

Original Research Article

IMPACT OF MANDATORY CAESAREAN SECTION AUDITS ON OBSTETRIC DECISION MAKING: A ROBSON CLASSIFICATION-BASED ANALYSIS OF CHANGING TRENDS IN A TEACHING HOSPITALS

Chimpiri Sudhakar¹, Nivedita Reshme², Sabahath³, A. Srilakshmi⁴

¹Associate Professor of OBG, Department of OBG, Government Medical College and GGH, Adoni, Kurnool District, Andhra Pradesh, India.

²Assistant Professor of OBG, Department of OBG, Ramaiah Medical College, Bengaluru, India.

³Assistant Professor of OBG, Department of OBG, Government Medical College and GGH, Adoni, Kurnool District, Andhra Pradesh, India.

⁴Professor of OBG, Government Medical College, Ananthapuramu, Andhra Pradesh, India.

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Corresponding Author:

Dr. Sabahath,
Assistant Professor of OBG,
Department of OBG, Government
Medical College and GGH, Adoni,
Kurnool District, Andhra Pradesh,
India.
Email: sabahathmbbs@gmail.com

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ABSTRACT

Background: Rising Caesarean Section (CS) rates have prompted governments and healthcare authorities to introduce mandatory CS audits to ensure that surgical deliveries are performed only for appropriate medical indications. The Robson Ten-Group Classification System provides a standardized method for evaluating CS trends and identifying opportunities to reduce unnecessary procedures while maintaining maternal and neonatal safety. **Aim:** To assess the impact of mandatory Caesarean Section audits on obstetric decision-making using the Robson Classification System and to evaluate changing trends in indications, maternal comorbidities, and pregnancy outcomes in a teaching hospital.

Materials and Methods: This observational study analyzed 1,897 deliveries before and after implementation of mandatory CS audits. Maternal demographic characteristics, Robson classification groups, obstetric and non-obstetric indications (anemia, cardiovascular, renal, endocrine, and respiratory disorders), audit compliance, and maternal and neonatal outcomes were evaluated.

Results: Of the 1,897 deliveries, 684 were Caesarean Sections. The overall CS rate decreased from 38.7% in the pre-audit period to 33.4% in the post-audit period. Robson Group 5 remained the largest contributor to CS deliveries (31.8%). Improved audit scrutiny reduced Caesarean Sections performed for poorly documented indications and increased successful vaginal birth after Caesarean from 22.4% to 35.8%. Severe anemia (7.1%), endocrine disorders (4.1%), cardiovascular diseases (3.4%), and renal disorders (2.2%) were the major non-obstetric contributors. Maternal morbidity decreased from 10.8% to 7.2%, while NICU admissions declined from 10.2% to 7.9%. Compliance with audit recommendations improved from 80.3% to 96.1%.

Conclusion: Mandatory Caesarean Section audits based on the Robson Classification System significantly improved evidence-based obstetric decision-making, reduced unnecessary Caesarean deliveries, and enhanced maternal and neonatal outcomes without compromising patient safety.

Keywords: Caesarean Section Audit, Robson Classification, Obstetric Decision-Making, Maternal Outcomes, Neonatal Outcomes, Quality Improvement.

INTRODUCTION

Caesarean Section (CS) is one of the most commonly performed surgical procedures in obstetric practice

and has contributed significantly to reductions in maternal and neonatal mortality when performed for appropriate medical indications. Over the past three decades, however, a substantial increase in Caesarean

Section rates has been observed worldwide, raising concerns regarding the overutilization of operative delivery in situations where vaginal birth may be safely achieved. According to global estimates, Caesarean Section rates have increased in almost all regions of the world, often exceeding the levels considered necessary for optimal maternal and neonatal outcomes.^[1]

The reasons for increasing Caesarean Section rates are multifactorial. Demographic changes such as delayed childbearing, increased maternal age, obesity, infertility treatments, and higher prevalence of chronic medical disorders have contributed to increased obstetric complexity.^[1,2,3]

In India and many developing countries, rising Caesarean Section rates have attracted the attention of healthcare administrators and policymakers. Concerns have been expressed regarding Caesarean deliveries being performed for non-standard indications, inadequate documentation, defensive medical practice, and variation in clinical judgment among healthcare providers. To address these issues, governmental agencies and healthcare organizations have increasingly advocated mandatory audit systems aimed at evaluating the appropriateness of Caesarean Section indications and promoting evidence-based obstetric care.^[4,5,6,7]

Several studies have demonstrated significant differences in Caesarean Section rates between public and private healthcare institutions, suggesting that non-clinical factors may also influence decision-making.^[8,9,10]

Clinical audit has emerged as an important quality improvement strategy in modern healthcare. Audit involves systematic review of clinical practices against established standards, identification of deficiencies, implementation of corrective measures, and reassessment of outcomes. In obstetrics, Caesarean Section audits provide an opportunity to evaluate decision-making processes, identify potentially avoidable procedures, improve documentation, and enhance adherence to clinical guidelines.^[11] Several quality improvement initiatives have demonstrated that structured audit and feedback mechanisms can successfully reduce unnecessary Caesarean Sections without adversely affecting maternal or neonatal outcomes.^[7,12,13]

A major challenge in Caesarean Section audit programs is the lack of standardized methods for comparing Caesarean rates across institutions and populations. Differences in patient characteristics, referral patterns, obstetric risk profiles, and clinical practices often make direct comparison difficult. To overcome these limitations, the Robson Ten-Group Classification System was developed by Michael Robson and subsequently endorsed by the World Health Organization as the preferred method for monitoring Caesarean Section rates.^[14,15]

The Robson Classification System categorizes all women admitted for delivery into ten mutually exclusive and totally inclusive groups based on five obstetric variables: parity, previous Caesarean

Section, onset of labour, fetal presentation, number of fetuses, and gestational age.^[16,17] Because every pregnant woman can be assigned to one and only one group, the system allows meaningful comparison between institutions, regions, and countries. Its simplicity, reproducibility, and clinical relevance have led to widespread international acceptance.

Numerous studies have demonstrated the utility of the Robson Classification System in identifying groups that contribute disproportionately to overall Caesarean Section rates.^[4,6,11] In addition, improvements in fetal surveillance, medicolegal concerns, fear of labor pain, maternal request for Caesarean delivery, convenience of scheduling deliveries, and variations in clinical practice patterns have all been implicated as contributing factors.^[13] In most institutions, Robson Group 5, consisting of women with previous Caesarean Sections and singleton cephalic pregnancies at term, contributes the largest proportion of operative deliveries. Groups 1 and 2, which include nulliparous women with singleton cephalic pregnancies at term, also contribute substantially to primary Caesarean Section rates.^[6,14] Identification of these high-contributing groups enables development of targeted interventions aimed at optimizing delivery practices.

The World Health Organization (WHO) has repeatedly emphasized that Caesarean Section should be performed only when medically justified and that efforts should focus on ensuring appropriate use rather than achieving a predetermined target rate.^[18] Although Caesarean delivery can be life-saving in selected clinical circumstances, unnecessary surgical intervention exposes mothers and newborns to avoidable risks including postpartum hemorrhage, infection, thromboembolic events, anesthetic complications, prolonged hospitalization, neonatal respiratory morbidity, and complications in subsequent pregnancies.^[17] Furthermore, excessive Caesarean Section rates contribute significantly to healthcare expenditure and place additional burdens on healthcare systems, particularly in resource-limited settings.

The WHO Robson Classification Implementation Manual recommends routine use of the classification system as a quality indicator and monitoring tool for obstetric services.^[17] Several hospitals worldwide have successfully integrated Robson classification into their quality assurance programs and demonstrated improvements in clinical decision-making, documentation quality, and Caesarean Section utilization.^[2,6,11] These findings support the use of Robson classification as an essential component of modern obstetric audit systems.

Another important aspect influencing Caesarean Section rates is the increasing prevalence of maternal medical comorbidities. Advances in healthcare have enabled more women with chronic medical conditions to achieve successful pregnancies. Consequently, obstetricians are increasingly required to manage pregnancies complicated by severe anemia, cardiovascular disease, diabetes mellitus,

renal disorders, respiratory illnesses, neurological conditions, and other systemic diseases.^[13] These conditions frequently influence decisions regarding timing and mode of delivery.

Severe maternal anemia remains a major public health problem in developing countries and has been associated with increased risk of maternal morbidity, postpartum hemorrhage, fetal growth restriction, preterm birth, and adverse neonatal outcomes. Similarly, cardiovascular diseases represent one of the leading indirect causes of maternal mortality worldwide and often necessitate multidisciplinary management during pregnancy and childbirth. Renal disorders, endocrine diseases, and respiratory illnesses may further complicate obstetric management and influence delivery decisions.

Although some maternal medical conditions clearly justify Caesarean delivery, others may not necessarily require operative intervention if appropriate monitoring and supportive care are available. Therefore, careful audit of indications becomes essential to ensure that Caesarean Sections are performed only when clinically warranted. The distinction between genuine medical necessity and potentially avoidable intervention remains a key objective of modern obstetric quality assurance programs.

The implementation of mandatory Caesarean Section audits has gained increasing attention as a mechanism for improving patient safety and quality of care. Audit programs encourage multidisciplinary review of indications, facilitate adherence to evidence-based protocols, improve documentation standards, and promote accountability among healthcare providers. Such systems may also help identify institutional trends, educational needs, and opportunities for practice improvement.^[7,12]

Despite increasing adoption of audit-based quality improvement initiatives, limited information is available regarding their impact in teaching hospitals serving mixed populations of low-risk and high-risk pregnancies. Furthermore, relatively few studies have evaluated both obstetric and non-obstetric indications within the framework of Robson classification-based audits. Understanding the contribution of maternal medical disorders to Caesarean Section decision-making is particularly important in tertiary care institutions that manage complex referrals.

Therefore, the present study was undertaken to evaluate the impact of mandatory Caesarean Section audits on obstetric decision-making using the Robson Ten-Group Classification System in a tertiary care teaching hospital. The study aimed to analyze changing trends in Caesarean Section rates, evaluate the distribution of obstetric and non-obstetric indications, assess maternal demographic characteristics, and determine the influence of audit-based interventions on maternal and neonatal outcomes. By identifying factors contributing to Caesarean Section utilization and assessing the effectiveness of structured audit programs, the study

seeks to support evidence-based obstetric practice and contribute to ongoing efforts aimed at optimizing Caesarean Section rates while maintaining maternal and neonatal safety.

MATERIALS AND METHODS

This hospitals-based observational analytical study was conducted in the Departments of Obstetrics and Gynecology of a tertiary care teaching hospitals over a period of 24 months to evaluate the impact of mandatory Caesarean Section (CS) audits on obstetric decision-making using the Robson Ten-Group Classification System. The study compared Caesarean Section trends, indications, audit outcomes, and maternal and neonatal outcomes before and after implementation of a structured Caesarean Section audit program as a multicentric study. Ethical clearance was obtained from the Institutional Ethics Committees prior to commencement of the study.

A total of 1,897 deliveries occurring during the study period were screened for eligibility. The inclusion criteria comprised all pregnant women delivering at or beyond 28 weeks of gestation within the institution, irrespective of age, parity, gravidity, booking status, socioeconomic status, or obstetric risk category. Both singleton and multiple pregnancies, women undergoing vaginal delivery, and those delivered by Caesarean Section were included. Women with previous Caesarean Sections and pregnancies complicated by obstetric or medical disorders were also eligible for inclusion. Exclusion criteria included incomplete medical records, missing documentation regarding delivery indications or maternal and neonatal outcomes, deliveries conducted outside the institution with subsequent referral after childbirth, and cases in which accurate Robson classification could not be assigned because of inadequate clinical information.

A multidisciplinary Caesarean Section Audit Committee consisting of senior obstetricians, anesthesiologists, neonatologists, and quality assurance personnel reviewed all Caesarean Section cases through weekly and monthly audit meetings. The audits assessed the appropriateness of indications, adherence to evidence-based clinical guidelines, quality of documentation, and maternal and neonatal outcomes. Cases were categorized as clearly justified obstetric indications, medically indicated non-obstetric conditions, relative indications requiring specialist review, or potentially avoidable Caesarean Sections.

Maternal demographic variables analyzed included age, gravidity, parity, educational status, socioeconomic status, body mass index, residence, gestational age at delivery, antenatal booking status, number of antenatal visits, and previous Caesarean Section history. Obstetric variables included onset of labor, induction status, fetal presentation, number of fetuses, gestational age, previous uterine scar,

premature rupture of membranes, labor progression, and intrapartum complications.

The indications for Caesarean Section were classified into obstetric and non-obstetric categories. Obstetric indications included previous Caesarean Section, fetal distress, failed induction of labor, cephalopelvic disproportion, obstructed labor, malpresentation, placenta previa, placenta accreta spectrum disorders, abruptio placentae, multiple pregnancy, hypertensive disorders of pregnancy, eclampsia, severe oligohydramnios, intrauterine growth restriction, cord prolapse, uterine rupture, and failed instrumental delivery.

Non-obstetric indications included maternal medical disorders that could influence the mode of delivery. These comprised severe anemia and other hematological disorders, cardiovascular diseases such as rheumatic heart disease, congenital heart disease and cardiomyopathy, renal disorders including chronic kidney disease and nephrotic syndrome, endocrine disorders such as gestational and pre-existing diabetes mellitus and thyroid disease, respiratory disorders including bronchial asthma and pulmonary hypertension, neurological disorders such as epilepsy, and other systemic illnesses including autoimmune, hepatic, infectious, and malignant conditions.

All women were categorized according to the World Health Organization-recommended Robson Ten-Group Classification System based on parity, previous Caesarean Section status, onset of labor, fetal presentation, number of fetuses, and gestational age. The contribution of each Robson group to the overall Caesarean Section rate was calculated and compared between the pre-audit and post-audit periods.

To objectively evaluate clinical decision-making, a Caesarean Justification Score with a maximum score of 20 points was utilized. The score assessed appropriateness of indication, guideline compliance, adequacy of maternal and fetal assessment, consultant approval, multidisciplinary review, and completeness of documentation. Scores of 18–20 were considered excellent, 15–17 good, 12–14 acceptable, and less than 12 indicative of the need for further review.

An Audit Compliance Score with a maximum score of 100 points was also employed to assess documentation quality, adherence to clinical guidelines, accuracy of Robson classification, appropriateness of indications, review of maternal and neonatal outcomes, and implementation of corrective actions. Scores above 90 indicated excellent compliance, scores between 80 and 89 indicated good compliance, scores between 70 and 79 indicated satisfactory compliance, and scores below 70 required quality improvement interventions.

Maternal outcome measures included postpartum hemorrhage, blood transfusion requirement, wound infection, endometritis, thromboembolic complications, intensive care unit admission, duration of hospital stay, maternal readmission, and maternal mortality. Neonatal outcomes assessed included birth weight, Apgar scores at one and five minutes, neonatal intensive care unit admission, respiratory distress syndrome, neonatal sepsis, neonatal mortality, and perinatal mortality.

Data were collected from labor room registers, operation theatre records, inpatient case sheets, discharge summaries, neonatal records, audit reports, and hospital information systems using a standardized data collection proforma. Statistical analysis was performed using SPSS version 26.0. Continuous variables were expressed as mean $\pm$ standard deviation and categorical variables as frequencies and percentages. Appropriate statistical tests including Chi-square test, Fisher's exact test, and Student's t-test were applied. A p-value of less than 0.05 was considered statistically significant.

RESULTS

A total of 1,897 deliveries were analyzed during the study period, comprising 948 deliveries in the pre-audit phase and 949 deliveries in the post-audit phase. Among these, 684 women underwent Caesarean Section, yielding an overall Caesarean Section rate of 36.1%. Following implementation of mandatory Caesarean Section audits, a reduction in Caesarean Section rates, improvement in documentation quality, and increased compliance with evidence-based obstetric guidelines were observed.

Table 1: Maternal Demographic Characteristics (n = 1897)

Variable	Number	Percentage (%)
Age <20 years	218	11.5
Age 21–30 years	1182	62.3
Age >30 years	497	26.2
Primigravida	805	42.4
Multigravida	1092	57.6
Urban Residence	1128	59.5
Rural Residence	769	40.5

The majority of women belonged to the 21–30 years age group, accounting for 62.3% of the study population. Multigravidas constituted 57.6% of deliveries, while urban residents formed the larger proportion of patients.

Inference: The study population predominantly consisted of young multigravid women belonging to the reproductive age group.

Table 2: Major Obstetric Indications for Caesarean Section (n = 684)

Indication	Number	Percentage (%)
Previous Caesarean Section	149	21.8
Fetal Distress	140	20.5
Failed Induction	77	11.2
Cephalopelvic Disproportion	67	9.8
Malpresentation	55	8.1
Hypertensive Disorders	49	7.2
Placenta Previa/Accreta	31	4.5
Others	116	16.9

Previous Caesarean Section and fetal distress were the leading indications for operative delivery, together contributing more than 40% of all Caesarean

Sections. Failed induction and cephalopelvic disproportion were other important contributors.

Inference: Repeat Caesarean Sections remain the major determinant of institutional Caesarean rates

Table 3: Non-Obstetric Medical Indications Influencing Caesarean Delivery

Medical Condition	Number	Percentage (%)
Severe Anemia	49	7.1
Diabetes Mellitus	28	4.1
Cardiovascular Disease	23	3.4
Renal Disorders	15	2.2
Respiratory Disorders	11	1.6
Neurological Disorders	9	1.3
Other Medical Disorders	20	2.9

Severe anemia was the most common non-obstetric factor influencing the decision for Caesarean delivery. Cardiovascular, endocrine, and renal disorders also contributed significantly to operative interventions.

Inference: Maternal medical comorbidities represent important determinants of Caesarean decision-making in high-risk pregnancies.

Table 4: Distribution According to Robson Classification

Robson Group	Number of CS	Percentage Contribution (%)
Group 1	105	15.4
Group 2	127	18.6
Group 3	54	7.9
Group 4	50	7.3
Group 5	217	31.8
Groups 6–10	131	19.0

Robson Group 5 contributed the highest proportion of Caesarean Sections, followed by Groups 2 and 1. Together, these three groups accounted for nearly two-thirds of all Caesarean deliveries.

Inference: Targeted interventions in Groups 1, 2, and 5 may substantially reduce institutional Caesarean rates.

Table 5: Impact of Mandatory Audit on Caesarean Section Rates

Parameter	Pre-Audit	Post-Audit
Total Deliveries	948	949
Caesarean Sections	367	317
CS Rate (%)	38.7	33.4
Evidence-Based Indications (%)	80.3	96.1
VBAC Success (%)	22.4	35.8

Following implementation of mandatory audits, the Caesarean Section rate decreased by more than 5 percentage points. Significant improvements were observed in documentation quality and utilization of vaginal birth after Caesarean.

Inference: Regular audit and feedback mechanisms improve adherence to evidence-based obstetric practices.

Table 6: Maternal and Neonatal Outcomes

Outcome	Pre-Audit (%)	Post-Audit (%)
Maternal Morbidity	10.8	7.2
Postpartum Hemorrhage	3.1	2.1
Wound Infection	3.9	2.0
ICU Admission	2.4	1.3
NICU Admission	10.2	7.9
Low Apgar Score	5.8	3.9

Maternal complications including postpartum hemorrhage, wound infection, and ICU admissions declined following implementation of audit recommendations. Improvements were also observed in neonatal outcomes, including reduced NICU admissions and low Apgar scores.

Inference: Audit-guided decision-making was associated with improved maternal and neonatal safety.

The findings of the present study are comparable with those reported by Abubeker et al., Vila-Candel et al., Eyi and Mollamahmutoglu, Baser et al., and Sharma et al., all of whom identified Robson Group 5 as the largest contributor to institutional Caesarean Section rates. The overall Caesarean Section rate observed in the present study (36.1%) falls within the range reported by similar tertiary care institutions internationally.

Table 7: Comparative Analysis of the Present Study with Published Robson Classification Studies

Study	Year	Sample Size	Overall CS Rate (%)	Major Contributing Robson Group
Present Study	2026	1897	36.1	Group 5
Abubeker et al. (Ethiopia)	2020	4,200	38.3	Group 5
Vila-Candel et al. (Spain)	2020	3,101	18.4	Group 5
Eyi and Mollamahmutoglu (Turkey)	2021	5,323	51.2	Group 5
Baser et al. (India)	2021	1,284	34.8	Group 5
Sharma et al. (India)	2019	1,200	32.6	Group 5

The reduction in Caesarean Section rates following implementation of mandatory audit mechanisms in the present study is consistent with observations from quality improvement initiatives reported by Bhartia et al. and Negrini et al., which demonstrated that structured audit and feedback systems improve adherence to evidence-based obstetric practices and reduce unnecessary operative deliveries.

Inference: The present study corroborates international evidence that Robson Group 5 remains the principal contributor to Caesarean Section rates and that regular audit-based review can serve as an effective quality assurance strategy for optimizing obstetric decision-making.

DISCUSSION

The present study demonstrated that implementation of mandatory Caesarean Section audits significantly influenced obstetric decision-making and resulted in a reduction in overall Caesarean Section rates from 38.7% to 33.4%. These findings support the growing evidence that structured audit systems can improve clinical practice, reduce unnecessary operative deliveries, and enhance compliance with evidence-based guidelines without adversely affecting maternal or neonatal outcomes.^[7,12]

The majority of women included in the study belonged to the 21–30-year age group, and multigravidas constituted more than half of the study population. These demographic findings are comparable to those reported by Abubeker et al. and Sharma et al., who observed similar age and parity distributions among women undergoing delivery in tertiary care settings.^[4,6] The demographic profile reflects the reproductive age group commonly encountered in obstetric practice and provides a representative population for evaluating Caesarean Section trends.

Robson Group 5 was identified as the largest contributor to Caesarean Section rates in the present study. This observation is consistent with reports

from Ethiopia, Spain, Turkey, and India, where women with previous Caesarean Sections accounted for the greatest proportion of operative deliveries.^[6,11,14] The findings reinforce the importance of reducing primary Caesarean Sections and encouraging carefully selected vaginal birth after Caesarean (VBAC) programs. Following implementation of audit recommendations, the VBAC success rate increased substantially, supporting recommendations made by the American College of Obstetricians and Gynecologists regarding trial of labor after Caesarean delivery.^[5]

Fetal distress and previous Caesarean Section were the most common indications for operative delivery. Similar findings have been reported in several studies utilizing the Robson classification system.^[4,8,15] The audit process encouraged more stringent evaluation of fetal heart rate abnormalities and consultant review of borderline indications, thereby reducing potentially avoidable Caesarean Sections.

An important finding of this study was the contribution of maternal medical disorders to Caesarean decision-making. Severe anemia emerged as the most common non-obstetric indication, followed by diabetes mellitus, cardiovascular disease, and renal disorders. These observations are particularly relevant in developing countries where maternal nutritional deficiencies and chronic medical conditions remain prevalent. Multidisciplinary review ensured that operative delivery was reserved for situations where maternal or fetal benefit clearly outweighed surgical risks.

The observed reduction in maternal morbidity following implementation of mandatory audits is noteworthy. Rates of postpartum hemorrhage, wound infection, and intensive care unit admission decreased during the post-audit period. Similar improvements have been reported following quality improvement initiatives aimed at optimizing Caesarean Section utilization.^[7,12] Reduced exposure to unnecessary surgery may have contributed directly to these favorable outcomes.

Neonatal outcomes also improved following implementation of the audit program. Reduced NICU admissions and lower rates of low Apgar scores suggest that efforts to decrease Caesarean Section rates did not compromise neonatal safety. These findings support the WHO recommendation that quality improvement initiatives should focus on appropriateness of Caesarean delivery rather than merely reducing operative rates.^[17,18,19]

The strengths of the present study include utilization of the WHO-recommended Robson Classification System, incorporation of structured audit mechanisms, assessment of both obstetric and non-obstetric indications, and evaluation of maternal and neonatal outcomes. The multidisciplinary nature of the audit process provided comprehensive review of clinical decision-making and facilitated implementation of corrective measures.

However, certain limitations should be acknowledged. The study was conducted at a single tertiary care teaching hospital and may not be representative of all healthcare settings. Variations in referral patterns, patient characteristics, and institutional policies may influence Caesarean Section rates and limit generalizability. Future multicenter studies involving larger populations and longer follow-up periods are recommended to further validate the effectiveness of mandatory audit systems.

In conclusion, mandatory Caesarean Section audits utilizing the Robson Ten-Group Classification System significantly improved evidence-based obstetric decision-making, reduced unnecessary Caesarean deliveries, and enhanced maternal and neonatal outcomes. Regular audit and feedback mechanisms should be integrated into institutional quality assurance programs to promote optimal Caesarean Section utilization and improve overall standards of obstetric care.

Limitations of the Study

Limitations

Although the study included a substantial number of deliveries, larger studies with longer follow-up periods may provide additional evidence regarding the impact of Caesarean Section audits. The observational design limits the ability to establish a direct causal relationship between audit implementation and changes in Caesarean Section rates. Long-term maternal and neonatal outcomes, as well as certain non-clinical factors influencing obstetric decision-making, were not evaluated in the present study.

CONCLUSION

Author Contributions

Author 1: Conceived and designed the study, developed the research protocol, supervised data collection, chaired the Caesarean Section audit committee, interpreted the results, and performed

critical revision of the manuscript for important intellectual content.

Author 2: Participated in online patient recruitment, data collection, maintenance of obstetric records, compilation of Robson Classification data, and contributed to literature review and preparation of the results section.

Author 3: Assisted in data analysis, statistical interpretation, audit documentation, evaluation of maternal and neonatal outcomes, preparation of tables, and drafting of the discussion section.

Author 4: Performed literature search, reference management, manuscript formatting, preparation of figures and comparative analysis tables, and contributed to manuscript writing, editing, and final proofreading.

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