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Which groups of women are driving the high caesarean section rate in private hospitals in eastern Ethiopia? A cohort study applying the Robson classification

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Strengths and limitation of the study

- The first study to apply the Robson classification to private hospitals in Ethiopia
- Inclusion of all women who delivered in both facilities (CS and vaginal deliveries) during the study period helped us to indicate the Robson distribution as a whole and also among those who had CS.
- Because routinely collected clinical data was used some sociodemographic variables of interest were missed.
- The retrospective nature of the study may be prone to incomplete documentation.

Abstract

Objective: Caesarean section (CS) rates in Ethiopian private hospitals are high compared to those in public facilities, and there are limited descriptions of the groups of women contributing to this high rate. The objective of this study was to describe the groups contributing to the increased CS rate using the Robson classification in selected private hospitals in eastern Ethiopia.

Design: Retrospective cross-sectional cohort study.

Setting: Two major private hospitals in eastern Ethiopia.

Participants: All women who underwent CS from January 09, 2019 to January 08, 2020.

Primary and secondary outcome measures: Primary outcome: Robson ten group classification. Secondary outcomes: indications for CS as recorded in the medical files.

Results: Of 1203 births in both hospitals combined during the study period, 415 (34.5%) were by CS. Women with a uterine scar due to previous CS (group 5), single cephalic term multiparous women in spontaneous labor (group 3), and single cephalic term nulliparous women in spontaneous labor (group 1) were the leading groups contributing 33%, 27.5%, and 17.1% respectively. The leading documented indications were fetal compromise (29.4%), previous CS (27.2%), and obstructed labor (12.3%).

Conclusion: Improving management of spontaneous labor and strengthening clinical practice around safely providing the option of vaginal birth after CS practice are strategies required to reduce the high CS rate in these private facilities.

***Keywords*:** Robson classification, private hospitals, caesarean section, audit

INTRODUCTION

With the unprecedent rise in caesarean section (CS) rates the need to institute a robust system to minimize unnecessary and medically nonindicated CS is warranted [1]. Risks associated with (repeated) CS for women and newborn are well established [2-4]. These range from increased risk of uterine rupture and abnormal placentation for the woman to stillbirth and iatrogenic preterm birth for the baby. Moreover, long term effect on hormonal, physical, bacterial, and physiological conditions and risk of allergic reactions on the newborn were also reported [4].

A recommended system for auditing clinical practice around CS is the Robson Ten Group Classification [4-6]. Based on obstetric history, course of labor and gestational age, the Robson classification categorizes all women undergoing CS into ten mutually exclusive and exhaustive groups [7-9]. Although the Robson classification has been promoted by the World Health Organization as a method to reduce CS rates [8, 10, 11], the system has rarely been applied to private facilities [12, 13].

Given the increase in global CS rates, including those in low-and middle-income countries [14-17] and in private facilities in particular, audit of CS practices and identifying groups contributing to CS rates are important methods to design appropriate interventions [12, 18-22]. To the best of our knowledge, no such study has been performed in private facilities in Ethiopia, rendering the contribution of different groups to overall CS rates in these institutions unknown [23, 24].

The aim of this study was to determine which groups are driving the CS rate in selected major private hospitals in eastern Ethiopia using the Robson Ten Group Classification system.

METHODS

Study designs and participants

This study was conducted as part of a larger study on maternal near miss and mortality in major private hospitals in eastern Ethiopia. A retrospective cross-sectional study was conducted from February 1 to 29, 2020 at the department of obstetrics and gynaecology of Harar General Hospital (HGH) and Bilal Hospital (BH)—the two major

private hospitals in Harar and Dire Dawa towns, eastern Ethiopia. The study population included all women who gave birth by CS in both hospitals from January 09, 2019 to January 08, 2020. To enable comparisons, records of women who gave birth vaginally were also reviewed. The identity of all women who visited both hospitals for maternity services were obtained from the admission and discharge registers, delivery log books, and operation theatre registers. Using their medical registration number, all files were retrieved from the archive rooms at both hospitals and reviewed by research assistants who received dedicated in-service training.

Study setting

HGH is a general specialized 33-bed private hospital in Harar providing specialized care in internal medicine, surgery, obstetrics and gynecology, pediatrics and child health, and some other smaller fields. During the study period, five consultants and six midwives were practicing at the department of obstetrics. It provides care for both emergency and planned CS by consultants, with approximately 1000 births annually. BH is one of the major private hospitals in Dire Dawa with almost 600 deliveries annually. Both hospitals have one major operation theatre which they share with all surgical specilities. Unlike public facilities, where all maternity services are free [25], a typical CS procedure costs 10,000-15,000 Ethiopian Birr ($267-400).

Variables

The dependent variable was the Robson classification groups, one to ten based on the category of the pregnancy, presence of previous uterine scar, the course of labour and delivery, and the gestational age of the pregnancy (Box 1) [7]. The independent variables included sociodemographic conditions (age, referral status, residence), medical and obstetric history and conditions present in the index pregnancy.

Box 1: Robson's ten group caesarean section classification system [7]

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

8	All multiple pregnancies (including previous CS)
9	All abnormal lies (including previous CS)
10	All single cephalic, <37 weeks (including previous CS)

Data collection

Trained research assistants collected data on maternal characteristics (age, parity, antenatal booking, referral status), obstetric and medical history and conditions (history of uterine scar, history or presence of obstetric complications), labor and delivery related information (onset, presentation, mode of birth, indication for CS for births by CS), fetal/neonatal information (vital status at birth, fifth minute APGAR score, admission to special intensive care unit, birth weight), and maternal and fetal outcome at discharge.

Data processing and analysis

All collected data were cross-checked for completeness and consistency and double entered to EpiData 3.1 (http://www.epidata.dk) and exported to Stata 13 (https://www.stata.com) for analysis. The Robson group was determined using the four basic obstetric concepts and their parameters—pregnancy category, history of CS, course of labor and gestational age [7]. In addition, indications reported for CS were classified as absolute and non-absolute indications as per the recommendation by Stanton and Ronsmans [26]. Absolute indications include obstructed labor, major antepartum hemorrhage (including placenta previa grades 3 and 4), malpresentation (transverse, oblique, and brow presentation), and uterine rupture in hierarchical order. Non-absolute indications included previous history of CS, fetal compromise, failure to progress (prolonged labor, failed induction), breech, severe pre-eclampsia and eclampsia without hierarchical order.

Patient and public involvement

Patients and/or the public were not involved in the design, or conduct, or reporting, or dissemination plans of this research.

RESULTS

During the study period, 1287 maternity admissions were reported. After excluding 73 (5.7%) lost or incomplete files, 1214 records with complete data were reviewed constituting 1203 births (excluding abortions and laparotomies not resulting in births). A total of 415 births were by CS, making the overall CS rate 34.5% (277/839; 33% in hospital A and 138/364; 37.9% in hospital B). The mean age of participants was 26.7(±5.3) years ranging from 17 to 40. The mean gestational age was 38.9(±1.6) weeks. The majority of women were married (98.8%), urban residents (70.6%), and self-referred (94.9%). Details of sociodemographic conditions are summarized in Table 1.

Table 1: Sociodemographic conditions of women who underwent CS in selected private hospitals in eastern Ethiopia, 2020

Variable	Frequency	%
Age		
<20	37	8.9
20-35	356	85.8
>35	22	5.3
Residence		
Urban	293	70.6
Rural	122	29.4
Type of CS		
Elective	85	20.5
Emergency	350	79.5
Referral status		
Self-referral	394	94.9
Referred from other facilities	21	5.1
Antenatal care (at least 1)		
Yes	387	93.3
No	28	6.7
Parity		
0	95	22.9
1-4	285	68.7
>4	35	8.4
Gestational age (weeks)		
Preterm (<37)	9	2.2
Term (37-42)	400	96.4
Post term (>42)	6	1.4
Onset of labor		
Spontaneous	285	68.7
Induced	24	5.8
CS before labor	106	25.5
Fetal presentation		
Cephalic	393	94.7
Breech	18	4.3
Transverse	4	1
Birth weight (gram)		
<2500	12	2.9
2500-4000	393	94.7
>4000	10	2.4

CS, cesarean section

Analysis of the Robson classification

The three leading Robson groups were Robson group 5 (n=137;33%), 3 (n=114; 27.5%) and 1 (n=71;17.1%). The overall contribution of the 'high risk groups' (group 6, 7,8, and 9) to the overall CS rate was almost nil (6.2%). Details of the Robson groups and their respective contributions are summarized in Figure 1 and Table 2.

Figure 1: Distribution of women undergoing CS according to the Robson groups in selected private hospitals in eastern Ethiopia, 2020.

Table 2: Distribution of Robson groups and their contribution to the overall CS rate in selected private hospitals in eastern Ethiopia, 2020.

Group	Description	CS/all births in the group	Contribution per group to total births (%)	CS rate within group (%)	Contribution per group to the CS rate (%)
1	Nulliparous, single cephalic, ≥ 37 weeks, in spontaneous labor	71/197	16.4	36.0	17.1
2	Nulliparous, single cephalic, ≥ 37 weeks, induced or CS before labor	19/27	2.2	70.4	4.6
3	Multiparous (excluding prev. CS), single cephalic, ≥ 37 weeks, in spontaneous labor	114/690	57.4	16.5	27.5
4	Multiparous (excluding prev. CS), single cephalic, ≥ 37 weeks, induced or CS before labor	39/72	6.0	54.2	9.4
5	Previous CS, single cephalic, ≥37 weeks	137/153	12.7	89.5	33.0
6	All nulliparous breeches	1/1	0.1	100	0.24
7	All multiparous breeches	13/22	1.8	59.1	3.1
8	All multiple pregnancies (including prev. CS)	9/15	1.2	60	2.2
9	All abnormal lies (including prev. CS)	3/3	0.3	100	0.7
10	All single cephalic, ≤ 36 weeks (including prev. CS)	9/23	1.9	39.1	2.2
	Total	**415/1203**	**100**	**34.5**	**100**

Overall and within group indication for CS

As indicated in Figure 2, the leading indications for performing CS in this study were fetal compromise (29.4%), previous CS (27.2%), and obstructed labor (12.3%). In general, CS was performed for absolute indications in 24.1% only (Figure 2).

Figure 2: Indications for performing CS in selected private hospitals in eastern Ethiopia, 2020.

Major indications within each Robson group are summarized in Table 3. Except for Robson groups 9 and 10 where malpresentation (n=3/3) and major APH (n=5/9) were

leading indications, non-absolute indications were the main indications in all other groups: fetal compromise in Groups 1 (n=40/71; 56.3%) and 3 (n=68/114; 59.6%); previous CS in Group 5 (n=106/137; 77.4%); breech presentation in Group 6 (n=1/1;100%), Group 7 (n=10/13;76.9%), Group 8 (n=4/9; 44.4%).

Table 3: Overall and within Robson group indications for performing CS in selected private hospitals in eastern Ethiopia, 2020.

indications	Group 1	Group 2	Group 3	Group 4	Group 5	Group 6	Group 7	Group 8	Group 9	Group 10	Total
Absolute indications											
Obstructed labor	19 (26.8)	2	24	2	4	0	0	0	0	0	51
Major APH	2	1	14	6	9	0	0	0	0	5 (55.6)	37
Malpresentation	0	0	0	0	0	0	0	2	3 (100)	0	5
Uterine rupture	0	0	0	0	7	0	0	0	0	0	7
Non-absolute indications											
Previous CS	0	0	2	2	106 (77.4)	0	2	1	0	0	113
Fetal compromise	40 (56.3)	0	68 (59.6)	4	5	0	1	1	0	3	122
Failure to progress	4	6	1	13	1	0	0	0	0	0	25
Breech	0	0	0	0	0	1 (100)	10 (76.9)	4 (44.4)	0	0	15
(Severe pre-) eclampsia	5	2	4	1	3	0	0	0	0	1	16
Others	1	8	1	11	2	0	0	1	0	0	24
Total	**71**	**19**	**114**	**39**	**137**	**1**	**13**	**9**	**3**	**9**	**415**

APH, antepartum hemorrhage; CS, caesarean section

DISCUSSION

This study was conducted to describe CS in selected private hospitals using the Robson classification. We found that women with a history of CS in a previous pregnancy (Group 5), single cephalic multiparous women at term in spontaneous labour with no previous history of CS (Group 3), and single cephalic nulliparous women at term and in spontaneous labour (Group 1) were the leading Robson groups contributing to eight in ten CS. In addition, the relatively moderate risk groups (Groups 1 to 4 combined), contributed to 58.6% of all CS in the participating private hospitals. The leading recorded indications for performing CS were fetal compromise, previous

CS, and obstructed labor. Although the application of Robson classification for auditing CS is common practice, to the best of our knowledge, this is only the second reported study to apply this classification to private hospitals in a low-and middle-income country after the study by Begum et al in Bangladesh [13].

Looking into the quality of data as per the WHO recommendation [8], shows good quality of data. The size of group 9 is in the expected range of <1% (0.3) with overall CS rate of 100%. In addition, looking into relative size of combination of 'group 1 and 2' (18.6%), and 'group 3 and 4' (63.3%) in Table 2 (column 3) shows the presence of high multiparous women in the database, as evidence by high total fertility rate (4.6) in the country [27]. It may also reflect high vaginal delivery among women without prior scars. Furthermore, the ratio of 'group 3 to 4' is higher than the ratio of 'group 1 to 2' indicating good quality of data [8]. However, the ratio of 'group 6 to 7' was very low (0.05) compared to the expected high breeches among nulliparas compared to multipara. Given the quality of our data is acceptable as indicated by other parameters above, this requires further audit.

Given that groups 5, 3 and 1 constitute large demographic shares, it was expected that these would contribute largely to the overall CS. However, the fact that CS rates within these groups were 89.5%,16.5%, and 36.0%, respectively indicates vast opportunities to reduce CS rates by strengthening clinical practice around vaginal birth, including vaginal birth after CS. The numbers do raise concerns about quality of care around vaginal birth in private care facilities in Ethiopia. Although group 5 comprised 12.5% of all births, it contributed 33% to the overall CS rate—possibly indicating low utilization of trial of labor or instrumental vaginal birth. Trial of labor in sub-Saharan Africa in general is low [28] although this practice may be justified in a majority of women with a previous scar if combined with proper labor monitoring [29]

Although the overall CS rate in this study is not as high as that in private hospitals in some other clinics, it requires further study since a majority (68%) of women who undergone CS did not have any underlying obstetric complications [30]. In addition, the high CS rate among women with a scarred uterus (89.2%) requires further audit of obstetric interventions provided to these women. Since these private hospitals are well equipped with fetal monitoring and the ability to perform CS quickly, trial of labor after CS should be attempted; the missed opportunities should be further explored.

Declarations

Acknowledgements We want to thank the hospital managers for allowing us to conduct this study in their respective hospitals.

Contributors AKT conceived the study and wrote the original draft of the manuscript which was subsequently reviewed by SG, SGF, and TvdA. SG was involved in proposal development and collected data under the supervision and mentorship of AKT. Analysis was done by AKT. SG, SGF, and TvdA reviewed the manuscript for intellectual content and participated in revision. All authors contributed to the writing and reviewed the article and approved the final version of the manuscript to be published.

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Disclaimer The funding organisation has no role in the design, execution or decision to publish the study.

Competing interests None declared.

Patient consent Not required.

Ethics approval This study was approved by the institutional health research ethics review committee of College of Health and Medical Sciences, Haramaya University, Ethiopia (IHRERC/045/2020).

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

REFERENCES

1 Betrán AP, Merialdi M, Lauer JA, et al. Rates of caesarean section: analysis of global, regional and national estimates, *Paediatr Perinat Epidemiol* 2007;21:98-113.

2 Keag OE, Norman JE, Stock SJ. Long-term risks and benefits associated with cesarean delivery for mother, baby, and subsequent pregnancies: Systematic review and meta-analysis, *PLoS Med* 2018;15:e1002494

3 Masukume G, McCarthy FP, Russell J, et al. Caesarean section delivery and childhood obesity: evidence from the growing up in New Zealand cohort, *J Epidemiol Community Health* 2019;73:1063-70.

4 Sandall J, Tribe RM, Avery L, et al. Short-term and long-term effects of caesarean section on the health of women and children, *Lancet* 2018;392:1349-57.

5 Betrán AP, Vindevoghel N, Souza JP, et al. A systematic review of the Robson classification for caesarean section: what works, doesn't work and how to improve it, *PLoS One* 2014;9:e97769.

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

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

8 World Health Organization. Robson classification: implementation manual, 2017.

9 Robson M. The Ten Group Classification System (TGCS) - a common starting point for more detailed analysis, *BJOG* 2015;122:701,0528.13267.

10 Alonso BD, Silva, F. M. B. D., Latorre, M. D. R. D. O., et al. Caesarean birth rates in public and privately funded hospitals: a cross-sectional study, *Rev Saude Publica* 2017;51:101,8787.2017051007054.

11 Hoxha I, Syrogiannouli L, Luta X, et al. Caesarean sections and for-profit status of hospitals: systematic review and meta-analysis, *BMJ Open* 2017;7:e013670.

12 Atnurkar KB, Mahale AR. Audit of Caesarean Section Births in Small Private Maternity Homes: Analysis of 15-Year Data Applying the Modified Robson Criteria, Canada, *J Obstet Gynaecol India* 2016;66:289-94.

13 Begum T, Nababan H, Rahman A, et al. Monitoring caesarean births using the Robson ten group classification system: A cross-sectional survey of private for-profit facilities in urban Bangladesh, *PLoS One* 2019;14:e0220693.

14 Betrán AP, Ye J, Moller AB, et al. The Increasing Trend in Caesarean Section Rates: Global, Regional and National Estimates: 1990-2014, *PLoS One* 2016;11:e0148343.

15 Cavallaro FL, Cresswell JA, França GV, et al. Trends in caesarean delivery by country and wealth quintile: cross-sectional surveys in southern Asia and sub-Saharan Africa, *Bull World Health Organ* 2013;91:914-922D.

16 Hanson C, Betrán AP, Opondo C, et al. Trends in caesarean section rates between 2007 and 2013 in obstetric risk groups inspired by the Robson classification: results from population-based surveys in a low-resource setting, *BJOG* 2019;126:690-700

17 Harrison MS, Saleem S, Ali S, et al. A Prospective, Population-Based Study of Trends in Operative Vaginal Delivery Compared to Cesarean Delivery Rates in Low- and Middle-Income Countries, 2010-2016, *Am J Perinatol* 2019;36:730-6

18 Chanrachakul B, Herabutya Y, Udomsubpayakul U. Epidemic of cesarean section at the general, private and university hospitals in Thailand, *J Obstet Gynaecol Res* 2000;26:357-61.

19 Phadungkiatwattana P, Tongsakul N. Analyzing the impact of private service on the cesarean section rate in public hospital Thailand, *Arch Gynecol Obstet* 2011;284:1375-9

20 Einarsdóttir K, Haggar F, Pereira G, et al. Role of public and private funding in the rising caesarean section rate: a cohort study, *BMJ Open* 2013;3:e002789.

21 Dahlen HG, Tracy S, Tracy M, et al. Rates of obstetric intervention among low-risk women giving birth in private and public hospitals in NSW: a population-based descriptive study, *BMJ Open* 2012;2:e001723.

22 Ali Y, Khan MW, Mumtaz U, et al. Identification of factors influencing the rise of cesarean sections rates in Pakistan, using MCDM, *Int J Health Care Qual Assur* 2018;31:1058-69.

23 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

24 Tura AK, Pijpers O, de Man M, et al. Analysis of caesarean sections using Robson 10-group classification system in a university hospital in eastern Ethiopia: a cross-sectional study, *BMJ Open* 2018;8:e020520.

25 Pearson L, Gandhi M, Admasu K, et al. User fees and maternity services in Ethiopia, *Int J Gynaecol Obstet* 2011;115:310-5.

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

27 CSA and ICF. Ethiopia Demographic and Health Survey 2016, *Addis Ababa, Ethiopia, and Rockville, Maryland, USA: CSA and ICF* 2016.

28 Boulvain M, Fraser WD, Brisson-Carroll G, et al. Trial of labour after caesarean section in sub-Saharan Africa: a meta-analysis, *Br J Obstet Gynaecol* 1997;104:1385-90.

29 van Roosmalen J. Vaginal birth after cesarean section in rural Tanzania, *Int J Gynaecol Obstet* 1991;34:211-5.

30 Bishop D, Dyer RA, Maswime S, et al. Maternal and neonatal outcomes after caesarean delivery in the African Surgical Outcomes Study: a 7-day prospective observational cohort study, *The Lancet Global Health* 2019;7:e513-22.

Figure 1

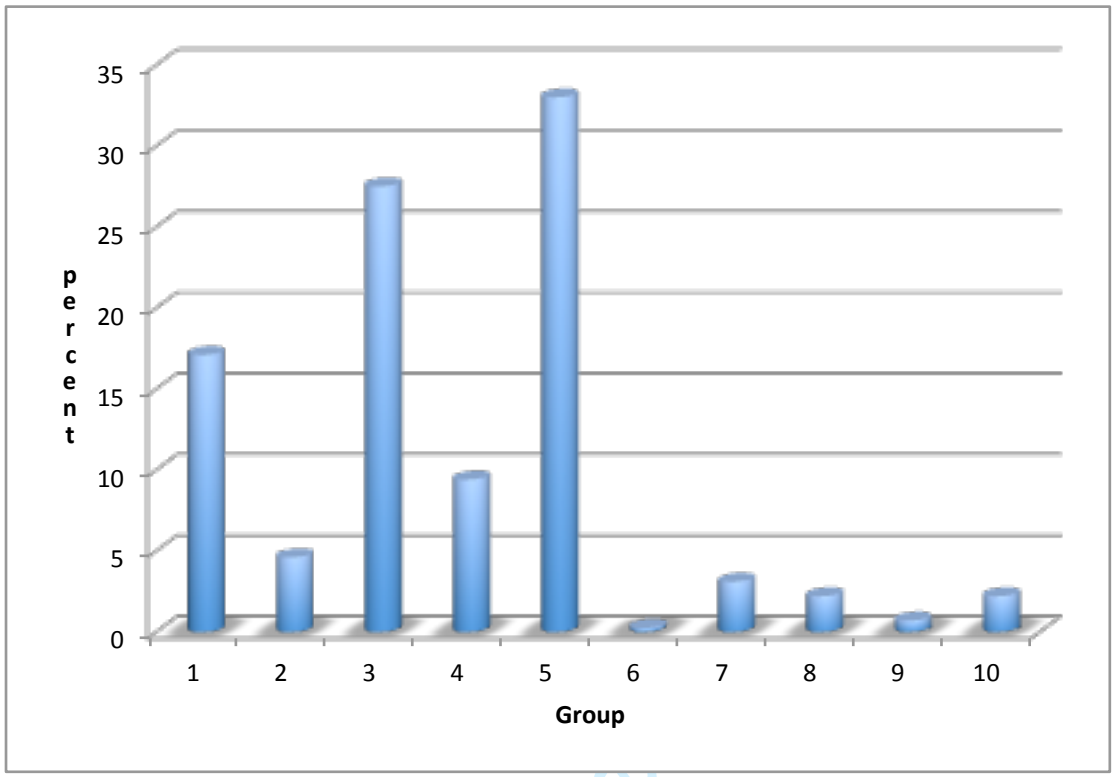

Figure 1: Distribution of women undergoing CS according to the Robson groups in selected private hospitals in eastern Ethiopia, 2020.

Figure 2

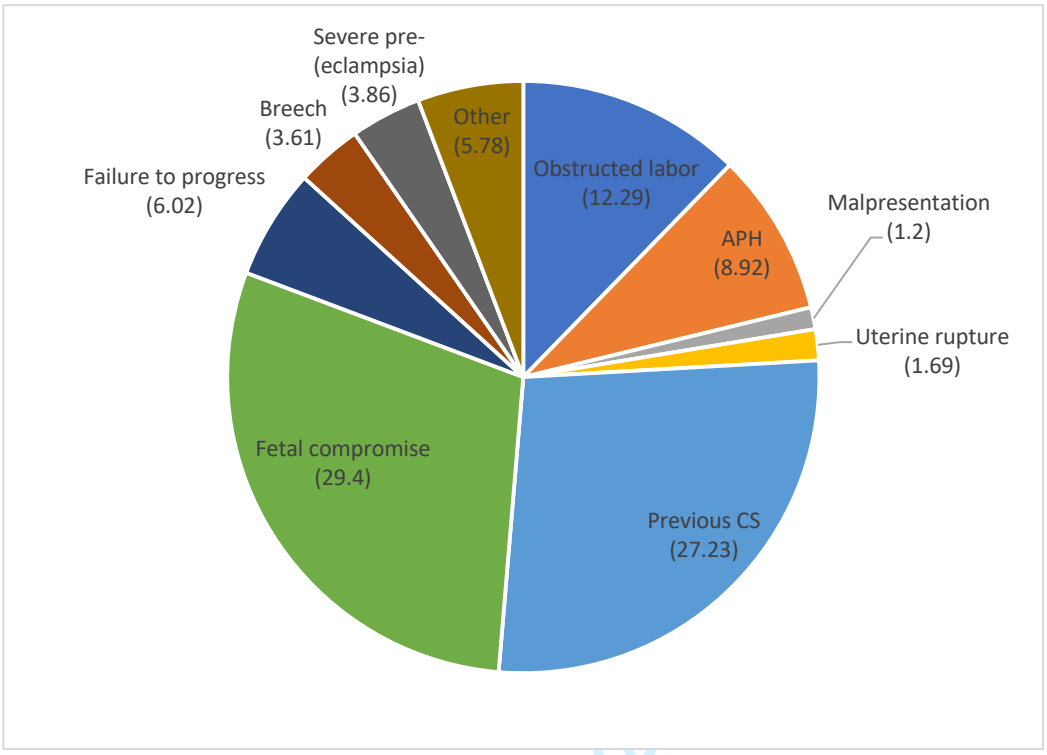

Figure 2: Indications for performing CS in selected private hospitals in eastern Ethiopia, 2020.

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

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

Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	6
		(b) Give reasons for non-participation at each stage	6
		(c) Consider use of a flow diagram	6
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	6
		(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	7-9
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	7-9
		(*b*) Report category boundaries when continuous variables were categorized	na
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	na
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	na
Discussion			
Key results	18	Summarise key results with reference to study objectives	9
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
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	10
Generalisability	21	Discuss the generalisability (external validity) of the study results	10
Other information			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	10

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

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

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Can the Robson Ten Group Classification System help identify which groups of women are driving the high caesarean section rate in major private hospitals in Eastern Ethiopia? A cross-sectional study

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Can the Robson Ten Group Classification System help identify which groups of women are driving the high caesarean section rate in major private hospitals in Eastern Ethiopia? A cross-sectional study

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Strengths and limitation of the study

- The first study to apply the Robson classification to private hospitals in Ethiopia
- Inclusion of all women who delivered in both facilities (CS and vaginal deliveries) during the study period helped us to indicate the Robson distribution as a whole and also among those who had CS.
- Because routinely collected clinical data was used some sociodemographic variables of interest were missed.
- The retrospective nature of the study may be prone to incomplete documentation.

Abstract

Objective: Caesarean section (CS) rates in Ethiopian private hospitals are high compared to those in public facilities, and there are limited descriptions of the groups of women contributing to this high rate. The objective of this study was to describe the groups contributing to the increased CS rate using the Robson classification in two major private hospitals in eastern Ethiopia.

Design: Cross-sectional study.

Setting: Two major private hospitals in eastern Ethiopia.

Participants: All women who gave birth from January 09, 2019 to January 08, 2020 in two major private hospitals in eastern Ethiopia.

Primary and secondary outcome measures: Primary outcome: Robson ten group classification. Secondary outcomes: indications for CS as recorded in the medical files.

Results: Of 1203 births in both hospitals combined during the study period, 415 (34.5%) were by CS. Women with a uterine scar due to previous CS (group 5), single cephalic term multiparous women in spontaneous labor (group 3), and single cephalic term nulliparous women in spontaneous labor (group 1) were the leading groups contributing 33%, 27.5%, and 17.1%, respectively. The leading documented indications were fetal compromise (29.4%), previous CS (27.2%), and obstructed labor (12.3%).

Conclusion: Women in Robson group 5, 3, and 1 are contributing to more than three in four CSs major private hospitals in eastern Ethiopia. Improving management of spontaneous labor and strengthening clinical practice around safely providing the option of vaginal birth after CS practice are strategies required to reduce the high CS rate in these private facilities.

***Keywords*:** Robson classification, private hospitals, caesarean section, audit, Ethiopia

INTRODUCTION

Although caesarean section (CS) is a life-saving intervention when vaginal delivery has higher risk for the women or the newborn, there is no significant improvement in maternal and neonatal health outcomes when population-based CS rate is higher than 15% [1, 2]. From being performed to save the life of women or the neonate, CS is also being performed for non-absolute indications like maternal request or obstructed labor with intact membrane [3]. The overall CS rate in Ethiopia is one of the lowest (0.6%) with huge regional variation [4]. Moreover, CS rates significantly vary within and among countries, with women from urban, literates and those visiting private facilities having more CS compared to their counterparts [4, 5], Ethiopia is not.

With the unprecedent rise in caesarean section (CS) rates the need to institute a robust system to minimize unnecessary and medically nonindicated CS is warranted [6]. Risks associated with (repeated) CS for women and newborn are well established [7-9]. These range from increased risk of uterine rupture and abnormal placentation for the woman to stillbirth and iatrogenic preterm birth for the baby. Moreover, long term effect on hormonal, physical, bacterial, and physiological conditions and risk of allergic reactions on the newborn were also reported [9].

A recommended system for auditing clinical practice around CS is the Robson Ten Group Classification [9-11]. Based on obstetric history, course of labor and gestational age, the Robson classification categorizes all women undergoing CS into ten mutually exclusive and exhaustive groups [12-14]. Although the Robson classification has been promoted by the World Health Organization as a method to reduce CS rates [13, 15, 16], the system has rarely been applied to private facilities in Africa [17, 18].

Given the increase in global CS rates, including in low-and middle-income countries [2, 19-21] and in private facilities in particular, audit of CS practices and identifying groups contributing to CS rates using the Robson Classification are important to design appropriate interventions [17, 22-26]. To the best of our knowledge, no such study has been performed in private facilities in Ethiopia, rendering the contribution of different groups to overall CS rates in these institutions unknown [27, 28].

The aim of this study was to determine which groups are driving the CS rate in selected major private hospitals in eastern Ethiopia using the Robson Ten Group Classification system.

METHODS

Study designs and participants

This study was conducted as part of a larger study on maternal near miss and mortality in major private hospitals in eastern Ethiopia, which has been described elsewhere [29]. In brief, all women who were admitted from January 09, 2019 to January 08, 2020 in two major private hospitals in eastern Ethiopia during pregnancy, childbirth or within 42 days of termination of pregnancy were identified. Then, all women who fulfilled the adapted sub-Saharan African maternal near miss criteria were identified [30]. Finally, data on sociodemographic conditions, reproductive and obstetric factors, and respective feto-maternal outcomes at discharge were collected from those identified as near miss or not (for comparison). The study was retrospectively conducted from February 1 to 29, 2020 at the department of obstetrics and gynaecology of Hospital 1 and Hospital 2—the two major private hospitals in Harar and Dire Dawa towns, eastern Ethiopia. As part of this study, data on category of the pregnancy, presence of previous uterine scar, the course of labour and delivery, and the gestational age, which are essential for the Robson Classification [12], were collected from all women who gave birth. To enable comparisons, records of women who gave birth vaginally were also reviewed. The identity of all women who visited both hospitals for maternity services were obtained from the admission and discharge registers, delivery log books, and operation theatre registers. Using their medical registration number, all files were retrieved from the archive rooms at both hospitals and reviewed by research assistants who received dedicated in-service training.

Study setting

Hospital 1 is a general specialized 33-bed private hospital in Harar providing specialized care in internal medicine, surgery, obstetrics and gynecology, pediatrics and child health, and some other smaller fields. During the study period, five consultants and six midwives were practicing at the department of obstetrics. It

provides care for both emergency and planned CS by consultants, with approximately 1000 births annually. Hospital 2 is one of the major private hospitals in Dire Dawa with almost 600 deliveries annually. Both hospitals have one major operation theatre which they share with all surgical specialties. Unlike public facilities, where all maternity services are free [31], a typical CS procedure costs 10,000-15,000 Ethiopian Birr ($267-400).

Variables

The dependent variable was the Robson classification groups, one to ten based on the category of the pregnancy, presence of previous uterine scar, the course of labour and delivery, and the gestational age of the pregnancy (Box 1) [12]. The independent variables included sociodemographic conditions (age, referral status, residence), medical and obstetric history and conditions present in the index pregnancy.

Box 1: Robson's ten group caesarean section classification system [12]

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

Data collection

Trained research assistants collected data on maternal characteristics (age, parity, antenatal booking, referral status), obstetric and medical history and conditions (history of uterine scar, history or presence of obstetric complications), labor and delivery related information (onset, presentation, mode of birth, indication for CS for births by CS), fetal/neonatal information (vital status at birth, fifth minute APGAR score, admission to special intensive care unit, birth weight), and maternal and fetal outcome at discharge.

Data processing and analysis

All collected data were cross-checked for completeness and consistency and double entered to EpiData 3.1 (http://www.epidata.dk) and exported to Stata 13 (https://www.stata.com) for analysis. The Robson group was determined using the four basic obstetric concepts and their parameters—pregnancy category, history of CS, course of labor and gestational age [12]. In addition, indications reported for CS were classified as absolute and non-absolute indications as per the recommendation by Stanton and Ronsmans [32]. Absolute indications include obstructed labor, major antepartum hemorrhage (including placenta previa grades 3 and 4), malpresentation (transverse, oblique, and brow presentation), and uterine rupture in hierarchical order. Non-absolute indications included previous history of CS, fetal compromise, failure to progress (prolonged labor, failed induction), breech, severe pre-eclampsia and eclampsia without hierarchical order.

Patient and public involvement

Patients and/or the public were not involved in the design, or conduct, or reporting, or dissemination plans of this research.

RESULTS

During the study period, 1287 maternity admissions were reported. After excluding 73 (5.7%) lost or incomplete files, 1214 records with complete data were reviewed constituting 1203 births (excluding abortions and laparotomies not resulting in births). A total of 415 births were by CS, making the overall CS rate 34.5% (277/839; 33% in hospital A and 138/364; 37.9% in hospital B). The mean age of participants was 26.7(±5.3) years ranging from 17 to 40. The mean gestational age was 38.9(±1.6) weeks. The majority of women were married (98.8%), urban residents (70.6%), and self-referred (94.9%). Details of sociodemographic conditions are summarized in Table 1.

Table 1: Sociodemographic conditions of women who underwent CS in selected private hospitals in eastern Ethiopia, 2020

Variable	Frequency	%
Age		
<20	37	8.9
20-35	356	85.8
>35	22	5.3
Residence		

Urban	293	70.6
Rural	122	29.4
Type of CS		
Elective	85	20.5
Emergency	350	79.5
Referral status		
Self-referral	394	94.9
Referred from other facilities	21	5.1
Antenatal care (at least 1)		
Yes	387	93.3
No	28	6.7
Parity		
0	95	22.9
1-4	285	68.7
>4	35	8.4
Gestational age (weeks) [33]		
Preterm (<37)	9	2.2
Term (37-41 6/7)	400	96.4
Post term (≥42)	6	1.4
Onset of labor		
Spontaneous	285	68.7
Induced	24	5.8
CS before labor	106	25.5
Fetal presentation		
Cephalic	393	94.7
Breech	18	4.3
Transverse	4	1
Birth weight (gram)		
<2500	12	2.9
2500-4000	393	94.7
>4000	10	2.4

CS, cesarean section

Analysis of the Robson classification

The three leading Robson groups were Robson group 5 (n=137;33%), 3 (n=114; 27.5%) and 1 (n=71;17.1%). The overall contribution of the 'high risk groups' (group 6, 7,8, and 9) to the overall CS rate was almost nil (6.2%). Details of the Robson groups and their respective contributions are summarized in Figure 1 and Table 2.

Figure 1: Distribution of women undergoing CS according to the Robson groups in selected private hospitals in eastern Ethiopia, 2020.

Table 2: Distribution of Robson groups and their contribution to the overall CS rate in selected private hospitals in eastern Ethiopia, 2020.

Group	Description	CS/all births in the group	Contribution per group to total births (%)	CS rate within group (%)	Contribution per group to the CS rate (%)
1	Nulliparous, single cephalic, ≥ 37 weeks, in spontaneous labor	71/197	16.4	36.0	17.1

2	Nulliparous, single cephalic, ≥ 37 weeks, induced or CS before labor	19/27	2.2	70.4	4.6
3	Multiparous (excluding prev. CS), single cephalic, ≥ 37 weeks, in spontaneous labor	114/690	57.4	16.5	27.5
4	Multiparous (excluding prev. CS), single cephalic, ≥ 37 weeks, induced or CS before labor	39/72	6.0	54.2	9.4
5	Previous CS, single cephalic, ≥37 weeks	137/153	12.7	89.5	33.0
6	All nulliparous breeches	1/1	0.1	100	0.24
7	All multiparous breeches	13/22	1.8	59.1	3.1
8	All multiple pregnancies (including prev. CS)	9/15	1.2	60	2.2
9	All abnormal lies (including prev. CS)	3/3	0.3	100	0.7
10	All single cephalic, ≤ 36 weeks (including prev. CS)	9/23	1.9	39.1	2.2
	Total	**415/1203**	**100**	**34.5**	**100**

Overall and within group indication for CS

As indicated in Figure 2, the leading indications for performing CS in this study were fetal compromise (29.4%), previous CS (27.2%), and obstructed labor (12.3%). In general, CS was performed for absolute indications in 24.1% only (Figure 2).

Figure 2: Indications for performing CS in selected private hospitals in eastern Ethiopia, 2020.

Major indications within each Robson group are summarized in Table 3. Except for Robson groups 9 and 10 where malpresentation (n=3/3) and major APH (n=5/9) were leading indications, non-absolute indications were the main indications in all other groups: fetal compromise in Groups 1 (n=40/71; 56.3%) and 3 (n=68/114; 59.6%); previous CS in Group 5 (n=106/137; 77.4%); breech presentation in Group 6 (n=1/1;100%), Group 7 (n=10/13;76.9%), Group 8 (n=4/9; 44.4%).

Table 3: Overall and within Robson group indications for performing CS in selected private hospitals in eastern Ethiopia, 2020.

indications	Group 1	Group 2	Group 3	Group 4	Group 5	Group 6	Group 7	Group 8	Group 9	Group 10	Total
Absolute indications											
Obstructed labor	19 (26.8)	2	24	2	4	0	0	0	0	0	51
Major APH	2	1	14	6	9	0	0	0	0	5 (55.6)	37
Malpresentation	0	0	0	0	0	0	0	2	3 (100)	0	5
Uterine rupture	0	0	0	0	7	0	0	0	0	0	7

Non-absolute indications											
Previous CS	0	0	2	2	106 (77.4)	0	2	1	0	0	113
Fetal compromise	40 (56.3)	0	68 (59.6)	4	5	0	1	1	0	3	122
Failure to progress	4	6	1	13	1	0	0	0	0	0	25
Breech	0	0	0	0	0	1 (100)	10 (76.9)	4 (44.4)	0	0	15
(Severe pre-) eclampsia	5	2	4	1	3	0	0	0	0	1	16
Others	1	8	1	11	2	0	0	1	0	0	24*
Total	**71**	**19**	**114**	**39**	**137**	**1**	**13**	**9**	**3**	**9**	**415**

APH, antepartum hemorrhage; CS, caesarean section; *18 on maternal requests and 6 unspecified

DISCUSSION

This study was conducted to describe CS in selected private hospitals using the Robson classification. We found that women with a history of CS in a previous pregnancy (Group 5), single cephalic multiparous women at term in spontaneous labour with no previous history of CS (Group 3), and single cephalic nulliparous women at term and in spontaneous labour (Group 1) were the leading Robson groups contributing to eight in ten CS. In addition, the relatively moderate risk groups (Groups 1 to 4 combined), contributed to 58.6% of all CS in the participating private hospitals. The leading recorded indications for performing CS were fetal compromise, previous CS, and obstructed labor. Although the application of Robson classification for auditing CS is common practice, to the best of our knowledge, this is only the second reported study to apply this classification to private hospitals in a low-and middle-income country after the study by Begum et al in Bangladesh [18].

Looking into the quality of data as per the WHO recommendation [13], shows good quality of data. The size of group 9 is in the expected range of <1% (0.3) with overall CS rate of 100%. In addition, looking into relative size of combination of ‘group 1 and 2’ (18.6%), and ‘group 3 and 4’ (63.3%) in Table 2 (column 3) shows the presence of high multiparous women in the database, as evidence by high total fertility rate (4.6) in the country [34]. It may also reflect high vaginal delivery among women without prior scars. Furthermore, the ratio of ‘group 3 to 4’ is higher than the ratio of ‘group 1 to 2’ indicating good quality of data [13]. However, the ratio of ‘group 6 to 7’ was very low (0.05) compared to the expected high breeches among nulliparas compared to

multipara. Given the quality of our data is acceptable as indicated by other parameters above, this requires further audit.

Given that groups 5, 3 and 1 constitute large demographic shares, it was expected that these would contribute largely to the overall CS. However, the fact that CS rates within these groups were 89.5%,16.5%, and 36.0%, respectively indicates vast opportunities to reduce CS rates by strengthening clinical practice around vaginal birth, including vaginal birth after CS. The numbers do raise concerns about quality of care around vaginal birth in private care facilities in Ethiopia. Although group 5 comprised 12.5% of all births, it contributed 33% to the overall CS rate—possibly indicating low utilization of trial of labor or instrumental vaginal birth. Trial of labor in sub-Saharan Africa in general is low [35] although this practice may be justified in a majority of women with a previous scar if combined with proper labor monitoring [36].

Strengths and limitations

This study is the first study to apply the Robson classification to major private hospitals in Ethiopia. Inclusion of all women who gave birth in both facilities (CS and vaginal deliveries) during the study period helped us to indicate the Robson distribution as a whole and also among those who had CS without selection bias. However, the study has some limitations to be considered. *First*, as the data were retrospectively collected from medical records, some important socio-economic variables—which are not routinely documented—were missed. *Second*, data on trial of labor or partograph use is not often documented making it difficult to comment on management of labor and timeliness of the decisions to undergo CS.

CONCLUSION

More than three-fourth of CS was performed among Robson groups 5, 3, and 1—indicating inadequate trial of labour after CS or management of labor among relatively low risk groups (3 and 1). Although the overall CS rate in this study is not as high as those reported in private hospitals in some other clinics, it requires further study since a majority (68%) of women who undergone CS did not have any underlying obstetric complications [37]. In addition, the high CS rate among women with a scarred uterus (89.2%) requires further audit of obstetric interventions provided to these women.

Since these private hospitals are well equipped with fetal monitoring and the ability to perform CS quickly, trial of labor after CS should be attempted and the missed opportunities should be further explored.

Declarations

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Contributors AKT conceived the study and wrote the original draft of the manuscript which was subsequently reviewed by SG, SGF, and TvdA. SG was involved in proposal development and collected data under the supervision and mentorship of AKT. Analysis was done by AKT. SG, SGF, and TvdA reviewed the manuscript for intellectual content and participated in revision. All authors contributed to the writing and reviewed the article and approved the final version of the manuscript to be published.

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Competing interests None declared.

Patient consent Not required.

Ethics approval This study was approved by the institutional health research ethics review committee of College of Health and Medical Sciences, Haramaya University, Ethiopia (IHRERC/045/2020).

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

REFERENCES

1 World Health Organization. World health statistics 2015: World Health Organization 2015.

2 Betrán AP, Ye J, Moller AB, et al. The Increasing Trend in Caesarean Section Rates: Global, Regional and National Estimates: 1990-2014, *PLoS One* 2016;11: e0148343.

3 Rijken MJ, Meguid T, van den Akker T, et al. Global surgery and the dilemma for obstetricians, *Lancet* 2015;386:1941-2.

4 Fesseha N, Getachew A, Hiluf M, et al. A national review of cesarean delivery in Ethiopia, *Int J Gynaecol Obstet* 2011;115:106-11.

5 Boatin AA, Schlotheuber A, Betran AP, et al. Within country inequalities in caesarean section rates: observational study of 72 low and middle income countries, *BMJ* 2018;360.

6 Betrán AP, Merialdi M, Lauer JA, et al. Rates of caesarean section: analysis of global, regional and national estimates, *Paediatr Perinat Epidemiol* 2007;21:98-113.

7 Keag OE, Norman JE, Stock SJ. Long-term risks and benefits associated with cesarean delivery for mother, baby, and subsequent pregnancies: Systematic review and meta-analysis, *PLoS Med* 2018;15: e1002494.

8 Masukume G, McCarthy FP, Russell J, et al. Caesarean section delivery and childhood obesity: evidence from the growing up in New Zealand cohort, *J Epidemiol Community Health* 2019;73:1063-70.

9 Sandall J, Tribe RM, Avery L, et al. Short-term and long-term effects of caesarean section on the health of women and children, *Lancet* 2018;392:1349-57.

10 Betrán AP, Vindevoghel N, Souza JP, et al. A systematic review of the Robson classification for caesarean section: what works, doesn't work and how to improve it, *PLoS One* 2014;9: e97769.

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

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

13 World Health Organization. Robson classification: implementation manual, 2017.

14 Robson M. The Ten Group Classification System (TGCS) - a common starting point for more detailed analysis, *BJOG* 2015;122:701,0528.13267.

15 Alonso BD, Silva, F. M. B. D., Latorre, M. D. R. D. O., et al. Caesarean birth rates in public and privately funded hospitals: a cross-sectional study, *Rev Saude Publica* 2017;51:101,8787.2017051007054.

16 Hoxha I, Syrogiannouli L, Luta X, et al. Caesarean sections and for-profit status of hospitals: systematic review and meta-analysis, *BMJ Open* 2017;7: e013670.

17 Atnurkar KB, Mahale AR. Audit of Caesarean Section Births in Small Private Maternity Homes: Analysis of 15-Year Data Applying the Modified Robson Criteria, Canada, *J Obstet Gynaecol India* 2016;66:289-94.

18 Begum T, Nababan H, Rahman A, et al. Monitoring caesarean births using the Robson ten group classification system: A cross-sectional survey of private for-profit facilities in urban Bangladesh, *PLoS One* 2019;14:e0220693.

19 Cavallaro FL, Cresswell JA, França GV, et al. Trends in caesarean delivery by country and wealth quintile: cross-sectional surveys in southern Asia and sub-Saharan Africa, *Bull World Health Organ* 2013;91:914-922D.

20 Hanson C, Betrán AP, Opondo C, et al. Trends in caesarean section rates between 2007 and 2013 in obstetric risk groups inspired by the Robson classification: results from population-based surveys in a low-resource setting, *BJOG* 2019;126:690-700.

21 Harrison MS, Saleem S, Ali S, et al. A Prospective, Population-Based Study of Trends in Operative Vaginal Delivery Compared to Cesarean Delivery Rates in Low- and Middle-Income Countries, 2010-2016, *Am J Perinatol* 2019;36:730-6.

22 Chanrachakul B, Herabutya Y, Udomsubpayakul U. Epidemic of cesarean section at the general, private and university hospitals in Thailand, *J Obstet Gynaecol Res* 2000;26:357-61.

23 Phadungkiatwattana P, Tongsakul N. Analyzing the impact of private service on the cesarean section rate in public hospital Thailand, *Arch Gynecol Obstet* 2011;284:1375-9.

24 Einarsdóttir K, Haggar F, Pereira G, et al. Role of public and private funding in the rising caesarean section rate: a cohort study, *BMJ Open* 2013;3: e002789.

25 Dahlen HG, Tracy S, Tracy M, et al. Rates of obstetric intervention among low-risk women giving birth in private and public hospitals in NSW: a population-based descriptive study, *BMJ Open* 2012;2: e001723.

26 Ali Y, Khan MW, Mumtaz U, et al. Identification of factors influencing the rise of cesarean sections rates in Pakistan, using MCDM, *Int J Health Care Qual Assur* 2018;31:1058-69.

27 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.

28 Tura AK, Pijpers O, de Man M, et al. Analysis of caesarean sections using Robson 10-group classification system in a university hospital in eastern Ethiopia: a cross-sectional study, *BMJ Open* 2018;8:e020520.

29 Tenaw SG, Assefa N, Mulatu T, et al. Maternal near miss among women admitted in major private hospitals in eastern Ethiopia: a retrospective study, *BMC Pregnancy and Childbirth* 2021;21:1-9.

30 Tura AK, Stekelenburg J, Scherjon SA, et al. Adaptation of the WHO maternal near miss tool for use in sub-Saharan Africa: An International Delphi study, *BMC Pregnancy Childbirth* 2017;17:445.

31 Pearson L, Gandhi M, Admasu K, et al. User fees and maternity services in Ethiopia, *Int J Gynaecol Obstet* 2011;115:310-5.

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

33 World Health Organization. ICD-10:International Statistical Classification of Diseases and Related Health Problems 2010:151-2.

34 CSACE I. Ethiopia Demographic and Health Survey 2016, *Addis Ababa, Ethiopia, and Rockville, Maryland, USA: CSA and ICF* 2016.

35 Boulvain M, Fraser WD, Brisson-Carroll G, et al. Trial of labour after caesarean section in sub-Saharan Africa: a meta-analysis, *Br J Obstet Gynaecol* 1997;104:1385-90.

36 van Roosmalen J. Vaginal birth after cesarean section in rural Tanzania, *Int J Gynaecol Obstet* 1991;34:211-5.

37 Bishop D, Dyer RA, Maswime S, et al. Maternal and neonatal outcomes after caesarean delivery in the African Surgical Outcomes Study: a 7-day prospective observational cohort study, *The Lancet Global Health* 2019;7:e513-22

Figure 1

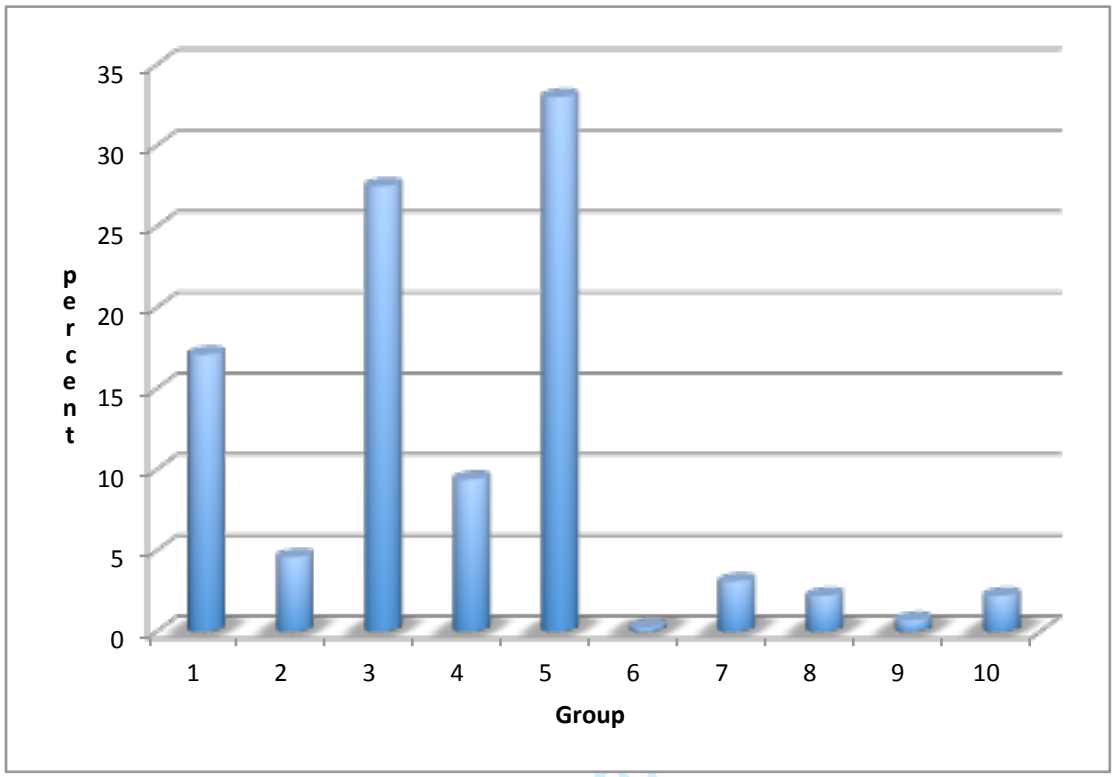

Figure 1: Distribution of women undergoing CS according to the Robson groups in selected private hospitals in eastern Ethiopia, 2020.

Figure 2

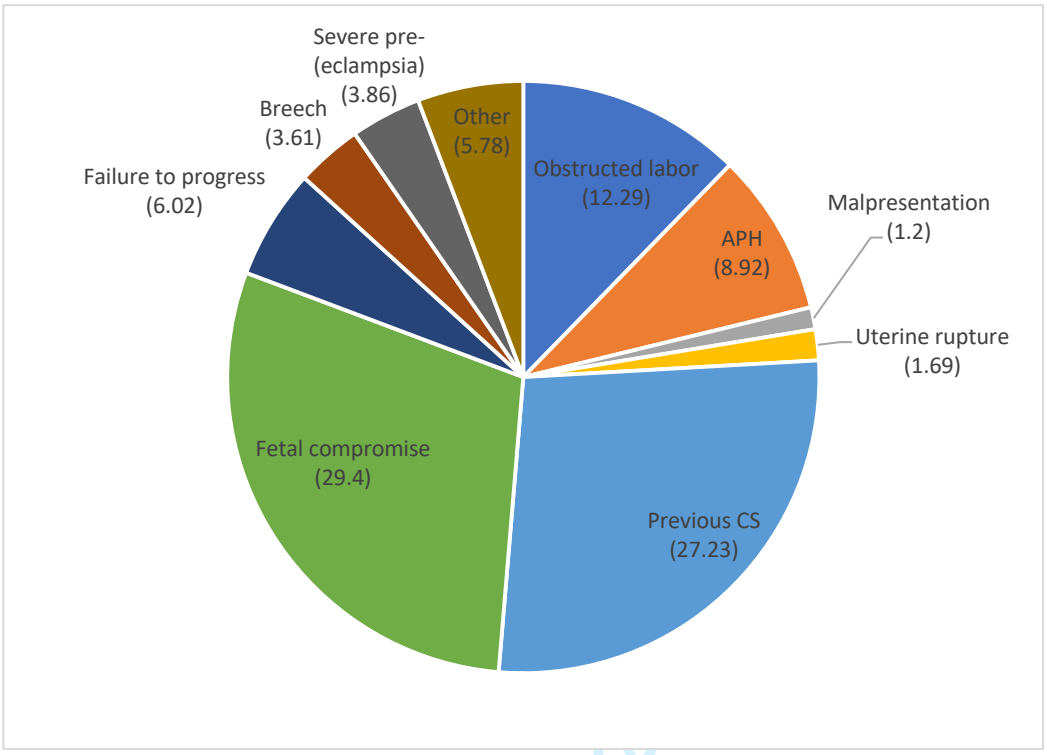

Figure 2: Indications for performing CS in selected private hospitals in eastern Ethiopia, 2020.

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

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

Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	6
		(b) Give reasons for non-participation at each stage	6
		(c) Consider use of a flow diagram	6
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	6
		(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	7-9
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	7-9
		(*b*) Report category boundaries when continuous variables were categorized	na
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	na
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	na
Discussion			
Key results	18	Summarise key results with reference to study objectives	9
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
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	10
Generalisability	21	Discuss the generalisability (external validity) of the study results	10
Other information			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	10

*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.

BMJ Open

Can the Robson Ten Group Classification System help identify which groups of women are driving the high caesarean section rate in major private hospitals in Eastern Ethiopia? A cross-sectional study

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Can the Robson Ten Group Classification System help identify which groups of women are driving the high caesarean section rate in major private hospitals in Eastern Ethiopia? A cross-sectional study

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Strengths and limitation of the study

- The first study to apply the Robson classification to private hospitals in Ethiopia
- Because routinely collected clinical data was used some sociodemographic variables of interest were missed.
- The retrospective nature of the study may be prone to incomplete documentation.

Abstract

Objective: Caesarean section (CS) rates in Ethiopian private hospitals are high compared to those in public facilities, and there are limited descriptions of the groups of women contributing to this high rate. The objective of this study was to describe the groups contributing to the increased CS rate using the Robson classification in two major private hospitals in eastern Ethiopia.

Design: Cross-sectional study.

Setting: Two major private hospitals in eastern Ethiopia.

Participants: All women who gave birth from January 09, 2019 to January 08, 2020 in two major private hospitals in eastern Ethiopia.

Primary and secondary outcome measures: Primary outcome: Robson ten group classification. Secondary outcomes: indications for CS as recorded in the medical files.

Results: Of 1203 births in both hospitals combined during the study period, 415 (34.5%) were by CS. Women with a uterine scar due to previous CS (group 5), single cephalic term multiparous women in spontaneous labor (group 3), and single cephalic term nulliparous women in spontaneous labor (group 1) were the leading groups contributing 33%, 27.5%, and 17.1%, respectively. The leading documented indications were fetal compromise (29.4%), previous CS (27.2%), and obstructed labor (12.3%).

Conclusion: More than three-fourth of CS was performed among Robson groups 5, 3, and 1—indicating inadequate trial of labour after CS or management of labor among relatively low risk groups (3 and 1). Improving management of spontaneous labor and strengthening clinical practice around safely providing the option of vaginal birth after CS practice are strategies required to reduce the high CS rate in these private facilities.

***Keywords*:** Robson classification, private hospitals, caesarean section, audit, Ethiopia

INTRODUCTION

Although caesarean section (CS) is a life-saving intervention when vaginal delivery has higher risk for the women or the newborn, there is no significant improvement in maternal and neonatal health outcomes when the population-based CS rate is higher than 15% [1, 2]. From being performed to save the life of women or the neonate, CS is also being performed for non-absolute indications like maternal request or obstructed labor with intact membrane [3]. The overall CS rate in Ethiopia is one of the lowest (0.6%) with huge regional variation [4]. Moreover, CS rates significantly vary within and among countries, with women from urban, literates and those visiting private facilities having more CS compared to their counterparts [4, 5].

With the unprecedented rise in caesarean section (CS) rates the need to institute a robust system to minimize unnecessary and medically nonindicated CS is warranted [6]. Risks associated with (repeated) CS for women and newborn are well established [7-9]. These range from increased risk of uterine rupture and abnormal placentation for the woman to stillbirth and iatrogenic preterm birth for the baby. Moreover, long term effect on hormonal, physical, bacterial, and physiological conditions and risk of allergic reactions on the newborn were also reported [9].

A recommended system for clinical auditing of CS is the Robson Ten Group Classification [9-11]. Based on obstetric history, course of labor and gestational age, the Robson classification categorizes all women undergoing CS into ten mutually exclusive and exhaustive groups [12-14]. Although the Robson classification has been promoted by the World Health Organization as a method to reduce CS rates [13, 15, 16], the system has rarely been applied to private facilities in Africa [17, 18].

Given the increase in global CS rates, including in low-and middle-income countries [2, 19-21] and in private facilities in particular, audit of CS practices and identifying groups contributing to CS rates using the Robson Classification are important to design appropriate interventions [17, 22-26]. To the best of our knowledge, no such study has been performed in private facilities in Ethiopia, rendering the contribution of different groups to overall CS rates in these institutions unknown [27, 28].

The aim of this study was to determine which groups are driving the CS rate in selected major private hospitals in eastern Ethiopia using the Robson Ten Group Classification system.

METHODS

Study designs and participants

This study was conducted as part of a larger study on maternal near miss and mortality in major private hospitals in eastern Ethiopia, which has been described elsewhere [29]. In brief, all women who were admitted from January 09, 2019 to January 08, 2020 in two major private hospitals in eastern Ethiopia during pregnancy, childbirth or within 42 days of termination of pregnancy were identified. Then, all women who fulfilled the adapted sub-Saharan African maternal near miss criteria were identified [30]. Finally, data on sociodemographic conditions, reproductive and obstetric factors, and respective feto-maternal outcomes at discharge were collected from those identified as near miss or not (for comparison). The study was retrospectively conducted from February 1 to 29, 2020 at the department of obstetrics and gynaecology of Hospital 1 and Hospital 2—the two major private hospitals in Harar and Dire Dawa towns, eastern Ethiopia. As part of this study, data on category of the pregnancy, presence of previous uterine scar, the course of labour and delivery, and the gestational age, which are essential for the Robson Classification [12], were collected from all women who gave birth. To enable comparisons, records of women who gave birth vaginally were also reviewed. The identity of all women who visited both hospitals for maternity services were obtained from the admission and discharge registers, delivery log books, and operation theatre registers. Using their medical registration number, all files were retrieved from the archive rooms at both hospitals and reviewed by research assistants who received dedicated in-service training.

Study setting

Hospital 1 is a general specialized 33-bed private hospital in Harar providing specialized care in internal medicine, surgery, obstetrics and gynecology, pediatrics and child health, and some other smaller fields. During the study period, five consultants and six midwives were practicing at the department of obstetrics. It

provides care for both emergency and planned CS by consultants, with approximately 1000 births annually. Hospital 2 is one of the major private hospitals in Dire Dawa with almost 600 deliveries annually. Both hospitals have one major operation theatre which they share with all surgical specialties. Unlike public facilities, where all maternity services are free of charge [31], a typical CS procedure costs 10,000-15,000 Ethiopian Birr ($267-400).

Variables

The dependent variable was the Robson classification groups, one to ten based on the category of the pregnancy, presence of previous uterine scar, the course of labour and delivery, and the gestational age of the pregnancy (Box 1) [12]. The independent variables included sociodemographic conditions (age, referral status, residence), medical and obstetric history and conditions present in the index pregnancy.

Box 1: Robson's ten group caesarean section classification system [12]

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

Data collection

This study was conducted as part of a larger study on maternal near miss [29]. The near miss study was conducted to assess magnitude of near miss among all women admitted to department of obstetrics and gynaecology. All women who fulfilled any of the sub-Saharan African maternal near miss criteria were included in the main study [30]. Trained research assistants collected data on maternal characteristics (age, parity, antenatal booking, referral status), obstetric and medical history and conditions (history of uterine scar, history or presence of obstetric complications), labor and delivery related information (onset, presentation, mode of birth, indication for CS for

births by CS), fetal/neonatal information (vital status at birth, fifth minute APGAR score, admission to special intensive care unit, birth weight), presence of maternal near miss events, and maternal and fetal outcome at discharge.

Data processing and analysis

All collected data were cross-checked for completeness and consistency and double entered to EpiData 3.1 (http://www.epidata.dk) and exported to Stata 13 (https://www.stata.com) for analysis. The Robson group was determined using the four basic obstetric concepts and their parameters—pregnancy category, history of CS, course of labor and gestational age [12]. In addition, indications reported for CS were classified as absolute and non-absolute indications as per the recommendation by Stanton and Ronsmans [32]. Absolute indications include obstructed labor, major antepartum hemorrhage (including placenta previa grades 3 and 4), malpresentation (transverse, oblique, and brow presentation), and uterine rupture in hierarchical order. Non-absolute indications included previous history of CS, fetal compromise, failure to progress (prolonged labor, failed induction), breech, severe pre-eclampsia and eclampsia without hierarchical order.

Patient and public involvement

Patients and/or the public were not involved in the design, or conduct, or reporting, or dissemination plans of this research.

RESULTS

During the study period, 1287 maternity admissions were reported. After excluding 73 (5.7%) lost or incomplete files, 1214 records with complete data were reviewed constituting 1203 births (excluding abortions and laparotomies not resulting in births). A total of 415 births were by CS, making the overall CS rate 34.5% (277/839; 33% in hospital A and 138/364; 37.9% in hospital B). The mean age of participants was 26.7(±5.3) years ranging from 17 to 40. The mean gestational age was 38.9(±1.6) weeks. The majority of women were married (98.8%), urban residents (70.6%), and self-referred (94.9%). Details of sociodemographic conditions are summarized in Table 1.

Table 1: Sociodemographic conditions of women who underwent CS in selected private hospitals in eastern Ethiopia, 2020

Variable	Frequency	%
Age		
<20	37	8.9
20-35	356	85.8
>35	22	5.3
Residence		
Urban	293	70.6
Rural	122	29.4
Type of CS		
Elective	85	20.5
Emergency	350	79.5
Referral status		
Self-referral	394	94.9
Referred from other facilities	21	5.1
Antenatal care (at least 1)		
Yes	387	93.3
No	28	6.7
Parity		
0	95	22.9
1-4	285	68.7
>4	35	8.4
Gestational age (weeks) [33]		
Preterm (<37)	9	2.2
Term (37-41 6/7)	400	96.4
Post term (≥42)	6	1.4
Onset of labor		
Spontaneous	285	68.7
Induced	24	5.8
CS before labor	106	25.5
Fetal presentation		
Cephalic	393	94.7
Breech	18	4.3
Transverse	4	1
Birth weight (gram)		
<2500	12	2.9
2500-4000	393	94.7
>4000	10	2.4

CS, cesarean section

Analysis of the Robson classification

The three leading Robson groups were Robson group 5 (n=137;33%), 3 (n=114; 27.5%) and 1 (n=71;17.1%). The overall contribution of the 'high risk groups' (group 6, 7,8, and 9) to the overall CS rate was almost nil (6.2%). Details of the Robson groups and their respective contributions are summarized in Figure 1 and Table 2.

Figure 1: Distribution of women undergoing CS according to the Robson groups in selected private hospitals in eastern Ethiopia, 2020.

Table 2: Distribution of Robson groups and their contribution to the overall CS rate in selected private hospitals in eastern Ethiopia, 2020.

Group	Description	CS/all births in the group	Contribution per group to total births (%)	CS rate within group (%)	Contribution per group to the CS rate (%)
1	Nulliparous, single cephalic, ≥ 37 weeks, in spontaneous labor	71/197	16.4	36.0	17.1
2	Nulliparous, single cephalic, ≥ 37 weeks, induced or CS before labor	19/27	2.2	70.4	4.6
3	Multiparous (excluding prev. CS), single cephalic, ≥ 37 weeks, in spontaneous labor	114/690	57.4	16.5	27.5
4	Multiparous (excluding prev. CS), single cephalic, ≥ 37 weeks, induced or CS before labor	39/72	6.0	54.2	9.4
5	Previous CS, single cephalic, ≥37 weeks	137/153	12.7	89.5	33.0
6	All nulliparous breeches	1/1	0.1	100	0.24
7	All multiparous breeches	13/22	1.8	59.1	3.1
8	All multiple pregnancies (including prev. CS)	9/15	1.2	60	2.2
9	All abnormal lies (including prev. CS)	3/3	0.3	100	0.7
10	All single cephalic, ≤ 36 weeks (including prev. CS)	9/23	1.9	39.1	2.2
	Total	**415/1203**	**100**	**34.5**	**100**

Overall and within group indication for CS

As indicated in Figure 2, the leading indications for performing CS in this study were fetal compromise (29.4%), previous CS (27.2%), and obstructed labor (12.3%). In general, CS was performed for absolute indications in 24.1% only (Figure 2).

Figure 2: Indications for performing CS in selected private hospitals in eastern Ethiopia, 2020.

Major indications within each Robson group are summarized in Table 3. Except for Robson groups 9 and 10 where malpresentation (n=3/3) and major APH (n=5/9) were leading indications, non-absolute indications were the main indications in all other groups: fetal compromise in Groups 1 (n=40/71; 56.3%) and 3 (n=68/114; 59.6%); previous CS in Group 5 (n=106/137; 77.4%); breech presentation in Group 6 (n=1/1;100%), Group 7 (n=10/13;76.9%), Group 8 (n=4/9; 44.4%).

Table 3: Overall and within Robson group indications for performing CS in selected private hospitals in eastern Ethiopia, 2020.

indications	Group 1	Group 2	Group 3	Group 4	Group 5	Group 6	Group 7	Group 8	Group 9	Group 10	Total

Absolute indications											
Obstructed labor	19	2	24	2	4	0	0	0	0	0	51
Major APH	2	1	14	6	9	0	0	0	0	5	37
Malpresentation	0	0	0	0	0	0	0	2	3	0	5
Uterine rupture	0	0	0	0	7	0	0	0	0	0	7
Non-absolute indications											
Previous CS	0	0	2	2	106	0	2	1	0	0	113
Fetal compromise	40	0	68	4	5	0	1	1	0	3	122
Failure to progress	4	6	1	13	1	0	0	0	0	0	25
Breech	0	0	0	0	0	1	10	4	0	0	15
(Severe pre-) eclampsia	5	2	4	1	3	0	0	0	0	1	16
Others	1	8	1	11	2	0	0	1	0	0	24*
Total	**71**	**19**	**114**	**39**	**137**	**1**	**13**	**9**	**3**	**9**	**415**

APH, antepartum hemorrhage; CS, caesarean section; *18 on maternal requests and 6 unspecified

DISCUSSION

This study was conducted to describe CS in selected private hospitals using the Robson classification. We found that women with a history of CS in a previous pregnancy (Group 5), single cephalic multiparous women at term in spontaneous labour with no previous history of CS (Group 3), and single cephalic nulliparous women at term and in spontaneous labour (Group 1) were the leading Robson groups contributing to eight in ten CS. In addition, the relatively moderate risk groups (Groups 1 to 4 combined), contributed to 58.6% of all CS in the participating private hospitals. The leading recorded indications for performing CS were fetal compromise, previous CS, and obstructed labor. Although the application of Robson classification for auditing CS is common practice, to the best of our knowledge, this is only the second reported study to apply this classification to private hospitals in a low-and middle-income country after the study by Begum et al in Bangladesh [18].

Our finding is consistent with a study previously conducted in a public university hospital in the same setting, although in a different order, where group 3, 5 and 1 were the leading contributors [28]. But the contribution of group 5 in our study is much higher compared to the previous study (33% vs 21.4%). The fact that women with no previous

CS (group 1, 2, 3 and 4) contributed to six in ten (58.6%) and mainly for non-absolute indications—fetal compromise and failure to progress—indicates the need to assess appropriateness of labor management in private settings. Minimizing primary CS in these low risk groups is essential since women with CS scar would often undergo CS.

Looking into the quality of data as per the WHO recommendation [13], shows good quality of data. The size of group 9 is in the expected range of <1% (0.3) with overall CS rate of 100%. In addition, looking into relative size of combination of 'group 1 and 2' (18.6%), and 'group 3 and 4' (63.3%) in Table 2 (column 3) shows the presence of high multiparous women in the database, as evidence by high total fertility rate (4.6) in the country [34]. It may also reflect high vaginal delivery among women without prior scars. Furthermore, the ratio of 'group 3 to 4' is higher than the ratio of 'group 1 to 2' indicating good quality of data [13]. However, the ratio of 'group 6 to 7' was very low (0.05) compared to the expected high breeches among nulliparas compared to multipara. Given the quality of our data is acceptable as indicated by other parameters above, this requires further audit.

Given that groups 5, 3 and 1 constitute large demographic shares, it was expected that these would contribute largely to the overall CS. However, the fact that CS rates within these groups were 89.5%,16.5%, and 36.0%, respectively indicates vast opportunities to reduce CS rates by strengthening clinical practice around vaginal birth, including vaginal birth after CS. The numbers do raise concerns about quality of care around vaginal birth in private care facilities in Ethiopia. Although group 5 comprised 12.5% of all births, it contributed 33% to the overall CS rate—possibly indicating low utilization of trial of labor or instrumental vaginal birth. Trial of labor in sub-Saharan Africa in general is low [35] although this practice may be justified in a majority of women with a previous scar if combined with proper labor monitoring [36].

Strengths and limitations

This study is the first study to apply the Robson classification to major private hospitals in Ethiopia. Inclusion of all women who gave birth in both facilities (CS and vaginal deliveries) during the study period helped us to indicate the Robson distribution as a whole and also among those who had CS without selection bias. However, the study has some limitations to be considered. *First*, as the data were retrospectively collected

from medical records, some important socio-economic variables—which are not routinely documented—were missed. *Second*, data on trial of labor or partograph use is not often documented making it difficult to comment on management of labor and timeliness of the decisions to undergo CS.

CONCLUSION

More than three-fourth of CS was performed among Robson groups 5, 3, and 1—indicating inadequate trial of labour after CS or management of labor among relatively low risk groups (3 and 1). Although the overall CS rate in this study is not as high as those reported in private hospitals in some other clinics, it requires further study since a majority (68%) of women who undergone CS did not have any underlying obstetric complications [37]. In addition, the high CS rate among women with a scarred uterus (89.2%) requires further audit of obstetric interventions provided to these women. Since these private hospitals are well equipped with fetal monitoring and the ability to perform CS quickly, trial of labor after CS should be attempted and the missed opportunities should be further explored.

Declarations

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Contributors AKT conceived the study and wrote the original draft of the manuscript which was subsequently reviewed by SG, SGF, and TvdA. SG was involved in proposal development and collected data under the supervision and mentorship of AKT. Analysis was done by AKT. SG, SGF, and TvdA reviewed the manuscript for intellectual content and participated in revision. All authors contributed to the writing and reviewed the article and approved the final version of the manuscript to be published.

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Competing interests None declared.

Patient consent Not required.

Ethics approval This study was approved by the institutional health research ethics review committee of College of Health and Medical Sciences, Haramaya University, Ethiopia (IHRERC/045/2020).

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

REFERENCES

1 World Health Organization. World health statistics 2015: World Health Organization 2015.

2 Betrán AP, Ye J, Moller AB, et al. The Increasing Trend in Caesarean Section Rates: Global, Regional and National Estimates: 1990-2014, *PLoS One* 2016;11: e0148343.

3 Rijken MJ, Meguid T, van den Akker T, et al. Global surgery and the dilemma for obstetricians, *Lancet* 2015;386:1941-2.

4 Fesseha N, Getachew A, Hiluf M, et al. A national review of cesarean delivery in Ethiopia, *Int J Gynaecol Obstet* 2011;115:106-11.

5 Boatin AA, Schlotheuber A, Betran AP, et al. Within country inequalities in caesarean section rates: observational study of 72 low and middle income countries, *BMJ* 2018;360.

6 Betrán AP, Merialdi M, Lauer JA, et al. Rates of caesarean section: analysis of global, regional and national estimates, *Paediatr Perinat Epidemiol* 2007;21:98-113.

7 Keag OE, Norman JE, Stock SJ. Long-term risks and benefits associated with cesarean delivery for mother, baby, and subsequent pregnancies: Systematic review and meta-analysis, *PLoS Med* 2018;15: e1002494.

8 Masukume G, McCarthy FP, Russell J, et al. Caesarean section delivery and childhood obesity: evidence from the growing up in New Zealand cohort, *J Epidemiol Community Health* 2019;73:1063-70.

9 Sandall J, Tribe RM, Avery L, et al. Short-term and long-term effects of caesarean section on the health of women and children, *Lancet* 2018;392:1349-57.

10 Betrán AP, Vindevoghel N, Souza JP, et al. A systematic review of the Robson classification for caesarean section: what works, doesn't work and how to improve it, *PLoS One* 2014;9: e97769.

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

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

13 World Health Organization. Robson classification: implementation manual, 2017.

14 Robson M. The Ten Group Classification System (TGCS) - a common starting point for more detailed analysis, *BJOG* 2015;122:701,0528.13267.

15 Alonso BD, Silva, F. M. B. D., Latorre, M. D. R. D. O., et al. Caesarean birth rates in public and privately funded hospitals: a cross-sectional study, *Rev Saude Publica* 2017;51:101,8787.2017051007054.

16 Hoxha I, Syrogiannouli L, Luta X, et al. Caesarean sections and for-profit status of hospitals: systematic review and meta-analysis, *BMJ Open* 2017;7: e013670.

17 Atnurkar KB, Mahale AR. Audit of Caesarean Section Births in Small Private Maternity Homes: Analysis of 15-Year Data Applying the Modified Robson Criteria, Canada, *J Obstet Gynaecol India* 2016;66:289-94.

18 Begum T, Nababan H, Rahman A, et al. Monitoring caesarean births using the Robson ten group classification system: A cross-sectional survey of private for-profit facilities in urban Bangladesh, *PLoS One* 2019;14:e0220693.

19 Cavallaro FL, Cresswell JA, França GV, et al. Trends in caesarean delivery by country and wealth quintile: cross-sectional surveys in southern Asia and sub-Saharan Africa, *Bull World Health Organ* 2013;91:914-922D.

20 Hanson C, Betrán AP, Opondo C, et al. Trends in caesarean section rates between 2007 and 2013 in obstetric risk groups inspired by the Robson classification: results from population-based surveys in a low-resource setting, *BJOG* 2019;126:690-700.

21 Harrison MS, Saleem S, Ali S, et al. A Prospective, Population-Based Study of Trends in Operative Vaginal Delivery Compared to Cesarean Delivery Rates in Low- and Middle-Income Countries, 2010-2016, *Am J Perinatol* 2019;36:730-6.

22 Chanrachakul B, Herabutya Y, Udomsubpayakul U. Epidemic of cesarean section at the general, private and university hospitals in Thailand, *J Obstet Gynaecol Res* 2000;26:357-61.

23 Phadungkiatwattana P, Tongsakul N. Analyzing the impact of private service on the cesarean section rate in public hospital Thailand, *Arch Gynecol Obstet* 2011;284:1375-9.

24 Einarsdóttir K, Haggar F, Pereira G, et al. Role of public and private funding in the rising caesarean section rate: a cohort study, *BMJ Open* 2013;3: e002789.

25 Dahlen HG, Tracy S, Tracy M, et al. Rates of obstetric intervention among low-risk women giving birth in private and public hospitals in NSW: a population-based descriptive study, *BMJ Open* 2012;2: e001723.

26 Ali Y, Khan MW, Mumtaz U, et al. Identification of factors influencing the rise of cesarean sections rates in Pakistan, using MCDM, *Int J Health Care Qual Assur* 2018;31:1058-69.

27 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.

28 Tura AK, Pijpers O, de Man M, et al. Analysis of caesarean sections using Robson 10-group classification system in a university hospital in eastern Ethiopia: a cross-sectional study, *BMJ Open* 2018;8:e020520.

29 Tenaw SG, Assefa N, Mulatu T, et al. Maternal near miss among women admitted in major private hospitals in eastern Ethiopia: a retrospective study, *BMC Pregnancy and Childbirth* 2021;21:1-9.

30 Tura AK, Stekelenburg J, Scherjon SA, et al. Adaptation of the WHO maternal near miss tool for use in sub-Saharan Africa: An International Delphi study, *BMC Pregnancy Childbirth* 2017;17:445.

31 Pearson L, Gandhi M, Admasu K, et al. User fees and maternity services in Ethiopia, *Int J Gynaecol Obstet* 2011;115:310-5.

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

33 World Health Organization. ICD-10:International Statistical Classification of Diseases and Related Health Problems 2010:151-2.

34 CSACE I. Ethiopia Demographic and Health Survey 2016, *Addis Ababa, Ethiopia, and Rockville, Maryland, USA: CSA and ICF* 2016.

35 Boulvain M, Fraser WD, Brisson-Carroll G, et al. Trial of labour after caesarean section in sub-Saharan Africa: a meta-analysis, *Br J Obstet Gynaecol* 1997;104:1385-90.

36 van Roosmalen J. Vaginal birth after cesarean section in rural Tanzania, *Int J Gynaecol Obstet* 1991;34:211-5.

37 Bishop D, Dyer RA, Maswime S, et al. Maternal and neonatal outcomes after caesarean delivery in the African Surgical Outcomes Study: a 7-day prospective observational cohort study, *The Lancet Global Health* 2019;7:e513-22

1 World Health Organization. World health statistics 2015: World Health Organization 2015.

2 Betrán AP, Ye J, Moller AB, et al. The Increasing Trend in Caesarean Section Rates: Global, Regional and National Estimates: 1990-2014, *PLoS One* 2016;11:e0148343 doi:10.1371/journal.pone.0148343 [doi] [published Online First: Feb 5].

3 Rijken MJ, Meguid T, van den Akker T, et al. Global surgery and the dilemma for obstetricians, *Lancet* 2015;386:1941-2.

4 Fesseha N, Getachew A, Hiluf M, et al. A national review of cesarean delivery in Ethiopia, *Int J Gynaecol Obstet* 2011;115:106-11 doi:10.1016/j.ijgo.2011.07.011 [doi] [published Online First: October 01].

5 Boatin AA, Schlotheuber A, Betran AP, et al. Within country inequalities in caesarean section rates: observational study of 72 low and middle income countries, *BMJ* 2018;360.

6 Betrán AP, Merialdi M, Lauer JA, et al. Rates of caesarean section: analysis of global, regional and national estimates, *Paediatr Perinat Epidemiol* 2007;21:98-113 doi:PPE786 [pii] [published Online First: Mar].

7 Keag OE, Norman JE, Stock SJ. Long-term risks and benefits associated with cesarean delivery for mother, baby, and subsequent pregnancies: Systematic review and meta-analysis, *PLoS Med* 2018;15:e1002494 doi:10.1371/journal.pmed.1002494 [doi] [published Online First: Jan 23].

8 Masukume G, McCarthy FP, Russell J, et al. Caesarean section delivery and childhood obesity: evidence from the growing up in New Zealand cohort, *J Epidemiol Community Health* 2019;73:1063-70 doi:10.1136/jech-2019-212591 [doi] [published Online First: Dec].

9 Sandall J, Tribe RM, Avery L, et al. Short-term and long-term effects of caesarean section on the health of women and children, *Lancet* 2018;392:1349-57 doi:S0140-6736(18)31930-5 [pii] [published Online First: Oct 13].

10 Betrán AP, Vindevoghel N, Souza JP, et al. A systematic review of the Robson classification for caesarean section: what works, doesn't work and how to improve it, *PLoS One* 2014;9:e97769 doi:10.1371/journal.pone.0097769 [doi] [published Online First: Jun 3].

11 Le Ray C, Blondel B, Prunet C, et al. Stabilising the caesarean rate: which target population? *BJOG* 2015;122:690-9 doi:10.1111/1471-0528.13199 [doi] [published Online First: Apr].

12 Robson MS. Can we reduce the caesarean section rate? *Best Pract Res Clin Obstet Gynaecol* 2001;15:179-94 doi:S1521693400901561 [pii] [published Online First: Feb].

13 World Health Organization. Robson classification: implementation manual, 2017.

14 Robson M. The Ten Group Classification System (TGCS) - a common starting point for more detailed analysis, *BJOG* 2015;122:701,0528.13267. Epub 2015 Jan 20 doi:10.1111/1471-0528.13267 [doi] [published Online First: Apr].

15 Alonso BD, Silva, F. M. B. D., Latorre, M. D. R. D. O., et al. Caesarean birth rates in public and privately funded hospitals: a cross-sectional study, *Rev Saude Publica* 2017;51:101,8787.2017051007054. Epub 2017 Nov 17 doi:S0034-89102017000100294 [pii].

16 Hoxha I, Syrogiannouli L, Luta X, et al. Caesarean sections and for-profit status of hospitals: systematic review and meta-analysis, *BMJ Open* 2017;7:e013670-013670 doi:10.1136/bmjopen-2016-013670 [doi] [published Online First: Feb 17].

17 Atnurkar KB, Mahale AR. Audit of Caesarean Section Births in Small Private Maternity Homes: Analysis of 15-Year Data Applying the Modified Robson Criteria, Canada, *J Obstet Gynaecol India* 2016;66:289-94 doi:10.1007/s13224-016-0894-y [doi] [published Online First: Oct].

18 Begum T, Nababan H, Rahman A, et al. Monitoring caesarean births using the Robson ten group classification system: A cross-sectional survey of private for-profit facilities in urban Bangladesh, *PLoS One* 2019;14:e0220693 doi:10.1371/journal.pone.0220693 [doi] [published Online First: Aug 8].

19 Cavallaro FL, Cresswell JA, França GV, et al. Trends in caesarean delivery by country and wealth quintile: cross-sectional surveys in southern Asia and sub-Saharan Africa, *Bull World Health Organ* 2013;91:914-922D doi:10.2471/BLT.13.117598 [doi] [published Online First: Dec 1].

20 Hanson C, Betrán AP, Opondo C, et al. Trends in caesarean section rates between 2007 and 2013 in obstetric risk groups inspired by the Robson classification: results from population-based surveys in a low-resource setting, *BJOG* 2019;126:690-700 doi:10.1111/1471-0528.15534 [doi] [published Online First: May].

21 Harrison MS, Saleem S, Ali S, et al. A Prospective, Population-Based Study of Trends in Operative Vaginal Delivery Compared to Cesarean Delivery Rates in Low- and Middle-Income Countries, 2010-2016, *Am J Perinatol* 2019;36:730-6 doi:10.1055/s-0038-1673656 [doi] [published Online First: Jun].

22 Chanrachakul B, Herabutya Y, Udomsubpayakul U. Epidemic of cesarean section at the general, private and university hospitals in Thailand, *J Obstet Gynaecol Res* 2000;26:357-61 doi:10.1111/j.1447-0756.2000.tb01339.x [doi] [published Online First: Oct].

23 Phadungkiatwattana P, Tongsakul N. Analyzing the impact of private service on the cesarean section rate in public hospital Thailand, *Arch Gynecol Obstet* 2011;284:1375-9 doi:10.1007/s00404-011-1867-0 [doi] [published Online First: Dec].

24 Einarsdóttir K, Haggar F, Pereira G, et al. Role of public and private funding in the rising caesarean section rate: a cohort study, *BMJ Open* 2013;3:e002789. doi:

10.1136/bmjopen-002789 doi:10.1136/bmjopen-2013-002789 [doi] [published Online First: May 2].

25 Dahlen HG, Tracy S, Tracy M, et al. Rates of obstetric intervention among low-risk women giving birth in private and public hospitals in NSW: a population-based descriptive study, *BMJ Open* 2012;2:e001723. doi: 10.1136/bmjopen,001723. Print 2012 doi:10.1136/bmjopen-2012-001723 [doi] [published Online First: Sep 10].

26 Ali Y, Khan MW, Mumtaz U, et al. Identification of factors influencing the rise of cesarean sections rates in Pakistan, using MCDM, *Int J Health Care Qual Assur* 2018;31:1058-69 doi:10.1108/IJHCQA-04-2018-0087 [doi] [published Online First: Oct 8].

27 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- doi:1742-4755-11-14 [pii].

28 Tura AK, Pijpers O, de Man M, et al. Analysis of caesarean sections using Robson 10-group classification system in a university hospital in eastern Ethiopia: a cross-sectional study, *BMJ Open* 2018;8:e020520-020520 doi:10.1136/bmjopen-2017-020520 [doi] [published Online First: Apr 4].

29 Tenaw SG, Assefa N, Mulatu T, et al. Maternal near miss among women admitted in major private hospitals in eastern Ethiopia: a retrospective study, *BMC Pregnancy and Childbirth* 2021;21:1-9.

30 Tura AK, Stekelenburg J, Scherjon SA, et al. Adaptation of the WHO maternal near miss tool for use in sub-Saharan Africa: an International Delphi study, *BMC Pregnancy Childbirth* 2017;17:445-x doi:10.1186/s12884-017-1640-x [doi] [published Online First: Dec 29].

31 Pearson L, Gandhi M, Admasu K, et al. User fees and maternity services in Ethiopia, *Int J Gynaecol Obstet* 2011;115:310-5.

32 Stanton C, Ronsmans C, Baltimore Group on Cesarean. Recommendations for routine reporting on indications for cesarean delivery in developing countries, *Birth* 2008;35:204-11 doi:10.1111/j.1523-536X.2008.00241.x [doi] [published Online First: Sep].

33 World Health Organization. ICD-10:International
Statistical
Classification
of Diseases and
Related Health
Problems 2010:151-2.

34 CSACE I. Ethiopia Demographic and Health Survey 2016, *Addis Ababa, Ethiopia, and Rockville, Maryland, USA: CSA and ICF* 2016.

35 Boulvain M, Fraser WD, Brisson-Carroll G, et al. Trial of labour after caesarean section in sub-Saharan Africa: a meta-analysis, *Br J Obstet Gynaecol* 1997;104:1385-90 doi:10.1111/j.1471-0528.1997.tb11008.x [doi] [published Online First: Dec].

36 van Roosmalen J. Vaginal birth after cesarean section in rural Tanzania, *Int J Gynaecol Obstet* 1991;34:211-5 doi:10.1016/0020-7292(91)90351-5 [doi] [published Online First: Mar].

37 Bishop D, Dyer RA, Maswime S, et al. Maternal and neonatal outcomes after caesarean delivery in the African Surgical Outcomes Study: a 7-day prospective observational cohort study, *The Lancet Global Health* 2019;7:e513-22 doi:10.1016/S2214-109X(19)30036-1.

Figure 1

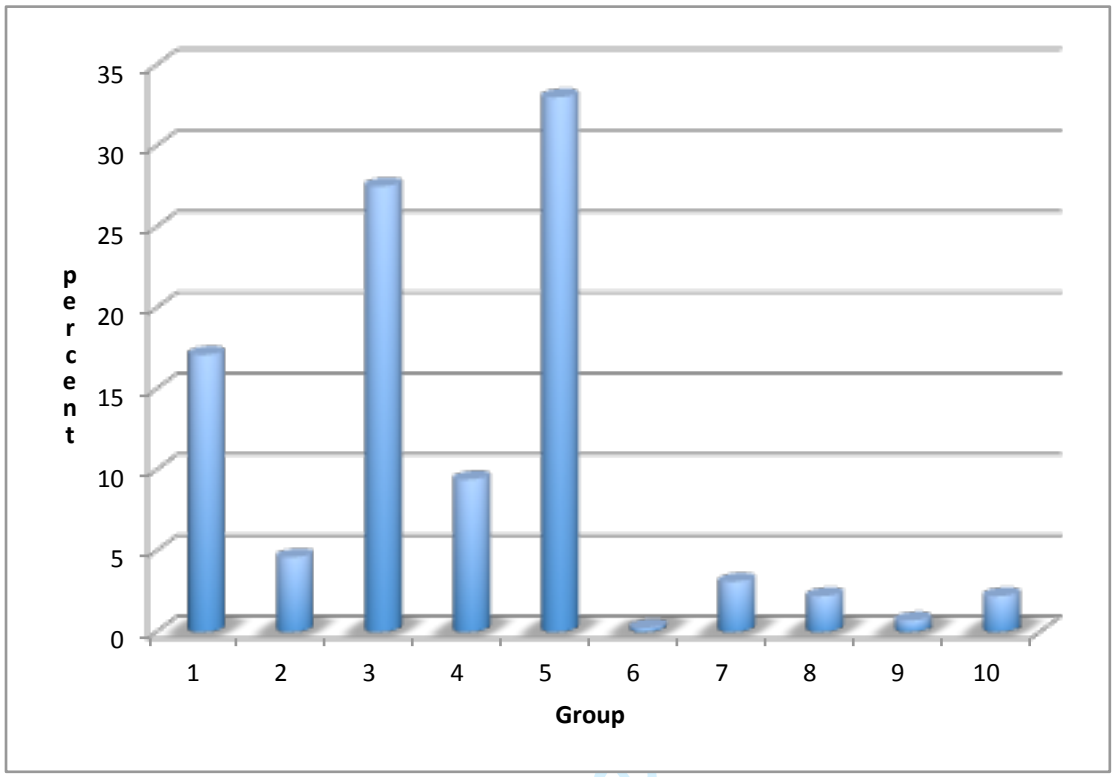

Figure 1: Distribution of women undergoing CS according to the Robson groups in selected private hospitals in eastern Ethiopia, 2020.

Figure 2

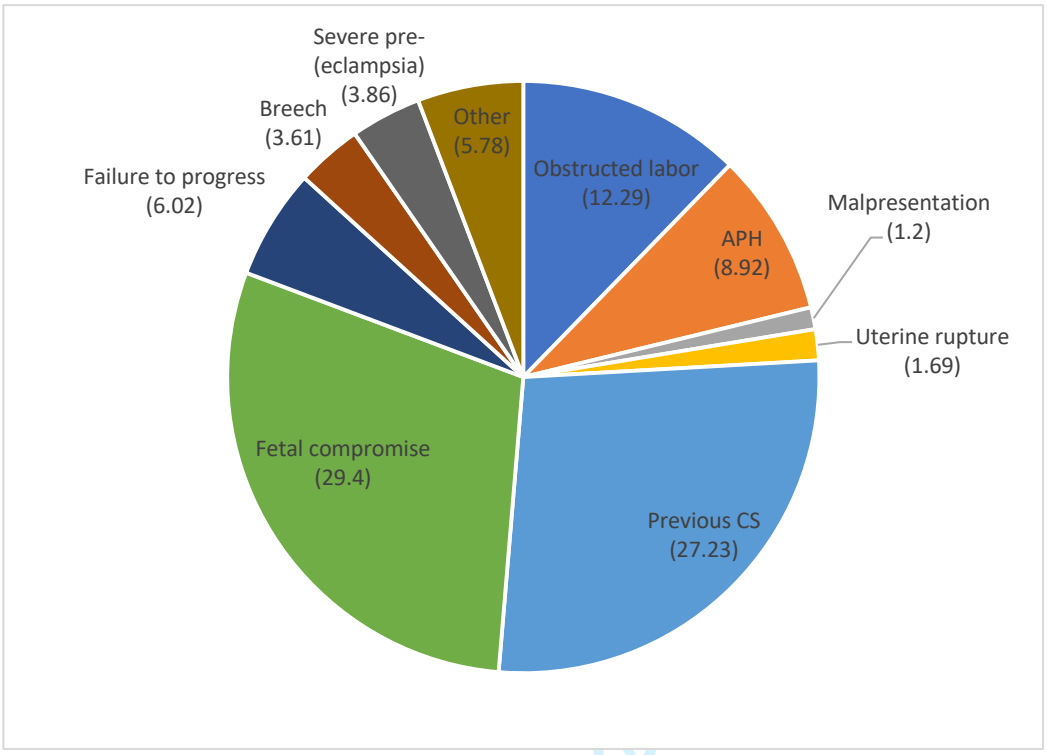

Figure 2: Indications for performing CS in selected private hospitals in eastern Ethiopia, 2020.

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

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

Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	6
		(b) Give reasons for non-participation at each stage	6
		(c) Consider use of a flow diagram	6
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	6
		(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	7-9
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	7-9
		(*b*) Report category boundaries when continuous variables were categorized	na
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	na
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	na
Discussion			
Key results	18	Summarise key results with reference to study objectives	9
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
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	10
Generalisability	21	Discuss the generalisability (external validity) of the study results	10
Other information			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	10

*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.