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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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3 1 **Analysis of Caesarean Sections using the Robson Ten Group Classification System in a**  
4 2 **University Hospital in eastern Ethiopia: a cross-sectional study**  
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3 1 **ABSTRACT**  
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5 2 **Objective:** To analyze caesarean section (CS) using the Robson Ten Group Classification  
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7 3 System in an Ethiopian university hospital.  
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9 4 **Design:** Cross-sectional study.  
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11 5 **Setting:** a university hospital in eastern, Ethiopia.  
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13 6 **Participants:** 980 Women who underwent CS from January 2016 to April 2017.  
14

15 7 **Main outcome:** Robson groups (one to ten—based on gestational age, fetal presentation,  
16  
17 8 number of fetus, onset of labour and history of CS), and indications for performing CS.  
18

19 9 **Results:** Robson group 3 (single cephalic multiparous women in spontaneous labour with no  
20  
21 10 history of CS), group 5 (single cephalic term pregnancy with history of CS), and group 1  
22  
23 11 (single cephalic nulliparous women at term and in spontaneous labour) were the major  
24  
25 12 contributor to the overall CS at 21.4%, 21.1% and 19.3% respectively. The three major  
26  
27 13 indications for CS were fetal compromise (mainly fetal distress) and obstructed labour  
28  
29 14 (mainly cephalopelvic disproportion), and previous CS.  
30

31 15 **Conclusion:** Robson groups 3, 5 and 1 were the major contributors to the overall CS rate.  
32  
33 16 Fetal compromise, obstructed labour and previous CS were the underlying indications for  
34  
35 17 performing CS. Further study is required to assess the appropriateness of the indications and  
36  
37 18 the reason behind high CS rates among low-risk groups (group 1 and 3).  
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39 19  
40 20 **Key words:** Caesarean section, audit, Ethiopia, maternal health, Robson classification  
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**1 Strengths and limitations of this study**

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

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## 1 INTRODUCTION

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

12 Although the national population based CS rate of Ethiopia is far below the WHO threshold  
13 (2%) (7), a national review of facility-based CS rate indicated a high CS rate in facilities (15%  
14 in public facilities vs. 46.1% in for-profit centres) (8). A study conducted in eastern Ethiopia  
15 indicated a CS rate of 34.3% (26.6% in public facilities and 58.7% in private hospitals) (9).  
16 The population-based study, from the Demographic and Health Survey, is low since many  
17 women in need of CS do never reach facilities (institutional delivery rate of 26%) (7). This  
18 indicates some women are being exposed to unnecessary CS while others do not get the CS  
19 they need (3). For example, CS is highest among women with at least secondary education,  
20 living in urban areas or is rich compared to their counterparts (10,11). In rural settings,  
21 however, lack of access to adequately staffed and equipped health institutions is contributing  
22 largely to maternal mortality and complications. In urban settings and among the rich, there is  
23 a concern in many countries that the intervention is being over utilized and unnecessary  
24 interventions are done.

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

1  
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3 1 exhaustive groups based on parity, presentation, previous history of CS, gestational age and  
4 2 nature of labour (15). Although the application of the TGCS and its importance for targeting  
5 3 population and reducing CS rates has been previously noted (16-18), there is no study in  
6 4 Ethiopia and contribution of different groups to the overall CS is unknown. In Ethiopia, where  
7 5 most facilities are situated in urban centres and high CS rate in referral hospitals is registered  
8 6 (9,19), an audit of CS deliveries using the TGCS is important to know which groups of  
9 7 women are contributing to the increase in CS. The aim of this study was to analyze caesarean  
10 8 sections using the TGCS in Hiwot Fana Specialized University Hospital in eastern Ethiopia.

## 9 **METHODS**

### 10 **Study design and participants**

11 We conducted a cross sectional study to analyze all CS performed from January 2016 to April  
12 2017 at the department of obstetrics of Hiwot Fana Specialized University Hospital (HFSUH)  
13 Harar, eastern Ethiopia. The study population included all women who underwent CS in the  
14 hospital during the specified period. Laparotomy for uterine rupture and files with missing  
15 information were excluded. The identity of women who underwent CS was obtained from the  
16 delivery logbook, admission and discharge register and operation theatre logbook. The  
17 admission and discharge register, and delivery logbooks contain information about all woman  
18 admitted in the hospital including mode of delivery (vaginal, CS) while the operation theatre  
19 logbook contains only information about women who underwent CS. Using the medical  
20 registration number of each woman, we accessed all CS files performed during the study  
21 period.

### 22 **Study setting**

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

29

30

## 1 Variables

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

12 Table 1: Robson's 10-group CS classification

Group	Description
1	Nulliparous, single cephalic, $\geq 37$ weeks, in spontaneous labour
2	Nulliparous, single cephalic, $\geq 37$ weeks, induced or CS before labour
3	Multiparous (excluding previous CS), single cephalic, $\geq 37$ weeks, in spontaneous labour
4	Multiparous (excluding previous CS), single cephalic, $\geq 37$ weeks, induced or CS before labour
5	Previous CS, single cephalic, $\geq 37$ 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)

## 14 Data collection

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

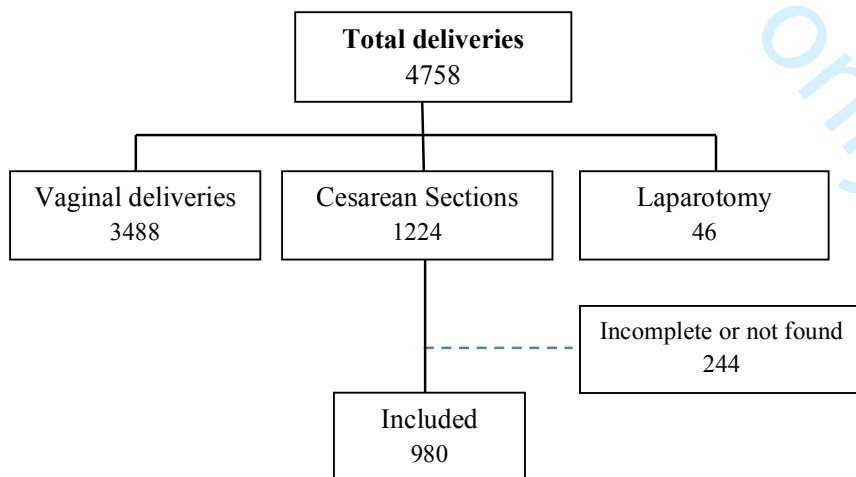


## 1 Data Processing and Analysis

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

## 16 RESULTS

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



29 Figure 1: Flowchart of the study in HFSUH, 2017

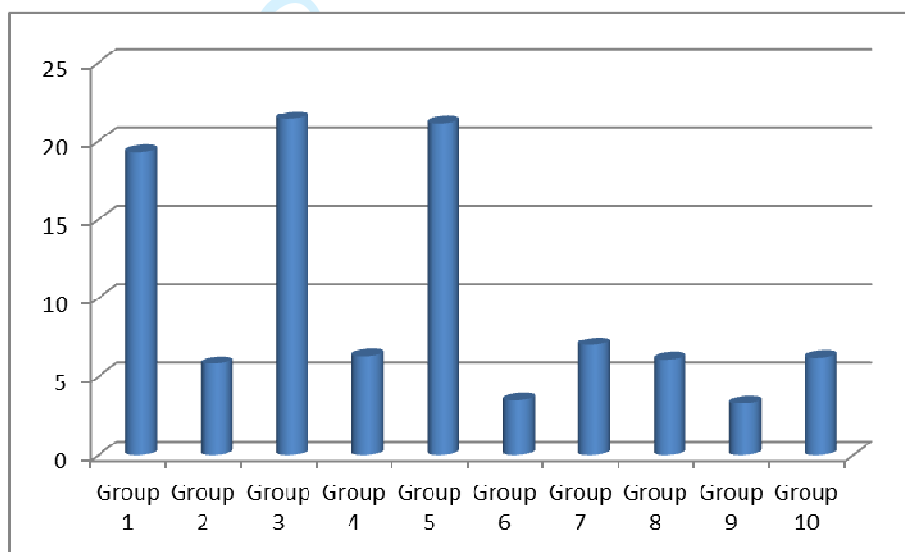
The mean age of participants was 26.3( $\pm$ 5.7) years. Mean duration of hospitalization was 6.3( $\pm$ 3.9) days. The mean gestational age was 37.7( $\pm$ 2.2) weeks. Sociodemographic characteristics and obstetric conditions are summarized in Table 2.

Table 2: Sociodemographic and obstetric conditions of study participants

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

## 1 Robson Ten Group Classification System (TGCS)

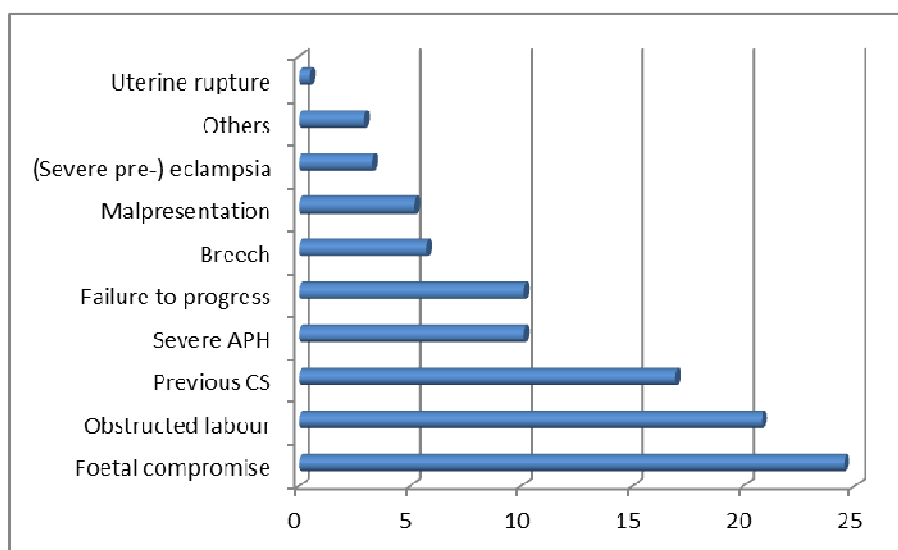
2 In our study, single cephalic multiparous women at term in spontaneous labour with no  
 3 previous history of CS (group 3) were the greater contributor to the overall CS rate,  
 4 contributing 21.4% of all CS. The second highest contributors were women with a single  
 5 cephalic presentation at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



10 Figure 2: Distribution of Robson group of CS in Hiwot Fana Specialized University Hospital,  
 11 2017

## 1 Indications for performing CS

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



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

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

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

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 (%)
<b>Absolute maternal indications</b>											<b>359(36.6)</b>
Obstructed labour <sup>1</sup>	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 <sup>2</sup>	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)
<b>Non-absolute indications</b>											<b>621(63.4)</b>
Fetal compromise <sup>3</sup>	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 <sup>4</sup>	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)
<b>Total (number)</b>	<b>189</b>	<b>57</b>	<b>210</b>	<b>62</b>	<b>207</b>	<b>34</b>	<b>68</b>	<b>60</b>	<b>32</b>	<b>61</b>	<b>980(100)</b>

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

## 6 DISCUSSION

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

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

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

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

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

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21 archive room for their support in re-locating women files.

### 22 **REFERENCES**

- 23 (1) World Health Organization. Appropriate Technology for Birth. The Lancet 1985 24  
24 August 1985;326(8452):436-437.
- 25 (2) World Health Organization. Reproductive Health. Managing complications in pregnancy  
26 and childbirth: a guide for midwives and doctors. : World Health Organization; 2003.
- 27 (3) Rijken MJ, Meguid T, van den Akker T, van Roosmalen J, Stekelenburg J. Global surgery  
28 and the dilemma for obstetricians. The Lancet 2015 14–20 November 2015;386(10007):1941-  
29 1942.
- 30 (4) Belachew J, Cnattingius S, Mulic-Lutvica A, Eurenus K, Axelsson O, Wikstrom AK.  
31 Risk of retained placenta in women previously delivered by caesarean section: a population-  
32 based cohort study. BJOG 2014 Jan;121(2):224-229.

- 1  
2  
3 1 (5) Kok N, Ruiter L, Hof M, Ravelli A, Mol BW, Pajkrt E, et al. Risk of maternal and  
4 2 neonatal complications in subsequent pregnancy after planned caesarean section in a first  
5 3 birth, compared with emergency caesarean section: a nationwide comparative cohort study.  
6 4 BJOG 2014 Jan;121(2):216-223.
- 7  
8 5 (6) Villar J, Carroli G, Zavaleta N, Donner A, Wojdyla D, Faundes A, et al. Maternal and  
9 6 neonatal individual risks and benefits associated with caesarean delivery: multicentre  
10 7 prospective study. BMJ 2007 Nov 17;335(7628):1025.
- 11  
12 8 (7) Central Statistical Agency (CSA) [Ethiopia] and ICF editor. Ethiopia Demographic and  
13 9 Health Survey 2016. : Addis Ababa, Ethiopia, and Rockville, Maryland, USA: CSA and ICF.
- 14  
15  
16 10 (8) Fesseha N, Getachew A, Hiluf M, Gebrehiwot Y, Bailey P. A national review of cesarean  
17 11 delivery in Ethiopia. Int J Gynaecol Obstet 2011 Oct;115(1):106-111.
- 18  
19 12 (9) Tsega F, Mengistie B, Dessie Y, Mengesha M. Prevalence of Cesarean Section in Urban  
20 13 Health Facilities and Associated Factors in Eastern Ethiopia: Hospital Based Cross Sectional  
21 14 Study. J Preg Child Health 2015;2(3):169-173.
- 22  
23 15 (10) Gibbons L, Belizan JM, Lauer JA, Betran AP, Merialdi M, Althabe F. Inequities in the  
24 16 use of cesarean section deliveries in the world. Am J Obstet Gynecol 2012  
25 17 Apr;206(4):331.e1-331.19.
- 26  
27 18 (11) Gebremedhin S. Trend and socio-demographic differentials of Caesarean section rate in  
28 19 Addis Ababa, Ethiopia: analysis based on Ethiopia demographic and health surveys data.  
29 20 Reprod Health 2014;11(1):14.
- 31  
32 21 (12) Stanton C, Ronsmans C, the Baltimore Group on Cesarean. Recommendations for  
33 22 Routine Reporting on Indications for Cesarean Delivery in Developing Countries. Birth  
34 23 2008;35(3):204-211.
- 35  
36 24 (13) Torloni MR, Betran AP, Souza JP, Widmer M, Allen T, Gulmezoglu M, et al.  
37 25 Classifications for cesarean section: a systematic review. PLoS One 2011 Jan 20;6(1):e14566.
- 38  
39  
40 26 (14) World Health Organization Human Reproduction Programme, 10 April 2015. WHO  
41 27 Statement on caesarean section rates. Reprod Health Matters 2015 May;23(45):149-150.
- 42  
43 28 (15) Robson M, Murphy M, Byrne F. Quality assurance: The 10-Group Classification System  
44 29 (Robson classification), induction of labor, and cesarean delivery. Int J Gynaecol Obstet 2015  
45 30 Oct;131 Suppl 1:S23-7.
- 46  
47 31 (16) Brennan DJ, Robson MS, Murphy M, O'Herlihy C. Comparative analysis of international  
48 32 cesarean delivery rates using 10-group classification identifies significant variation in  
49 33 spontaneous labor. Am J Obstet Gynecol 2009 Sep;201(3):308.e1-308.e8.
- 50  
51 34 (17) Costa ML, Cecatti JG, Souza JP, Milanez HM, Gulmezoglu MA. Using a Caesarean  
52 35 Section Classification System based on characteristics of the population as a way of  
53 36 monitoring obstetric practice. Reprod Health 2010 Jun 26;7:13-4755-7-13.
- 54  
55  
56  
57  
58  
59  
60



- 1  
2  
3 1 (18) Le Ray C, Blondel B, Prunet C, Khireddine I, Deneux-Tharaux C, Goffinet F. Stabilising  
4 2 the caesarean rate: which target population? *BJOG* 2015 Apr;122(5):690-699.  
5  
6 3 (19) Abebe FE, Gebeyehu AW, Kidane AN, Eyassu GA. Factors leading to cesarean section  
7 4 delivery at Felegehiwot referral hospital, Northwest Ethiopia: a retrospective record review.  
8 5 *Reprod Health* 2016 Jan 20;13:6-015-0114-8.  
9  
10 6 (20) Robson MS. Can we reduce the caesarean section rate? *Best Pract Res Clin Obstet*  
11 7 *Gynaecol* 2001 Feb;15(1):179-194.  
12  
13 8 (21) Litorp H, Kidanto HL, Nystrom L, Darj E, Essen B. Increasing caesarean section rates  
14 9 among low-risk groups: a panel study classifying deliveries according to Robson at a  
15 10 university hospital in Tanzania. *BMC Pregnancy Childbirth* 2013 May 8;13:107-2393-13-107.  
16  
17 11 (22) Makhanya V, Govender L, Moodley J. Utility of the Robson Ten Group Classification  
18 12 System to determine appropriateness of caesarean section at a rural regional hospital in  
19 13 KwaZulu-Natal, South Africa. *S Afr Med J* 2015 Apr;105(4):292-295.  
20  
21 14 (23) Loué VA, Gbary EA, Koffi SV, Koffi AK, Traoré M, Konan JK, et al. Analysis of  
22 15 caesarean rate and indications of university hospitals in sub-Saharan African developing  
23 16 countries using Robson classification system: the case of Cocody's hospital center, Abidjan-  
24 17 Cote d'Ivoire. *International Journal of Reproduction, Contraception, Obstetrics and*  
25 18 *Gynecology* 2017;5(6):1773-1777.  
26  
27 19 (24) Kelly S, Sprague A, Fell DB, Murphy P, Aelicks N, Guo Y, et al. Examining caesarean  
28 20 section rates in Canada using the Robson classification system. *J Obstet Gynaecol Can* 2013  
29 21 Mar;35(3):206-214.  
30  
31 22 (25) Kazmi T, Saiseema S5, Khan S. Analysis of Cesarean Section Rate - According to  
32 23 Robson's 10-group Classification. *Oman Med J* 2012 Sep;27(5):415-417.  
33  
34 24 (26) Roberge S, Dube E, Blouin S, Chaillet N. Reporting Caesarean Delivery in Quebec  
35 25 Using the Robson Classification System. *J Obstet Gynaecol Can* 2017 Mar;39(3):152-156.  
36  
37 26 (27) Stavrou EP, Ford JB, Shand AW, Morris JM, Roberts CL. Epidemiology and trends for  
38 27 Caesarean section births in New South Wales, Australia: a population-based study. *BMC*  
39 28 *Pregnancy Childbirth* 2011 Jan 20;11:8-2393-11-8.  
40  
41 29 (28) Markos D, Bogale D. Documentation status of the modified World Health Organization  
42 30 partograph in public health institutions of Bale zone, Ethiopia. *Reprod Health* 2015 Sep  
43 31 3;12:81-015-0074-z.  
44  
45 32 (29) Yisma E, Dessalegn B, Astatkie A, Fesseha N. Completion of the modified World Health  
46 33 Organization (WHO) partograph during labour in public health institutions of Addis Ababa,  
47 34 Ethiopia. *Reprod Health* 2013 Apr 18;10:23-4755-10-23.  
48  
49 35 (30) van Roosmalen J, van der Does CD. Caesarean birth rates worldwide. A search for  
50 36 determinants. *Trop Geogr Med* 1995;47(1):19-22.  
51  
52  
53  
54  
55  
56  
57  
58  
59  
60



1  
2  
3 1 (31) Delbaere I, Cammu H, Martens E, Tency I, Martens G, Temmerman M. Limiting the  
4 2 caesarean section rate in low risk pregnancies is key to lowering the trend of increased  
5 3 abdominal deliveries: an observational study. BMC Pregnancy Childbirth 2012 Jan 9;12:3-  
6 4 2393-12-3.

8 5 (32) Robson M. The Ten Group Classification System (TGCS) - a common starting point for  
9 6 more detailed analysis. BJOG 2015 Apr;122(5):701-0528.13267. Epub 2015 Jan 20.

### 7 **Ethical approval and consent to participate**

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

### 13 **Availability of data and material**

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

### 16 **Competing interests**

17 The authors declare no competing interest

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19 AKT received a PhD grant from the Dutch Organization for Internationalization in Education  
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21 publish the study.

### 22 **Authors' contributions**

23 Conceived the study: AKT, JS

24 Collected data: OP, MM, MC, IK

25 Supervision and mentorship: AKT, TG, JS

26 Analysis: AKT

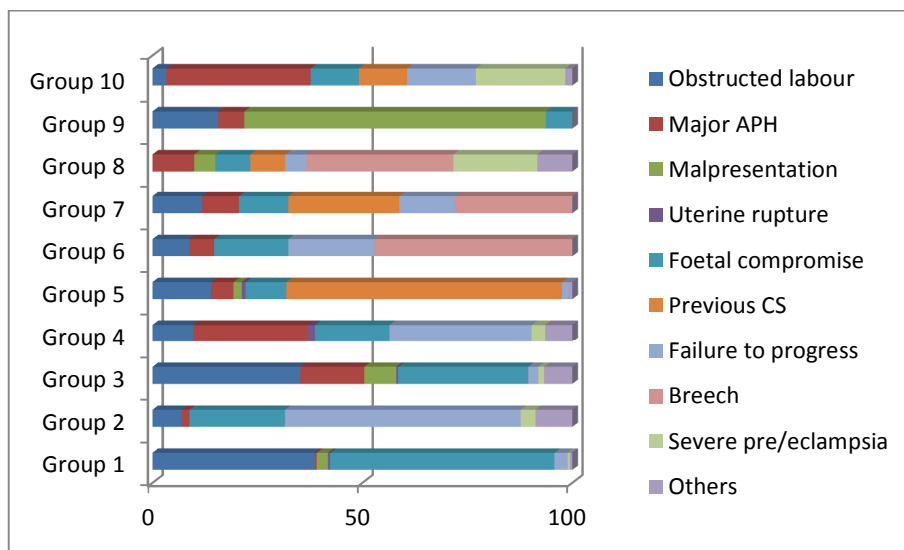
27 Writing—original draft: AKT, JS

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

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

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**Additional files**



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

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

Section/Topic	Item #	Recommendation	Reported on page #
<b>Title and abstract</b>	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
<b>Introduction</b>			
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
<b>Methods</b>			
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
<b>Results</b>			

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
<b>Discussion</b>			
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
<b>Other information</b>			
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](http://www.strobe-statement.org).

# BMJ Open

## 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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Keywords:	Caesarean section, Ethiopia, maternal health, Robson classification, Audit < CARDIOLOGY

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3 **Analysis of Caesarean Sections using Robson Ten Group Classification System in a**  
4 **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

For peer review only



## 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

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

## 24 **METHODS**

### 27 **Study design and participants**

29 We conducted a cross-sectional study to analyze all CS performed from January 2016 to April  
30 2017 at the department of obstetrics of Hiwot Fana Specialized University Hospital (HFSUH)  
31 Harar, eastern Ethiopia. The study population included all women who underwent CS in the  
32 hospital during the specified period. Laparotomy for uterine rupture and files with missing  
33 information were excluded. The identity of women who underwent CS was obtained from the  
34 delivery logbook, admission and discharge register and operation logbook. The admission and  
35 discharge register, and delivery logbooks contain information about all woman admitted in the  
36 hospital including mode of delivery (vaginal, CS) while the operation theatre logbook  
37 contains only information about women who underwent CS. Using the medical registration  
38 number of each woman, we accessed all CS files performed during the study period.

### 46 **Study setting**

47 HFSUH is a tertiary referral hospital affiliated with the College of Health and Medical  
48 Sciences, Haramaya University, Ethiopia where around 3500 deliveries took place annually.  
49 The hospital serves both referred complicated cases and self-referred uncomplicated births.  
50 During the study period, the department of obstetrics was run by seven consultants, eight  
51 residents, and 16 (nurse) midwives. The department has its operation theatre for obstetric  
52 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, 5<sup>th</sup> 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 ( $\geq 37$  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  $\geq 2500$ gm 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, $\geq 37$ weeks, in spontaneous labour
2	Nulliparous, single cephalic, $\geq 37$ weeks, induced or CS before labour
3	Multiparous (excluding previous CS), single cephalic, $\geq 37$ weeks, in spontaneous labour
4	Multiparous (excluding previous CS), single cephalic, $\geq 37$ weeks, induced or CS before labour
5	Previous CS, single cephalic, $\geq 37$ 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 ( $\leq 36$ 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
	$\geq 7$	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 (%)
<b>Absolute maternal indications</b>											<b>359(36.6)</b>
Obstructed labour <sup>1</sup>	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 <sup>2</sup>	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)
<b>Non-absolute indications</b>											<b>621(63.4)</b>
Fetal compromise <sup>3</sup>	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 <sup>4</sup>	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)
<b>Total (number)</b>	<b>189</b>	<b>57</b>	<b>210</b>	<b>62</b>	<b>207</b>	<b>34</b>	<b>68</b>	<b>60</b>	<b>32</b>	<b>61</b>	<b>980(100)</b>

<sup>1</sup>cephalo-pelvic disproportion, macrosomia, and unspecified disproportions; <sup>2</sup>transverse, oblique or brow; <sup>3</sup>fetal distress, cord prolapse, and intrauterine growth restriction; <sup>4</sup>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



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3 performed for absolute maternal indications. A quarter of the women had potentially life-  
4 threatening complication (including nine maternal deaths), resulting in admission for more  
5 than seven days in one-third of the women (29.1%). The hospital is the major referral centre  
6 for women with complications in the region. Since majority of births in Ethiopia are occurring  
7 at home (10), most births in the hospital are among women with complications or women  
8 living in the urban areas nearby the hospital.  
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13 We found that Robson groups 3, 5 and 1 were the major contributor to the overall CS rate  
14 (62%) similar to the literature (24). Our findings are in line with a classification applied in  
15 hospitals from Tanzania and South Africa (25,26) where the three major groups (1, 3, and 5)  
16 were the same, though in a different order. In South Africa, groups 1, 5, and 3 while in  
17 Tanzania groups 1, 3, and 5 were the leading contributors. This may be related to the variation  
18 in population demographics and overall CS rates (24). The contribution of group 3 could be  
19 justifiable in our study since the majority of the CS was performed for absolute maternal  
20 indications (obstructed labour and major antepartum hemorrhage).  
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27 In a study from a university hospital in Cote d'Ivoire, however, the most common groups were  
28 group 1, 2 and 3 (27). The importance of group 2 (nulliparous single cephalic term pregnancy,  
29 induced or caesarean before labour) in the study from Cote d'Ivoire could be explained by  
30 variations in indications for inductions of vaginal birth or CS in the two settings. In most  
31 high-income settings group 5, 2 and 1 are the major contributors to overall CS rate unlike the  
32 studies from low-income settings (28-31). The variations between high-income settings and  
33 our study may be related to fertility trends and, therefore, stronger presentation of group 1 and  
34 2 in high income settings, compared to stronger presentation of multiparous women (group 3)  
35 in our low resource setting with high fertility rates (10,24). Induction of labour (group 2) is  
36 more frequently practiced in high-income settings ranging from 8.3% in Latvia to 33% in  
37 Wallonia (Belgium) compared to 4.4% in Africa (32,33). Risk selection in antenatal care is  
38 better developed, which leads to more frequently indicating induction of labour(34). Barriers  
39 for induction of labour in low resource settings might be the unavailability of facilities to  
40 perform CS in case of failed induction (35). The fact that group 5 women were one of the  
41 major contributors both in high and low-income settings indicates the importance of  
42 preventing primary caesarean if a meaningful reduction in overall CS rate is to be achieved. In  
43 a study from Tanzania both primary and secondary CS were rising overtime (25).  
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3 The strength of this study is the inclusion of all CSs performed over 16 months in a referral  
4 hospital covering large population. Although the hospital is serving both uncomplicated births  
5 and women with complications, the majority of the cases were cases of women referred with  
6 already existing complications and may be less generalizable. Accessing all CS files was  
7 difficult due to non-digital archiving of hospital files. Incompleteness of information (history  
8 of previous CS, fetal presentation) and incorrect recording of medical registration numbers on  
9 logbooks were the reasons for exclusion. We feel that incompleteness of information and  
10 inability to locate medical records were not related to any outcomes, and therefore, would not  
11 introduce a systematic bias. Although the core variables for Robson classification (parity,  
12 history of CS, the onset of labour, number of the fetuses, gestational age, and fetal lie and  
13 presentation) are part of routine obstetric assessment (24), the retrospective design of our  
14 study may have affected our results because of the incompleteness of the records. We were  
15 unable to apply the Robson classification to women with vaginal deliveries, and therefore, we  
16 cannot say anything about the relative size of each group and are unable to compare women  
17 who underwent CS with women who gave birth vaginally.  
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28 The performance of CS among the low-risk groups (group 1,2,3 and 4) for non-absolute  
29 medical indications—fetal compromise and failure to progress—should be further examined.  
30 In the majority of facilities, and HFSUH is not an exception, birth monitoring is minimal with  
31 a low recording of fetal heart rate on partograph (36,37). Inadequate facilities for monitoring  
32 fetal heart rate and lack of close monitoring are challenges to relying on such indications (38).  
33 Opportunities for instrumental delivery and training staff to increase its uptake are warranted  
34 to decrease primary caesarean among low-risk groups. Limiting the caesarean section rate in  
35 low-risk pregnancies is key to lowering the trend of increased CS (39). Since TGCS is not an  
36 audit of the appropriateness of indications for CS (40), a continuous audit of indications for  
37 CS should be designed to achieve an optimum level of appropriate CS rates. Possible reasons  
38 for the increase in CS among group 1 and 3 should be explored to decrease overall CS rate,  
39 and repeat cesarean in the future (group 5). A prospective study consisting both women who  
40 delivered vaginally and through CS, is necessary to understand the proportion of CS within  
41 each Robson group.  
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## REFERENCES

(1) Betran AP, Ye J, Moller A, Zhang J, Gulmezoglu AM, Torloni MR. The Increasing Trend in Caesarean Section Rates: Global, Regional and National Estimates: 1990-2014. PLoS ONE 2016 01/15;11(2):e0148343.

(2) World Health Organization Human Reproduction Programme, 10 April 2015. WHO Statement on caesarean section rates. *Reprod Health Matters* 2015 May;23(45):149-150.

(3) Ye J, Zhang J, Mikolajczyk R, Torloni MR, Gulmezoglu AM, Betran AP. Association between rates of caesarean section and maternal and neonatal mortality in the 21st century: a worldwide population-based ecological study with longitudinal data. *BJOG* 2016 Apr;123(5):745-753.

(4) Betran AP, Torloni MR, Zhang J, Ye J, Mikolajczyk R, Deneux-Tharoux C, et al. What is the optimal rate of caesarean section at population level? A systematic review of ecologic studies. *Reprod Health* 2015 Jun 21;12(1):57.

(5) World Health Organization. *Reproductive Health. Managing complications in pregnancy and childbirth: a guide for midwives and doctors.* : World Health Organization; 2003.

(6) Rijken MJ, Meguid T, van den Akker T, van Roosmalen J, Stekelenburg J. Global surgery and the dilemma for obstetricians. *The Lancet* 2015 14–20 November 2015;386(10007):1941-1942.

(7) Belachew J, Cnattingius S, Mulic-Lutvica A, Eurenus K, Axelsson O, Wikstrom AK. Risk of retained placenta in women previously delivered by caesarean section: a population-based cohort study. *BJOG* 2014 Jan;121(2):224-229.

(8) Kok N, Ruiter L, Hof M, Ravelli A, Mol BW, Pajkrt E, et al. Risk of maternal and neonatal complications in subsequent pregnancy after planned caesarean section in a first birth, compared with emergency caesarean section: a nationwide comparative cohort study. *BJOG* 2014 Jan;121(2):216-223.

(9) Villar J, Carroli G, Zavaleta N, Donner A, Wojdyla D, Faundes A, et al. Maternal and neonatal individual risks and benefits associated with caesarean delivery: multicentre prospective study. *BMJ* 2007 Nov 17;335(7628):1025.

(10) Central Statistical Agency (CSA) [Ethiopia] and ICF editor. *Ethiopia Demographic and Health Survey 2016.* : Addis Ababa, Ethiopia, and Rockville, Maryland, USA: CSA and ICF.

(11) Fesseha N, Getachew A, Hiluf M, Gebrehiwot Y, Bailey P. A national review of cesarean delivery in Ethiopia. *Int J Gynaecol Obstet* 2011 Oct;115(1):106-111.

1  
2  
3 (12) Tsega F, Mengistie B, Dessie Y, Mengesha M. Prevalence of Cesarean Section in Urban  
4 Health Facilities and Associated Factors in Eastern Ethiopia: Hospital Based Cross Sectional  
5 Study. *J Preg Child Health* 2015;2(3):169-173.

6  
7 (13) Gibbons L, Belizan JM, Lauer JA, Betran AP, Merialdi M, Althabe F. Inequities in the  
8 use of cesarean section deliveries in the world. *Am J Obstet Gynecol* 2012 Apr; 206(4): 331.  
9 e1-331.19.

10  
11 (14) Gebremedhin S. Trend and socio-demographic differentials of Caesarean section rate in  
12 Addis Ababa, Ethiopia: analysis based on Ethiopia demographic and health surveys data.  
13 *Reprod Health* 2014;11(1):14.

14  
15 (15) Johnson CT, Johnson TRB, Adanu RMK. Obstetric Surgery. In: Debas HT, Donkor P,  
16 Gawande A, Jamison DT, Kruk ME, Mock CN, editors. *Essential Surgery: Disease Control*  
17 *Priorities, Third Edition (Volume 1)* Washington (DC): International Bank for Reconstruction  
18 and Development / The World Bank; 2015.

19  
20 (16) Stanton C, Ronsmans C, the Baltimore Group on Cesarean. Recommendations for  
21 Routine Reporting on Indications for Cesarean Delivery in Developing Countries. *Birth*  
22 2008;35(3):204-211.

23  
24 (17) Torloni MR, Betran AP, Souza JP, Widmer M, Allen T, Gulmezoglu M, et al.  
25 Classifications for cesarean section: a systematic review. *PLoS One* 2011 Jan 20;6(1):e14566.

26  
27 (18) Robson MS. Can we reduce the caesarean section rate? *Best Pract Res Clin Obstet*  
28 *Gynaecol* 2001 Feb;15(1):179-194.

29  
30 (19) Brennan DJ, Robson MS, Murphy M, O'Herlihy C. Comparative analysis of international  
31 cesarean delivery rates using 10-group classification identifies significant variation in  
32 spontaneous labor. *Am J Obstet Gynecol* 2009 Sep;201(3):308.e1-308.e8.

33  
34 (20) Costa ML, Cecatti JG, Souza JP, Milanez HM, Gulmezoglu MA. Using a Caesarean  
35 Section Classification System based on characteristics of the population as a way of  
36 monitoring obstetric practice. *Reprod Health* 2010 Jun 26;7:13-4755-7-13.

37  
38 (21) Le Ray C, Blondel B, Prunet C, Khireddine I, Deneux-Tharoux C, Goffinet F. Stabilising  
39 the caesarean rate: which target population? *BJOG* 2015 Apr;122(5):690-699.

40  
41 (22) Abebe FE, Gebeyehu AW, Kidane AN, Eyassu GA. Factors leading to cesarean section  
42 delivery at Felegehiwot referral hospital, Northwest Ethiopia: a retrospective record review.  
43 *Reprod Health* 2016 Jan 20;13:6-015-0114-8.

44  
45 (23) Say L, Souza JP, Pattinson RC, WHO working group on Maternal Mortality and  
46 Morbidity classifications. Maternal near miss--towards a standard tool for monitoring quality  
47 of maternal health care. *Best Pract Res Clin Obstet Gynaecol* 2009 Jun;23(3):287-296.

48  
49 (24) World Health Organization. Robson classification: implementation manual. 2017.

- 1  
2  
3 (25) Litorp H, Kidanto HL, Nystrom L, Darj E, Essen B. Increasing caesarean section rates  
4 among low-risk groups: a panel study classifying deliveries according to Robson at a  
5 university hospital in Tanzania. *BMC Pregnancy Childbirth* 2013 May 8;13:107-2393-13-107.  
6
- 7 (26) Makhanya V, Govender L, Moodley J. Utility of the Robson Ten Group Classification  
8 System to determine appropriateness of caesarean section at a rural regional hospital in  
9 KwaZulu-Natal, South Africa. *S Afr Med J* 2015 Apr;105(4):292-295.  
10
- 11 (27) Loué VA, Gbary EA, Koffi SV, Koffi AK, Traoré M, Konan JK, et al. Analysis of  
12 caesarean rate and indications of university hospitals in sub-Saharan African developing  
13 countries using Robson classification system: the case of Cocody's hospital center, Abidjan-  
14 Cote d'Ivoire. *International Journal of Reproduction, Contraception, Obstetrics and*  
15 *Gynecology* 2017;5(6):1773-1777.  
16
- 17 (28) Kelly S, Sprague A, Fell DB, Murphy P, Aelicks N, Guo Y, et al. Examining caesarean  
18 section rates in Canada using the Robson classification system. *J Obstet Gynaecol Can* 2013  
19 Mar;35(3):206-214.  
20
- 21 (29) Kazmi T, Saiseema S5, Khan S. Analysis of Cesarean Section Rate - According to  
22 Robson's 10-group Classification. *Oman Med J* 2012 Sep;27(5):415-417.  
23
- 24 (30) Roberge S, Dube E, Blouin S, Chaillet N. Reporting Caesarean Delivery in Quebec  
25 Using the Robson Classification System. *J Obstet Gynaecol Can* 2017 Mar;39(3):152-156.  
26
- 27 (31) Stavrou EP, Ford JB, Shand AW, Morris JM, Roberts CL. Epidemiology and trends for  
28 Caesarean section births in New South Wales, Australia: a population-based study. *BMC*  
29 *Pregnancy Childbirth* 2011 Jan 20;11:8-2393-11-8.  
30
- 31 (32) Vogel JP, Souza JP, Gulmezoglu AM. Patterns and Outcomes of Induction of Labour in  
32 Africa and Asia: A Secondary Analysis of the WHO Global Survey on Maternal and Neonatal  
33 Health. *PLoS ONE* 2013 04/29;8(6):e65612.  
34
- 35 (33) Zeitlin J, Mohangoo A, Delnorn M, Alexander S, Blondel B, Bouvier-Colle M, et al.  
36 European perinatal health report. The health and care of pregnant women and babies in  
37 Europe in 2010. 2013.  
38
- 39 (34) Rayburn WF, Zhang J. Rising rates of labor induction: present concerns and future  
40 strategies. *Obstet Gynecol* 2002 Jul;100(1):164-167.  
41
- 42 (35) Vogel JP, Moore JE, Timmings C, Khan S, Khan DN, Defar A, et al. Barriers,  
43 Facilitators and Priorities for Implementation of WHO Maternal and Perinatal Health  
44 Guidelines in Four Lower-Income Countries: A GREAT Network Research Activity. *PLoS*  
45 *ONE* 2016 07/12;11(11):e0160020.  
46
- 47 (36) Markos D, Bogale D. Documentation status of the modified World Health Organization  
48 partograph in public health institutions of Bale zone, Ethiopia. *Reprod Health* 2015 Sep  
49 3;12:81-015-0074-z.  
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3 (37) Yisma E, Dessalegn B, Astatkie A, Fesseha N. Completion of the modified World Health  
4 Organization (WHO) partograph during labour in public health institutions of Addis Ababa,  
5 Ethiopia. *Reprod Health* 2013 Apr 18;10:23-4755-10-23.

6  
7 (38) van Roosmalen J, van der Does CD. Caesarean birth rates worldwide. A search for  
8 determinants. *Trop Geogr Med* 1995;47(1):19-22.

9  
10 (39) Delbaere I, Cammu H, Martens E, Tency I, Martens G, Temmerman M. Limiting the  
11 caesarean section rate in low risk pregnancies is key to lowering the trend of increased  
12 abdominal deliveries: an observational study. *BMC Pregnancy Childbirth* 2012 Jan 9;12:3-  
13 2393-12-3.

14  
15 (40) Robson M. The Ten Group Classification System (TGCS) - a common starting point for  
16 more detailed analysis. *BJOG* 2015 Apr;122(5):701-0528.13267. Epub 2015 Jan 20.

### 17 18 19 **Ethical approval and consent to participate**

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

### 25 26 27 **Availability of data and material**

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

### 30 31 32 **Competing interests**

33 The authors declare no competing interest

### 34 35 36 **Funding**

37 AKT received a PhD grant from the Dutch Organization for Internationalization in Education  
38 (NUFFIC). The funding organization has no role in the design, execution or decision to  
39 publish the study.

### 40 41 42 **Authors' contributions**

43 Conceived the study: AKT, JS

44 Collected data: OP, MM, MC, IK

45 Supervision and mentorship: AKT, TG, JS

46 Analysis: AKT

47 Writing—original draft: AKT, JS

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

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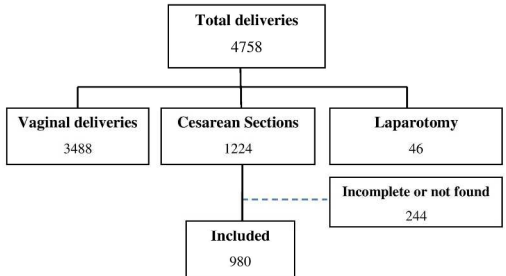


Figure 1: Flowchart of the study in HFSUH, 2017

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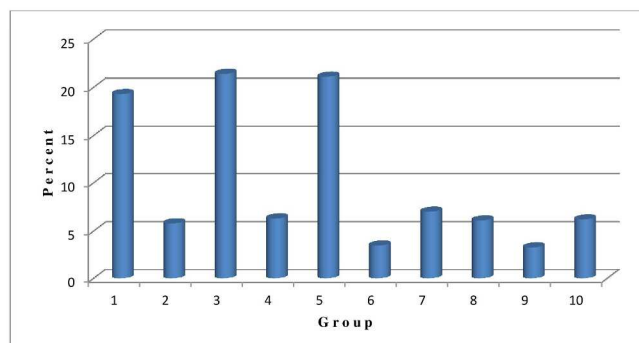
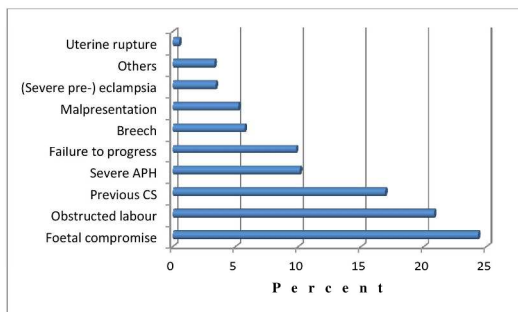


Figure 2: Distribution of Robson group of CS in Hiwot Fana Specialized University Hospital, 2017

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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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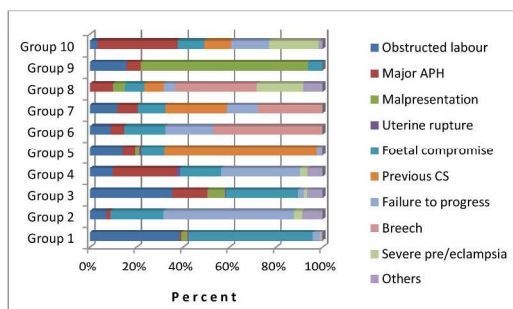


Figure 4: Indications for CS within the ten groups in a university hospital in eastern, Ethiopia

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

Section/Topic	Item #	Recommendation	Reported on page #
<b>Title and abstract</b>	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
<b>Introduction</b>			
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
<b>Methods</b>			
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
<b>Results</b>			

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
<b>Discussion</b>			
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
<b>Other information</b>			
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](http://www.strobe-statement.org).

# BMJ Open

## 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

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## 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



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

## 24 **METHODS**

### 27 **Study design and participants**

29 We conducted a cross-sectional study to analyze all CS performed from January 2016 to April  
30 2017 at the department of obstetrics of Hiwot Fana Specialized University Hospital (HFSUH)  
31 Harar, eastern Ethiopia. The study population included all women who underwent CS in the  
32 hospital during the specified period. Laparotomy for uterine rupture and files with missing  
33 information were excluded. The identity of women who underwent CS was obtained from the  
34 delivery logbook, admission and discharge register and operation logbook. The admission and  
35 discharge register, and delivery logbook contain information about all women who delivered  
36 in the hospital regardless of mode of delivery (vaginal, CS) while the operation logbook  
37 contains only information about women who underwent CS. Using the medical registration  
38 number of each woman, we accessed all CS files performed during the study period.

### 46 **Study setting**

48 HFSUH is a tertiary referral hospital affiliated with the College of Health and Medical  
49 Sciences, Haramaya University, Ethiopia where around 3500 deliveries took place annually.  
50 The hospital serves both referred complicated cases and self-referred uncomplicated births.  
51 During the study period, the department of obstetrics was run by seven consultants, eight  
52 residents, and 16 (nurse) midwives. The department has its operation theatre for obstetric  
53 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, 5<sup>th</sup> 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 ( $\geq 37$  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  $\geq 2500$ gm 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, $\geq 37$ weeks, in spontaneous labour
2	Nulliparous, single cephalic, $\geq 37$ weeks, induced or CS before labour
3	Multiparous (excluding previous CS), single cephalic, $\geq 37$ weeks, in spontaneous labour
4	Multiparous (excluding previous CS), single cephalic, $\geq 37$ weeks, induced or CS before labour
5	Previous CS, single cephalic, $\geq 37$ 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 ( $\leq 36$ 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
	$\geq 7$	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 ( $\geq 1$ 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 Robson 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(%)
<b>Absolute maternal indications</b>											<b>359(36.6)</b>
Obstructed labour <sup>1</sup>	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 <sup>2</sup>	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)
<b>Non-absolute indications</b>											<b>621(63.4)</b>
Fetal compromise <sup>3</sup>	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 <sup>4</sup>	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(0.0)	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)
<b>Total n(%)</b>	<b>189(100)</b>	<b>57(100)</b>	<b>210(100)</b>	<b>62(100)</b>	<b>207(100)</b>	<b>34(100)</b>	<b>68(100)</b>	<b>60(100)</b>	<b>32(100)</b>	<b>61(100)</b>	<b>980(100)</b>

<sup>1</sup>cephalo-pelvic disproportion, macrosomia, and unspecified disproportions; <sup>2</sup>transverse, oblique or brow; <sup>3</sup>fetal distress, cord prolapse, and intrauterine growth restriction; <sup>4</sup>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

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3 life-threatening complication (including nine maternal deaths), resulting in admission for  
4 more than seven days in 29.2% of the women. Since a majority of births in Ethiopia are  
5 occurring at home[10], most births in the hospital are among women with complications or  
6 women living in the urban areas nearby the hospital.  
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10 Our findings are in line with a classification applied in hospitals from Tanzania and South  
11 Africa[24, 25] where the three major groups (1, 3, and 5) were the same, though in a different  
12 order. In South Africa, groups 1, 5, and 3 while in Tanzania groups 1, 3, and 5 were the  
13 leading contributors. This may be related to variations in population demographics and overall  
14 CS rates[26]. The contribution of group 3 could be justifiable in our study since the majority  
15 of the CS were performed for absolute maternal indications (obstructed labour and major  
16 antepartum hemorrhage).  
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20 In a study from a university hospital in Cote d'Ivoire, however, the most common groups were  
21 groups 1, 2 and 3[27]. The importance of group 2 (nulliparous single cephalic term  
22 pregnancy, induced or caesarean before labour) in the study from Cote d'Ivoire could be  
23 explained by variations in indications for inductions of vaginal birth or CS in the two settings.  
24 In most high-income settings, group 5, 2 and 1 are the major contributors to overall CS rate  
25 unlike the studies from low-income settings[28-31]. The variations between high-income  
26 settings and our study may be related to fertility trends and, therefore, stronger presentation of  
27 group 1 and 2 in high income settings, compared to stronger presentation of multiparous  
28 women (group 3) in our low resource setting with high fertility rates[10, 26]. Induction of  
29 labour (group 2) is more frequently practiced in high-income settings ranging from 8.3% in  
30 Latvia to 33% in Wallonia (Belgium) compared to 4.4% in Africa[32, 33]. Risk selection in  
31 antenatal care is better developed, which leads to more frequently indicating induction of  
32 labour[34]. Barriers for induction of labour in low resource settings might be the  
33 unavailability of facilities to perform CS in case of failed induction[35]. The fact that group 5  
34 women were one of the major contributors both in high and low-income settings indicates the  
35 importance of preventing primary caesarean if a meaningful reduction in overall CS rate is to  
36 be achieved. In a study from Tanzania both primary and secondary CS were rising  
37 overtime[24].  
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52 The strength of this study is the inclusion of all cesarean sections performed over 16 months  
53 in a referral hospital covering large catchment area. Although the hospital is serving both  
54 uncomplicated births and women with complications, the majority of the cases were cases of  
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3 women referred with already existing complications and may be less generalizable. Accessing  
4 all CS files was difficult due to non-digital archiving of hospital files. Incompleteness of  
5 information (history of previous CS, fetal presentation) and incorrect recording of medical  
6 registration numbers on logbooks were the reasons for exclusion. We feel that incompleteness  
7 of information and inability to locate medical records were not related to any outcomes, and  
8 therefore, would not introduce systematic bias. Although the core variables for Robson  
9 classification (parity, history of CS, onset of labour, number of fetus, gestational age, and fetal  
10 lie and presentation) are part of routine obstetric assessment[26], the retrospective design of  
11 our study may have affected our results because of the incompleteness of the records. We  
12 were unable to compute relative size of each Robson groups, and therefore, we cannot say  
13 anything about the relative size of each group and are unable to compare women who  
14 underwent CS with women who gave birth vaginally.  
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23 The performance of CS among low-risk groups (group 1,2,3 and 4) for non-absolute medical  
24 indications—fetal compromise and failure to progress—should be further examined. In the  
25 majority of facilities, and HFSUH is not an exception, birth monitoring is minimal with a low  
26 recording of fetal heart rate on partograph[36, 37]. Inadequate facilities for monitoring fetal  
27 heart rate and lack of close monitoring are challenges to relying on such indications [38].  
28 Opportunities for instrumental delivery and training staff to increase its uptake are warranted  
29 to decrease primary caesarean among low-risk groups. Limiting the caesarean section rate in  
30 low-risk pregnancies is key to lowering the trend of increased CS[39]. Since TGCS is not an  
31 audit of the appropriateness of indications for CS[40], a continuous audit of indications for CS  
32 should be designed to achieve an optimum level of appropriate CS rates. Possible reasons for  
33 the increase in CS among group 1 and 3 should be explored to decrease overall CS rate, and  
34 repeat cesarean in the future (group 5). A prospective study consisting both women who  
35 delivered vaginally and through CS, is necessary to understand the proportion of CS within  
36 each Robson group.  
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50 archive room for their support in re-locating women's medical files.  
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## REFERENCES

- 1 Betran AP, Ye J, Moller A, et al. The Increasing Trend in Caesarean Section Rates: Global, Regional and National Estimates: 1990-2014, *PLoS ONE* 2016;11:e0148343.
- 2 World Health Organization Human Reproduction Programme, 10 April 2015. WHO Statement on caesarean section rates, *Reprod Health Matters* 2015;23:149-50.
- 3 Ye J, Zhang J, Mikolajczyk R, et al. Association between rates of caesarean section and maternal and neonatal mortality in the 21st century: a worldwide population-based ecological study with longitudinal data, *BJOG* 2016;123:745-53.
- 4 Betran AP, Torloni MR, Zhang J, et al. What is the optimal rate of caesarean section at population level? A systematic review of ecologic studies, *Reprod Health* 2015;12:57.
- 5 World Health Organization. Reproductive Health. Managing complications in pregnancy and childbirth: a guide for midwives and doctors: World Health Organization 2003.
- 6 Rijken MJ, Meguid T, van den Akker T, et al. Global surgery and the dilemma for obstetricians, *Lancet* 2015;386:1941-2.
- 7 Belachew J, Cnattingius S, Mulic-Lutvica A, et al. Risk of retained placenta in women previously delivered by caesarean section: a population-based cohort study, *BJOG* 2014;121:224-9.
- 8 Kok N, Ruiter L, Hof M, et al. Risk of maternal and neonatal complications in subsequent pregnancy after planned caesarean section in a first birth, compared with emergency caesarean section: a nationwide comparative cohort study, *BJOG* 2014;121:216-23.
- 9 Villar J, Carroli G, Zavaleta N, et al. Maternal and neonatal individual risks and benefits associated with caesarean delivery: multicentre prospective study, *BMJ* 2007;335:1025.
- 10 Central Statistical Agency (CSA) [Ethiopia] and ICF, ed. Ethiopia Demographic and Health Survey 2016: Addis Ababa, Ethiopia, and Rockville, Maryland, USA: CSA and ICF.
- 11 Fesseha N, Getachew A, Hiluf M, et al. A national review of cesarean delivery in Ethiopia, *Int J Gynaecol Obstet* 2011;115:106-11.
- 12 Tsega F, Mengistie B, Dessie Y, et al. Prevalence of Cesarean Section in Urban Health Facilities and Associated Factors in Eastern Ethiopia: Hospital Based Cross Sectional Study, *J Preg Child Health* 2015;2:169-73.
- 13 Gibbons L, Belizan JM, Lauer JA, et al. Inequities in the use of cesarean section deliveries in the world, *Am J Obstet Gynecol* 2012;206:331.e1,331.19.
- 14 Gebremedhin S. Trend and socio-demographic differentials of Caesarean section rate in Addis Ababa, Ethiopia: analysis based on Ethiopia demographic and health surveys data, *Reprod Health* 2014;11:14.



1  
2  
3 15 Johnson CT, Johnson TRB, Adanu RMK. Obstetric Surgery. In: Debas HT, Donkor P,  
4 Gawande A, et al., eds. Essential Surgery: Disease Control Priorities, Third Edition (Volume  
5 1). Washington (DC): International Bank for Reconstruction and Development / The World  
6 Bank 2015.

7  
8 16 Stanton C, Ronsmans C, Baltimore Group on Cesarean. Recommendations for routine  
9 reporting on indications for cesarean delivery in developing countries, *Birth* 2008;35:204-11.

10  
11 17 Torloni MR, Betran AP, Souza JP, et al. Classifications for cesarean section: a systematic  
12 review, *PLoS One* 2011;6:e14566.

13  
14 18 Robson MS. Can we reduce the caesarean section rate? *Best Pract Res Clin Obstet*  
15 *Gynaecol* 2001;15:179-94.

16  
17 19 Brennan DJ, Robson MS, Murphy M, et al. Comparative analysis of international cesarean  
18 delivery rates using 10-group classification identifies significant variation in spontaneous  
19 labor, *Am J Obstet Gynecol* 2009;201:308.e1,308.e8.

20  
21 20 Costa ML, Cecatti JG, Souza JP, et al. Using a Caesarean Section Classification System  
22 based on characteristics of the population as a way of monitoring obstetric practice, *Reprod*  
23 *Health* 2010;7:13,4755-7-13.

24  
25 21 Le Ray C, Blondel B, Prunet C, et al. Stabilising the caesarean rate: which target  
26 population? *BJOG* 2015;122:690-9.

27  
28 22 Abebe FE, Gebeyehu AW, Kidane AN, et al. Factors leading to cesarean section delivery  
29 at Felegehiwot referral hospital, Northwest Ethiopia: a retrospective record review, *Reprod*  
30 *Health* 2016;13:6,015-0114-8.

31  
32 23 Say L, Souza JP, Pattinson RC, et al. Maternal near miss--towards a standard tool for  
33 monitoring quality of maternal health care, *Best Pract Res Clin Obstet Gynaecol*  
34 2009;23:287-96.

35  
36 24 Litorp H, Kidanto HL, Nystrom L, et al. Increasing caesarean section rates among low-risk  
37 groups: a panel study classifying deliveries according to Robson at a university hospital in  
38 Tanzania, *BMC Pregnancy Childbirth* 2013;13:107,2393-13-107.

39  
40 25 Makhanya V, Govender L, Moodley J. Utility of the Robson Ten Group Classification  
41 System to determine appropriateness of caesarean section at a rural regional hospital in  
42 KwaZulu-Natal, South Africa, *S Afr Med J* 2015;105:292-5.

43  
44 26 World Health Organization. Robson classification: implementation manual. 2017.

45  
46 27 Loué VA, Gbary EA, Koffi SV, et al. Analysis of caesarean rate and indications of  
47 university hospitals in sub-Saharan African developing countries using Robson classification  
48 system: the case of Cocody's hospital center, Abidjan-Cote d'Ivoire, *International Journal of*  
49 *Reproduction, Contraception, Obstetrics and Gynecology* 2017;5:1773-7.

50  
51 28 Kelly S, Sprague A, Fell DB, et al. Examining caesarean section rates in Canada using the  
52 Robson classification system, *J Obstet Gynaecol Can* 2013;35:206-14.

- 1  
2  
3 29 Kazmi T, Saiseema S5, Khan S. Analysis of Cesarean Section Rate - According to  
4 Robson's 10-group Classification, *Oman Med J* 2012;27:415-7.  
5  
6 30 Roberge S, Dube E, Blouin S, et al. Reporting Caesarean Delivery in Quebec Using the  
7 Robson Classification System, *J Obstet Gynaecol Can* 2017;39:152-6.  
8  
9 31 Stavrou EP, Ford JB, Shand AW, et al. Epidemiology and trends for Caesarean section  
10 births in New South Wales, Australia: a population-based study, *BMC Pregnancy Childbirth*  
11 2011;11:8,2393-11-8.  
12  
13 32 Vogel JP, Souza JP, Gulmezoglu AM. Patterns and Outcomes of Induction of Labour in  
14 Africa and Asia: a secondary analysis of the WHO Global Survey on Maternal and Neonatal  
15 Health, *PLoS One* 2013;8:e65612.  
16  
17 33 Zeitlin J, Mohangoo A, Delnorn M, et al. European perinatal health report. The health and  
18 care of pregnant women and babies in Europe in 2010, 2013.  
19  
20 34 Rayburn WF, Zhang J. Rising rates of labor induction: present concerns and future  
21 strategies, *Obstet Gynecol* 2002;100:164-7.  
22  
23 35 Vogel JP, Moore JE, Timmings C, et al. Barriers, Facilitators and Priorities for  
24 Implementation of WHO Maternal and Perinatal Health Guidelines in Four Lower-Income  
25 Countries: A GREAT Network Research Activity, *PLoS ONE* 2016;11:e0160020.  
26  
27 36 Markos D, Bogale D. Documentation status of the modified World Health Organization  
28 partograph in public health institutions of Bale zone, Ethiopia, *Reprod Health*  
29 2015;12:81,015-0074-z.  
30  
31 37 Yisma E, Dessalegn B, Astatkie A, et al. Completion of the modified World Health  
32 Organization (WHO) partograph during labour in public health institutions of Addis Ababa,  
33 Ethiopia, *Reprod Health* 2013;10:23,4755-10-23.  
34  
35 38 van Roosmalen J, van der Does CD. Caesarean birth rates worldwide. A search for  
36 determinants, *Trop Geogr Med* 1995;47:19-22.  
37  
38 39 Delbaere I, Cammu H, Martens E, et al. Limiting the caesarean section rate in low risk  
39 pregnancies is key to lowering the trend of increased abdominal deliveries: an observational  
40 study, *BMC Pregnancy Childbirth* 2012;12:3,2393-12-3.  
41  
42 40 Robson M. The Ten Group Classification System (TGCS) - a common starting point for  
43 more detailed analysis, *BJOG* 2015;122:701,0528.13267. Epub 2015 Jan 20.  
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#### **Ethical approval and consent to participate**

48  
49 This study was conducted as part of a PhD study on severe maternal morbidity and mortality  
50 in Ethiopia. The study was approved by the institutional research ethics review committee of  
51 College of Health and Medical Sciences, Haramaya University in Ethiopia (ref no:  
52 C/A/R/D/01/1681/16). Informed consent was waived since the study was conducted after  
53 discharge of the women and no interview was planned.  
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### **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

### **Funding**

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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

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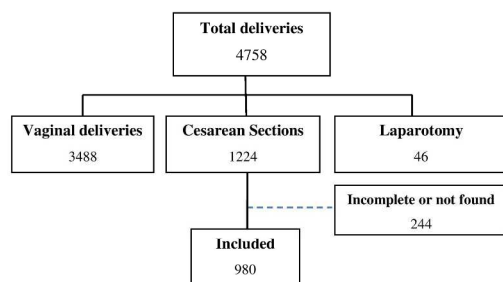


Figure 1: Flowchart of the study in HFSUH, 2017

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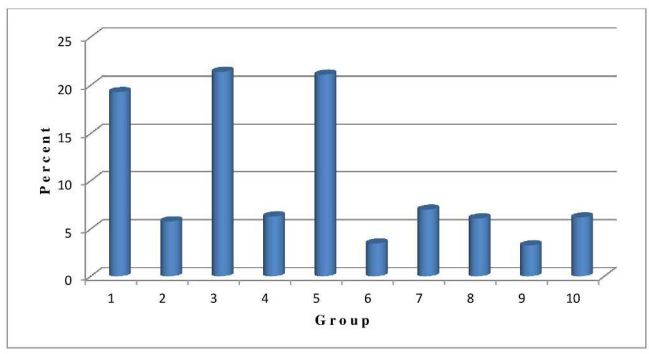
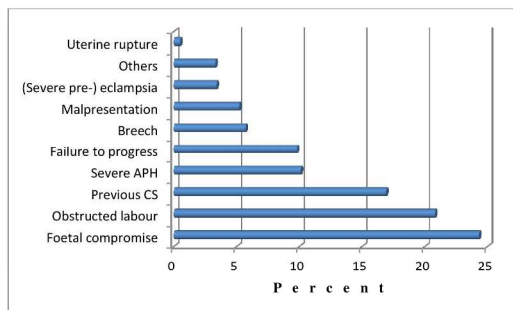


Figure 2: Distribution of Robson group of CS in Hiwot Fana Specialized University Hospital, 2017  
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Obstructed labour (cephalo-pelvic disproportion, macrosomia, unspecified disproportions); APH= antepartum hemorrhage; failure to progress (prolonged 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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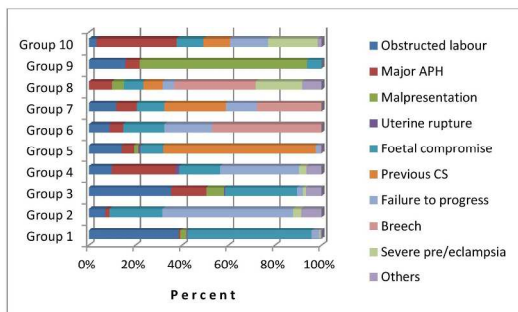


Figure 4: Indications for CS within the ten groups in a university hospital in eastern, Ethiopia

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

Section/Topic	Item #	Recommendation	Reported on page #
<b>Title and abstract</b>	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
<b>Introduction</b>			
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
<b>Methods</b>			
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
<b>Results</b>			



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
<b>Discussion</b>			
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
<b>Other information</b>			
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](http://www.strobe-statement.org).