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Analysis of Caesarean Sections using the Robson Ten Group Classification System in a University Hospital in eastern Ethiopia: a cross-sectional study

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ABSTRACT

Objective: To analyze caesarean section (CS) using the Robson Ten Group Classification System in an Ethiopian university hospital.

Design: Cross-sectional study.

Setting: a university hospital in eastern, Ethiopia.

Participants: 980 Women who underwent CS from January 2016 to April 2017.

Main outcome: Robson groups (one to ten—based on gestational age, fetal presentation, number of fetus, onset of labour and history of CS), and indications for performing CS.

Results: Robson group 3 (single cephalic multiparous women in spontaneous labour with no history of CS), group 5 (single cephalic term pregnancy with history of CS), and group 1 (single cephalic nulliparous women at term and in spontaneous labour) were the major contributor to the overall CS at 21.4%, 21.1% and 19.3% respectively. The three major indications for CS were fetal compromise (mainly fetal distress) and obstructed labour (mainly cephalopelvic disproportion), and previous CS.

Conclusion: Robson groups 3, 5 and 1 were the major contributors to the overall CS rate. Fetal compromise, obstructed labour and previous CS were the underlying indications for performing CS. Further study is required to assess the appropriateness of the indications and the reason behind high CS rates among low-risk groups (group 1 and 3).

***Key words*:** Caesarean section, audit, Ethiopia, maternal health, Robson classification

Strengths and limitations of this study

- Conducted in a university hospital with large catchment population
- Analyzed CS over 16 months to avoid seasonal variations
- Because of retrospective design, some relevant information might be missing
- Most of the women were referred cases with underlying complications, and may not be generalized to general population
- Single-hospital (with large burden of referred cases) study, might be less generalizable

INTRODUCTION

Over the last few decades, the global caesarean section (CS) rate has significantly increased and exceeded the World Health Organisation's recommendation of 10-15% (1). CS is performed when vaginal delivery is not possible or contraindicated (2). In such cases not performing a CS could endanger the life of the mother and the fetus. However, CS is also performed without medical reason or with imprecise indications such as obstructed labour, with intact membranes (3). This potentially life-saving procedure is not without risk and might become life-threatening in the index and future pregnancies for both mother and child. Immediate and long-term complications of CS including increased risk of maternal mortality and morbidity, increased the need for blood transfusion, longer hospitalization, postpartum infections, retained placenta, still births and postpartum haemorrhage were reported(4-6).

Although the national population based CS rate of Ethiopia is far below the WHO threshold (2%) (7), a national review of facility-based CS rate indicated a high CS rate in facilities (15% in public facilities vs. 46.1% in for-profit centres) (8). A study conducted in eastern Ethiopia indicated a CS rate of 34.3% (26.6% in public facilities and 58.7% in private hospitals) (9). The population-based study, from the Demographic and Health Survey, is low since many women in need of CS do never reach facilities (institutional delivery rate of 26%) (7). This indicates some women are being exposed to unnecessary CS while others do not get the CS they need (3). For example, CS is highest among women with at least secondary education, living in urban areas or is rich compared to their counterparts (10,11). In rural settings, however, lack of access to adequately staffed and equipped health institutions is contributing largely to maternal mortality and complications. In urban settings and among the rich, there is a concern in many countries that the intervention is being over utilized and unnecessary interventions are done.

The challenge is to keep CS rates low while maintaining safe outcomes for the mother and infant. This requires continuous auditing of CS. Three different classifications—based on primary clinical indications; degree of urgency or absolute need for caesarean delivery; and Robson classification—have been reported as a framework for auditing CS (12). A systematic review comparing different classifications concluded that Robson classification is optimal for monitoring CS (13) and the World Health Organization recommended Robson classification as a global standard tool for monitoring CS (14). The Robson classification also called the Ten Group Classification System (TGCS), classifies CS into ten mutually exclusive and

exhaustive groups based on parity, presentation, previous history of CS, gestational age and nature of labour (15). Although the application of the TGCS and its importance for targeting population and reducing CS rates has been previously noted (16-18), there is no study in Ethiopia and contribution of different groups to the overall CS is unknown. In Ethiopia, where most facilities are situated in urban centres and high CS rate in referral hospitals is registered (9,19), an audit of CS deliveries using the TGCS is important to know which groups of women are contributing to the increase in CS. The aim of this study was to analyze caesarean sections using the TGCS in Hiwot Fana Specialized University Hospital in eastern Ethiopia.

METHODS

Study design and participants

We conducted a cross sectional study to analyze all CS performed from January 2016 to April 2017 at the department of obstetrics of Hiwot Fana Specialized University Hospital (HFSUH) Harar, eastern Ethiopia. The study population included all women who underwent CS in the hospital during the specified period. Laparotomy for uterine rupture and files with missing information were excluded. The identity of women who underwent CS was obtained from the delivery logbook, admission and discharge register and operation theatre logbook. The admission and discharge register, and delivery logbooks contain information about all woman admitted in the hospital including mode of delivery (vaginal, CS) while the operation theatre logbook contains only information about women who underwent CS. Using the medical registration number of each woman, we accessed all CS files performed during the study period.

Study setting

HFSUH is a tertiary referral hospital affiliated with the College of Health and Medical Sciences, Haramaya University, Ethiopia where around 3500 deliveries took place annually. The hospital serves both referred complicated cases and self-referred uncomplicated births. During the study period, the department of obstetrics was run by seven consultants, eight residents, and 16 (nurse) midwives. The department has its own operation theatre for obstetric cases.

Variables

For each CS case, we collected data on maternal characteristics (age, history of CS, parity and gravidity), pregnancy-related information (gestational age, fetal presentation, number of fetus and onset of labour), and maternal and neonatal outcome (complications, 5 minute APGAR score, birth weight, fetal and maternal outcome on discharge). The dependent variable was the Robson classification group. The ten groups and their characteristics are shown in Table 1. All presentations were classified as cephalic, breech or transverse/oblique. Gestational age was categorized as a term (>37 weeks) or preterm (<37 weeks). The course of pregnancy was categorized as spontaneous or induced/CS before labour. Number of parity was classified as nulliparous or multiparous. Number of the fetus was categorized as a singleton or multiple pregnancies.

Table 1: Robson's 10-group CS classification

Group	Description
1	Nulliparous, single cephalic, ≥ 37 weeks, in spontaneous labour
2	Nulliparous, single cephalic, ≥ 37 weeks, induced or CS before labour
3	Multiparous (excluding previous CS), single cephalic, ≥37 weeks, in spontaneous labour
4	Multiparous (excluding previous CS), single cephalic, ≥37 weeks, induced or CS before labour
5	Previous CS, single cephalic, ≥ 37 weeks
6	All nulliparous breeches
7	All multiparous breeches (including previous CS)
8	All multiple pregnancies (including previous CS)
9	All abnormal lies (including previous CS)
10	All single cephalic, <37 weeks (including previous CS)

Data collection

Data were collected by medical students (OP, MM, MC, IK) from University of Groningen, the Netherlands. Data collectors were trained and supervised by the principal investigator (AKT). All data quality, indications, and eligibility of cases were confirmed by a senior obstetrician (TG). All CSs during the study period were retrieved from the operation register and were double checked with delivery logbook and admission and discharge registers. Completeness of data was checked by the principal investigator (AKT).

Data Processing and Analysis

All completed data were entered using EpiData v3.1(http://www.epidata.dk) and analyzed using SPSS v23 (IBM SPSS Statistics for Windows, version 23 (IBM Corp., Armonk, N.Y., USA). Descriptive statistics of study participants and variables was conducted. The Robson group was assigned based on four obstetric concepts (with their parameters)—category of the pregnancy, previous obstetric history, course of labour and gestational age (20). All reported indications were classified as absolute maternal and non-absolute indications using the recommendations by Stanton et al. (12). Absolute maternal indications include obstructed labour, major APH, malpresentation (transverse, oblique and brow) and uterine rupture in hierarchal order. Non-absolute indications include fetal compromise, previous CS, failure to progress, breech, severe pre-eclampsia, and eclampsia (with no hierarchy). Results were presented as frequencies, percentages, means, and standard deviations. This study was part of a PhD study on severe maternal morbidity and mortality in Eastern Ethiopia which was approved by the Institutional Health Research Ethics Review Committee of Haramaya University, Ethiopia (Ref N: C/A/R/D/01/1681/16).

RESULTS

During the study period, there were 4758 deliveries, of which 1224 (25.7%) were caesarean sections. After excluding incomplete cases and files not accessed, 980 cases were included in the final analysis (Figure 1).

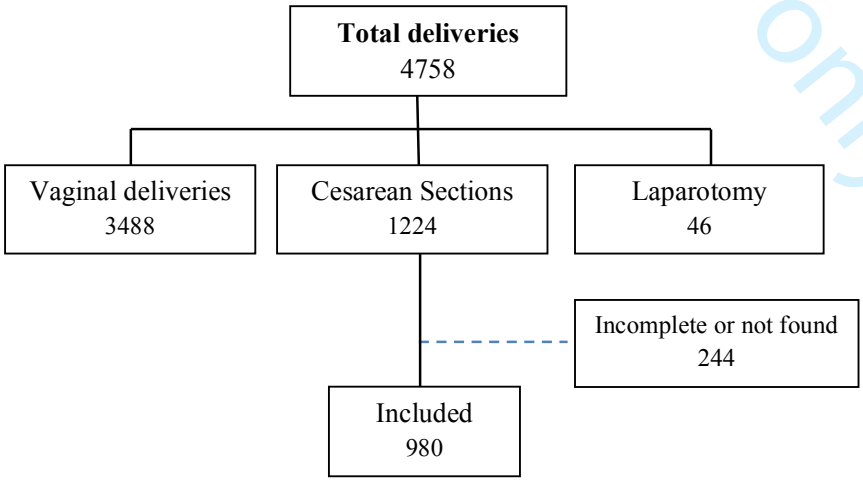


Figure 1: Flowchart of the study in HFSUH, 2017

The mean age of participants was 26.3(±5.7) years. Mean duration of hospitalization was 6.3(±3.9) days. The mean gestational age was 37.7(±2.2) weeks. Sociodemographic characteristics and obstetric conditions are summarized in Table 2.

Table 2: Sociodemographic and obstetric conditions of study participants

Variables	n	%
Age (years)		
<20	78	7.9
20-35	850	86.7
>35	53	5.4
Duration of hospitalization		
1-7 days	674	70.8
>7 days	278	29.2
Type of CS		
Planned	72	7.4
Emergency	908	92.6
Gravidity		
1	305	31.1
2-4	421	43.0
>4	254	25.9
Parity		
0	319	32.5
1-4	473	48.3
>4	188	19.2
Gestational age		
Preterm (≤36 weeks)	111	11.3
Term (37-42 weeks)	863	88.1
Post term (>42 weeks)	4	0.6
Onset of labour		
Spontaneous	728	74.4
Induced/CS before labour	251	25.6
Fetal presentation		
Cephalic	808	82.4
Breech	135	13.8
Transverse/oblique/brow/others	37	3.8
Fetal status at birth		
Alive	924	94.3
Still births (fresh and macerated)	56	5.7
Apgar score at 5 minutes		
<7	89	9.5
≥7	836	90.5
Birth weight (gram)		
<2500	157	16.1
2500-4000	779	80.1
>4000	37	3.8
Maternal outcome at discharge		
Alive	971	99.1
Dead	9	0.9

Robson Ten Group Classification System (TGCS)

In our study, single cephalic multiparous women at term in spontaneous labour with no previous history of CS (group 3) were the greater contributor to the overall CS rate, contributing 21.4% of all CS. The second highest contributors were women with a single cephalic presentation at term and previous CS (group 5) contributing 21.1% to the overall CS. The third highest contributors were single cephalic nulliparous women at term and in spontaneous labour (group 1) with 19.3%. All women with breech, transverse or oblique presentation (group 6, 7, and 9 combined) contributed 13.8% to the overall CS. All single cephalic women in preterm (group 10) contributed 6.2% of all the CS (Figure 2).

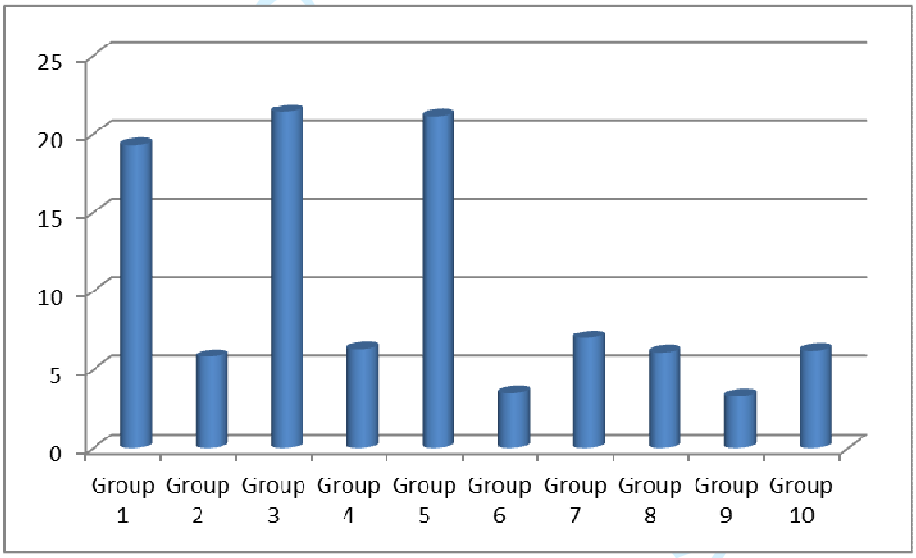
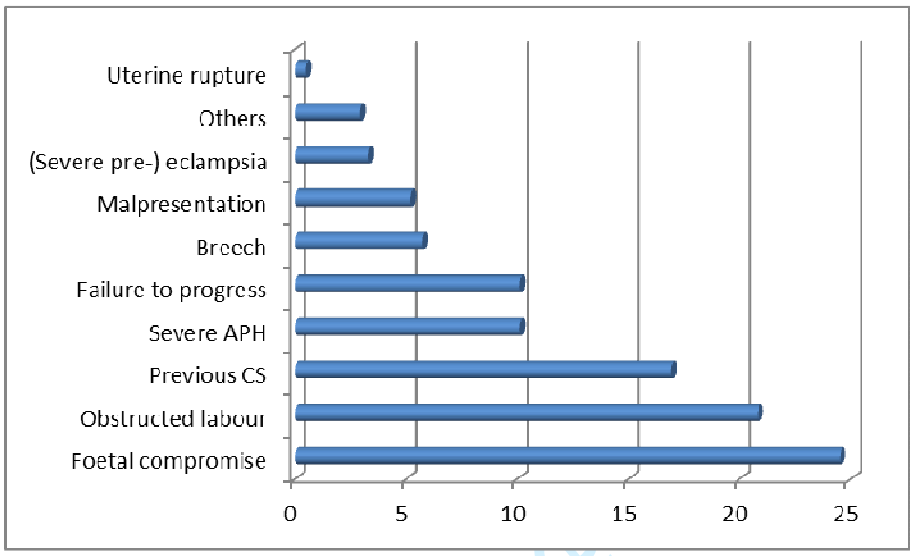


Figure 2: Distribution of Robson group of CS in Hiwot Fana Specialized University Hospital, 2017

Indications for performing CS

As shown in Figure 3, the main indications for performing CS were fetal compromise (fetal distress, cord prolapse or intrauterine growth retardation) followed by obstructed labour (cephalo-pelvic disproportion, fetal macrosomia or unspecified disproportions) and previous CS.



Obstructed labour (cephalo-pelvic disproportion, macrosomia, unspecified disproportions); APH= ante partum hemorrhage; failure to progress (prolonged labour and failed induction), foetal compromise (foetal distress, cord prolapse and intra uterine growth retardation)

Figure 3: Indications for CS in an Hiwot Fana Specialized University Hospital, 2017

Indications per each Robson groups are shown in Table 3. Absolute maternal indications (obstructed labour, major APH, malpresentation or uterine rupture) were the leading indications only in three groups: group 3 (obstructed labour), group 9 (malpresentation) and group 10 (major APH). In other Robson groups, other non-absolute indications were the leading indications for performing CS—group 1 (fetal compromise), group 2 and 4 (failure to progress), group 5 (previous CS), group 6,7, and 8 (breech presentation). In general, CS was performed for absolute maternal indications in 36.6% (359/980) of the cases (Table 3). Diagrammatic represenatation of the contribution of each indication within the groups is presented in **additional file 1**.

Table 3: Indications for performing CS in HFSUH, eastern Ethiopia 2017

Indications	Group 1	Group 2	Group 3	Group 4	Group 5	Group 6	Group 7	Group 8	Group 9	Group 10	Total n (%)
Absolute maternal indications											**359(36.6)**
Obstructed labour[1]	73	4	74	6	29	3	8	0	5	2	204(20.8)
Major APH	1	1	32	17	11	2	6	6	2	21	99(10.1)
Malpresentation[2]	5	0	16	0	4	0	0	3	23	0	51(5.2)
Uterine rupture	1	0	1	1	2	0	0	0	0	0	5(0.5)
Non-absolute indications											**621(63.4)**
Fetal compromise[3]	101	13	65	11	20	6	8	5	2	7	238(24.3)
Previous CS	0	0	0	0	136	0	18	5	0	7	166(16.9)
Failure to progress[4]	6	32	5	21	3	7	9	3	0	10	96(9.8)
Breech presentation	0	0	0	0	0	16	19	21	0	0	56(5.7)
(Severe pre-) eclampsia	1	2	3	2	0	0	0	12	0	13	33(3.4)
Others	1	5	14	4	2	0	0	5	0	1	32(3.3)
Total (number)	**189**	**57**	**210**	**62**	**207**	**34**	**68**	**60**	**32**	**61**	**980(100)**

[1]cephalo-pelvic disproportion, macrosomia and unspecified disproportions; [2]transverse, oblique or brow; [3]fetal distress, cord prolapse and intrauterine growth restriction; [4]prolonged labour, cervical arrest, and failed induction; APH= antepartum hemorrhage; CS=cesarean section

DISCUSSION

Our study showed that group 3, 5, and 1 were the major contributor to the overall CS rate. This indicates high CS rate both in primary (groups 1 and 3) and secondary (group 5) caesarean section. The study also showed that only one third (36.6%) of the CSs were performed for absolute maternal indications.

Our findings are in line with a classification applied in hospitals from Tanzania and South Africa (21,22) where the three major groups (1, 3, and 5) were the same, though in a different order. In a study from a university hospital in Cote d'Ivoire, however, the most common groups were group 1, 2 and 3 (23). The importance of group 2 (nulliparous single cephalic term pregnancy, induced or caesarean before labour) in the study from Cote d'Ivoire could be explained by variations in indications for inductions of vaginal birth or CS in the two settings. In most high-income settings group 5, 2 and 1 are the major contributors to overall CS rate unlike the studies from low-income settings (24-27). The fact that group 5 women are one of the major contributors both in high and low-income settings indicates the importance of

preventing primary caesarean if a meaningful reduction in overall CS rate is to be achieved. In a study from Tanzania both primary and secondary CS were rising overtime (21).

The strength of this study is the inclusion of all CSs performed over 16 months in a referral hospital covering large population. Although the hospital is serving both uncomplicated births and women with complications, the majority of the cases were cases of women referred with already existing complications. Accessing all CS files was difficult due to non-digital nature of the hospital files.

The performance of CS among the low-risk groups (group 1,2,3 and 4) for non-absolute medical indications—fetal compromise and failure to progress—should be further examined. In the majority of facilities, and HFSUH is not an exception, birth monitoring is minimal with a low recording of fetal heart rate on partograph (28,29). Inadequate facilities for monitoring fetal heart rate and lack of close monitoring are challenges to relying on such indications (30). Opportunities for instrumental delivery and training staff to increase its uptake are warranted to decrease primary caesarean among low-risk groups. Limiting the caesarean section rate in low-risk pregnancies is key to lowering the trend of increased CS (31). Since TGCS is not an audit of the appropriateness of indications of CS (32), a continuous audit of indications for CS should be designed to achieve optimum level appropriate CS rates.

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Ethical approval and consent to participate

This study was conducted as part of PhD study on severe maternal morbidity and mortality in Ethiopia. The study was approved by the institutional research ethics review committee of College of Health and Medical Sciences, Haramaya University in Ethiopia (ref no: C/A/R/D/01/1681/16). Informed consent was waived since the study was conducted after discharge of the women and no interview was planned.

Availability of data and material

Data essential for conclusion are included in this manuscript. Additional data can be obtained from the corresponding author on reasonable request.

Competing interests

The authors declare no competing interest

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Authors' contributions

Conceived the study: AKT, JS

Collected data: OP, MM, MC, IK

Supervision and mentorship: AKT, TG, JS

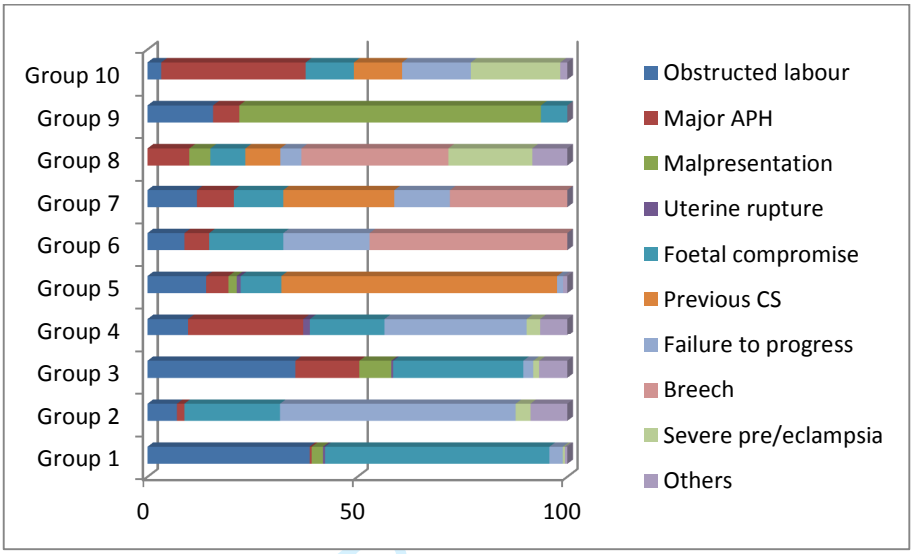
Analysis: AKT

Writing–original draft: AKT, JS

Writing–review & editing critically for intellectual content: AKT, OP, MM, MC, IK, TG, JS

All authors approved the final version of the manuscript to be published

Additional files



Additional file 1: Indications for CS within the ten groups in a university hospital in eastern Ethiopia

STROBE 2007 (v4) Statement—Checklist of items that should be included in reports of *cross-sectional studies*

Section/Topic	Item #	Recommendation	Reported on page #
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract	1
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found	2
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	4
Objectives	3	State specific objectives, including any prespecified hypotheses	5
Methods			
Study design	4	Present key elements of study design early in the paper	5
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	5
Participants	6	(*a*) Give the eligibility criteria, and the sources and methods of selection of participants	6
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	6
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	6
Bias	9	Describe any efforts to address potential sources of bias	na
Study size	10	Explain how the study size was arrived at	6
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	7
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding	7
		(*b*) Describe any methods used to examine subgroups and interactions	na
		(*c*) Explain how missing data were addressed	na
		(*d*) If applicable, describe analytical methods taking account of sampling strategy	na
		(*e*) Describe any sensitivity analyses	na
Results			

Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	7
		(b) Give reasons for non-participation at each stage	7
		(c) Consider use of a flow diagram	7
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	8
		(b) Indicate number of participants with missing data for each variable of interest	na
Outcome data	15*	Report numbers of outcome events or summary measures	8-9
Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	8-9
		(*b*) Report category boundaries when continuous variables were categorized	na
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	na
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	na
Discussion			
Key results	18	Summarise key results with reference to study objectives	11
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	12
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	12
Generalisability	21	Discuss the generalisability (external validity) of the study results	12
Other information			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	15

*Give information separately for cases and controls in case-control studies and, if applicable, for exposed and unexposed groups in cohort and cross-sectional studies.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at www.strobe-statement.org.

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Analysis of Caesarean Sections using Robson Ten Group Classification System in a University Hospital in eastern Ethiopia: a cross-sectional study

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Analysis of Caesarean Sections using Robson Ten Group Classification System in a University Hospital in eastern Ethiopia: a cross-sectional study

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ABSTRACT

Objective: To analyze caesarean section (CS) using Robson Ten Group Classification System in an Ethiopian university hospital.

Design: Cross-sectional study.

Setting: A university hospital in eastern, Ethiopia.

Participants: 980 Women who underwent CS from January 2016 to April 2017.

Main outcome: Robson groups (one to ten—based on gestational age, fetal presentation, number of fetus, onset of labour and history of CS), and indications for CS.

Results: Robson group 3 (multiparous women with single cephalic full-term pregnancy in spontaneous labour with no history of CS), group 5 (multiparous women with single cephalic full-term pregnancy with history of CS), and group 1 (single cephalic nulliparous women full-term pregnancy in spontaneous labour) were the major contributor to the overall CS at 21.4%, 21.1% and 19.3% respectively. The three major indications for CS were fetal compromise (mainly fetal distress) and obstructed labour (mainly cephalopelvic disproportion), and previous CS.

Conclusion: Robson groups 3, 5 and 1 were the major contributors to the overall CS rate. Fetal compromise, obstructed labour and previous CS were the underlying indications for performing CS. Further study is required to assess the appropriateness of the indications, and to reduce CS among the low-risk groups (group 1 and 3).

***Key words*:** Caesarean section, audit, Ethiopia, maternal health, Robson classification

Strengths and limitations of this study

- Conducted in a university hospital with large catchment population
- Analyzed CS over 16 months to avoid seasonal variations
- Because of retrospective design, some relevant information might be missing
- Most of the women were referred cases with underlying complications, and may not be generalized to general population
- Single-hospital (with large burden of referred cases) study, might be less generalizable

INTRODUCTION

Over the last few decades, the global caesarean section (CS) rate has significantly increased and reached an unprecedented level (1). Although there is no specific rate of recommended CS rate (2), no improvement in maternal and neonatal outcomes was observed in CS rates above 10% (3,4). CS is performed when vaginal delivery is not possible or contraindicated (5). In such cases not performing a CS could endanger the life of the mother and the fetus. However, CS is also performed without medical reason or with imprecise indications such as obstructed labour, with intact membranes (6). This potentially life-saving procedure is not without risk and might become life-threatening in the index and future pregnancies for both mother and child. Immediate and long-term complications of CS including increased risk of maternal mortality and morbidity, increased need for blood transfusion, longer hospitalization, postpartum infections, retained placenta, stillbirths, and postpartum haemorrhage were reported (7-9).

Although the national population-based CS rate of Ethiopia is far below the WHO threshold (2%) (10), a national review conducted in 2011 indicated a high CS rate in facilities (15% in public facilities vs. 46.1% in for-profit centres) (11), which is expected to be higher now because of the general increase in the CS rate. A study conducted in eastern Ethiopia indicated a CS rate of 34.3% (26.6% in public facilities and 58.7% in private hospitals) (12). The population-based study, from the Demographic and Health Survey, is low since many women in need of CS do never reach facilities (institutional delivery rate of 26%) (10). This indicates some women are being exposed to unnecessary CS while others do not get the CS they need (6). For example, CS is highest among women with at least secondary education, living in urban areas or is rich compared to their counterparts (13,14). In urban settings and among the rich, there is a concern, in many countries, that the intervention is being over utilized and unnecessary interventions are done. In rural settings, however, lack of access to adequately staffed and equipped health institutions for providing essential obstetric surgery is contributing largely to maternal mortality and complications (15).

The challenge is to keep CS rates low while maintaining safe outcomes for the mother and infant. This requires continuous auditing of CS. Three different classifications—based on primary clinical indications; the degree of urgency or absolute need for caesarean delivery; and Robson classification—have been reported as a framework for auditing CS (16). A systematic review comparing different classifications concluded that Robson classification is

optimal for monitoring CS (17) and the World Health Organization recommended Robson classification as a global standard tool for monitoring CS (2). The Robson classification also called the Ten Group Classification System (TGCS), classifies CS into ten mutually exclusive and exhaustive groups based on the category of the pregnancy, the previous obstetric record of the woman, the course of labour and delivery, and the gestational age of the pregnancy (18). Although the application of the TGCS and its importance for targeting population and reducing CS rates has been previously noted (19-21), there is no study in Ethiopia and contribution of different groups to the overall CS is unknown. In Ethiopia, where most facilities are situated in urban centres, and high CS rate in referral hospitals is registered (12,22), an audit of CS deliveries using the TGCS is important to know which groups of women are contributing to the increase in CS. The aim of this study was to analyze caesarean sections using the TGCS, and identify indications for CS in Hiwot Fana Specialized University Hospital in eastern Ethiopia.

METHODS

Study design and participants

We conducted a cross-sectional study to analyze all CS performed from January 2016 to April 2017 at the department of obstetrics of Hiwot Fana Specialized University Hospital (HFSUH) Harar, eastern Ethiopia. The study population included all women who underwent CS in the hospital during the specified period. Laparotomy for uterine rupture and files with missing information were excluded. The identity of women who underwent CS was obtained from the delivery logbook, admission and discharge register and operation logbook. The admission and discharge register, and delivery logbooks contain information about all woman admitted in the hospital including mode of delivery (vaginal, CS) while the operation theatre logbook contains only information about women who underwent CS. Using the medical registration number of each woman, we accessed all CS files performed during the study period.

Study setting

HFSUH is a tertiary referral hospital affiliated with the College of Health and Medical Sciences, Haramaya University, Ethiopia where around 3500 deliveries took place annually. The hospital serves both referred complicated cases and self-referred uncomplicated births. During the study period, the department of obstetrics was run by seven consultants, eight residents, and 16 (nurse) midwives. The department has its operation theatre for obstetric cases.

Variables

For each CS case, we collected data on maternal characteristics (age, history of CS, parity, and gravidity), pregnancy-related information (gestational age, fetal presentation, number of fetus and onset of labour), and maternal and fetal outcomes at discharge (complications, 5th minute APGAR score, birth weight, fetal and maternal status). Maternal complications included the presence of potentially life-threatening complications (severe postpartum hemorrhage, severe pre-eclampsia, eclampsia, ruptured uterus, sepsis or severe systemic infections), admission to the intensive care unit, receiving blood products or severe maternal outcomes (maternal near miss or deaths) (23). The dependent variable was the Robson classification group. The ten groups and their characteristics are shown in Table 1. All presentations were classified as cephalic, breech or transverse/oblique. Gestational age was categorized as a term (≥37 weeks) or preterm (<37 weeks) based on early prenatal ultrasound or last menstrual period. For cases with no early prenatal ultrasound or unknown last menstrual period, we used a birth weight of ≥2500gm as a proxy to term pregnancy. The course of pregnancy was categorized as spontaneous and induced/CS before labour. Number of parity was classified as nulliparous or multiparous. The number of fetuses was categorized as singleton or multiple pregnancies.

Table 1: Robson's 10-group CS classification

Group	Description
1	Nulliparous, single cephalic, ≥ 37 weeks, in spontaneous labour
2	Nulliparous, single cephalic, ≥ 37 weeks, induced or CS before labour
3	Multiparous (excluding previous CS), single cephalic, ≥37 weeks, in spontaneous labour
4	Multiparous (excluding previous CS), single cephalic, ≥37 weeks, induced or CS before labour
5	Previous CS, single cephalic, ≥ 37 weeks
6	All nulliparous breeches
7	All multiparous breeches (including previous CS)
8	All multiple pregnancies (including previous CS)
9	All abnormal lies (including previous CS)
10	All single cephalic, <37 weeks (including previous CS)

Data collection

Data were collected by medical students (OP, MM, MC, IK) from University of Groningen, the Netherlands. Data collectors were trained and supervised by the first author (AKT). All data quality, indications, and eligibility of cases were confirmed by a senior obstetrician (TG). All CSs during the study period were retrieved from the operation register and were double

checked with delivery logbook and admission and discharge registers. Completeness of data was checked by the first author (AKT).

Data Processing and Analysis

All completed data were entered using EpiData v3.1(http://www.epidata.dk) and analyzed using SPSS v23 (IBM SPSS Statistics for Windows, version 23 (IBM Corp., Armonk, N.Y., USA). Descriptive statistics of study participants and variables was conducted. The Robson group was assigned based on four obstetric concepts (with their parameters)—category of the pregnancy, previous obstetric history, course of labour and gestational age (18). Missing files in the archive room and cases with incomplete information were excluded. All reported indications were classified as absolute maternal and non-absolute indications using the recommendations by Stanton et al. (16). Absolute maternal indications included obstructed labour, major antepartum hemorrhage (APH), mal-presentation (transverse, oblique and brow) and uterine rupture in hierarchal order. Non-absolute indications include fetal compromise, previous CS, failure to progress, breech, severe pre-eclampsia, and eclampsia (with no hierarchy). Results were presented as frequencies, percentages, means, and standard deviations. This study was conducted as part of a PhD study on severe maternal morbidity and mortality in Eastern Ethiopia which was approved by the Institutional Health Research Ethics Review Committee of College of Health and Medical Sciences, Haramaya University, Ethiopia (Ref No: C/A/R/D/01/1681/16).

RESULTS

During the study period, there were 4758 deliveries, of which 1224 (25.7%) were caesarean sections. After excluding incomplete cases and files not accessed, 980 cases were included in the final analysis (Figure 1).

The most common reasons for exclusion were missing files (n=148), and incompleteness of information (n=96). Files were missing because of incorrect transfer of medical registration numbers to the delivery logbook or missing of the complete file in the archive room. Incomplete information occurred when some papers from the medical files were lost, or information on history of CS, gestational age, fetal presentation, course of labour, or parity was missing. The mean age of participants was 26.3(±5.7) years. Mean duration of hospitalization was 6.3(±3.9) days. A quarter of study participants (25%) had potentially life-threatening complications, including 2.8% women with maternal near miss and deaths. The mean gestational age was 37.7(±2.2) weeks. Sociodemographic characteristics and obstetric conditions are summarized in Table 2.

Table 2: Sociodemographic and obstetric conditions of study participants

Variables		n	%
Age (years)	<20	78	7.9
	20-35	850	86.7
	>35	53	5.4
Duration of hospitalization	1-7 days	674	70.8
	>7 days	278	29.2
Type of CS	Planned	72	7.4
	Emergency	908	92.6
Gravidity	1	305	31.1
	2-4	421	43.0
	>4	254	25.9
Parity	0	319	32.5
	1-4	473	48.3
	>4	188	19.2
Gestational age	Preterm (≤36 weeks)	111	11.3
	Term (37-42 weeks)	863	88.1
	Post term (>42 weeks)	4	0.6
Onset of labour	Spontaneous	728	74.4
	Induced/CS before labour	251	25.6
Fetal presentation	Cephalic	808	82.4
	Breech	135	13.8
	Transverse/oblique/brow/others	37	3.8
Fetal status at birth	Alive	924	94.3
	Stillbirths	56	5.7
Apgar score at 5 minutes	<7	89	9.5
	≥7	836	90.5
Birth weight (gram)	<2500	157	16.1
	2500-4000	779	80.1
	>4000	37	3.8
Potential life-threatening complications (n=245)	Severe postpartum hemorrhage	18	1.8
	Severe pre-eclampsia	122	12.4
	Eclampsia	62	6.3
	Ruptured uterus	6	0.6
	Sepsis	14	1.4
	Transfusion of blood (at least one unit of RBC)	107	10.9
Maternal status at discharge	Alive	971	99.1
	Dead	9	0.9

RBC, red blood cells

Robson Ten Group Classification System (TGCS)

In our study, single cephalic multiparous women at term in spontaneous labour with no previous history of CS (group 3) were the greater contributor to the overall CS rate, contributing 21.4% of all CS. The second highest contributors were women with a single cephalic presentation at term and previous CS (group 5) contributing 21.1% to the overall CS. The third highest contributors were single cephalic nulliparous women at term and in spontaneous labour (group 1) with 19.3%. All women with breech, transverse or oblique presentation (group 6, 7, and 9 combined) contributed 13.8% to the overall CS. All single cephalic women in preterm (group 10) contributed 6.2% of all the CS (Figure 2).

Indications for performing CS

As shown in Figure 3, the main indications for performing CS were fetal compromise (fetal distress, cord prolapse or intrauterine growth retardation) followed by obstructed labour (cephalo-pelvic disproportion, fetal macrosomia or unspecified disproportions) and previous CS.

Indications per group are shown in Table 3. Absolute maternal indications (obstructed labour, major APH, malpresentation or uterine rupture) were the leading indications only in three groups: group 3 (obstructed labour), group 9 (malpresentation) and group 10 (major APH). In other Robson groups, other non-absolute indications were the leading indications for performing CS—group 1 (fetal compromise), group 2 and 4 (failure to progress), group 5 (previous CS), group 6,7, and 8 (breech presentation). In general, CS was performed for absolute maternal indications in 36.6% (359/980) of cases (Table 3). Diagrammatic representation of contribution of each indication within the groups is presented in Figure 4.

Indications	Group 1	Group 2	Group 3	Group 4	Group 5	Group 6	Group 7	Group 8	Group 9	Group 10	Total n (%)
Absolute maternal indications											**359(36.6)**
Obstructed labour[1]	73	4	74	6	29	3	8	0	5	2	204(20.8)
Major APH	1	1	32	17	11	2	6	6	2	21	99(10.1)
Malpresentation[2]	5	0	16	0	4	0	0	3	23	0	51(5.2)
Uterine rupture	1	0	1	1	2	0	0	0	0	0	5(0.5)
Non-absolute indications											**621(63.4)**
Fetal compromise[3]	101	13	65	11	20	6	8	5	2	7	238(24.3)
Previous CS	0	0	0	0	136	0	18	5	0	7	166(16.9)
Failure to progress[4]	6	32	5	21	3	7	9	3	0	10	96(9.8)
Breech presentation	0	0	0	0	0	16	19	21	0	0	56(5.7)
(Severe pre-) eclampsia	1	2	3	2	0	0	0	12	0	13	33(3.4)
Others	1	5	14	4	2	0	0	5	0	1	32(3.3)
Total (number)	**189**	**57**	**210**	**62**	**207**	**34**	**68**	**60**	**32**	**61**	**980(100)**

[1]cephalo-pelvic disproportion, macrosomia, and unspecified disproportions; [2]transverse, oblique or brow; [3]fetal distress, cord prolapse, and intrauterine growth restriction; [4]prolonged labour, cervical arrest, and failed induction; APH= antepartum hemorrhage; CS=cesarean section

DISCUSSION

Our study showed that group 3, 5, and 1 were the major contributor to the overall CS rate. This indicates high CS rate both in primary (groups 1 and 3) and secondary (group 5) caesarean section. The study also showed that only one third (36.6%) of the CSs were

performed for absolute maternal indications. A quarter of the women had potentially life-threatening complication (including nine maternal deaths), resulting in admission for more than seven days in one-third of the women (29.1%). The hospital is the major referral centre for women with complications in the region. Since majority of births in Ethiopia are occurring at home (10), most births in the hospital are among women with complications or women living in the urban areas nearby the hospital.

We found that Robson groups 3, 5 and 1 were the major contributor to the overall CS rate (62%) similar to the literature (24). Our findings are in line with a classification applied in hospitals from Tanzania and South Africa (25,26) where the three major groups (1, 3, and 5) were the same, though in a different order. In South Africa, groups 1, 5, and 3 while in Tanzania groups 1, 3, and 5 were the leading contributors. This may be related to the variation in population demographics and overall CS rates (24). The contribution of group 3 could be justifiable in our study since the majority of the CS was performed for absolute maternal indications (obstructed labour and major antepartum hemorrhage).

In a study from a university hospital in Cote d'Ivoire, however, the most common groups were group 1, 2 and 3 (27). The importance of group 2 (nulliparous single cephalic term pregnancy, induced or caesarean before labour) in the study from Cote d'Ivoire could be explained by variations in indications for inductions of vaginal birth or CS in the two settings. In most high-income settings group 5, 2 and 1 are the major contributors to overall CS rate unlike the studies from low-income settings (28-31). The variations between high-income settings and our study may be related to fertility trends and, therefore, stronger presentation of group 1 and 2 in high income settings, compared to stronger presentation of multiparous women (group 3) in our low resource setting with high fertility rates (10,24). Induction of labour (group 2) is more frequently practiced in high-income settings ranging from 8.3% in Latvia to 33% in Wallonia (Belgium) compared to 4.4% in Africa (32,33). Risk selection in antenatal care is better developed, which leads to more frequently indicating induction of labour(34). Barriers for induction of labour in low resource settings might be the unavailability of facilities to perform CS in case of failed induction (35). The fact that group 5 women were one of the major contributors both in high and low-income settings indicates the importance of preventing primary caesarean if a meaningful reduction in overall CS rate is to be achieved. In a study from Tanzania both primary and secondary CS were rising overtime (25).

The strength of this study is the inclusion of all CSs performed over 16 months in a referral hospital covering large population. Although the hospital is serving both uncomplicated births and women with complications, the majority of the cases were cases of women referred with already existing complications and may be less generalizable. Accessing all CS files was difficult due to non-digital archiving of hospital files. Incompleteness of information (history of previous CS, fetal presentation) and incorrect recording of medical registration numbers on logbooks were the reasons for exclusion. We feel that incompleteness of information and inability to locate medical records were not related to any outcomes, and therefore, would not introduce a systematic bias. Although the core variables for Robson classification (parity, history of CS, the onset of labour, number of the fetuses, gestational age, and fetal lie and presentation) are part of routine obstetric assessment (24), the retrospective design of our study may have affected our results because of the incompleteness of the records. We were unable to apply the Robson classification to women with vaginal deliveries, and therefore, we cannot say anything about the relative size of each group and are unable to compare women who underwent CS with women who gave birth vaginally.

The performance of CS among the low-risk groups (group 1,2,3 and 4) for non-absolute medical indications—fetal compromise and failure to progress—should be further examined. In the majority of facilities, and HFSUH is not an exception, birth monitoring is minimal with a low recording of fetal heart rate on partograph (36,37). Inadequate facilities for monitoring fetal heart rate and lack of close monitoring are challenges to relying on such indications (38). Opportunities for instrumental delivery and training staff to increase its uptake are warranted to decrease primary caesarean among low-risk groups. Limiting the caesarean section rate in low-risk pregnancies is key to lowering the trend of increased CS (39). Since TGCS is not an audit of the appropriateness of indications for CS (40), a continuous audit of indications for CS should be designed to achieve an optimum level of appropriate CS rates. Possible reasons for the increase in CS among group 1 and 3 should be explored to decrease overall CS rate, and repeat cesarean in the future (group 5). A prospective study consisting both women who delivered vaginally and through CS, is necessary to understand the proportion of CS within each Robson group.

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Ethical approval and consent to participate

This study was conducted as part of PhD study on severe maternal morbidity and mortality in Ethiopia. The study was approved by the institutional research ethics review committee of College of Health and Medical Sciences, Haramaya University in Ethiopia (ref no: C/A/R/D/01/1681/16). Informed consent was waived since the study was conducted after discharge of the women and no interview was planned.

Availability of data and material

Data essential for conclusion are included in this manuscript. Additional data can be obtained from the corresponding author on reasonable request.

Competing interests

The authors declare no competing interest

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Authors' contributions

Conceived the study: AKT, JS

Collected data: OP, MM, MC, IK

Supervision and mentorship: AKT, TG, JS

Analysis: AKT

Writing–original draft: AKT, JS

Writing–review & editing critically for intellectual content: AKT, OP, MM, MC, IK, TG, JS

All authors approved the final version of the manuscript to be published

List of figures

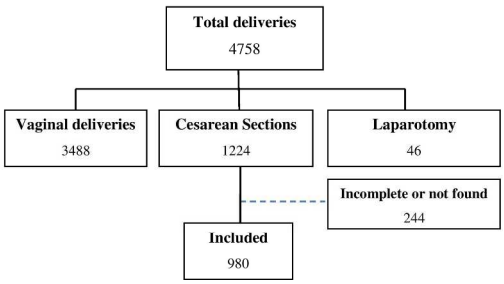

Figure 1: Flowchart of the study in HFSUH, 2017

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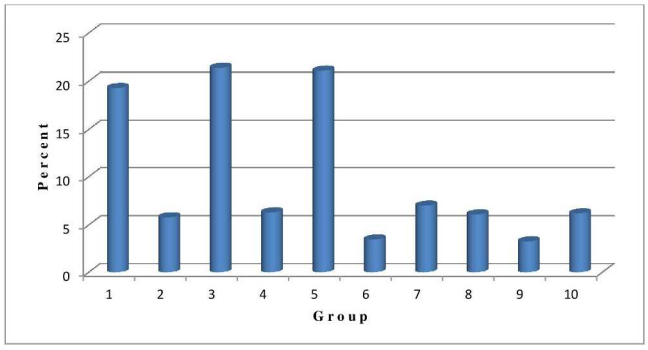

Figure 2: Distribution of Robson group of CS in Hiwot Fana Specialized University Hospital, 2017

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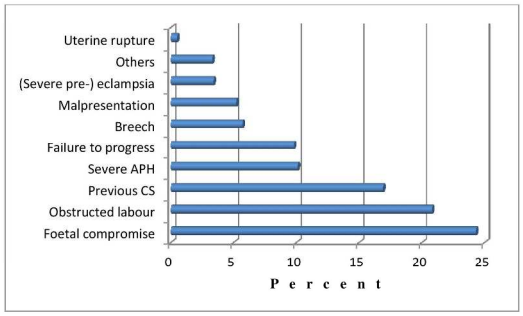

Obstructed labour (cephalo-pelvic disproportion, macrosomia, unspecified disproportions); APH= antepartum hemorrhage; failure to progress (prolonged labour and failed induction), fetal compromise (fetal distress, cord prolapse, and intra uterine growth retardation)

Figure 3: Indications for CS in an Hiwot Fana Specialized University Hospital, 2017

210x297mm (300 x 300 DPI)

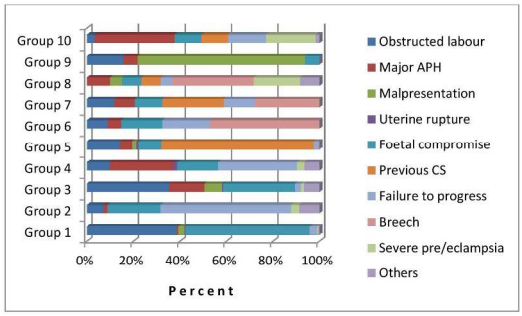

Figure 4: Indications for CS within the ten groups in a university hospital in eastern, Ethiopia

210x297mm (300 x 300 DPI)

STROBE 2007 (v4) Statement—Checklist of items that should be included in reports of *cross-sectional studies*

Section/Topic	Item #	Recommendation	Reported on page #
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract	1
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found	2
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	4-5
Objectives	3	State specific objectives, including any prespecified hypotheses	5
Methods			
Study design	4	Present key elements of study design early in the paper	5
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	5
Participants	6	(*a*) Give the eligibility criteria, and the sources and methods of selection of participants	6
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	6
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	6
Bias	9	Describe any efforts to address potential sources of bias	na
Study size	10	Explain how the study size was arrived at	6
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	6
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding	7
		(*b*) Describe any methods used to examine subgroups and interactions	na
		(*c*) Explain how missing data were addressed	na
		(*d*) If applicable, describe analytical methods taking account of sampling strategy	na
		(*e*) Describe any sensitivity analyses	na
Results			

Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	7
		(b) Give reasons for non-participation at each stage	7
		(c) Consider use of a flow diagram	Figure 1
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	8
		(b) Indicate number of participants with missing data for each variable of interest	na
Outcome data	15*	Report numbers of outcome events or summary measures	8-9
Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	8-9
		(*b*) Report category boundaries when continuous variables were categorized	na
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	na
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	na
Discussion			
Key results	18	Summarise key results with reference to study objectives	10
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	11
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	11
Generalisability	21	Discuss the generalisability (external validity) of the study results	11
Other information			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	15

*Give information separately for cases and controls in case-control studies and, if applicable, for exposed and unexposed groups in cohort and cross-sectional studies.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at www.strobe-statement.org.

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Analysis of Caesarean Sections using Robson Ten Group Classification System in a University Hospital in eastern Ethiopia: a cross-sectional study

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Analysis of Caesarean Sections using Robson Ten Group Classification System in a University Hospital in eastern Ethiopia: a cross-sectional study

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ABSTRACT

Objective: To analyze caesarean section (CS) using Robson Ten Group Classification System in an Ethiopian university hospital.

Design: Cross-sectional study.

Setting: A university hospital in eastern, Ethiopia.

Participants: 980 women who underwent CS from January 2016 to April 2017.

Main outcome: Robson groups (one to ten—based on gestational age, fetal presentation, number of fetus, onset of labour, and history of CS), and indications for CS.

Results: Robson group 3 (multiparous women with single cephalic full-term pregnancy in spontaneous labour with no history of CS), group 5 (multiparous women with single cephalic full-term pregnancy with history of CS), and group 1 (single cephalic nulliparous women full-term pregnancy in spontaneous labour) were the major contributors to the overall CS at 21.4%, 21.1% and 19.3% respectively. The three major indications for CS were fetal compromise (mainly fetal distress) and obstructed labour (mainly cephalopelvic disproportion), and previous CS.

Conclusion: Robson groups 3, 5 and 1 were the major contributors to the overall CS rate. Fetal compromise, obstructed labour and previous CS were the underlying indications for performing CS. Further study is required to assess the appropriateness of the indications and to reduce CS among the low-risk groups (group 1 and 3).

***Key words*:** Caesarean section, audit, Ethiopia, maternal health, Robson classification

Strengths and limitations of this study

- Conducted in a university hospital with large catchment population
- Analyzed CS over 16 months to avoid seasonal variations
- Because of retrospective design, some relevant information might be missing
- Most of the women were referred cases with underlying complications, and may not be generalized to general population
- Single-hospital (with large burden of referred cases) study, might be less generalizable

INTRODUCTION

Over the last few decades, the global caesarean section (CS) rate has significantly increased and reached an unprecedented level[1]. Although there is no specific rate of recommended CS rate[2], no improvement in maternal and neonatal outcomes was observed in CS rates above 10%[3, 4]. CS is performed when vaginal delivery is not possible or contraindicated[5]. In such cases not performing a CS could endanger the life of the mother and the fetus. However, CS is also performed without medical reasons or with imprecise indications such as obstructed labour, with intact membranes[6]. This potentially life-saving procedure is not without risk and might become life-threatening in the index or future pregnancies for both the mother and child. Immediate and long-term complications of CS including increased risk of maternal mortality and morbidity, increased need for blood transfusion, longer hospitalization, postpartum infections, retained placenta, stillbirths, and postpartum haemorrhage were reported[7-9].

Although the national population-based CS rate of Ethiopia is still one of the one of the lowest in the world (2%)[10], a national review conducted in 2011 indicated a high CS rate in facilities (15% in public facilities vs. 46.1% in for-profit centres)[11], which is expected to be higher now because of the general increase in the CS rate. A study conducted in eastern Ethiopia indicated a CS rate of 34.3% (26.6% in public facilities and 58.7% in private hospitals)[12]. The population-based study, from the Demographic and Health Survey, is low since many women in need of CS do never reach facilities (institutional delivery rate of 26%)[10]. This indicates that some women might be exposed to unnecessary CS while others do not get the CS they need[6]. For example, CS is highest among women with at least secondary education, living in urban areas or are rich compared to their counterparts[13, 14]. In urban settings and among the rich, there is a concern, in many countries, that the intervention is being over utilized and unnecessary interventions are done. In rural settings, however, lack of access to adequately staffed and equipped health institutions for providing essential obstetric surgery is contributing largely to maternal mortality and complications[15].

The challenge is to keep CS rates low while maintaining safe outcomes for the mother and infant. This requires continuous auditing of CS. Three different classifications—based on primary clinical indications; the degree of urgency or absolute need for caesarean delivery; and Robson classification—have been reported as a framework for auditing CS[16]. A systematic review comparing different classifications concluded that the Robson classification

is optimal for monitoring CS[17] and the World Health Organization recommended Robson classification as a global standard tool for monitoring CS[2]. The Robson classification also called the Ten Group Classification System (TGCS), classifies CS into ten mutually exclusive and exhaustive groups based on the category of the pregnancy, the previous obstetric record of the woman, the course of labour and delivery, and the gestational age of the pregnancy[18]. Although the application of the TGCS and its importance for targeting population and reducing CS rates has been previously noted[19-21], there is no study in Ethiopia and contribution of different groups to the overall CS is unknown. In Ethiopia, where most facilities are situated in urban centres, and high CS rate in referral hospitals is registered[12, 22], an audit of CS deliveries using the TGCS is important to know which groups of women are mainly contributing to the increase in CS rate. The aim of this study was to analyze caesarean sections using the TGCS, and identify indications for CS in Hiwot Fana Specialized University Hospital in eastern Ethiopia.

METHODS

Study design and participants

We conducted a cross-sectional study to analyze all CS performed from January 2016 to April 2017 at the department of obstetrics of Hiwot Fana Specialized University Hospital (HFSUH) Harar, eastern Ethiopia. The study population included all women who underwent CS in the hospital during the specified period. Laparotomy for uterine rupture and files with missing information were excluded. The identity of women who underwent CS was obtained from the delivery logbook, admission and discharge register and operation logbook. The admission and discharge register, and delivery logbook contain information about all women who delivered in the hospital regardless of mode of delivery (vaginal, CS) while the operation logbook contains only information about women who underwent CS. Using the medical registration number of each woman, we accessed all CS files performed during the study period.

Study setting

HFSUH is a tertiary referral hospital affiliated with the College of Health and Medical Sciences, Haramaya University, Ethiopia where around 3500 deliveries took place annually. The hospital serves both referred complicated cases and self-referred uncomplicated births. During the study period, the department of obstetrics was run by seven consultants, eight residents, and 16 (nurse) midwives. The department has its operation theatre for obstetric cases.

Variables

For each CS case, we collected data on maternal characteristics (age, history of CS, parity, and gravidity), pregnancy-related information (gestational age, fetal presentation, number of fetus and onset of labour), and maternal and fetal outcomes at discharge (complications, 5th minute APGAR score, birth weight, fetal and maternal status). Maternal complications included presence of a potentially life-threatening complication (severe postpartum hemorrhage, severe pre-eclampsia, eclampsia, ruptured uterus, sepsis or severe systemic infections), admission to the intensive care unit other than for routine postoperative recovery, or receiving blood products. Presence of any life-threatening complication (including maternal near miss or deaths) was assessed at discharge. Maternal near miss refers to a woman who nearly died (developed organ dysfunction) but survived the complication, based on the WHO definition[23]. The dependent variable was the Robson classification group. The ten groups and their characteristics are shown in table 1. Fetal presentations were classified as cephalic, breech or transverse/oblique. Gestational age was categorized as a term (≥37 weeks) or preterm (<37 weeks). Gestational age is assessed using early prenatal ultrasound or last menstrual period. In case of no early ultrasound and unknown last menstrual period, a combination of physical examination, third trimester ultrasound and estimated fetal weight is used for estimation of gestational age. For cases with undocumented gestational age, we used a birth weight of ≥2500gm as a proxy to term pregnancy. The course of pregnancy was categorized as spontaneous and induced/CS before labour. Number of parity was classified as nulliparous or multiparous. The number of fetuses was categorized as singleton or multiple pregnancies.

Table 1: Robson's 10-group classification

Group	Description
1	Nulliparous, single cephalic, ≥ 37 weeks, in spontaneous labour
2	Nulliparous, single cephalic, ≥ 37 weeks, induced or CS before labour
3	Multiparous (excluding previous CS), single cephalic, ≥37 weeks, in spontaneous labour
4	Multiparous (excluding previous CS), single cephalic, ≥37 weeks, induced or CS before labour
5	Previous CS, single cephalic, ≥ 37 weeks
6	All nulliparous breeches
7	All multiparous breeches (including previous CS)
8	All multiple pregnancies (including previous CS)
9	All abnormal lies (including previous CS)
10	All single cephalic, <37 weeks (including previous CS)

Data collection

Data were collected by medical students (OP, MM, MC, IK) from University of Groningen, the Netherlands. Data collectors were trained and supervised by the first author (AKT). All data quality, indications, and eligibility of cases were confirmed by a senior obstetrician (TG). All CSs during the study period were retrieved from the operation register and were double checked with delivery logbook and admission and discharge registers. Completeness of data was checked by the first author (AKT).

Data Processing and Analysis

All completed data were entered using EpiData v3.1(http://www.epidata.dk) and analyzed using SPSS v23 (IBM SPSS Statistics for Windows, version 23 (IBM Corp., Armonk, N.Y., USA). Descriptive statistics of study participants and variables was conducted. The Robson group was assigned based on four obstetric concepts (with their parameters)—category of the pregnancy, previous obstetric history, course of labour and gestational age[18]. Missing files in the archive room and cases with incomplete information were excluded. All reported indications were classified as absolute maternal and non-absolute indications using the recommendations by Stanton et al.[16]. Absolute maternal indications included obstructed labour, major antepartum hemorrhage (APH), mal-presentation (transverse, oblique and brow) and uterine rupture in hierarchal order. Non-absolute indications include fetal compromise, previous CS, failure to progress, breech, severe pre-eclampsia, and eclampsia (with no hierarchy). Results were presented as frequencies, percentages, means, and standard deviations. This study was conducted as part of a PhD study on severe maternal morbidity and mortality in Eastern Ethiopia which was approved by the Institutional Health Research Ethics Review Committee of College of Health and Medical Sciences, Haramaya University, Ethiopia (Ref No: C/A/R/D/01/1681/16).

RESULTS

During the study period, there were 4758 deliveries, of which 1224 (25.7%) were caesarean sections. After excluding incomplete cases (n=96) and missing files (148), 980 cases were included in the final analysis (figure 1). The mean age of participants was 26.3(±5.7) years. Mean duration of hospitalization was 6.3(±3.9) days. A quarter of study participants (25%) had a potentially life-threatening complication, including 2.8% women with maternal near miss and nine maternal deaths. The mean gestational age was 37.7(±2.2) weeks. Sociodemographic characteristics and obstetric conditions are summarized in table 2.

Table 2: Sociodemographic and obstetric conditions of study participants

Variables		n	%
Age (years)	<20	78	7.9
	20-35	850	86.7
	>35	53	5.4
Duration of hospitalization	1-7 days	674	70.8
	>7 days	278	29.2
Type of CS	Elective/planned	72	7.4
	Emergency	908	92.6
Gravidity	1	305	31.1
	2-4	421	43.0
	>4	254	25.9
Parity	0	319	32.5
	1-4	473	48.3
	>4	188	19.2
Gestational age	Preterm (≤36 weeks)	111	11.3
	Term (37-42 weeks)	863	88.1
	Post term (>42 weeks)	4	0.6
Onset of labour	Spontaneous	728	74.4
	Induced/CS before labour	251	25.6
Fetal presentation	Cephalic	808	82.4
	Breech	135	13.8
	Transverse/oblique/brow/others	37	3.8
Fetal status at birth	Alive	924	94.3
	Stillbirths	56	5.7
Apgar score at 5 minutes	<7	89	9.5
	≥7	836	90.5
Birth weight (gram)	<2500	157	16.1
	2500-4000	779	80.1
	>4000	37	3.8
Potential life-threatening complications (n=245)	Severe postpartum hemorrhage	18	1.8
	Severe pre-eclampsia	122	12.4
	Eclampsia	62	6.3
	Ruptured uterus	6	0.6
	Sepsis	14	1.4
	Transfusion of blood (≥1 unit of RBC)	107	10.9
Maternal status at discharge	Alive	971	99.1
	Dead	9	0.9

RBC, red blood cells

Robson Ten Group Classification System (TGCS)

In our study, single cephalic multiparous women at term in spontaneous labour with no previous history of CS (group 3) were the highest contributors to the overall CS rate, contributing 21.4% of all CS. The second highest contributors were women with a single cephalic presentation at term and previous CS (group 5) contributing 21.1% to the overall CS. The third highest contributors were single cephalic nulliparous women at term and in spontaneous labour (group 1) with 19.3%. All women with breech, transverse or oblique

presentation (group 6, 7, and 9 combined) contributed 13.8% to the overall CS. All single cephalic women in preterm (group 10) contributed 6.2% of all the CS (figure 2).

Indications for performing CS

As shown in figure 3, the main indications for performing CS were fetal compromise (fetal distress, cord prolapse or intrauterine growth retardation), obstructed labour (cephalo-pelvic disproportion, fetal macrosomia or unspecified disproportions), and previous CS. Indications per Robson group are shown in table 3. Absolute maternal indications (obstructed labour, major APH, malpresentation or uterine rupture) were the leading indications only in three groups: group 3 (obstructed labour), group 9 (malpresentation) and group 10 (major APH). In the other groups, non-absolute indications were the leading indications for performing CS—group 1 (fetal compromise), group 2 and 4 (failure to progress), group 5 (previous CS), group 6,7, and 8 (breech presentation). In general, CS was performed for absolute maternal indications in 36.6% (359/980) of cases (table 3). Diagrammatic representation of contribution of each indication within the groups is presented in figure 4.

Table 3: Indications for CS within Rosbson group in an Ethiopian university hospital

Indications	Group 1	Group 2	Group 3	Group 4	Group 5	Group 6	Group 7	Group 8	Group 9	Group 10	Total n(%)
Absolute maternal indications											**359(36.6)**
Obstructed labour[1]	73(38.6)	4(7.0)	74(35.2)	6(9.7)	29(14.0)	3(8.8)	8(11.8)	0(0.0)	5(15.6)	2(3.3)	204(20.8)
Major APH	1(0.5)	1(1.8)	32(15.2)	17(27.4)	11(5.3)	2(5.9)	6(8.8)	6(10.0)	2(6.3)	21(34.4)	99(10.1)
Malpresentation[2]	5(2.7)	0(0.0)	16(7.6)	0(0.0)	4(1.9)	0(0.0)	0(0.0)	3(5.0)	23(71.8)	0(0.0)	51(5.2)
Uterine rupture	1(0.5)	0(0.0)	1(0.5)	1(1.6)	2(1.0)	0(0.0)	0(0.0)	0(0.0)	0(0.0)	0(0.0)	5(0.5)
Non-absolute indications											**621(63.4)**
Fetal compromise[3]	101(53.5)	13(22.8)	65(31.0)	11(17.7)	20(9.7)	6(17.6)	8(11.8)	5(8.3)	2(6.3)	7(11.5)	238(24.3)
Previous CS	0(0.0)	0(0.0)	0(0.0)	0(0.0)	136(65.7)	0(0.0)	18(26.5)	5(8.3)	0(0.0)	7(11.5)	166(16.9)
Failure to progress[4]	6(3.2)	32(56.1)	5(2.4)	21(33.9)	3(1.4)	7(20.6)	9(13.2)	3(5.0)	0(0.0)	10(16.4)	96(9.8)
Breech presentation	0(0.0)	0(0.0)	0(0.0)	0(0.0)	0(0.0)	16(47.1)	19(27.9)	21(35.0)	0(0.0)	0(0.0)	56(5.7)
(Severe pre-) eclampsia	1(0.5)	2(3.5)	3(1.4)	2(3.2)	0(0.0)	0(0.0)	0(0.00	12(20.0)	0(0.0)	13(21.3)	33(3.4)
Others	1(0.5)	5(8.8)	14(6.7)	4(6.5)	2(1.0)	0(0.0)	0(0.0)	5(8.3)	0(0.0)	1(1.6)	32(3.3)
Total n(%)	**189(100)**	**57(100)**	**210(100)**	**62(100)**	**207(100)**	**34(100)**	**68(100)**	**60(100)**	**32**(100)	**61(100)**	**980(100)**

[1]cephalo-pelvic disproportion, macrosomia, and unspecified disproportions; [2]transverse, oblique or brow; [3]fetal distress, cord prolapse, and intrauterine growth restriction; [4]prolonged labour, cervical arrest, and failed induction; APH= antepartum hemorrhage; CS=cesarean section

DISCUSSION

Our study showed that group 3, 5, and 1 were the major contributors to the overall CS rate. This indicates high CS rate both in primary (groups 1 and 3) and secondary (group 5) caesarean section. The study also showed that only one third (36.6%) of the cesarean sections were performed for absolute maternal indications. A quarter of the women had a potentially

life- threatening complication (including nine maternal deaths), resulting in admission for more than seven days in 29.2% of the women. Since a majority of births in Ethiopia are occurring at home[10], most births in the hospital are among women with complications or women living in the urban areas nearby the hospital.

Our findings are in line with a classification applied in hospitals from Tanzania and South Africa[24, 25] where the three major groups (1, 3, and 5) were the same, though in a different order. In South Africa, groups 1, 5, and 3 while in Tanzania groups 1, 3, and 5 were the leading contributors. This may be related to variations in population demographics and overall CS rates[26]. The contribution of group 3 could be justifiable in our study since the majority of the CS were performed for absolute maternal indications (obstructed labour and major antepartum hemorrhage).

In a study from a university hospital in Cote d'Ivoire, however, the most common groups were groups 1, 2 and 3[27]. The importance of group 2 (nulliparous single cephalic term pregnancy, induced or caesarean before labour) in the study from Cote d'Ivoire could be explained by variations in indications for inductions of vaginal birth or CS in the two settings. In most high-income settings, group 5, 2 and 1 are the major contributors to overall CS rate unlike the studies from low-income settings[28-31]. The variations between high-income settings and our study may be related to fertility trends and, therefore, stronger presentation of group 1 and 2 in high income settings, compared to stronger presentation of multiparous women (group 3) in our low resource setting with high fertility rates[10, 26]. Induction of labour (group 2) is more frequently practiced in high-income settings ranging from 8.3% in Latvia to 33% in Wallonia (Belgium) compared to 4.4% in Africa[32, 33]. Risk selection in antenatal care is better developed, which leads to more frequently indicating induction of labour[34]. Barriers for induction of labour in low resource settings might be the unavailability of facilities to perform CS in case of failed induction[35]. The fact that group 5 women were one of the major contributors both in high and low-income settings indicates the importance of preventing primary caesarean if a meaningful reduction in overall CS rate is to be achieved. In a study from Tanzania both primary and secondary CS were rising overtime[24].

The strength of this study is the inclusion of all cesarean sections performed over 16 months in a referral hospital covering large catchment area. Although the hospital is serving both uncomplicated births and women with complications, the majority of the cases were cases of

women referred with already existing complications and may be less generalizable. Accessing all CS files was difficult due to non-digital archiving of hospital files. Incompleteness of information (history of previous CS, fetal presentation) and incorrect recording of medical registration numbers on logbooks were the reasons for exclusion. We feel that incompleteness of information and inability to locate medical records were not related to any outcomes, and therefore, would not introduce systematic bias. Although the core variables for Robson classification (parity, history of CS, onset of labour, number of fetus, gestational age, and fetal lie and presentation) are part of routine obstetric assessment[26], the retrospective design of our study may have affected our results because of the incompleteness of the records. We were unable to compute relative size of each Robson groups, and therefore, we cannot say anything about the relative size of each group and are unable to compare women who underwent CS with women who gave birth vaginally.

The performance of CS among low-risk groups (group 1,2,3 and 4) for non-absolute medical indications—fetal compromise and failure to progress—should be further examined. In the majority of facilities, and HFSUH is not an exception, birth monitoring is minimal with a low recording of fetal heart rate on partograph[36, 37]. Inadequate facilities for monitoring fetal heart rate and lack of close monitoring are challenges to relying on such indications [38]. Opportunities for instrumental delivery and training staff to increase its uptake are warranted to decrease primary caesarean among low-risk groups. Limiting the caesarean section rate in low-risk pregnancies is key to lowering the trend of increased CS[39]. Since TGCS is not an audit of the appropriateness of indications for CS[40], a continuous audit of indications for CS should be designed to achieve an optimum level of appropriate CS rates. Possible reasons for the increase in CS among group 1 and 3 should be explored to decrease overall CS rate, and repeat cesarean in the future (group 5). A prospective study consisting both women who delivered vaginally and through CS, is necessary to understand the proportion of CS within each Robson group.

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Ethical approval and consent to participate

This study was conducted as part of a PhD study on severe maternal morbidity and mortality in Ethiopia. The study was approved by the institutional research ethics review committee of College of Health and Medical Sciences, Haramaya University in Ethiopia (ref no: C/A/R/D/01/1681/16). Informed consent was waived since the study was conducted after discharge of the women and no interview was planned.

Availability of data and material

Data essential for conclusion are included in this manuscript. Additional data can be obtained from the corresponding author on reasonable request.

Competing interests

The authors declare no competing interest

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Authors' contributions

Conceived the study: AKT, JS

Collected data: OP, MM, MC, IK

Supervision and mentorship: AKT, TG, JS

Analysis: AKT

Writing–original draft: AKT, JS

Writing–review & editing critically for intellectual content: AKT, OP, MM, MC, IK, TG, JS

All authors approved the final version of the manuscript to be published

List of figures

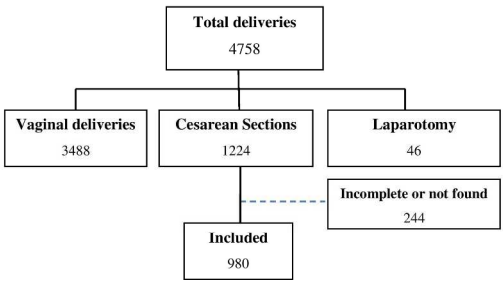

Figure 1: Flowchart of the study in HFSUH, 2017

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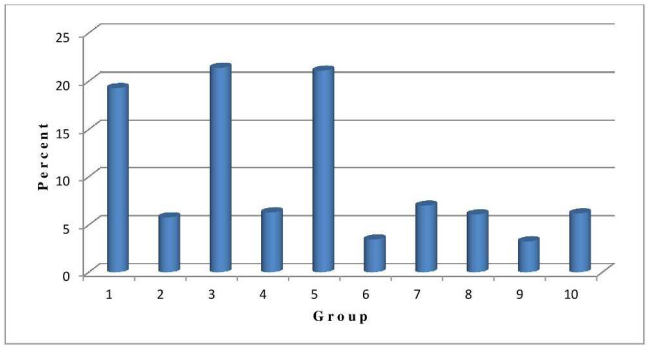

Figure 2: Distribution of Robson group of CS in Hiwot Fana Specialized University Hospital, 2017

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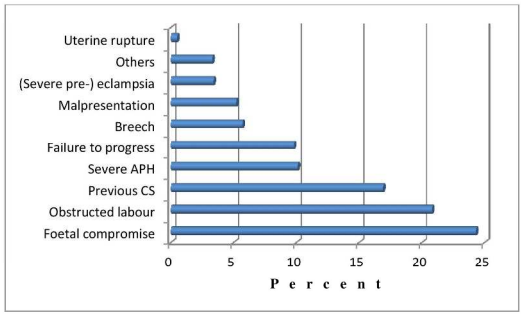

Obstructed labour (cephalo-pelvic disproportion, macrosomia, unspecified disproportions); APH= antepartum hemorrhage; failure to progress (prolonged labour and failed induction), fetal compromise (fetal distress, cord prolapse, and intra uterine growth retardation)

Figure 3: Indications for CS in an Hiwot Fana Specialized University Hospital, 2017

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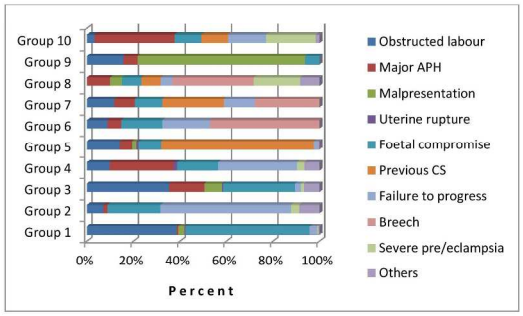

Figure 4: Indications for CS within the ten groups in a university hospital in eastern, Ethiopia

210x297mm (300 x 300 DPI)

STROBE 2007 (v4) Statement—Checklist of items that should be included in reports of *cross-sectional studies*

Section/Topic	Item #	Recommendation	Reported on page #
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract	1
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found	2
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	4-5
Objectives	3	State specific objectives, including any prespecified hypotheses	5
Methods			
Study design	4	Present key elements of study design early in the paper	5
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	5
Participants	6	(*a*) Give the eligibility criteria, and the sources and methods of selection of participants	6
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	6
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	7
Bias	9	Describe any efforts to address potential sources of bias	na
Study size	10	Explain how the study size was arrived at	7
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	7
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding	7
		(*b*) Describe any methods used to examine subgroups and interactions	na
		(*c*) Explain how missing data were addressed	na
		(*d*) If applicable, describe analytical methods taking account of sampling strategy	na
		(*e*) Describe any sensitivity analyses	na
Results			

Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	7
		(b) Give reasons for non-participation at each stage	7
		(c) Consider use of a flow diagram	Figure 1
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	8
		(b) Indicate number of participants with missing data for each variable of interest	na
Outcome data	15*	Report numbers of outcome events or summary measures	8-9
Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	8-9
		(*b*) Report category boundaries when continuous variables were categorized	na
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	na
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	na
Discussion			
Key results	18	Summarise key results with reference to study objectives	9-10
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	10-11
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	11
Generalisability	21	Discuss the generalisability (external validity) of the study results	11
Other information			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	15

*Give information separately for cases and controls in case-control studies and, if applicable, for exposed and unexposed groups in cohort and cross-sectional studies.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at www.strobe-statement.org.