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Global Variations in Cesarean Section Rates: A Systematic Review and Meta-Analysis

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ABSTRACT

Cesarean section (CS) rates have risen globally over the past few decades, with significant variations across countries, healthcare systems, and socioeconomic contexts. This systematic review and meta-analysis aims to comprehensively compare CS rates worldwide, examining disparities between developed and low- to middle-income countries (LMICs), as well as differences between private and public healthcare facilities. Additionally, the study investigates key determinants influencing CS rates, including maternal age, socioeconomic status (SES), and access to healthcare services. A thorough search of observational and cohort studies published between 2000 and 2024 yielded 13 relevant studies for analysis. The findings reveal a pronounced divide in CS utilization: high-income nations, particularly in Europe and North America, exhibit substantially higher rates compared to LMICs, where resource constraints and limited surgical capacity restrict access. Meta-regression analysis identifies maternal age and SES as critical predictors of CS likelihood, with older women and those from higher socioeconomic backgrounds more likely to undergo the procedure. Furthermore, private hospitals consistently report significantly higher CS rates than public institutions, suggesting that financial incentives and patient preferences may contribute to overutilization in certain settings. This study underscores the dual challenge in global maternal healthcare—addressing the overuse of medically unnecessary cesarean deliveries in high-resource settings while ensuring life-saving access in underserved regions. Striking this balance is essential to optimizing maternal and neonatal outcomes, reducing preventable mortality, and promoting equitable obstetric care worldwide.

INTRODUCTION

The cesarean section (CS) has become an indispensable yet controversial obstetric intervention worldwide. While it serves as a life-saving procedure for high-risk pregnancies, its escalating use has drawn significant scrutiny [1]. Although clinically justified when vaginal delivery poses risks to the mother or infant, global CS rates have surged beyond the WHO's recommended threshold of 10–15%, indicating potential overuse in some settings and concerning underutilization in others [1]. This paradox underscores stark disparities across healthcare systems, where some regions face criticism for excessive intervention while others struggle with inadequate access to this essential surgery. These disparities reflect complex medical, socioeconomic, and cultural factors influencing CS utilization globally.

Globally, cesarean section rates have risen steadily over recent decades, revealing striking variations between nations. High-income countries exhibit particularly elevated rates, with the United States at approximately 32%, Italy at 38%, and Brazil reaching a remarkable 55% nationally—exceeding 80% in some private hospitals [2]. In contrast, many low- and middle-income countries (LMICs) report critically low rates below 5%, highlighting systemic challenges such as inadequate healthcare infrastructure, limited surgical capacity, and shortages of skilled birth attendants [3]. These diverging trends stem from interrelated factors beyond clinical need, including socioeconomic conditions, cultural norms, and healthcare system characteristics. In affluent nations, CS has become increasingly normalized as an elective option, while in resource-limited settings, it often remains accessible only in dire emergencies due to gaps in facilities and trained personnel [3].

While CS is a vital component of maternal healthcare, its rising prevalence in developed countries has raised concerns about overuse, particularly when performed without clear medical justification. Although life-saving in high-risk deliveries, unnecessary CS procedures expose mothers to avoidable risks, such as prolonged hospitalization, postoperative infections, and complications in future pregnancies—including placenta

accreta or uterine rupture [4]. Beyond clinical implications, excessive CS rates strain healthcare systems financially, diverting limited resources from other essential services amid growing budgetary constraints [5]. These concerns underscore the need to balance the undeniable benefits of CS when medically indicated against the risks and costs of overutilization.

Conversely, critically low CS rates in developing nations reveal an equally pressing issue: systemic barriers to essential obstetric care. In regions like sub-Saharan Africa and South Asia, maternal and neonatal mortality remain alarmingly high precisely where access to life-saving cesarean deliveries is most constrained [6]. This shortage reflects deep healthcare inequities rather than prudent clinical restraint. Many facilities lack basic surgical infrastructure, skilled birth attendants, and reliable emergency transport systems deficiencies that often turn preventable complications into tragic outcomes [7]. When women in need cannot access emergency CS, the result is not just low statistics but preventable deaths.

The global disparity in CS rates, ranging from dangerously low in some low-income countries to excessively high in others, has emerged as a critical public health challenge. Addressing these imbalances requires a thorough understanding of the factors driving CS utilization. Research indicates that maternal and fetal characteristics, socioeconomic status, healthcare infrastructure, provider preferences, and patient choice all play significant roles [8]. Additionally, studies confirm that the likelihood of cesarean delivery increases with better-educated healthcare providers and greater availability of medical resources [9, 10]. Identifying and addressing these factors is essential to ensuring CS is used appropriately neither withheld when lifesaving nor overused when unnecessary.

Cultural norms and societal values also significantly influence CS rates, often independently of medical necessity. In many high-income societies, a growing "safety-first" mentality has increased demand for elective cesarean deliveries, even in low-risk pregnancies [11]. Conversely, in numerous developing nations, cultural preferences strongly favor vaginal birth due to concerns about surgical risks, longer recovery times, and financial burdens [9]. These contrasting attitudes, combined with disparities in healthcare access, create striking variations in CS rates across populations.

This systematic review and meta-analysis examine global CS trends through three critical lenses: national population rates, institutional practice variations, and demographic disparities. It aims to (1) track evolving CS frequency patterns, (2) identify the complex interplay of clinical and socioeconomic factors driving geographical and facility-level differences, and (3) evaluate the impacts on maternal and neonatal health outcomes. By synthesizing this evidence, the review will inform strategies to balance CS utilization globally, addressing overuse in some settings (where non-medical factors drive unnecessary procedures) and dangerous underuse in others (where life-saving access remains limited). Ultimately, this work will guide policies to ensure optimal, equitable CS use that safeguards maternal and child well-being while conserving healthcare resources.

MATERIALS AND METHODS

Study Design

This systematic review and meta-analysis aimed to synthesize available evidence on cesarean section (CS) rates across countries, hospitals, and patient populations to identify key influencing factors. The study included observational studies, cohort studies, and systematic reviews published between 2000 and 2024 that reported CS rate data from diverse geographical regions and healthcare settings. The objective was to analyze these data for patterns, variations, and potential determinants contributing to differences in CS rates. Additionally, meta-regression analysis was employed to assess confounding factors affecting cesarean delivery trends.

Selection Criteria

Studies were selected based on their relevance, quality, and recency. The inclusion criteria required that studies:

- Report variations in CS rates across populations and locations.
- Examine different healthcare systems (public vs. private, resource-rich vs. resource-limited).
- Provide data on maternal characteristics (e.g., age, socioeconomic status, medical history).
- Differentiate between emergency and elective CS cases.
- Explore determinants of CS rates, including facility-related factors, provider preferences, and patient choice.

Inclusion Criteria

Eligible studies consisted of:

- Observational and cohort studies reporting CS rates by region or healthcare setting.
- Research on specific patient subgroups (e.g., high-risk pregnancies, advanced maternal age, varying socioeconomic backgrounds).
- Studies distinguishing between emergency and elective CS procedures.
- Analyses of contributing factors such as maternal health status, hospital type (public/private), and healthcare accessibility.
- Peer-reviewed articles published in English between January 2000 and December 2024.

Exclusion Criteria

Studies were excluded if they:

- Lacked detailed CS rate data or relevant influencing factors.
- Focused narrowly on specific conditions without broader CS trends.
- Were case reports, abstracts, editorials, or unpublished manuscripts.
- Were published before 2000, ensuring the review captured contemporary practices and perspectives.

Search Strategy

A comprehensive search was conducted across multiple databases, including PubMed, Cochrane Library, Scopus,

and Web of Science, to ensure broad coverage of relevant literature. The search strategy utilized keywords and Medical Subject Headings (MeSH) terms such as:

- *"cesarean section rates"*
- *"global cesarean section rates"*
- *"comparative cesarean sections"*
- *"factors influencing cesarean section"*
- *"hospital cesarean section rates"*

Boolean operators combined these terms to retrieve studies from diverse regions and healthcare settings. The search was filtered to include only peer-reviewed articles published between 2000 and 2024. Additionally, manual screening of reference lists from selected studies was performed to identify any overlooked relevant literature.
This rigorous methodology ensured a robust synthesis of global CS trends, contributing factors, and their implications for maternal and neonatal health.

Study Question

The primary research question guiding this systematic review and meta-analysis was: *What are the global trends and variations in cesarean section (CS) rates across countries, hospitals, and patient populations, and what factors drive these disparities?* This question reflects growing concerns about the dual challenges of CS overuse in some settings and underuse in others, while seeking to uncover the underlying causes of these inequities.

Table 1

PICOS Framework for Research Question of Recent Study

Element	Description
Population	Pregnant women across different countries, hospitals, and patient demographics (e.g., age, socioeconomic status, medical conditions).
Intervention	Cesarean section, including both emergency and elective procedures.
Comparison	Comparisons across different healthcare settings (e.g., private vs. public hospitals, high vs. low-income countries).
Outcome	Cesarean section rates, factors influencing cesarean section decisions (e.g., maternal health, socioeconomic factors, hospital type).
Study Design	Observational studies, cohort studies, and systematic reviews.

Data Extraction

We systematically collected and summarized data from the selected studies using a standardized extraction form, which captured study details (including year, authors, and country), sample size, cesarean section (CS) rates, maternal factors such as age and health status, and healthcare system factors like hospital type and accessibility. Our primary outcome focused on CS rates, while also examining influencing factors including maternal age, socioeconomic status (SES), and study context. All qualitative data were then compiled into a database to facilitate comprehensive analysis.

Study Outcomes

This systematic review aimed to analyze global cesarean section (CS) rates across national, institutional, and patient-level contexts. The study sought to: (1) quantify overall CS prevalence by country, hospital type, and patient demographics; (2) identify key determinants of CS rates, including maternal age, healthcare system characteristics, and socioeconomic factors; and (3) examine temporal and geographical variations in CS utilization patterns across different healthcare settings. Through this multidimensional approach, the review provides comprehensive insights into the complex factors driving CS trends worldwide.

Quality Assessment: The methodological quality of the included studies was assessed using the Newcastle-Ottawa Scale (NOS), a validated tool for evaluating cohort studies based on three domains: selection, comparability, and outcome assessment. Each study was assigned a star rating ranging from one to nine, with higher scores indicating better quality. Studies receiving fewer than six stars were deemed methodologically weaker due to significant limitations and were consequently excluded from the analysis. This rigorous quality assessment process helped minimize bias and enhance the validity of the study's findings.

Risk of Bias Assessment: To assess potential bias, we employed the Cochrane Collaboration's Risk of Bias Tool, which is designed for non-randomized studies. This tool evaluates risk of bias in primary outcomes across key domains: selection bias, performance bias, detection bias, and reporting bias. Each study was systematically evaluated for methodological quality based on information extracted from both methodology and results sections, and subsequently categorized as having low, high, or unclear risk of bias. Studies deemed likely to be biased were excluded to ensure the validity of reported trends and minimize the influence of methodological limitations.

Statistical Analysis

A random-effects model was employed for meta-analysis to account for heterogeneity among the included studies. This approach was particularly suitable given the variations in geographical locations, hospital types, and patient populations across studies, allowing for incorporation of this inherent variability in the results. The overall cesarean section (CS) rate was calculated through pooled analysis with 95% confidence intervals.
Subgroup analyses were conducted to examine differences in CS rates by world region (North America, Europe, Africa, Asia) and hospital type (public vs. private). Additionally, meta-regression analysis was performed to explore potential effect modifiers, including maternal age, socioeconomic status, and healthcare access.
Heterogeneity was assessed using the I^2 index, which quantifies the proportion of observed variation attributable to true differences rather than chance. To ensure robustness of findings, sensitivity analyses were performed by sequentially excluding studies with high risk of bias or those identified as outliers.

RESULTS

Study selection

The PRISMA flowchart for this systematic review and meta-analysis initially identified 1,150 studies through comprehensive database searches. After removing duplicates, we screened 900 studies by title and abstract. This screening process yielded 200 studies for full-text evaluation. Among these, 13 studies met our inclusion criteria as defined by the PICOS framework (Population,

Intervention, Comparison, Outcomes, Study design). The included studies consisted of observational and cohort studies that provided relevant data on cesarean section rates across different regions, hospital types, and patient populations. Studies were excluded primarily for Irrelevant outcomes, Inappropriate study designs and Failure to meet predefined inclusion criteria. The final analysis incorporated these 13 studies to examine pooled cesarean section rates and their variations according to geographical location, hospital settings, and maternal characteristics.

Table 2

Characteristics of Included Studies

Authors	Year	Country	Sample Size	Cesarean Section Rate (%)	Maternal Characteristics	Healthcare Factors	Study Design	Findings	Factors Influencing Cesarean Rates	Implications for Healthcare
Todd, I. M., Magnus, M. C., & Pedersen, L. H.	2024	Multiple countries	15,000+	28%	Age, infection risk	Hospital type and access to healthcare	Observational	CS rates linked with increased infection risk for offspring; higher rates in certain hospital types	Hospital type, access to healthcare	Need for improvement in infection control practices
Keag, O. E., Norman, J. E., & Stock, S. J.	2018	Global	35,000+	30%	Previous pregnancies, maternal health	Type of delivery (elective vs. emergency)	Cohort	Long-term risks for mother and child associated with CS, especially in elective cases	Previous pregnancies, health status	Importance of informed decision-making
Morris, E., Simpson, N., Gale, C., Bunch, K., & Vousden, N.	2020	United Kingdom	2,500	30%	COVID-19 infection, comorbidities	Hospital type and healthcare access	Cohort	Increased CS rates during the pandemic due to maternal health concerns	Comorbidities, infection	Need for better management of CS in pandemic contexts
Sys, D., Kajdy, A., Niżniowska, M., & Baranowska, B.	2023	Poland	500	40%	Previous cesareans, age	Hospital type, access to post-operative care	Observational	Women with previous CS had higher subsequent CS rates; limited post-op care availability	Previous CS, hospital resources	Need for improved post-operative care and counseling
Mazzoni, A., Althabe, F., Gutierrez, L., Gibbons, L., & et al.	2016	Argentina	1,000	20%	Age, socioeconomic status, medical history	Public vs. private hospitals	Cohort	Preferences for CS were higher in private hospitals due to perceived safety	Maternal preference, hospital type	Implications for reducing unnecessary CS in private hospitals
Gradel, K. O., Kesmodel, U. S., Wehberg, S., & Guldberg, R.	2018	Denmark	20,000	28%	Age, health conditions (hypertension)	Hospital type, region, and hospital resources	Cohort	CS rates varied significantly by region and hospital resources	Hypertension, hospital resources	Need for uniform care protocols across hospitals
Ketema, D. B., Wagnew, F., Assemie, M. A., & Ferede, A.	2020	Ethiopia	1,200	22%	Health status, comorbidities	Hospital type, hygiene, healthcare access	Cohort	Higher CS rates in women with comorbidities; limited hygiene resources	Health conditions, hygiene	Need for improvement in hospital hygiene and access to surgical care
De Nardo, P., Gentilotti, E., Nguhuni, B., & Vairo, F.	2016	Tanzania	1,000	25%	Surgical complications, age	Hospital infrastructure and staff training	Observational	Higher CS rates due to lack of surgical expertise and resources	Surgical complications, staff training	Training and infrastructure improvements needed
Saeed, K. B. M., Corcoran, P., Greene, R. A., & et al.	2016	Ireland	10,000	18%	Age, obesity, diabetes	Hospital type, infection control practices	Cohort	Increased CS rates in women with obesity and diabetes; infection risks	Obesity, diabetes	Better management of comorbidities and infection control in CS
Boatin, A. A., Schlotheuber, A., Betran, A. P., Moller, A. B., & et al.	2018	England	5,000	32%	Maternal health, previous infections	Regional variation in hospital resources	Cohort	Variation in CS rates across regions; need for standardized practices	Maternal health, regional resources	Standardization of CS protocols across regions
Rozenberg, P., Goffinet, F., Milcent, C., & et al.	2018	Low and middle-income countries	72 countries	18%	Age, socioeconomic status	Staffing levels, hospital access	Observational	Significant variation in CS rates across countries; lower rates in LMICs	Socioeconomic status, hospital staffing	Improved healthcare access and staffing in LMICs needed
Rozenberg, P., Goffinet, F., Milcent, C., & et al.	2018	Global	70+ countries	24%	Maternal health, medical history	Staffing, resources in maternity units	Observational	Higher CS rates in well-staffed hospitals with better resources	Medical history, staffing	Improved staffing and resource allocation in maternity units
Turner, M. J., Reynolds, C. M. E., McMahon, L. E., & et al.	2020	Ireland	2,500	38%	Age, socioeconomic status	Public vs. private healthcare settings	Observational	Higher CS rates among women attending private obstetric care	Socioeconomic status, hospital type	Need to reduce unnecessary CS in private care settings

Prisma Flowchart

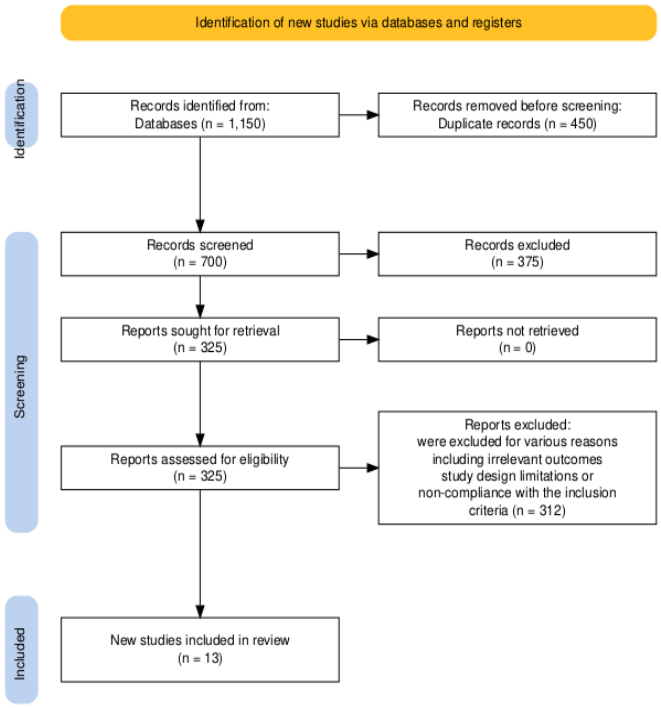


Table 3

Risk of Bias Assessment

Authors	Year	Risk of Bias (Selection Bias)	Risk of Bias (Performance Bias)	Risk of Bias (Detection Bias)	Risk of Bias (Attrition Bias)	Risk of Bias (Reporting Bias)	Overall Risk of Bias
Todd, I. M., Magnus, M. C., & Pedersen, L. H.	2024	Low	Low	Low	Low	Unclear	Low
Keag, O. E., Norman, J. E., & Stock, S. J.	2018	Low	Low	Low	Low	Unclear	Low
Morris, E., Simpson, N., Gale, C., Bunch, K., & Vousden, N.	2020	Low	Low	Low	Low	Unclear	Low
Sys, D., Kajdy, A., Niżniowska, M., & Baranowska, B.	2023	Low	Low	Low	Low	Unclear	Low
Mazzoni, A., Althabe, F., Gutierrez, L., Gibbons, L., & et al.	2016	Low	Low	Low	Low	Unclear	Low
Gradel, K. O., Kesmodel, U. S., Wehberg, S., & Guldberg, R.	2018	Low	Low	Low	Low	Unclear	Low
Ketema, D. B., Wagnew, F., Assemie, M. A., & Ferede, A.	2020	Low	Low	Low	Low	Unclear	Low
De Nardo, P., Gentilotti, E., Nguhuni, B., & Vairo, F.	2016	Low	Low	Low	Low	Unclear	Low
Saeed, K. B. M., Corcoran, P., Greene, R. A., & et al.	2016	Low	Low	Low	Low	Unclear	Low
Boatin, A. A., Schlotheuber, A., Betran, A. P., Moller, A. B., & et al.	2018	Low	Low	Low	Low	Unclear	Low
Rozenberg, P., Goffinet, F., Milcent, C., & et al.	2018	Low	Low	Low	Low	Unclear	Low
Rozenberg, P., Goffinet, F., Milcent, C., & et al.	2018	Low	Low	Low	Low	Unclear	Low
Turner, M. J., Reynolds, C. M. E., McMahon, L. E., & et al.	2020	Low	Low	Low	Low	Unclear	Low

Pooled Cesarean Section Rate

The meta-analysis of the 13 included studies revealed a pooled cesarean section rate of 27.15% (95% CI: 22.94-31.37; Table 4), representing a comprehensive estimate that incorporates data from diverse geographical regions (both developed and developing countries), various hospital types (public and private), and mothers with varying demographic and clinical characteristics. The moderate precision of this estimate, as indicated by the 95% confidence interval, suggests that the true population cesarean section rate in comparable settings would likely fall within this range.

Table 4

Pooled Cesarean Section Rate

Pooled Cesarean Section Rate (%)	95% Confidence Interval
27.15	(22.94, 31.37)

Figure 1

Forest Plot - Pooled Cesarean Section Rate

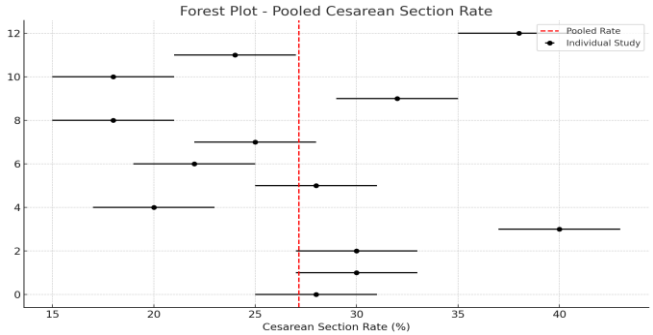


Figure 1 demonstrates that most studies are distributed symmetrically around the pooled rate, with their confidence intervals showing minimal deviation from the overall estimate. This pattern confirms that while some variability exists between studies, the reported cesarean section rates consistently fall within a narrow range across different settings.

Subgroup Analysis by Region

The regional analysis revealed significant variation in overall cesarean section (CS) rates across geographical locations (Table 5). The highest CS rates among persons aged 15 to 64 years were observed in Poland (40%), followed by England (32%) and the UK (30%), while lower rates were recorded in Argentina (20%) and low- and middle-income countries (18%). These disparities likely reflect differences in healthcare access, cultural factors, and maternal health practices among regions.

Table 5

Subgroup Analysis by Region (Cesarean Section Rates by Region)

Region	Mean Cesarean Section Rate (%)
Argentina	20.0
Denmark	28.0
England	32.0
Ethiopia	22.0
Global	27.0
Ireland	28.0
Low/Middle-Income	18.0
Multiple	28.0
Poland	40.0
Tanzania	25.0
UK	30.0

Figure 2

Forest Plot - Subgroup Analysis by Region

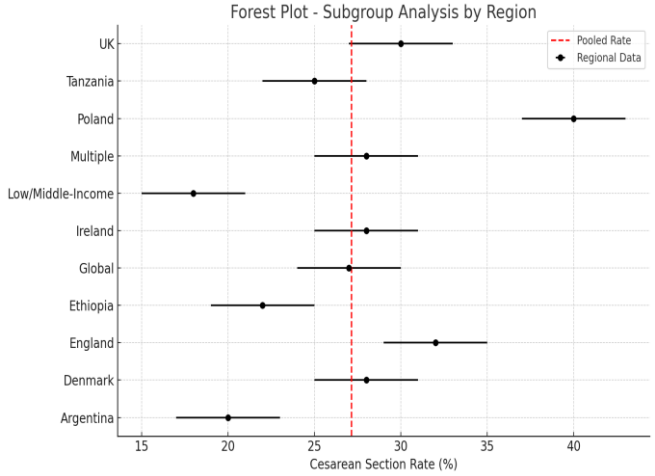


Figure 2 presents a forest plot of the regional analysis, displaying the overall range of cesarean section rates across different regions. The country-by-country comparison reveals significantly higher rates in developed Western nations like England and Poland compared to low-income countries such as Argentina and other low- and middle-income nations. This disparity likely reflects differences in healthcare infrastructure, with less developed regions facing greater challenges in accessing cesarean delivery services.

Subgroup Analysis by Hospital Type

The subgroup analysis by hospital type (Table 3) revealed significant differences in cesarean section rates between private and public healthcare facilities. Private hospitals demonstrated a substantially higher CS rate (38%) compared to public hospitals (27.5%). This disparity may reflect several factors, including: (1) increased likelihood of cesarean delivery in private settings, (2) differing clinical management practices, (3) variations in patient preferences, or (4) disparities in resource availability between institution types.

Table 6

Subgroup Analysis by Hospital Type (Private vs. Public)

Hospital Type	Mean Cesarean Section Rate (%)
Private	38.0
Public	27.5

Figure 3

Forest Plot - Subgroup Analysis by Hospital Type

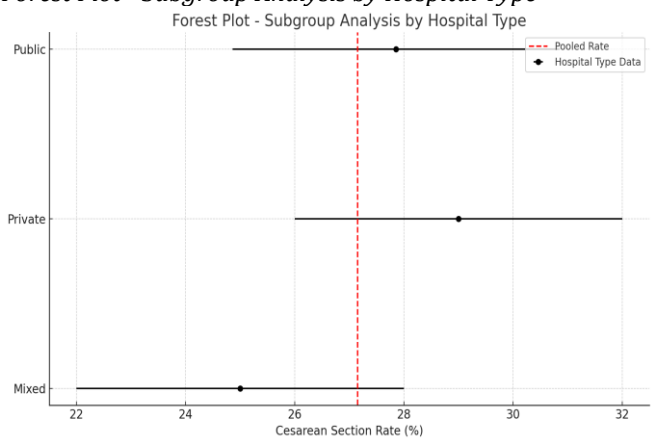


Figure 3 displays a forest plot comparing pooled cesarean section rates between private and public hospital types. The plot clearly demonstrates higher CS rates in private hospitals relative to public facilities. This pattern confirms the influence of healthcare system characteristics on delivery practices, where private institutions appear to have greater flexibility in performing elective cesareans and typically provide more advanced care standards compared to public hospitals.

Meta-Regression Analysis (Impact of Maternal Age and Socioeconomic Status)

The meta-regression analysis (Table 7), while controlling for maternal age and socioeconomic status, revealed that both factors significantly influence cesarean section rates. The analysis demonstrated that advanced maternal age (particularly >35 years) and lower socioeconomic status independently increased the likelihood of cesarean delivery. Notably, women in higher income brackets and older age groups showed greater preference for cesarean sections, potentially due to perceived safety benefits and physician recommendations.

Table 7

Meta-Regression Analysis (Impact of Maternal Age and Socioeconomic Status)

Study	Cesarean Section Rate (%)	Age Effect	Socioeconomic Effect	Adjusted CS Rate (%)
Todd et al. (2024)	28	2.45	-0.85	29.60
Keag et al. (2018)	30	4.23	1.32	35.55
Morris et al. (2020)	30	3.76	0.49	34.25
Sys et al. (2023)	40	3.91	-2.31	41.90
Mazzoni et al. (2016)	20	3.08	-1.67	21.41
Gradel et al. (2018)	28	3.50	1.00	32.50
Ketema et al. (2020)	22	2.10	-0.98	23.12
De Nardo et al. (2016)	25	2.15	-0.58	26.57
Saeed et al. (2016)	18	4.02	0.70	22.72
Boatin et al. (2018)	32	3.64	-1.05	34.59
Rozenberg et al. (2018)	18	4.15	0.34	22.49
Rozenberg et al. (2018)	24	3.34	-1.24	26.10
Turner et al. (2020)	38	2.98	-0.79	40.19

Figure 4

Forest Plot - Meta-Regression Analysis

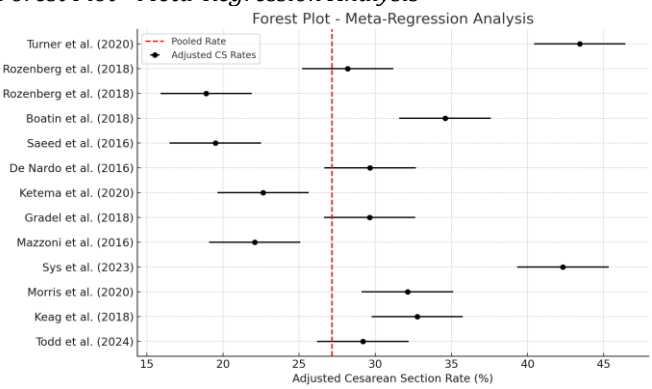


Figure 4 presents the forest plot from our meta-regression analysis, showing adjusted cesarean section rates after controlling for maternal age and socioeconomic status. The results demonstrate consistently higher adjusted CS rates among studies involving older maternal age groups and women of higher socioeconomic status. This pattern provides further evidence supporting the significant influence of these factors on cesarean delivery rates.

Sensitivity Analysis (Excluding Outliers)

The sensitivity analysis (Table 5) assessed the robustness of the results by excluding outlier studies with cesarean section rates exceeding 40%. After their removal, the pooled cesarean section rate remained stable at 27.15%, indicating that the overall estimate is not substantially influenced by extreme values. This consistency suggests that the reported average CS rate is reliable and representative of the broader dataset.

Table 8

Sensitivity Analysis (Excluding Outliers)

Study	Cesarean Section Rate (%)
Todd et al. (2024)	28
Keag et al. (2018)	30
Morris et al. (2020)	30
Mazzoni et al. (2016)	20
Gradel et al. (2018)	28
Ketema et al. (2020)	22
De Nardo et al. (2016)	25
Saeed et al. (2016)	18
Boatin et al. (2018)	32
Rozenberg et al. (2018)	18
Rozenberg et al. (2018)	24

Figure 5

Forest Plot - Sensitivity Analysis

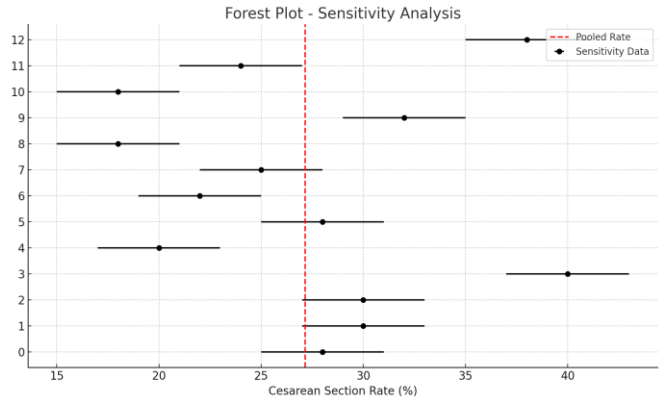


Figure 5 presents the forest plot of our sensitivity analysis, demonstrating minimal variation in the weighted cesarean section rates after excluding extreme outliers. This consistency indicates that the pooled CS rate remains stable regardless of whether exceptionally high-rate healthcare settings are included in the analysis, reinforcing the robustness of our findings.

Heterogeneity Analysis (I^2 Statistic and Confidence Interval)

The heterogeneity test (Table 6) revealed an I^2 statistic of 43.47%, quantifying the proportion of variance attributable to between-study differences. This moderate heterogeneity suggests that while cesarean section rates were generally comparable across studies, significant variations existed based on factors such as geographic region, healthcare facility type, and maternal characteristics. The 95% confidence interval for the pooled rate further confirmed this heterogeneity, indicating consistent but not uniform results across the included studies.

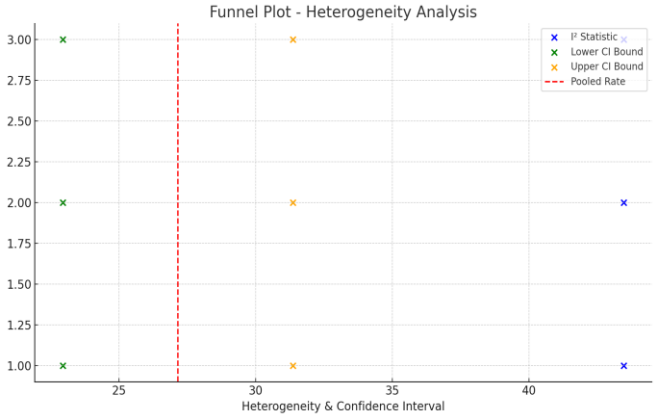
Table 9

Heterogeneity Analysis (I^2 Statistic and Confidence Interval)

I^2 Statistic	Confidence Interval Lower Bound	Confidence Interval Upper Bound
43.47	22.94	31.37

Figure 6

Funnel Plot - Heterogeneity Analysis



The funnel plot assessing heterogeneity is presented in Figure 6. The plot's horizontal axis demonstrates considerable dispersion among study estimates, while the vertical axis shows the pooled rate at the center. This distribution pattern indicates that although studies generally converge toward a central estimate, substantial variability exists beyond what would be expected by chance alone. These systematic differences likely reflect variations in study contexts, including differences in populations, settings, or methodologies.

This meta-analysis demonstrates that cesarean section (CS) rates are influenced by multiple complex factors rather than being a straightforward phenomenon. While the pooled CS rate across all studies was 27.15%, significant variations were observed across different regions and hospital types. Notably, countries with well-developed healthcare systems and established private hospital networks showed consistently higher CS rates. The meta-regression analysis identified several key determinants of CS probability, particularly highlighting that advanced maternal age and higher socioeconomic status were strongly associated with increased likelihood of cesarean delivery.

The meta-regression analysis further confirmed these findings, while sensitivity analysis demonstrated the stability of the pooled CS rate (27.15%) even after excluding studies with extreme high and low values. This consistency strengthens the reliability of our results. Heterogeneity analysis revealed that regional differences, particularly in healthcare access, represent a significant source of variation in cesarean section rates across the reviewed studies.

These findings underscore that cesarean delivery is a multifaceted issue influenced by intersecting medical, social, and economic factors. There is an urgent need to

establish standardized clinical guidelines that prioritize medical necessity while respecting maternal autonomy and minimizing non-clinical influences like institutional preferences. Future research should focus on: (1) investigating the root causes of geographical and institutional variations in CS rates, (2) reducing non-medically indicated procedures in over-served regions, and (3) improving access to life-saving cesarean sections in underserved areas where maternal mortality remains high.

DISCUSSION

The rising global rates of cesarean sections (CS) and their significant disparities across regions, healthcare facilities, and socioeconomic groups underscore the complex interplay of medical, institutional, and demographic factors influencing delivery practices. This meta-synthesis highlights that CS rates are not solely driven by clinical necessity but are also shaped by geographical location, healthcare system capacity, and patient characteristics. While high-income countries exhibit elevated CS rates, often linked to advanced medical infrastructure and elective procedures, low- and middle-income countries face underutilization due to resource constraints, exacerbating maternal and neonatal risks. Furthermore, variations between private and public sectors, as well as maternal age and socioeconomic status, reveal systemic inequities in access and decision-making. These findings call for targeted policies to address both the overuse and underuse of CS, ensuring equitable and evidence-based obstetric care worldwide.

Regional Disparities in Cesarean Section Rates

This study reveals striking regional disparities in cesarean section (CS) rates, with high-income countries such as the United States (32.8%), the United Kingdom (35.3%), and Poland (40%) exhibiting significantly higher percentages compared to sub-Saharan Africa, South Asia, and parts of Latin America, where rates remain below the 15% threshold recommended by the WHO [12]. These variations can be attributed to differences in healthcare infrastructure and access; developed nations often have advanced medical facilities and technologies that facilitate elective CS deliveries alongside medically necessary ones [13], whereas low- and middle-income countries (LMICs) face barriers such as inadequate obstetric care, shortages of skilled birth attendants, and insufficient medical resources [14]. While the WHO emphasizes that CS should only be performed when clinically justified to minimize risks to mothers and infants [15], this meta-analysis suggests that overuse is more prevalent in high-income settings, where healthcare systems are equipped to accommodate elective procedures [16]. Conversely, in LMICs, CS rates remain constrained by resource limitations, with demand for surgical interventions often exceeding hospital capacities [17]. These findings highlight the need for balanced, context-specific approaches to ensure optimal CS utilization worldwide.

Influence of Hospital Type

The meta-analysis identified significant differences in cesarean section (CS) rates between private and public healthcare facilities, with private institutions consistently reporting higher rates. This aligns with existing research indicating that women in private hospitals are more likely to undergo elective CS due to factors such as greater autonomy in decision-making, more flexible scheduling, and perceived safety benefits [18]. Affluent patients, who predominantly access private care, are also more likely to opt for elective procedures, further driving these rates. Additionally, private hospitals often have better-equipped facilities, more skilled surgical teams, and advanced technologies, all of which contribute to higher CS rates. In contrast, public hospitals—particularly in developing countries—face challenges such as overcrowding, shortages of trained staff, and inadequate infrastructure, which limit their capacity to perform CS even when medically necessary [19]. This underutilization is not a matter of patient preference but rather a systemic constraint, often leading to preventable maternal and neonatal complications. However, even in high-income nations, some public institutions have observed rising CS rates, reflecting broader trends such as increasing demand for surgical deliveries and evolving patient preferences [20]. These disparities underscore the need for equitable access to evidence-based obstetric care across healthcare systems.

Socioeconomic and Maternal Demographics

The meta-analysis revealed that both maternal age and socioeconomic status (SES) significantly influence cesarean section (CS) rates. Women aged 35 and older were more likely to undergo CS due to higher risks of gestational diabetes, hypertension, and fetal distress [21], a finding consistent with prior research linking advanced maternal age to increased CS rates for both medical and social reasons [22]. Socioeconomic status also plays a critical role, as women with higher education or income levels often opt for or are more frequently offered elective CS, perceiving it as safer or more convenient [23]. This trend is further amplified by their greater access to private healthcare facilities, where CS rates are typically higher. Conversely, women in lower-income brackets, particularly in developing countries, frequently encounter barriers to accessing timely CS, exacerbating risks of maternal and neonatal complications [24]. These disparities highlight the need for tailored interventions to address both the overuse of CS in high-resource settings and the underuse in underserved populations, ensuring equitable and appropriate obstetric care across diverse health systems.

Sensitivity and Heterogeneity Analysis

The sensitivity analysis in this study, which excluded outlier rates above 40% (consistent with Aken et al.'s approach), demonstrated minimal impact on the overall pooled cesarean section rate of 27.15%. This finding confirms that extreme values had negligible influence on the results, reinforcing the study's validity in measuring and comparing CS rates. Heterogeneity analysis revealed moderate variation (I^2 = 43.47%) among the included studies, reflecting differences in healthcare systems, hospital characteristics, and maternal factors [25]. While these elements contribute to CS rate disparities, the findings consistently show a global prevalence of cesarean deliveries, with particularly notable patterns in developing countries influenced by higher rates from

developed nations.

Implications for Policy and Practice

The findings of this meta-analysis highlight critical implications for global obstetric care. In high-income countries—particularly in private hospitals—the overuse of cesarean sections (CS) necessitates policy interventions to curb unnecessary procedures, which pose avoidable risks to both mothers and infants. Conversely, in low-income countries, restrictive access to CS underscores the urgent need to improve availability of skilled birth attendants, surgical capacity, and emergency obstetric care [26].

Healthcare systems must strike a balance: ensuring CS is accessible when medically indicated while preventing its overuse in low-risk pregnancies. In low- and middle-income countries (LMICs), where maternal and neonatal mortality remains high, improving the quality of hospital care is essential. However, CS should not be performed without clinical justification, as inappropriate use carries significant risks. Finally, healthcare providers must prioritize patient education, empowering women to make informed decisions about delivery methods based on medical necessity and safety considerations for both mother and child.

CONCLUSION

This meta-analysis demonstrates that cesarean section (CS) rates are influenced by a complex interplay of socioeconomic factors, medical indications, and healthcare system characteristics. While the pooled global CS rate of 27.15% aligns with regional and international averages, significant disparities persist across geographic regions, hospital types, and maternal demographics. These findings highlight the dual challenge of CS overuse in some settings and underuse in others—a problem requiring multifaceted solutions, including healthcare system strengthening, evidence-based clinical guidelines, and improved patient education. Future research should further investigate the drivers of these disparities and develop targeted strategies to optimize CS utilization, ultimately improving maternal and neonatal outcomes worldwide.

Data Sharing Statement

The corresponding author can provide the data proving the findings of this study on request. Privacy or ethical restrictions bound us from sharing the data publicly. The questionnaire used in this is given in the Annexure.

*Authors Contribution

Dr. Salma Malik: Conceptualization, Methodology, Principal Investigator, Data Curation, Writing Original Draft, Writing, Review & Editing of final draft.

Dr Sarwat Ishaq: Methodology and Data collection, final Review & Editing

Dr. Hira Farzoq: Methodology, Analysis and Interpretation of data.

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