The overall CS rate in the study population was 28.1%. 81.7% of the deliveries belong to groups 1-5 (all women giving birth at term to a singleton foetus in cephalic presentation). Group 1 and 3 (nulliparous and multiparous women giving birth at term to a singleton foetus in cephalic presentation in spontaneous labour, without a previous CS) were accountable for 73.7%. Group 1 had a CS rate of 24.7% and group 3 a CS rate of 18.0%. 5.2% of the women in our population are classified in group 5 (women with one or more previous CS, with a single cephalic pregnancy at term) and the CS rate for this group is 76.8%. The most common indication for a CS was mechanical or dynamic dystocia (35.0%).

Conclusion: Findings from group 1-4 (all women with a single cephalic pregnancy at term who have not undergone a previous CS) could indicate a need to improve labour management, especially the use of augmentation and induction. High CS rates were found in group 1 and 3, usually low-risk groups. Further research is necessary to more thoroughly evaluate the use of CS in Sierra Leone, especially in the low-risk groups.

Bakgrunn: Keisersnitt er en livsviktig prosedyre, men bør bare gjøres når det er medisinsk nødvendig. Selv om keisersnittfrekvensen i Sierra Leone bare er 4.1%, langt under WHO sin anbefalte frekvens mellom 10-15%, er det viktig å evaluere bruken av keisersnitt i landet. WHO anbefaler å anvende Robson klassifikasjonen til å evaluere bruken av keisersnitt.

Mål: Målet med studien var å utføre en obstetrisk kartlegging og klassifikasjon av keisersnitt i henhold til Robson klassifikasjonen på åtte sykehus for å evaluere bruken av keisersnitt i Sierra Leone.

Metode: Studien var en retrospektiv, deskriptiv studie av et bekvemmelighetsutvalg av åtte av sykehusene som utfører keisersnitt i Sierra Leone. Data nødvendig for å angi en Robson-gruppe ble samlet inn for alle fødende kvinner i januar, mai, september og oktober 2021 på de åtte sykehusene, totalt 4771 kvinner ble inkludert. Det ble også samlet inn annen data som bidrar til å kunne evaluere bruken av keisersnitt; indikasjonen for keisersnitt, dødfødsler og mødredødlighet, og kirurgisk personnel.

Resultater: Den totale keisersnittfrekvensen for den inkluderte populasjonen var 28.1%. 81.7% av kvinnene var i gruppe 1-5 (alle kvinner som føder ett barn til termin i hodeleie, med og uten tidligere keisersnitt). 73.7% av kvinnene inkludert var i gruppe 1 og 3 (nullipara og multipara kvinner som føder ett barn til termin i spontan fødsel og hodeleie, uten tidligere keisersnitt). Gruppe 1 hadde en keisersnittfrekvens på 24.7%, og gruppe 3 en frekvens på 18.0%. Gruppe 5 (alle kvinner som føder ett barn til termin i hodeleie, med ett eller flere tidligere keisersnitt) utgjorde 5.2% av kvinnene inkludert og 76.8% av disse fikk keisersnitt. Den hyppigste indikasjonen for keisersnitt var mekanisk og dynamisk dystoci (35.0%).

Konklusjon: Funn fra gruppe 1-4 (alle kvinner som føder ett barn til termin i hodeleie, uten tidligere keisersnitt) kan indikere et behov for å bedre fødselshjelpen, spesielt bruken av stimulering av rier og induksjon. Det ble også funnet høye keisersnittfrekvenser i lavrisikogruppene 1 og 3. Videre studier er nødvendig for å grundigere evaluere bruken av keisersnitt i Sierra Leone, spesielt i lavrisikogruppene.

Introduction

CS as life saving procedure

Caesarean section (CS) is an essential surgical intervention that is necessary if certain complications occur before or during labour. Indications for a CS are among others, haemorrhage, foetal asphyxia, or positioning of the foetus in an abnormal way, such as a breech presentation. In situations like these, a CS may be lifesaving[1].

CS rate recommendations

WHO states that, although CS can be life-saving for mother and child, CS should only be performed "when medically necessary"[2]. CS rates above 20% seems not to improve outcomes[3]. The WHO statement on CS rates concludes that the optimum population rates lie between 10-15%, as they have shown to reduce the risk for poor outcomes for both the child and the mother[2].

Disparities in CS rates over the world

Many countries have a much higher population rate of CS than recommended. For instance, in 2015, the rates were reported to be 44.3% in Latin America and Caribbean[3]. In Norway, the CS rate was 15.9% in 2018[4]. However, the rates of CS are far lower in other parts of the world, even below the recommended 10%. In the west and central parts of Africa, the overall CS rate was 4.1% in 2015[3]. Sierra Leone also had a rate of 4.1% in 2019, but with great variation between districts[5]. The low CS rate indicates poor access to this essential operation in Sierra Leone, and patients who need a lifesaving CS, are at risk of dying due to the procedure not being accessible[6].

Access to surgical care in Sierra Leone

Sierra Leone has one of the highest maternal mortality rates (717 per 100,000 live births) and one of the highest mortality rates for neonates (122 per 1000 live births) in the world[5]. CS constitutes 21% of all surgical procedures in Sierra Leone, and overall numbers from 2012 show that there is an unmet need of over 90% for all surgical care in Sierra Leone[7]. To increase the access to surgical care and thus cover more of the surgical need in Sierra Leone, the non-profit organization CapaCare, together with the Ministry of Health and Sanitation in

Sierra Leone initiated a surgical training programme in 2011[8]. Through this programme, junior Medical Doctors (MDs) and Community Health Officers (CHOs) are trained to manage the most common life-threatening emergency surgical and obstetrical conditions at the country's district hospitals. Graduated CHOs become Surgical Assistant Community Health Officer (SACHO) after finishing the program, and they are currently performing a substantial volume of the CSs in the country[9].

Complications of CS

CSs are associated with increased risk of maternal death and serious acute and late complications, both in an emergency and elective setting[10]. Therefore, it is important that every CS is done for a clear indication. This is of particular importance in countries such as Sierra Leone, where access to CS is limited. Previous CS increases the risk for placental abruption, uterine rupture, placenta accreta and placenta previa in the subsequent pregnancies[11]. The risk of repeated CS is increased, especially for women who delivered their first child by CS[12]. For these women in their subsequent pregnancies, it is crucial to deliver in a facility that can provide a repeat CS.

Clinical decision making for CS

Although the population CS rate in Sierra Leone is increasing, it is still below the WHO recommended level. There is limited knowledge of the indications and decision making for CSs in Sierra Leone. Certainly, the low rate in itself does not justify the conclusion that all the CSs performed are a necessity. In the last decade, several interventions were implemented to improve access to emergency obstetric care in the country, including free health care for pregnant women and introduction of task-sharing in major surgery including operative emergency obstetric care. In this changing environment, the decision making for CS is highly relevant. Is there an overuse of CS in certain patient groups who rarely should undergo a CS, or underuse in groups of patients that in general often need CS?

The Robson Classification System

To evaluate the rates of CS and potential over or under utilisation, the WHO recommends the Robson Classification to compare CS rates between health facilities and countries[2]. This Robson Classification distributes all CS into 10 groups, with the possibility of further subdivision. The Robson Classification with sub-divisions can be seen in table 1 below. This system is easily applicable to facilities performing CS and can be used to analyse and compare CS rates[13]. With background data from hospital records, the Robson Classification can be used in numerous ways to analyse and compare use of CS in Sierra Leone. The Robson Classification is based on five parameters; obstetric history, onset of labour, foetal lie, number of neonates and gestational age[13]. A study from the National Maternity Hospital in Ireland found that the Robson Groups 1-4 are the classification groups that have the lowest rate of CS[1313]. Group 1-4 consist of both nulliparous and multiparous women who have a cephalic pregnancy, and have not undergone a previous CS. They are all at gestational week 37 or more[2]. Because the women in group 1-4 have not undergone a CS before, and have statistically low rates of CS from other studies[13], these groups are of particular interest.

Group	Obstetric population
1	Nulliparous women with a single cephalic pregnancy, ≥37 weeks gestation in spontaneous labour
2	Nulliparous women with a single cephalic pregnancy, ≥37 weeks gestation who had labour induced or were delivered by CS before labour
2a	Labour induced
2b	CS before labour
3	Multiparous women without a previous CS, with a single cephalic pregnancy, ≥37 weeks gestation in spontaneous labour
4	Multiparous women without a previous CS, with a single cephalic pregnancy, ≥37 weeks gestation who had labour induced or were delivered by CS before labour
4a	Labour induced
4b	CS before labour
5	All multiparous women with at least one previous CS, with a single cephalic pregnancy, ≥37 weeks gestation
5.1	With one previous CS
5.2	With two or more previous CS
6	All nulliparous women with a single breech pregnancy
7	All multiparous women with a single breech pregnancy including women with previous CS(s)
8	All women with multiple pregnancies including women with previous CS(s)
9	All women with a single pregnancy with a transverse or oblique lie, including women with previous CS(s)
10	All women with a single cephalic pregnancy < 37 weeks gestation, including women with previous CS(s)

Table 1, The Robson Classification with sub-divisions[14]. CS= Caesarean section

Methods and Materials

This study was a retrospective, facility based, descriptive study of a convenience sample of 8 of the hospitals performing caesarean sections in Sierra Leone. Local supervisor, Rosa Roemers (MD Global Health, CapaCare national coordinator), was consulted when choosing the eight hospitals to land at a good representation of the hospitals performing CS. The convenience sample consisted of five governmental hospitals and three Non-Governmental Organisation (NGO) hospitals. Hospitals from six different districts (Tonkolili, Bombali, Kono, Koinadugu, Kenema and Western area) were included to get a geographical distribution across the country, see figure 2. Data on all deliveries occurring during four months in 2021 were collected between february 1st 2022 and April 10th the same year by two medical students from Norwegian University of Science and Technology (NTNU). Data collectors were supervised by supervisor Josien Westendorp and locally by local supervisor Rosa Roemers. The study was approved by the Sierra Leone Ethics and Scientific Review Committee on 15.12.2021, see appendix 1.

Data retrieval

Data was collected on all deliveries occurring during four months in 2021, January, May, September and October. These months were chosen as it represents both the wet and the dry season. The delivery logbook at one hospital had missing pages for about 75% of the deliveries in January 2021. February 2021 was used as a substitute for January 2021 in this case, as the data for February was in good shape and it is still a dry month.

Information on all deliveries was obtained from two different primary sources, the delivery logbook and the patient files. The existence and quality of patient files was very variable across the hospitals. In the hospitals where the patient files were not available, the delivery logbook was the only primary source. The delivery logbook was the only primary source for 65% of the cases included. In addition, the admission logbook and the Operation Theatre (OT) logbook were used to obtain missing data from the primary sources.

The following data, where available, were collected:

- Information needed for Robson Classification – gravida, para, earlier obstetric history, number of foetuses, positioning, gestational age, spontaneous or induced labour
- Outcome data for mother and baby; maternal mortality, live birth, stillbirth, early neonatal mortality (death before seven days of a live born neonate, or before discharge of mother)
- Admission, delivery-and discharge date
- Obstetrical and surgical provider –nurse, midwife, CapaCare's surgical assistants in training (STP), CapaCare graduate SACHO, non-specialist MD or specialist MD
- Indication for Caesarean Section (CS) as written in the logbooks
- Indication for Assisted Vaginal Delivery (AVD) as written in the delivery logbook
- Complications of Normal Vaginal Delivery (NVD), AVD or CS

Data were collected from paper records, and transcribed. The data was logged into Microsoft Excel 2016 (Microsoft Corp., Redmond, WA, USA). The SPSS software was used to analyse the data (SPSS Inc, Chicago, IL, USA).

Variables needed for the Robson classification

For each delivery, data was collected on maternal characteristics (history of CS, parity), pregnancy-related information (gestational age, foetal presentation, number of foetuses and onset of labour) and the infant birth weight. Foetal presentation is classified as cephalic, breech and transverse. Oblique lies are classified as transverse. In the Robson system gestational age is classified as term (>37 weeks) and preterm (<37 weeks). In Sierra Leone the gestational age is usually unknown, and therefore birth weight is used as a proxy indicator for gestational age. Birth weight of < 2500 g is considered preterm (<37 weeks) and birth weight ≥ 2500 g is considered term (>37 weeks). This strategy has been employed in other studies conducted in similar settings[15, 16, 17]. The deliveries are classified as spontaneous, induced or CS before labour. Parity was collected, and when classifying into Robson the woman is categorised as nulliparous or multiparous. The number of foetuses is classified as singleton or multiple. Final mode of delivery is classified into two categories: vaginal delivery and CS. Vaginal delivery could have been either simple vaginal delivery, that included all vaginal deliveries not requiring forceps or vacuum, and assisted vaginal delivery that included all vaginal deliveries that required forceps or vacuum. The excel sheet used for data retrieval was programmed to assign a Robson group based on the variables entered.

Data processing and analysis

A birth was defined as an infant with a weight over 500g, as suggested in The Robson Implementation Manual[14]. Cases that did not meet this definition were not included. Cases with missing parity, birth weight**,** or mode of delivery (vaginal delivery or CS) were excluded as these are critical values to assign Robson grouping.

In addition to the occasional missing data on parity, birth weight and mode of delivery, the delivery and OT logbooks do not routinely contain information on the onset of labour (spontaneous, induced or CS before labour) and if the women had a previous CS. In some cases the logbooks do contain these variables, but for most cases this information is only found in the patient files. As the existence and quality of the patient files were variable across the facilities, it was decided to also include the deliveries only found in the delivery logbook. These cases will therefore often lack information regarding previous CS and onset of labour. For these cases with missing data it is assumed that the onset of labour was spontaneous, and that the woman has not had a previous CS. The implications of this are discussed in the discussion part of this thesis.

For the cases that did contain details around the onset of labour, the following definition was used to diagnose labour, and consequently classify the delivery as spontaneous; regular contractions with cervical changes. Where there was incomplete information about contractions or cervical changes, it was classified as spontaneous if “active phase of labour” or “latent phase of labour” was charted. There were cases wrongly noted as augmentation when it was induction, and the other way around. When the drug misoprostol was given, the case was classified as induced. In cases where a woman was recorded as induced after she had contractions with cervical changes, she was classified as in spontaneous labour. In cases where it was difficult to assess if a woman was in spontaneous labour or not, supervisor Dr. Josien Westendorp reviewed the cases.

In order to evaluate the indications for the CSs an adapted version of two indication-based classification systems was used, the Anderson model[18] and Althabe model[19]. These two classification systems scored the highest of the indication-based classification systems of CS in a systematic review[20]. In a systematic review of the Robson Classification it was also recommended to use a hierarchical and standardised system, for example the Anderson model, when analysing indications[21]. The adapted version of the two systems by Anderson and Althabe was also used in Tognon et al[16], a similar study done in a similar setting to ours. When more than one indication was written in the logbook, only one was chosen for the analysis. This was done by using the hierarchy used by Tognon et al[16]: (1) urgent or emergency CS (eclampsia, pre-eclampsia, abruptio placentae, placenta previa, uterine rupture), (2) mechanical or dynamic dystocia, (3) previous scar(s), (4) malpresentation, (5) cephalopelvic disproportion, (6) foetal distress, (7) breech, (8) multiples and, (9) others.

Results

During the selected four months of 2021, there were 4934 deliveries in total for all eight hospitals (range, 140-951). After excluding cases due to missing parity (16), mode of delivery (1), birth weight (146), 4771 cases were included in the final analysis. Supervisor Dr. Josien Westendorp was consulted on 49 cases where the onset of labour was difficult to assess. The overall CS rate in the included population was 28.1%. Table 2 represents the Robson report table for all hospitals collectively. The Robson report table was analysed and interpreted according to the Robson Classification Interpretation Guidelines published by WHO[14], and is shown in table 3. 81.7% of the deliveries belong to groups 1-5 (all women giving birth at term to a singleton foetus in cephalic presentation). Group 1 and 3 (nulliparous and multiparous women giving birth at term to a singleton foetus in cephalic presentation in spontaneous labour, without a previous CS) were accountable for 73.7% of the women included. Group 1 had a CS rate of 24.7% and group 3 a CS rate of 18.0%. 5.2% of the women in our population are classified in group 5 (women with one or more previous CS, with a single cephalic pregnancy at term) and the CS rate for this group is 76.8%. 86.4% of group 5 had only undergone 1 previous CS (group 5.1) while 13.6% of them had undergone 2 or more CSs (group 5.2).

At all hospitals combined it was recorded 13 maternal deaths, where 11 were in the CS group. There were 284 stillbirths, giving a stillbirth rate of 6.0% overall. The stillbirth rate was 8.4% (112/1341) for those who delivered by CS. About 70% of the stillbirths occurred in group 1 (12.3%), 3 (29.9%) and 10 (30.3%) (all women with a single cephalic pregnancy preterm, including women with a previous CS). The stillbirth rate in each Robson group can be seen as an additional column in the Robson report table in table 2.

The overall CS rate by hospital is shown in figure 1, ranging from 17.9% to 47.8%. The geographical distribution of the included hospitals can be seen in figure 2. Hospital A, D and G are NGO-hospitals and B, C, E, F and H are governmental hospitals. Table 4 represents the CS rate in each Robson group stratified by hospitals. There is a wide range in CS rates between the hospitals in each group, for example it ranges from 0%-53.3%, 6.9%-34.2% and 14.3%-94.1% in group 1, 3 and 5 respectively.

The provider of the CS was recorded for 1273 of the 1341 CS performed, and is presented in figure 3 below. When there were several providers for one CS, the first provider listed was used in the analysis. Most of the CS were done by CapaCare graduates (SACHO) and CapaCare's surgical assistants in training (STP), who combined performed 47.8% (641) of all the CSs. Non-specialist MDs performed 30.1% of the CSs (404), while the specialist MDs performed 17.0% of the CSs. In 5.1% of the cases (68) the provider was not recorded and is categorised as unknown.

Overall the three most common indications for CS were mechanical or dynamic dystocia (35.0%), urgent or emergency CS (18.9%) and previous scar(s) (11.3%), as shown in figure 4. Over 50% of the CSs occurred in the low risk groups 1 and 3. The distribution of indications in these two groups is shown in table 5. Mechanical or dynamic dystocia was the most frequent indication for CS in both groups (51.1% in group 1 and 48.3% in group 3).

In addition to the results presented, data on indications for AVD and induction, complications of NVD, AVD or CS was also collected. This data will not be discussed in this thesis.

	Robson group	Number of CS in group	Total number of deliveries in group	Group size (%)	Group CS rate (%)	Absolute group contribution to overall CS rate (%)	Relative group contribution to overall CS rate (%)	Number of stillbirths in group (%)
1	Nulliparous with a single cephalic pregnancy, at term in spontaneous labour	347	1406	29.5	24.7	7.3	25.9	35 (2.5)
2	Nulliparous with a single cephalic pregnancy, at term who had labour induced or were delivered by CS before labour	29	44	0.9	65.9	0.6	2.2	0 (0.0)
3	Multiparous without a previous CS, with a single cephalic pregnancy at term in spontaneous labour	379	2108	44.2	18.0	7.9	28.3	85 (4.0)
4	Multiparous without a previous CS, with a single cephalic pregnancy at term who had labour induced or were delivered by CS before labour	49	89	1.9	55.1	1.0	3.7	12 (13.5)
5	All multiparous with at least one previous CS, with a single cephalic pregnancy at term	192	250	5.2	76.8	4.0	14.3	8 (3.2)
6	All nulliparous with a single breech pregnancy	40	62	1.3	64.5	0.8	3.0	11 (17.7)
7	All multiparous with a single breech pregnancy including women with previous CS(s)	59	97	2.0	60.8	1.2	4.4	19 (19.6)
8	All with multiple pregnancies including women with previous CS(s)	94	200	4.2	47.0	2.0	7.0	23 (11.5)
9	All with a single pregnancy with a transverse or oblique lie, including women with previous CS(s)	27	27	0.6	100.0	0.6	2.0	5 (18.5)
10	All with a pre-term single cephalic pregnancy, including women with previous CS(s)	125	488	10.2	25.6	2.6	9.3	86 (17.6)
Total		1341	4771	100	28.1	28.1	100	284 (6.0)

Table 2, Robson Report table and stillbirths for all deliveries occurring in January, May, September, October 2021 in a convenience sample of eight hospitals performing CS in Sierra Leone. CS = Caesarean section. Group size (%)=n of women in the group/total n women delivered in the hospital × 100. Group CS rate (%)=n of CS in the group/total n of women in the group × 100. Absolute contribution (%)=n of CS in the group/total n of women delivered in the hospital × 100. Relative contribution (%)=n of CS in the group/total n of CS in the hospital × 100. Stillbirth (%) = n of stillbirths in the group/ total n of women in the group x 100

		Hospitals																	
Robson group	WHO MCS	All hospitals combined		A		B		C		D		E		F		G		H	
	CS rate (%)	n	CS rate (%)	n	CS rate (%)	n	CS rate (%)	n	CS rate (%)	n	CS rate (%)	n	CS rate (%)	n	CS rate (%)	n	CS rate (%)	n	CS rate (%)
1	9.8	347/1406	24.7	5/31	16.1	23/ 128	18.0	77/265	29.1	0/16	0.0	45/144	31.3	66/264	25.0	43/393	10.9	88/165	53.3
2	39.9	29/44	65.9	0/0	-	4/13	30.8	3/6	50.0	1/2	50.0	0/0	-	1/1	100.0	7/9	77.8	13/13	100.0
3	3.0	379/2108	18.0	11/76	14.5	30/244	12.3	87/365	23.8	7/56	12.5	40/220	18.2	64/460	13.9	24/348	6.9	116/339	34.2
4	23.7	49/89	55.1	3/6	50.0	3/16	18.8	6/8	75.0	1/3	33.3	2/2	100.0	2/2	100.0	5/10	50.0	27/42	64.3
5	74.4	192/250	76.8	1/7	14.3	22/44	50.0	28/33	84.8	5/ 6	83.3	14/15	93.3	32/34	94.1	50/61	82.0	40/50	80.0
6	78.5	40/62	64.5	0/0	-	2/9	22.2	7/11	63.6	0/0	-	6/9	66.7	8/11	72.7	11/14	78.6	6/8	75.0
7	73.8	59/97	60.8	3/6	50.0	7/12	58.3	23/30	76.7	3/8	37.5	5/13	38.5	3/5	60.0	8/12	66.7	7/11	63.6
8	57.7	94/200	47.0	3/8	37.5	9/37	24.3	21/29	72.4	2/6	33.3	13/24	54.2	12/34	35.3	7/18	38.9	27/44	61.4
9	88.6	27/27	100.0	0/0	-	3/3	100.0	5/5	100.0	0/0	-	6/6	100.0	8/8	100.0	1/1	100.0	4/4	100.0
10	25.1	125/488	25.6	0/11	0.0	8/85	9.4	29/72	40.3	2/10	20.0	13/69	18.8	23/78	29.5	12/74	16.2	38/89	42.7

Table 4, CS rates in each Robson group by hospital. From a convenience sample of eight hospitals performing CS in Sierra Leone, in January, May, September and October 2021. The values from the World Health Organisation Multi Country Survey (WHO MCS) reference population is listed in column number two for reference (subpopulation in the WHO MCS with relatively low CS rates at the same time as good maternal and foetal outcome data)[22]. CS = Caesarean section. n = n of CS in group/total n of women in the group. CS rate % =n of CS in the group/total n of women in the group × 100

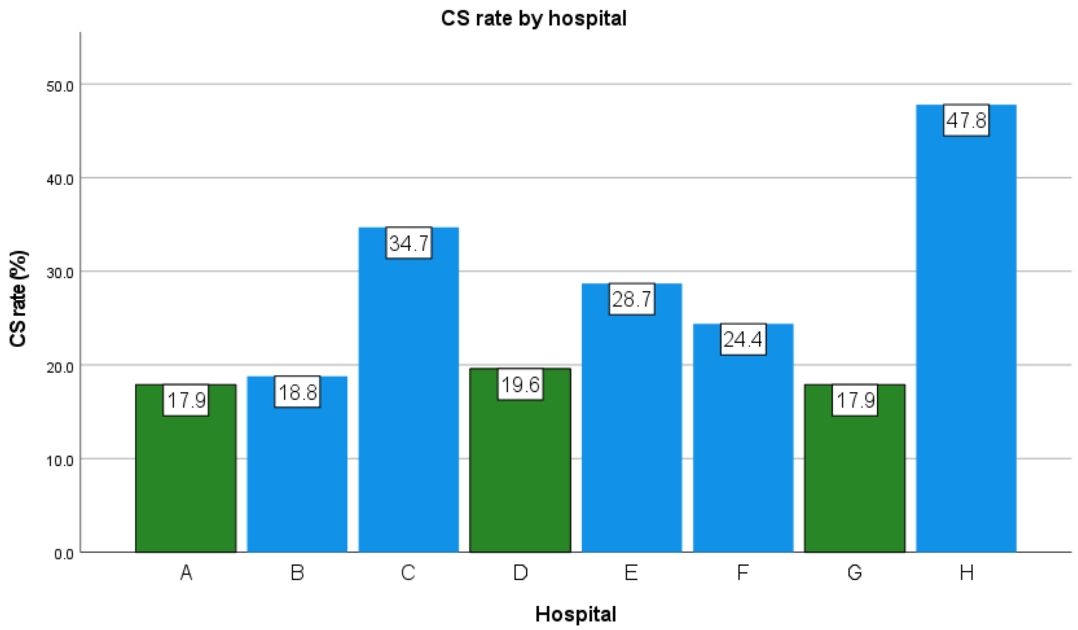

Figure 1, overall CS rate by hospital in a convenience sample of eight hospitals performing CS in Sierra Leone, in January, May, September and October 2021 NGO-hospitals are in green, governmental hospitals are in blue. CS = Caesarean section. CS rate % =n of CS in the hospital/ total n of women delivered at the hospital × 100

Figure 2, location for the included hospitals in the convenience sample. A, D and G are NGO-hospitals and B,C, E, F and H are governmental hospitals[23].

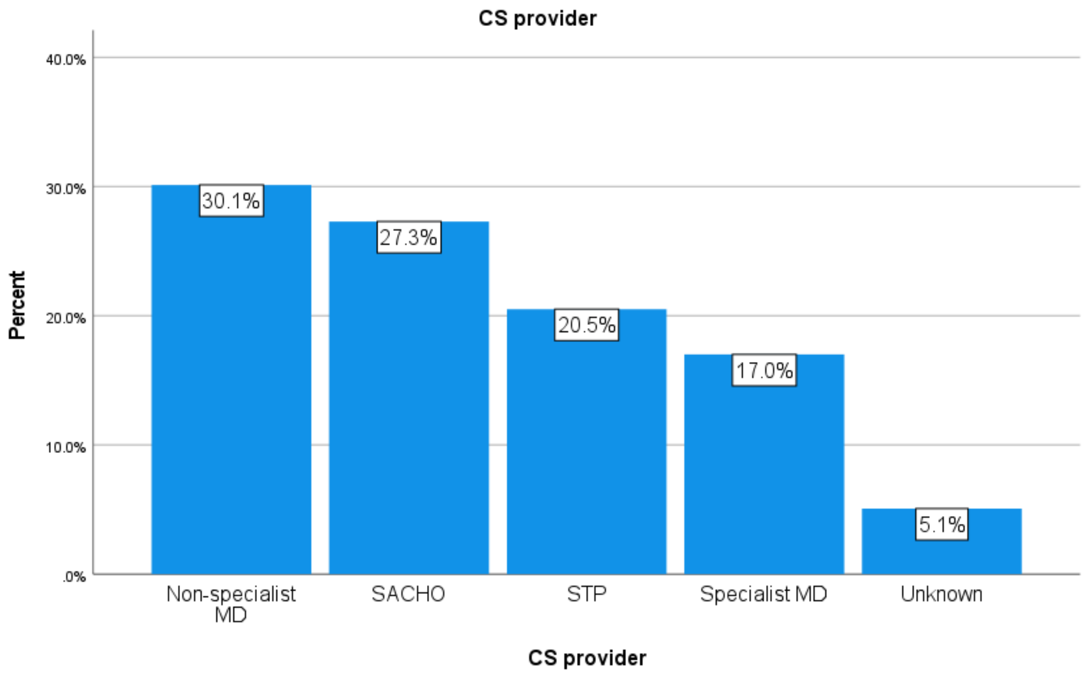

Figure 3, Percentages of the CS provider for all CSs performed in a convenience sample of eight hospitals performing caesarean sections in Sierra Leone, in January, May, September and October 2021. CS = Caesarean section. MD = Medical doctor. SACHO = Surgical assistant community health officer. STP = CapaCare's surgical assistants in training (STP).

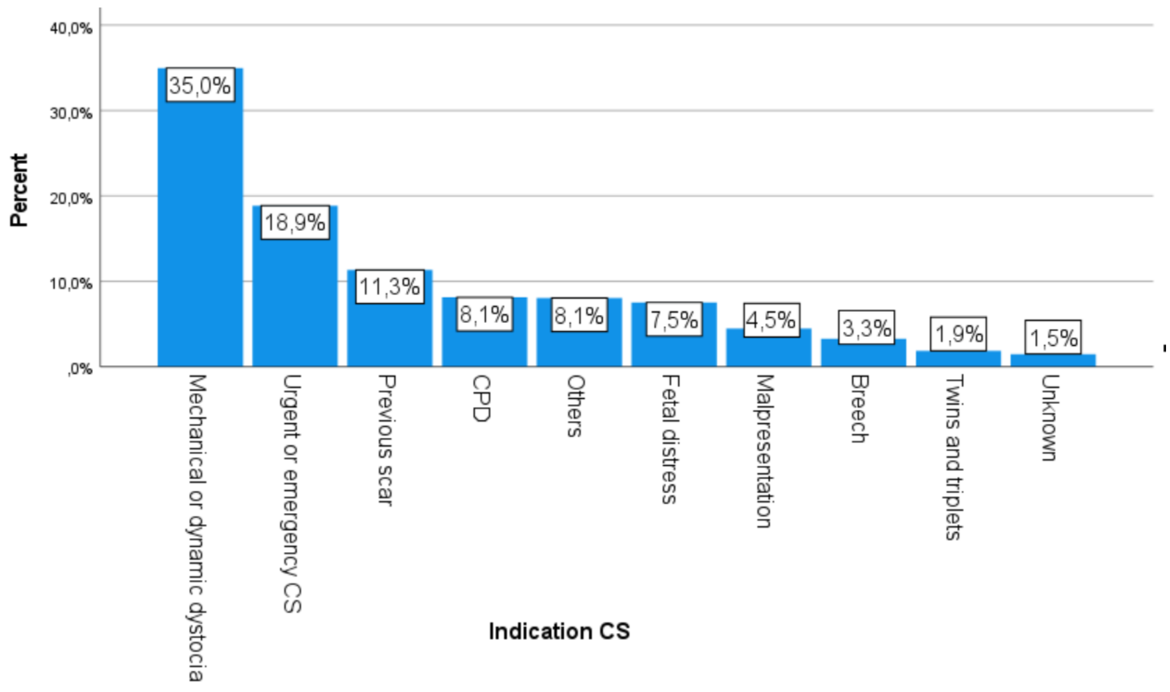

Figure 4, Indication for all CSs in a convenience sample of eight hospitals performing CS in Sierra Leone, in January, May, September and October 2021. CS = Caesarean section. CPD = cephalopelvic disproportion

Indication for CS	Robson group 1 (%)	Robson group 3 (%)
Mechanical or dynamic dystocia	51.9	48.3
Urgent or emergency CS	13.3	19.0
Cephalopelvic disproportion	16.1	7.7
Fetal distress	10.1	11.1
Malpresentation	1.7	3.4
Unknown	1.7	2.1
Others	5.2	8.4
Breech	0.0	0.0
Multiples	0.0	0.0
Previous CS	0.0	0.0
Total	100.0	100.0

Table 5, Indication for CS in Robson group 1 and 3. From a convenience sample of eight hospitals performing CS in Sierra Leone, in January, May, September and October 2021. CS = Caesarean section. Group 1 = nulliparous women without a previous CS, with a single cephalic pregnancy at term in spontaneous labour. Group 3 = Multiparous women without a previous CS, with a single cephalic pregnancy at term in spontaneous labour.

<table>
<tr><th colspan="2">Interpretation of the Robson classification in eight hospitals in Sierra Leone January, May, September, and October 2021 following the WHO Robson Classification Interpretation Manual[14]</th></tr>
<tr><td>Quality of data</td><td>➢ The sum of the values in the column “Nr of CS in group” and the sum of the values in the column “Total nr of deliveries in group” are identical to the total number of CS and women delivered in our study population.
➢ The size of group 9 is 0.6%. It is less than 1%, which indicates that the probability of foetal presentations being misclassified as transverse is low.
➢ The CS rate of group 9 is 100%.</td></tr>
<tr><td>Type of population</td><td>➢ The size of group 1 and 2 is 30.4%. This is lower than the Robson guidelines, but expected as Sierra Leone has a lower proportion of nulliparous women. The ratio of group 1 to 2 is very high at 32.0. In the WHO Multi Country Survey (WHO MCS) reference population (subpopulation in the WHO MCS with relatively low CS rates at the same time as good maternal and foetal outcome data), the ratio is 3.3[14, 22]. Similarly the ratio of the size of group 3</td></tr>
</table>

vs the size of group 4 is 23.7, which is also very high compared with 6.3 in the WHO MCS population. A reason for the high ratios could be low use of induction of labour or CS performed before labour. However, another contributor to high ratios could be the data where there is no information regarding the onset of labour, and it is assumed spontaneous. This is a limitation to our study. Another factor that supports an underutilisation of induction of labour is the high CS rates of group 1 and 3. These rates are 24.7% and 18.0% respectively. The two groups are generally considered low-risk and one should aim for lower rates, which among other strategies may be achieved with higher induction rates.

- The ratio of group 3 to 4 should always be higher than the ratio of group 1 to 2 according to Robson implementation manual[14]. In our population the ratio of group 1 to 2 is higher than that for group 3 to 4. Further investigation into the use of induction and pre-labour CS in Sierra Leone is required.
- The size of group 3 and 4 is 46.1%. This is high, which is expected as Sierra Leone has a high fertility rate of 4.2 children per woman[5]. According to the Robson guidelines groups 3 and 4 usually represent 30% of women, but will be higher in settings with high proportions of women with more than one child. In addition, one factor that could lead to an overestimation of group 3, and subsequently underestimation of group 5, is missing information about previous CS for some hospitals.
- The size of groups 6 and 7 is 3.3%. This is within the expected range of breech deliveries at 3-4%[14]. Furthermore the ratio of group 6 to group 7 is 0.7. Usually this is a 2:1 ratio because breeches are more frequent in nulliparous women than in multiparous women. The low ratio could be explained by the high proportion of multiparous women in our study population.
- The size of group 8 is 4.2%. This is higher than the expected 1-2 %[14]. This could be explained by the fact that a woman with a high risk pregnancy or a complicated delivery is more likely to give birth in a hospital than at home or at a lower level health facility in Sierra Leone[24].
- The size of group 10 is 10.2%. This is higher than 5% which the Robson guideline states is expected from a normal risk-setting[14]. As several of the included hospitals are referral facilities and therefore not a normal risk-setting, this could contribute to a higher group 10 in our study population. In addition, Sierra Leone countrywide can be considered a high risk population for preterm labour, as studies found that the preterm birth rate is around 12% in sub-saharan Africa[25, 26]. However, a source of error could be that birth weight was used as a proxy for gestational age. Poor nutritional status of the mother and comorbidities like malaria or

	diarrhoea-diseases during pregnancy can lead to growth restriction and low-birth weight[27]. It is estimated that 14.6% of the children born in Sierra Leone have a low birth weight (<2500g)[28]. As this is higher than the suggested rates for preterm labour, the use of birth weight as a proxy for gestational age could lead to an overestimation of group 10.
Assessment of CS rates	➢ The CS rate of group 1 is 24.7%. This is higher than what the Robson guidelines states as achievable, which is under 10%[14]. This together with the high ratio of group 1 to 2 again supports the thesis that there is a need to increase the use of induction, and perhaps other obstetric tools like AVD and augmentation of labour. A closer examination of group 1 is indicated. ➢ The CS rate of group 2 is according to the Robson guidelines consistently around 20-35%[14]. In our population the CS rate in group 2 was 65.9%. There are multiple reasons as to why the CS rate is so high for our population. Firstly, it could be due to misclassification of successfully induced women into group 1 rather than group 2. Facilities where data was not based on patient files, only the delivery logbook and OT logbook could have undiscovered group 2 cases. In the OT logbooks there could be found information about a woman being induced, if she ended up with a CS after a failed induction. However if a woman was induced successfully this might go un-noted in the delivery logbook as that information was not routinely written down there. This could lead to an unequal distribution of successful and failed inductions in group 2, ending up with a falsely high CS rate for induced women. Group 2 can be subdivided into group 2a (induced labour) and group 2b (CS before labour). A high CS rate in group 2 could be explained by a large group 2b, however our population has a small group 2b, 27.3%. A high CS rate in group 2 without a large group 2b indicates a poor success rate of induction or poor choice of women to induce. This is reflected in the CS rate of group 2a which is 53.1%. ➢ The CS rate of group 3 is 18.0%. This should normally not be higher than 3% according to the Robson guidelines[14]. A possible contribution to the high CS rate could be misclassification of women who underwent a CS into group 3 rather than group 5. Information about a previous CS could go undiscovered when patient files were not available, as this is where the information is routinely written. Another possible reason for a high CS rate could be that group 3 women giving birth in hospitals are a higher risk population than the group 3 women giving birth out of hospital. A closer examination of group 3 is indicated. ➢ The CS rate of group 4 is 55.1%. This is much higher than 15% which the Robson guidelines states it should rarely exceed[14]. There are multiple reasons as to why the CS rate is so high for

our population. Firstly, it could be due to misclassification of successfully induced women into group 3 rather than group 4. Facilities where data was not based on patient files, only the delivery logbook and OT logbook could have undiscovered group 4 cases. In the OT logbooks there could be found information about a woman being induced, if she ended up with a CS after a failed induction. However if a woman was induced successfully this might go un-noted in the delivery logbook as that information was not routinely written down there. This could lead to an unequal distribution of successful and failed inductions in group 4, ending up with a falsely high CS rate for induced women. Similarly to group 2, the high CS rate in group 4 is not justified by the size of group 4b (CS before labour), which is 37.1% of group 4. This indicates a poor success rate of induction or poor choice of women to induce, which is reflected in the CS rate of group 4a (induced labour), 28.6%.

- The CS rate of group 5 is 76.8%. The WHO MCS reference population had a CS rate of 74.4%, which is not far from our population[22]. However, the Robson guidelines state that rates of 50-60% are considered appropriate, provided you have good maternal and perinatal outcomes[14]. It is not probable that the high CS rate is due to a large group 5.2 (2 or more previous CS) as this only contributes to 13.6% of group 5. Therefore the high CS rate could be due to multiple other factors. Firstly, it is probable that more women with previous CS that underwent another CS in the current pregnancy were discovered, as that is often written in the OT logbook. Women who had a Vaginal Birth After Caesarean (VBAC) would only be noted in the delivery logbook, where information about a previous CS is not routinely written. Secondly, a high CS rate could also be due to low frequency of giving a Trial Of Labour After Caesarean Section (TOLAC).
- The CS rate of group 8 is 47.0%. This is lower than what the Robson guidelines states, that it is usually around 60%[14]. 11.5% of all group 8 deliveries was a stillbirth (one or all multiples). This is higher than the stillbirth rate of the sample population in total (6.0%). Multiple pregnancies are higher risk than singleton pregnancies, but this might indicate a need to increase deliveries of multiples by CS. Certainly it does indicate a need to increase intrapartum care. Close monitoring of foetal condition is always necessary, but especially in multiple pregnancies.
- The CS rate of group 10 is 25.6%. In most populations this rate is around 30%[14]. This suggests a relatively higher rate of preterm spontaneous labour in the study population and hence a lower CS rate.

	➢ The relative contribution of group 1, 2, and 5 to the overall CS rate is 42.4%. They normally add up to around 66% of all the CS performed in a hospital[14]. In our population group 3 has a relative contribution of 28.3% of the CS, the highest of all the groups. This partly explains why group 1, 2, and 5 do not add up to as high a percentage as it normally does. ➢ The absolute contribution of group 5 to the overall CS rate is 4.0%. This indicates low CS rates the previous years, which is true for Sierra Leone. The CS rate was found to be 2,9% in the national Demographic and Health Survey (DHS) from 2013[29], and still low but increased in the 2019 DHS at 4.1%[5].

Table 3, Interpretation of the Robson classification in eight hospitals in Sierra Leone January, May, September, and October 2021 following the WHO Robson Classification Interpretation Manual[14]

Discussion

The CS rate in the eight hospitals combined was 28.1% of all births. This is 5% percent higher than the 23% in-facility CS rate found in Holmer et al.[6], which included all CSs done in 2016 at all the 36 hospitals performing CS in Sierra Leone. The increased in-facility CS rate in our study might be a result of increased use of CS at hospitals in Sierra Leone. It is expected that the overall CS rate in the country has increased during this six year period, as it increased from 2.9% in 2013[29] to 4.1% in 2019[5]. However it is a possibility that the higher rate in our study is due to a selection bias as only eight of the 36 hospitals performing CS are included.

Some of the most interesting findings are the high CS rates in group 1 (nulliparous women without a previous CS, with a single cephalic pregnancy at term in spontaneous labour) and group 3 (multiparous women without a previous CS, with a single cephalic pregnancy at term in spontaneous labour), usually considered low risk groups. Group 1 had a CS rate of 24.7%, and group 3 had a CS rate of 18.0%. These rates deviated substantially from the Robson guidelines, especially in group 3 where they state it should normally not be higher than 3%[14].

There are multiple factors that could contribute to the high CS rates in group 1 and 3. Firstly, a large group of women deliver outside of a health facility or in a primary health care unit (PHU) instead of a hospital in Sierra Leone. It is therefore expected that the in-facility CS rate is higher for the low risk groups in Sierra Leone than in countries where most women deliver in a hospital. The high proportion of women giving birth outside of a hospital could indicate sub-optimal access to health care, but is also affected by common beliefs of childbirth being a natural process, and that more trust is given to traditional birth attendants than professional nurses[30]. The exact number of deliveries outside of a health facility is unknown, with studies finding estimates ranging between 28% (from the 2017 The Sierra Leone Rapid Emergency Obstetric and Newborn Care (EmONC) Assessment)[24] to 83.4% (from the 2019 DHS)[5]. The DHS included deliveries that took place in lower level health facilities such as health posts with no skilled attendant that were not included in the EmONC assessment. In addition, the 2019 DHS also showed that with increasing parity, even more women deliver outside of a health facility, which could be reflected in the large deviation from the Robson guidelines in group 3[5].

A large proportion of the women in the study population delivered the same day as they were admitted to hospital (69%). This could imply a high incidence of late presentation to hospital, some perhaps because a complicated labour has occurred. In addition to poor access to health care and low health-care-seeking behaviour, dysfunctional referral systems for those that do seek a health facility contributes to women presenting late to hospital. This is supported by Boatin et al.[31] which shows that dysfunctional referral systems are an issue in Low- and Middle-Income Countries (LMICs), referrals are often made too late, and referral mechanisms (for example transport) are inadequate or unavailable. Thus, assuming group 1 and 3 in our study population are more high risk groups than usual, this could partly explain the high CS rates. To say for certain if CSs in the low risk groups could have been avoided, a further audit of such cases should be done in the future, including referral status, intrapartum care, other risk factors in pregnancy, more detailed indication for CS, care received antenatally, and information around the decision making process of the CS.

The CS rate of group 6 and 7 (all women with a single breech delivery) was 64.5% and 60.8% respectively. This is lower than the WHO MCS reference population where the CS rates were 78.5% (group 6) and 73.8% (group 7)[22]. According to J. P. Vogel et al.[32] the current rates could represent an unmet need for CS. This statement is also supported by the high rates of stillbirth in these groups; 17.7% (group 6) and 19.6% (group 7). On the other hand, the high stillbirth rates could indicate a need to increase external version before labour, which could improve outcomes in groups 6 and 7 without increasing the CS rate.

This would most likely require training of staff as well as encouragement of women to come to facility earlier to identify and manage such a risk factor. The high stillbirth rates in these groups could also be affected by the high rate of premature births in our population. In our sample 21.4% of the babies in group 6 and 7 are premature (< 2500g). Finally, a breech position is associated with congenital anomalies[33]. As there is no data on this in our population, it cannot be said how this could have contributed to the stillbirth rate.

There were 13 maternal deaths recorded in the logbooks for all the eight hospitals combined. This gives a maternal mortality rate of 0.2%. This is lower than the maternal mortality ratio found in the 2019 DHS, 717 per 100 000 live births[5]. Thus it might indicate missing recordings of maternal deaths in the logbooks. However, it is important to note that our study only has data for the time the woman is in hospital. The maternal mortality ratio is a more extensive term, and amongst other aspects it includes deaths that occur within 42 days of termination of pregnancy.

Overall, the three most common indications for CS were mechanical or dynamic dystocia (35.0%), urgent or emergency CS (18.9%) and previous scar(s) (11.3%). Over 50% of the CS occurred in the low risk groups 1 and 3 (women without a previous CS, with a single cephalic pregnancy at term in spontaneous labour). Mechanical or dynamic dystocia was the most frequent indication for CS in both groups by far (51.1% in group 1 and 48.3% in group 3). Urgent or emergency CS (eclampsia, pre-eclampsia, abruptio placentae, placenta previa, uterine rupture) were also large contributors in group 1 (13.3%) and 3 (19.0%). The large contributions from urgent indications and dystocia could support the thesis that a high proportion of women presents late to hospital. In addition, the high frequency of dystocia as an indication for CS could indicate an underuse of augmentation of labour and AVD. Information about the use of partograph in the study population could have provided a better comprehension of the dystocia-group. Overall, a more detailed classification of indications, especially in the low-risk groups, is indicated as it could provide further insight into the appropriateness of the CS done.

For group 1 (nulliparous women without a previous CS, with a single cephalic pregnancy at term in spontaneous labour) the second most frequent indication was cephalopelvic disproportion (CPD), at 16.1%. CS indicated by CPD accounts for a significant increase in the CS rate around the world, which is partly associated with an overdiagnosis of CPD[34]. The high frequency of CPD in our population could indicate an overdiagnosis of this condition, and could represent a proportion of inappropriate CS usage.

Foetal indication for CS is interesting to look into. Only 7.53% of the CSs were indicated by foetal distress, which is a lower rate than has been described in other LMICs [35]. The frequency of foetal distress as indications for CS could imply a limited degree of intrapartum foetal monitoring[36]. 2.8% of the CS in our population had IntraUterine Foetal Death (IUFD) as one of the indications. When IUFD was a sole indication, it was classified as "others", but most often another indication was higher in the hierarchy and therefore used in the analysis. When foetal monitoring confirms that a foetus has died, CS should be avoided to keep a woman from obtaining an 'avoidable scar' that will increase the risks in a consecutive pregnancy[36, 37].

Comparisons between facilities

The overall CS rate differed greatly between the hospitals, ranging from 17.9% to 47.8%. However, comparisons should be done with care as the function and characteristics of the hospitals vary greatly. Five of the hospitals are governmental, while three hospitals are NGO-driven. Three of the hospitals are regional referral hospitals. Moreover, the hospitals serve different socio demographic populations, and the sample sizes vary greatly between hospitals (range 140-951). This leads to an heterogeneous distribution of CS risk factors across the hospitals. Another difference is the access and quality of patient files across hospitals. This can lead to an underestimation of group 2 (nulliparous women with a single cephalic pregnancy at term, induced labour or CS before labour), 4 (multiparous women with a single cephalic pregnancy at term, induced labour or CS before labour) and 5 (women with one or more previous CS, with a single cephalic pregnancy at term) in some hospitals.
These factors must be taken into consideration especially when comparing Robson groups between hospitals.

Hospital H has by far the highest overall CS rate 47.8%. It is over 10% higher than hospital C which has the second highest CS rate, at 34.6%. Furthermore hospital H has the highest CS rates in the low risk groups 1 and 3 (53.3% and 34.2%), while every other hospital has a CS rate less than 33% in group 1 and less than 25% in group 3. The high CS rates in these two low risk groups might indicate unnecessary use of CS at hospital H.

The use of CS in group 5 (women with one or more previous CS, with a single cephalic pregnancy at term) ranged from 14.3% in hospital A to 94.1% in hospital F. It must be taken into consideration that Group 5 at hospital A only included 7 patients. Only two of the hospitals included (A and B) had a CS rate in group 5 ≤ 50%, while the other six hospitals had a CS rate ≥80% in this group. A low rate of TOLAC could be due to little experience, or little knowledge about the previous CS, indications, and complications, and that it is therefore considered safer to perform another CS[16]. Furthermore, a recent study from Cameroon showed that the success rate of TOLAC is low with a high rate of complications[38]. If this is applicable to Sierra Leone, there needs to be strategies implemented before one could recommend a higher use of TOLAC. Group 5 is a growing group of women with a higher risk pregnancy, and it is important to have good evidence-based management which takes a low-resource setting into consideration.

The governmental hospitals combined have a much higher CS rate than the NGO-hospitals combined, the rates are 31.5% and 18.0% respectively. To investigate this difference further, the CS providers were stratified by hospital type, and with great caution we want to suggest some possible factors. In the NGO-hospitals specialist MDs performed 33.0% of the CSs, while only 13.9% of the CSs were performed by specialist MDs in governmental hospitals. At the governmental hospitals, SACHOs and STPs performed 54.9% of the CSs, while they performed 10.7% at the NGO-hospitals. A higher proportion of specialist MDs can indicate a more robust obstetrical team, but multiple other aspects and differences between the two groups factor in as well. One difference being that the governmental hospitals include the three regional referral hospitals in our sample, so a higher risk group and therefore a higher CS rate, is expected in these facilities.

The large discrepancies in CS rates across the facilities could indicate large differences in access to and capacity of CS across the country, as was found to be the case in Holmer et al.[6] It is important to disaggregate within a country, and not just look at a national or total CS rate. A low CS rate at the national level can hide overuse of CS in some populations and a severe lack of access in others. This study looked at 8 different hospitals in six different districts in Sierra Leone (Tonkolili, Bombali, Kono, Koinadugu, Kenema and Western area). In addition to this study that gives an insight into geographical differences, it is of high importance to examine it from a socioeconomic perspective as well. This is strongly supported in Boatin et al[39], which exemplifies this by showing to findings from Ghana, where national CS rates more than tripled from 3.7% in 2003[40] to 16% in 2017[41] achieving a national level population rate that could be considered adequate. However, when disaggregating the 2017 CS rate in Ghana it revealed rates of 12% in the poorest fifth of the population compared to 46% in the richest fifth. This perspective has also been investigated in Sierra Leone in Van Duinen[42], which showed a higher proportion of CS in the richest fifth. The study was however prone to selection bias as it included a large group of patients from Western Area which gave a more conservative estimate for financial hardship. The study also showed that the poorest fifth in Sierra Leone have the highest expenses related to a CS, and that many are facing catastrophic expenditure, which can limit their access to care[42].

Comparisons with other countries

Use of the Robson classification system allows one to make a standardised comparison of data across countries. Tognon et al.[16] published in 2019 an observational retrospective study which analysed caesarean sections and neonatal outcome using the Robson classification at a rural district hospital in Tanzania. This study is of a similar methodology as our study and is set in a relatively similar setting, a low-resource country with high maternal and neonatal mortality. The maternal mortality rate is one of the highest in the world in Sierra Leone, at 717 per 100,000[5], while lower but still high at 556 deaths per 100,000 live births in Tanzania[43]. A key difference between the two studies is that this study visited eight hospitals in SL, whereas there was only one hospital studied in Tanzania, Tosamaganga Hospital. Tosamaganga Hospital is a district referral hospital in a rural area which serves a population of 265 000 inhabitants, and the study included 3012 women. The overall CS rate was found to be 35.2%, which is slightly higher than the 28.1% at the eight hospitals in SL. This could be due to several factors, one being that not all the hospitals visited in Sierra Leone are regional referral hospitals.

Similarly to Sierra Leone, Tanzania has a high fertility rate. Therefore it is expected that group 3 (multiparous women without a previous CS, with a single cephalic pregnancy at term in spontaneous labour) accounts for a large proportion of the women in both studies. Group 3 accounts for 44.2% of all women in our study, while 32.3% in the Tosamaganga sample. 32.3% was lower than they expected, however this can be explained by a large group 5, 15.4% (women with one or more previous CS, with a single cephalic pregnancy at term). The distribution of multiparous women in group 3 and 5 indicates a higher use of CS in Tanzania than in Sierra Leone in the previous years; group 5 is expected to rise in Sierra

Leone in the years to come.

In both studies, a major part of the total number of CSs took place in groups 1 and 3 (women without a previous CS, with a single cephalic pregnancy at term in spontaneous labour), and both studies found high CS rates in these two groups. The CS rate of group 1 and 3 in Tosamaganga Hospital was 27.4% and 15.1%, quite similar to the high rates in our study, 24.7% and 18.0%. A crucial step in evaluating the CS rate in the Robson groups is to consider the maternal and perinatal outcomes. The majority of severe neonatal outcomes at Tosamaganga Hospital were observed in groups 1 (27.7%), 10 (24.5%) and 3 (19.1%). The majority of the stillbirths also occurred in groups 10 (30.3%), 3 (29.9%), and 1 (12.3%) at our eight hospitals in Sierra Leone. Tognon et al.[16] concluded that the large size and high CS rates of groups 1 and 3, combined with the perinatal mortality rates, may indicate insufficient induction rates and the need to provide more timely referrals so that women will get to the hospital before their conditions have become too critical. As the findings are similar to our study, the same conclusion could be drawn to our population in Sierra Leone as well.

For further comparisons, a study that compares the WHO Global Survey of Maternal and Perinatal Health (WHO GS, 2004-2008) and the WHO Multi-Country Survey of Maternal and Newborn Health (WHO MCS, 2010-2011) is used[32]. The study included 287 facilities in 21 countries. The countries were grouped according to Human Development Index (HDI) groups (very high/high, medium, or low), and then the Robson classification was applied.

In our study population, group 3 (multiparous women without a previous CS, with a single cephalic pregnancy at term in spontaneous labour) was the largest group followed by groups 1 (nulliparous women without a previous CS, with a single cephalic pregnancy at term in spontaneous labour) and 10 (all women with a single cephalic, preterm pregnancy, including previous CS). The other countries in the low HDI-group showed the same trend. A key finding in our study was the high CS rate for group 3, 18.0%. This rate was only 5.2% in WHO GS and 6.8% in WHO MCS for the low-HDI group, which again raises interest in the high CS rate found in our population's group 3. Our study also had a high CS rate in group 1, 24.7%, which is higher than the low-HDI group in both WHO studies, 11.4% and 14.8%. Group 3 has the largest absolute contribution to the CS rate in our study, while it is group 5 (women with one or more previous CS, with a single cephalic pregnancy at term) in the low-

HDI group. This could reflect that Sierra Leone is behind on CS capacity, but that it is growing. Group 5 is expected to increase as many of the women in the large groups 1 and 3 with high CS rates will fall into group 5 in their next pregnancy.

Strengths and limitations

A strength of this study is that data is collected from both the dry and the wet season, lessening the chance of bias due to seasonal differences. Another strength of this study is that it collected data from eight different hospitals around the country, both NGO-driven and governmental. The study included hospitals from six different districts in Sierra Leone (Tonkolili, Bombali, Kono, Koinadugu, Kenema and Western area). This heightens the possibility of generalising our findings to country-level rather than a one-facility study. However due to it being a convenience sample of eight out of the 36 hospitals in Sierra Leone that perform CS, generalising must be done with care. Furthermore, the study collected data beyond variables needed for the Robson classification. This is a strength as the Robson classification system has limitations in its use to evaluate the use of CS. Therefore, the additional data collected on outcomes (maternal mortality and stillbirths) and indications for CS provides a broader insight than Robson alone. When both primary sources were available the information was cross checked between the patient files and the delivery logbook. Finally, the data collection was done by two Norwegian medical students with no personal or professional affiliation to the included hospitals, which increases the chance of objectivity.

There were a number of limitations to this study as well. The data was collected retrospectively from handwritten records and some of the information may not have been recorded accurately. Another source of error could be wrong practice when documenting parity, for example including the current pregnancy in the parity, which was sometimes observed. Furthermore, the records were often poorly kept and there was missing data due to injury to the paper. It is also a limitation that the data was retrieved from two different primary sources, the delivery logbook and the patient files. In the hospitals where the patient files were not usable, the delivery logbook was the only primary source (65% of the cases). This led to different information retrieved from different hospitals, resulting in underreporting of certain variables and consequently certain Robson Groups. Firstly, undiscovered information about a previous CS could lead to misclassification of women into group 3 (multiparous women without a previous CS, with a single cephalic pregnancy at term in spontaneous labour) rather than group 5 (women with one or more previous CS, with a single cephalic pregnancy at term), which could have contributed to the high CS rate in group 3. Secondly, missing information about the onset of labour could have underestimated groups 2 and 4 (nulliparous and multiparous women with a single cephalic pregnancy at term, induced labour or CS before labour without a previous CS), and overestimated groups 1 (nulliparous women without a previous CS, with a single cephalic pregnancy at term in spontaneous labour) and 3. At one hospital where a very large portion of the data for January 2021 was missing, February 2021 was used as a substitute. Due to a lack of reliable data on gestational age, birth weight was used as a proxy. Finally, PCMH Freetown was not included in our hospital selection. This is a limitation as it is a high volume, and the only tertiary obstetrical center in Sierra Leone, which would have provided interesting data.

Conclusion

The overall CS rate for the eight included facilities was 28.1%, but with large variations across the facilities. Findings from group 1-4 (all women with a single cephalic pregnancy at term who have not undergone a previous CS) could indicate a need to increase the use of induction, augmentation and AVD. Group 5 (women with one or more previous CS, with a single cephalic pregnancy at term) was a small group in our study population, but is expected to grow in the following years as the CS rate is increasing across the country, and will be important to follow and evaluate. The Robson classification system has limitations in its use to evaluate the use of CS. However, findings can be used to indicate where to examine closer. Group 3 (multiparous women without a previous CS, with a single cephalic pregnancy at term in spontaneous labour) is especially interesting in our study as it is the largest group, and that it has a very high CS rate. Mechanical or dynamic dystocia, followed by urgent or emergency indications were the most frequent indications for CS in group 3. This could support the thesis that women are often late presenting and have a higher risk profile than usual if they do deliver in hospital. The high rate could however also imply inappropriate indications. Further stratification of the indications for CS, in addition to other aspects of the decision making process and circumstances around a CS is needed to better understand and evaluate the use of CS in Sierra Leone. Although the CS rate of Sierra Leone is still below what is recommended, it is a procedure that should only be performed when medically necessary, and is therefore just as important to evaluate as in settings where the rate is higher than recommended.

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Appendix

Appendix 1, Ethical approval from the Sierra Leone Ethics and Scientific Review Committee

GOVERNMENT OF SIERRA LEONE
Office of the Sierra Leone Ethics and Scientific Review Committee
Directorate of Training and Research
5th Floor, Youyi Building Brookfields, Freetown
Ministry of Health and Sanitation

15th December, 2021

To: **Sigrid-Anne Bjorøy** (Medical Student) **Co-Principal Investigator**
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Guro Stamland (Medical Student) **Co-Principal Investigator**
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Study Title: Obstetrical Mapping and Classification of Caesarean Sections according to the Robson Groups in Hospital Facilities in Sierra Leone

Version: 1.0 of 19 November, 2021

Submission Type: First protocol version submitted for review

Data Source: Hospital logbooks

Funding: Faculty of Medicine and Health Sciences, Norwegian University of Science and Technology

Supervisor: **Dr. Josien Westendorp**
Research Fellow
Department of Global Health
Norwegian University of Science and Technology
Trondheim, Norway

Committee Action: Expedited Review

Approval Date: 15 December, 2021

For further enquiries please contact: efoday@mohs.gov.sl

GOVERNMENT OF SIERRA LEONE
Office of the Sierra Leone Ethics and Scientific Review Committee
Directorate of Training and Research
5th Floor, Youyi Building Brookfields, Freetown
Ministry of Health and Sanitation

The Sierra Leone Ethics and Scientific Review Committee (SLESRC) having conducted an expedited review of the above study protocol and determined that it presents minimal risk to subjects, **hereby grants ethical and scientific approval for it to be conducted in Sierra Leone.** The approval is valid for the period, **15 December, 2021 – 14 December, 2022.** It is your responsibility to obtain re-approval/extension for any on-going research prior to its expiration date. The request for re-approval/extension must be supported by a progress report.

Review Comments:

- **Amendments:** Intended changes to the approved protocol such as the study design and key study personnel, must be submitted for approval by the SLESRC prior to implementation.
- **Termination of the study:** When study procedures and data analyses are fully complete, please inform the SLESRC that you are terminating the study and submit a brief report covering the protocol activities. Individual identifying information should be destroyed unless there is sufficient justification to retain, approved by the SLESRC. All findings should be based on de-identified aggregate data and all published results in aggregate or group form. A copy of any publication be submitted to the SLESRC for its archive
- ***In Hospital Facilities Consent Form, delete email for Willietta and replace with efoday@mohs.gov.sl***

Professor Hector G. Morgan
Chair

For further enquiries please contact: efoday@mohs.gov.sl

NTNU

Kunnskap for en bedre verden