

# A Systematic Review of Maternal and Neonatal Outcomes Following Caesarean and Vaginal Delivery in Primigravida among Low- & Middle-Income Countries

Ayalur Gopalkrishnan Radhika<sup>1</sup>, Nishad Plakkal<sup>2</sup>, Usha Devi<sup>2</sup>, Amita Suneja<sup>1</sup>, Sreekumaran Nair<sup>3</sup>, Vasumati Sriganesh<sup>4</sup>, Anish Keepanaseril<sup>2</sup>, Kushagra Shiromani<sup>1</sup>

<sup>1</sup>Department of Obstetrics & Gynaecology, UCMS & GTBH, Delhi, India

<sup>2</sup>Department of Neonatology, JIPMER, Puducherry, India

<sup>3</sup>Department of Biostatistics, JIPMER, Puducherry, India

<sup>4</sup>QMed Knowledge Foundation, Mumbai, India

Email: raradhikaag@gmail.com, plakkal@gmail.com, Dr.ushaa@gmail.com, amita\_suneja@yahoo.co.in, nsknairmanipal@gmail.com, vasu@qmed.ngo

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## Abstract

**Introduction:** Cesarean section (CS) rates have been rising globally, particularly in LMICs, often exceeding WHO recommendations. This systematic review evaluates maternal and neonatal outcomes of CS versus vaginal delivery (VD) among primigravida in LMICs and highlights implications for balanced policy and practice. **Methods:** We searched PUBMED, EMBASE, SCOPUS, LENS, GIM, BASE, and Google Scholar for studies published in English between 2000-2024, following PRISMA 2020 and SWiM (Synthesis Without Meta-analysis) guidelines. Eligible studies included observational study designs. Seven studies involving 110,062 primigravid women were included. Data was extracted independently by two reviewers, with quality assessment via ROBINS-I and GRADE framework. A narrative synthesis was conducted due to study heterogeneity, presenting outcomes as frequencies and percentages, with findings synthesized narratively for each outcome across the included studies, and no pooled estimates were calculated. **Results:** Wide variability in episiotomy (20.8% - 96%); 15.5% and 4% reported 1st & 2nd degree perineal tears in vaginal deliveries. Severe PPH was higher in CS (5.11%) than VD (2.38%) with longer hospital stay ( $1.83 \pm 0.91$  vs  $1.43 \pm 0.69$  days;  $p < 0.001$ ). Stress UI ranged 6.6% - 14.1% CS versus 16.3% - 29.3% VD across different timepoints. Fecal incontinence ranged 1.3% - 2.6% CS versus 4.8% - 7.5% VD. Infection rates (CS versus VD) post-delivery were similar: UTI 3.3% vs 4%;

wound infection 2.7% vs 1.6%; fever 3.6% vs 2.3% ( $p > 0.3$ ). Neonatal mortality was 3.3% CS and 4% VD; Apgar scores were marginally higher in CS at 1 min ( $8.95 \pm 0.22$  vs  $8.57 \pm 1.13$ ) and 5 min ( $9.97 \pm 0.17$  vs  $9.68 \pm 0.95$ ;  $p < 0.001$ ). No increased risk of preterm birth (2.6% vs 0.5% vs 3.9%) or low birth weight (1.8% vs 0.2% vs 1.8%) was observed in subsequent pregnancies after elective CS, emergency CS and VD. **Conclusion:** While CS reduces long-term incontinence, it carries higher short- and long-term maternal risks. Neonatal outcomes were similar across delivery modes. These findings support judicious CS use and informed decision-making among primigravidas in LMICs.

## Keywords

Primigravida, Cesarean Section, Vaginal Delivery, Route of Delivery, Low-Middle Income Country, Systematic Review, Secondary Research

## 1. Background

Cesarean section (CS) rates have risen dramatically worldwide over the past four decades, increasing from approximately 6.7% of births globally in 1990 to 21.1% in 2015, with projections reaching 28.5% by 2030 [1]. This escalation is particularly pronounced in low- and middle-income countries (LMICs), where rates have surged from 4.4% to 19.5% during the same period, often exceeding the World Health Organization's recommended range of 10% - 15% for population-level CS rates [2]. Countries such as China (50.5%), Brazil (55.6%), and Iran (47.9%) now report some of the highest CS rates globally, raising significant public health concerns about unnecessary surgical interventions and their associated consequences [3].

The mode of delivery carries profound implications for both immediate and long-term maternal and neonatal health outcomes, particularly among primigravida women who face unique physiological and clinical challenges during their first birth experience [4]. Cesarean delivery has been associated with increased risks of severe postpartum hemorrhage, with odds ratios ranging from 1.5 to 2.4 compared to vaginal delivery, alongside prolonged hospital stays and higher healthcare costs [5] [6]. Additionally, CS significantly increases the likelihood of abnormal placentation in subsequent pregnancies, including placenta previa (OR 1.74, 95% CI 1.62 - 1.87) and placenta accreta spectrum disorders (OR 2.95, 95% CI 1.32 - 6.6), conditions that carry substantial risks of life-threatening hemorrhage and emergency hysterectomy [7] [8].

Conversely, vaginal delivery is associated with higher rates of immediate perineal trauma, including episiotomy rates that vary dramatically across LMICs from 20% to 96% among primigravida [9] [10]. Pelvic floor dysfunction, including stress urinary incontinence and fecal incontinence, occurs more frequently following vaginal delivery, with long-term implications for women's quality of life and sexual health [11] [12]. However, the protective effects of CS against pelvic

floor disorders must be weighed against the increased risks of respiratory complications in neonates, including transient tachypnea of the newborn and respiratory distress syndrome, particularly following elective CS without labor [13] [14].

From a neonatal perspective, the evidence regarding optimal delivery mode remains complex and context-dependent [15]. While some studies suggest equivalent neonatal mortality rates between CS and vaginal delivery, others indicate increased risks of NICU admission and respiratory complications following cesarean birth [15] [16]. Apgar scores, often used as immediate markers of neonatal well-being, show inconsistent patterns across different populations and clinical settings, with some studies reporting higher scores following CS while others demonstrate no significant differences [17].

The epidemiological landscape in LMICs presents unique challenges that distinguish these settings from high-income countries [18]. Healthcare infrastructure limitations, varying levels of skilled birth attendance, cultural preferences for surgical delivery, and different patterns of maternal morbidity and mortality create distinct risk-benefit profiles for delivery mode decisions [18] [19]. Despite this, the majority of existing systematic reviews and meta-analyses have predominantly focused on evidence from high-income countries, creating a substantial knowledge gap in understanding optimal delivery practices specifically within LMIC contexts [20].

Primigravida women represent a particularly vulnerable population in this landscape, as they face higher baseline risks of prolonged labor, instrumental delivery, and emergency CS compared to multiparous women [21]. The decision-making process surrounding delivery mode for first-time mothers in LMICs is further complicated by limited access to emergency obstetric care, variable quality of antenatal counseling, and socioeconomic factors that may influence both patient preferences and provider recommendations [22] [23].

Current evidence synthesis efforts have been hampered by methodological heterogeneity, variable outcome definitions, and the predominance of observational studies given the ethical constraints preventing randomized controlled trials directly comparing planned CS versus VD [24]. The GRADE certainty of evidence for most maternal and neonatal outcomes remains low to moderate, reflecting the inherent limitations of available study designs and the complexity of comparing delivery modes across diverse clinical scenarios [25].

Despite the growing burden of cesarean delivery in LMICs and its implications for maternal and neonatal health, there exists a critical gap in synthesized evidence specifically addressing outcomes among primigravida in these settings [26]. Previous systematic reviews have either focused primarily on high-income country data, combined outcomes across all parities, or examined only selected outcomes rather than providing comprehensive assessments of both maternal and neonatal consequences [26] [27]. This evidence gap impedes evidence-based policy development and clinical decision-making in resource-constrained settings where the stakes of delivery mode decisions are often highest [18].

The present systematic review addresses this knowledge gap by synthesizing available evidence on maternal and neonatal outcomes following CS versus vaginal delivery specifically among primigravida in LMICs, with the aim of informing clinical practice guidelines, health policy decisions, and future research priorities in these critical healthcare contexts [20].

## 2. Methodology

Following PICO formulation, inclusion/exclusion criteria were set (Table 1). Eligible studies were primarily observational, as randomized controlled trials directly comparing cesarean section versus vaginal delivery were not available & also ethically as well as practically unfeasible. A systematic review was conducted as per PRISMA 2020 and SWiM (Synthesis Without Meta-analysis) guidelines [28] and registered with PROSPERO (CRD42023404221).

**Table 1.** Inclusion and exclusion criteria.

|                           |   |
|---------------------------|---|
| <b>Inclusion Criteria</b> | <ul style="list-style-type: none"> <li>➤ Studies based in LMICs published from 2000 to 2024</li> <li>➤ Randomized controlled trials and quasi-randomized studies, prospective and retrospective cohort studies, case-control studies, and cross-sectional studies.</li> <li>➤ Only English-language articles</li> </ul> |
| <b>Exclusion Criteria</b> | <ul style="list-style-type: none"> <li>➤ Systematic reviews, meta-analyses, commentaries, editorials, case reports and publications with duplicated data, Conference abstracts and proceedings.</li> <li>➤ Studies from high income countries (HICs)</li> </ul>   |

### Literature Search

An experienced librarian (VS) developed and tested the search strategy (PUBMED, EMBASE, SCOPUS, LENS, GIM, BASE, Google Scholar) using MeSH terms and truncation [Annexure I] based on the COCHRANE Handbook for Systematic Reviews and the PRISMA guidelines. The comprehensive search covered publications from January 2000 to August 2024. The strategy, adapted for each database, was structured around four key pillars: the population (primigravida), the intervention and comparator (cesarean section and vaginal delivery), a broad range of maternal and neonatal outcomes, and the LMIC setting. It employed a combination of controlled vocabulary (e.g., MeSH in PubMed, Emtree in Embase) and an extensive list of free-text keywords with truncation and boolean operators to maximize sensitivity. The full line-by-line search strategies for each database are detailed in Annexure I. Searches, limited to English, ran April 1-30, 2024, with grey literature searches August 1-25, 2024. To ensure methodological consistency and maintain high accuracy in data extraction—thereby avoiding potential misinterpretations or loss of clinical nuance from translation—and in light of practical resource limitations, the search was restricted to English-language publications. Three assessors (AGR, UD, AK) independently screened titles/abstracts and appraised full texts after deduplication.

### Data Synthesis

Due to substantial clinical and methodological heterogeneity across the included studies in terms of study populations, outcome definitions, measurement timepoints, and follow-up periods, formal meta-analysis was not feasible. We conducted a narrative synthesis of the findings, presenting results descriptively with absolute numbers and percentages for each outcome. No pooled estimates or odds ratios were calculated. Results were tabulated to facilitate comparison across studies while acknowledging the heterogeneity in study characteristics.

### Selection of studies, data extraction and management

Data (study design, sample size, demographics, absolute numbers and percentages) for each outcome were extracted using Microsoft Excel [29] then onto COV- IDENCE (KS, UD) [30] covering study design, sample size, demographics and outcome variables. Authors were contacted for clarification on ambiguities [8] [16]. The outcome measures are presented in **Table 2**.

**Table 2.** Primary and secondary maternal and neonatal outcomes.

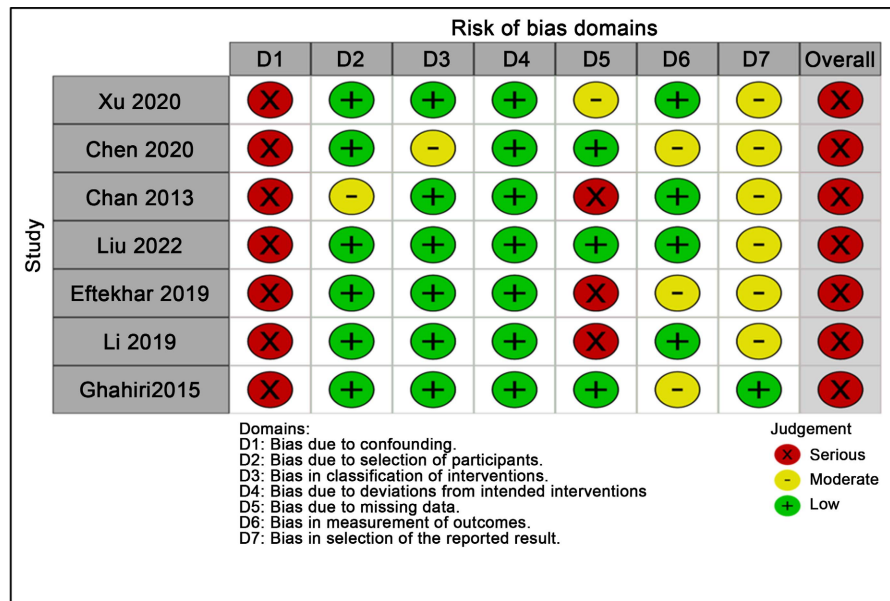
| Group  | Primary Outcomes  | Secondary Outcomes  |
|--|---|---|
| <b>Maternal Outcomes</b>   | ➤ <i>Specific to vaginal delivery</i>   |   |
|  | • Episiotomy—hematoma, resuturing, gaped episiotomy, surgical site infection/dehiscence                     |   |
|  | • Obstetric Perineal lacerations/tears  |   |
|  | • Instrumental delivery   |   |
|  | • Uterine inversion   |   |
|  | ➤ <i>Specific to caesarean delivery</i>   |   |
|  | • Complications from anaesthesia—aspiration syndrome, regional anaesthesia complications, high spinal block | • Pelvic floor dysfunction                                    |
|  | • Injury to bladder or other abdominal organs   | • Sexual dysfunction  |
|  | ➤ <i>Maternal Complications (within 42 days of delivery)</i>  | • Chronic backache  |
|  | • Near Miss Maternal mortality & morbidity  | • Postpartum Depression                                       |
|  | • Primary and Secondary Postpartum Haemorrhage  | • Infections—Urinary tract infection after cesarean delivery. |
|  | • Thromboembolism—amniotic fluid embolism, deep vein thrombosis, pulmonary embolism                         | • Need of hysterectomy  |
|  | • Postpartum sepsis, puerperal sepsis, wound infection  | • Need for blood transfusion                                  |
|  | • Breast complications Postpartum mastitis  | • Admission to intensive care unit                            |
| • Unplanned hospital readmission—retained products of conception, placenta & membranes, manual removal of placenta | • Need for mechanical ventilation (Other than for anaesthesia)  |   |
| • Injury to genital tract-rupture uterus, cervical tear, broad ligament hematoma                                   | • Mental health problems such as depression or anxiety within 42 days of delivery.                          |   |
| • Urinary and rectovaginal fistula   |   |   |
| ➤ <i>Long-term Delayed Outcomes</i>  |   |   |
| • Maternal collapse  |   |   |
| • Urinary and Fecal Incontinence   |   |   |
| • Length of hospital stay  |   |   |
| • Patient Satisfaction   |   |   |

## Continued

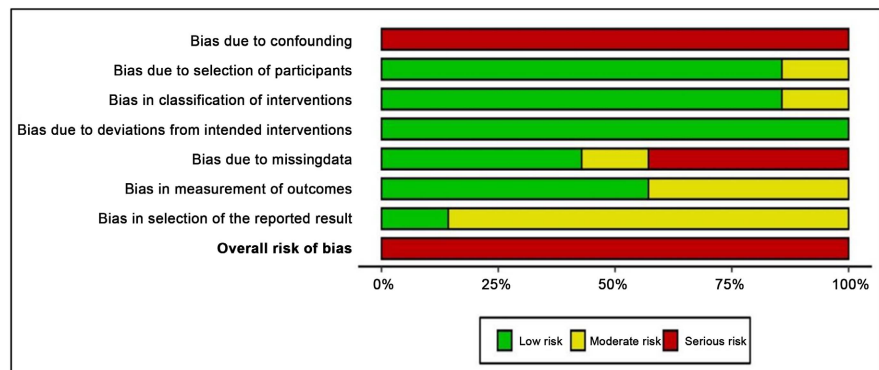
|  |  |
|--|--|
| <b>Maternal<br/>Outcomes in<br/>Subsequent<br/>Pregnancies</b> | <ul style="list-style-type: none"> <li>• Risk of Postpartum Hemorrhage</li> <li>• Risk of Placenta Previa and morbidly adherent placenta</li> </ul>  |
| <b>Neonatal<br/>Outcomes</b>                                   | <ul style="list-style-type: none"> <li>• Perinatal mortality (stillbirth and neonatal death)</li> <li>• Admission to neonatal intensive care unit</li> <li>➤ <b>Neonatal Complications</b></li> <li>• Neonatal sepsis</li> <li>• Asphyxia</li> <li>• Hypoxic ischemic encephalopathy</li> <li>• Preterm birth</li> <li>• Small for gestational age</li> <li>• Low birth weight</li> <li>• Transient tachypnea of newborn</li> <li>• Respiratory distress syndrome</li> <li>• Birth trauma</li> <li>• Neonatal seizures</li> <li>• Necrotising enterocolitis</li> <li>• Neonatal hypoglycemia</li> <li>• Intracranial hemorrhage</li> <li>• Meconium aspiration syndrome</li> <li>• Skin/gut microbiome</li> <li>• Early Initiation of breastfeeding</li> <li>• Exclusive breastfeeding at discharge</li> <li>• Exclusive breastfeeding at 6 months</li> <li>• Skin-to-skin care in the delivery room</li> <li>• Kangaroo Mother Care</li> <li>➤ <b>Long term outcomes</b></li> <li>• Neurological outcomes</li> <li>• Obesity</li> <li>• Wheezing</li> <li>• Hyperactive airway disease</li> </ul> |
| <b>Neonatal<br/>Outcomes in<br/>Subsequent<br/>Pregnancies</b> | <ul style="list-style-type: none"> <li>• Risk of Preterm Birth</li> <li>• Risk of Low birth weight</li> </ul>  |

Risk of bias was assessed using the ROBINS-I tool (**Figure 1, Annexure V**) and ROBVIS for summary (**Figure 2**) [31]. Disagreements were resolved through discussion or a third reviewer. Two reviewers (KS, UD) performed quality assessments, with discrepancies resolved by consensus and involving a third reviewer (AGR). Statistical analyses were performed using Microsoft Excel 2007 [29]. GRADE assessment [32] was used to evaluate the quality and certainty of evidence. Two reviewers (AGR, KS) independently rated evidence quality and certainty. The quality of evidence was categorized as high, moderate, low, or very

low. This study was funded by Indian Council of Medical Research (ICMR), grant number 5/7/03/MH/2023-RCN. Ethical approval was not required for this study as it was a systematic review of previously published data. Inclusion and exclusion criteria are tabulated in **Table 1**.



**Figure 1.** Risk of bias assessment. Traffic Light Plot [31].



**Figure 2.** Risk of bias assessment. Summary Plot [31].

### 3. Results

A search of electronic databases yielded 2131 citations, with 57 papers identified through hand-searching. After exclusions and deduplication, seven observational studies were included (**Annexure IV** PRISMA flowchart); the list of excluded studies with reasons for exclusion is provided in **Annexure III**. As the studies reported different maternal/neonatal outcomes, a sensitivity meta-analysis was not feasible, therefore, narrative review was undertaken. **Annexure II** lists the characteristics of the included studies.

The findings from the seven included observational studies are synthesized nar-

ratively below. The results are organized by clinical outcome to provide a clear and narrative synthesis. A total of 110,062 primigravida from LMICs were included, with 55,128 undergoing cesarean section and 54,934 vaginal deliveries. Patient characteristics are presented in **Table 3**. None of the seven included studies reported maternal mortality.

**Table 3.** Patient characteristics

| Study ID                         | Maternal Age Mean $\pm$ SD | BMI Mean $\pm$ SD (kg/m <sup>2</sup> ) |
|----------------------------------|----------------------------|--|
| Chen <i>et al.</i> , (2020)      | 32.4 $\pm$ 3.3             | 22.47 $\pm$ 2.9                        |
| Liu <i>et al.</i> , (2022)       | 27.91 $\pm$ 2.65           | 22.53 $\pm$ 2.72                       |
| Chan <i>et al.</i> , (2013)      | 30.6 $\pm$ 3.8             | 21 $\pm$ 2.8                           |
| Li <i>et al.</i> , (2019)        | Not available              | 22.36 $\pm$ 2.93                       |
| Xu <i>et al.</i> , (2020)        | Not available              | Not available                          |
| Eftekhari <i>et al.</i> , (2006) | Not available              | Not available                          |
| Ghahiri <i>et al.</i> , (2015)   | Not available              | Not available                          |

### *Primary Maternal outcomes*

#### Vaginal delivery (Tables 4-6)

**Episiotomy:** Of 63,001 vaginal deliveries, episiotomy was required in 13,203 (20.78% to 96%, average 20.9%) (**Table 4**).

**Table 4.** Episiotomy at vaginal delivery.

| Maternal Outcomes | Study ID  | Study population | Vaginal      |                  |       |
|-------------------|-----------|------------------|--------------|------------------|-------|
|                   |           |                  | Participants | Episiotomy given | %     |
| Episiotomy        | Chan 2013 | Primi            | 252          | 242              | 96    |
| Episiotomy        | Xu 2020   | Primi            | 62364        | 12961            | 20.78 |

**Obstetric Perineal Lacerations/Tears (Table 5):** 1st and 2nd degree perineal tears were documented in 15.47% and 3.96% women among 252 vaginal deliveries. Levator Ani avulsion at 10 months post-delivery was found in 6.9% women [33].

**Table 5.** Perineal tears in Primi Population.

| Maternal Outcomes        | Study ID  | Study population | Vaginal |         |       |
|--------------------------|-----------|------------------|---------|---------|-------|
|                          |           |                  | Total   | Numbers | %     |
| Perineal 1st degree tear | Chan 2013 | Primi            | 252     | 39      | 15.47 |
| Perineal 2nd degree tear | Chan 2013 | Primi            | 252     | 10      | 3.96  |

**Continued**

|                                     |          |       |    |   |     |
|-------------------------------------|----------|-------|----|---|-----|
| LA avulsion at full term pregnancy  | Liu 2022 | Primi | 29 | 0 | 0   |
| LA avulsion at 10 months postpartum | Liu 2022 | Primi | 29 | 2 | 6.9 |

**Instrumental Delivery (Table 6):** Of 48,755 women with instrumental vaginal deliveries, forceps and vacuum extractions were 1.36% and 0.56% respectively.

**Table 6.** Instrumental delivery in Primi Population.

| Maternal Outcomes               | Study ID  | Study population | Vaginal |         |       |
|---------------------------------|-----------|------------------|---------|---------|-------|
|                                 |           |                  | Total   | Numbers | %     |
| Instrumental Delivery (Forceps) | Chan 2013 | Primi            | 252     | 14      | 5.55  |
| Instrumental Delivery (Forceps) | Xu 2020   | Primi            | 48523   | 650     | 1.33  |
| Instrumental Delivery (Vacuum)  | Xu 2020   | Primi            | 48523   | 230     | 0.47  |
| Instrumental Delivery (Vacuum)  | Chan 2013 | Primi            | 252     | 46      | 18.25 |

**Cesarean Delivery**

None of the seven included studies reported primary outcomes specific to cesarean section, such as anesthesia complications, abdominal organ injury, or wound sepsis.

**Primary Postpartum Hemorrhage (Table 7 & Table 8)**

**Table 7.** Primary Postpartum Hemorrhage < 900 ml blood loss.

| Maternal Outcomes             | Study ID | Study population | Cesarean |         |       | Vaginal |         |       | p-value |
|-------------------------------|----------|------------------|----------|---------|-------|---------|---------|-------|---------|
|                               |          |                  | Total    | Numbers | %     | Total   | Numbers | %     |         |
| Mild PPH (<900 ml blood loss) | Xu 2020  | Primi            | 50,543   | 47,957  | 94.88 | 48,523  | 47364   | 97.61 | <0.01   |

**Table 8.** Primary Postpartum Hemorrhage > 900 ml blood loss.

| Maternal Outcomes  | Study ID | Study population | Cesarean |         |      | Vaginal |         |      | p-value |
|--|----------|------------------|----------|---------|------|---------|---------|------|---------|
|  |          |                  | Total    | Numbers | %    | Total   | Numbers | %    |         |
| Primary Postpartum Hemorrhage > 900 ml blood loss (900 to 2100 ml) | Xu 2020  | Primi            | 50,543   | 2586    | 5.11 | 48,523  | 1159    | 2.38 | <0.01   |

The World Health Organization (WHO) defines primary postpartum hemor-

rhage (PPH) as blood loss of  $\geq 500$  ml within 24 hours of the birth after vaginal delivery and 1000 ml after cesarean birth; Severe PPH is defined as  $\geq 2000$  ml blood loss [34]. Xu *et al.* (2020) only provided the data on postpartum hemorrhage, categorizing it by blood loss volume. 47,957/50,543 (94.88%) in CS group had mild PPH compared to 47,364/48,523 (97.61%) women in the VD group. 2586/50,543 (5.11%) women in the CS group had severe PPH compared to 1159/48,523 (2.38%) women in the VD group [5].

#### Hospital Stay

CS group had longer stay ( $1.83 \pm 0.91$  days) versus VD ( $1.43 \pm 0.69$ ,  $p < 0.001$ ) [16].

#### Patient Satisfaction

Higher satisfaction in CS (81%) versus VD (70.3%) ( $p = 0.001$ ); dissatisfaction was higher in VD (21%) versus CS (11.3%) [31].

#### Secondary Maternal outcomes

##### Postpartum Urinary Incontinence (Tables 9-12)

**Table 9.** Stress urinary incontinence.

| Maternal Outcomes                                 | Study ID          | Study population | Cesarean |         |       | Vaginal |         |       | p-value |
|---|-------------------|------------------|----------|---------|-------|---------|---------|-------|---------|
|   |                   |                  | Total    | Numbers | %     | Total   | Numbers | %     |         |
| Stress UI at 2 months                             | Chan 2013         | Primi            | 78       | 5       | 6.4   | 252     | 56      | 22    | 0.002   |
| Stress UI at 4 months<br>(Elective CS versus VD)  | Eftekhari<br>2006 | Primi            | 309      | 33      | 10.7  | 357     | 57      | 15.96 | 0.007   |
| Stress UI at 4 months<br>(Emergency CS versus VD) | Eftekhari<br>2006 | Primi            | 36       | 9       | 25    | 357     | 57      | 15.96 | 0.17    |
| Stress UI at 6 months                             | Chan 2013         | Primi            | 78       | 10      | 12.82 | 252     | 62      | 24.6  | 0.035   |
| Stress UI at 12 months                            | Chan 2013         | Primi            | 78       | 11      | 14.1  | 252     | 74      | 29.36 | 0.009   |
| Stress UI at 7 years                              | Li 2019           | Primi            | 543      | 36      | 6.62  | 572     | 93      | 16.25 | 0.001   |

**Table 10.** Urge incontinence.

| Maternal Outcomes    | Study ID  | Study population | Cesarean |         |      | Vaginal |         |      | p-value |
|----------------------|-----------|------------------|----------|---------|------|---------|---------|------|---------|
|                      |           |                  | Total    | Numbers | %    | Total   | Numbers | %    |         |
| Urge UI at 2 months  | Chan 2013 | Primi            | 78       | 2       | 2.56 | 252     | 27      | 10.7 | 0.03    |
| Urge UI at 6 months  | Chan 2013 | Primi            | 78       | 3       | 3.84 | 252     | 15      | 5.95 | 0.77    |
| Urge UI at 12 months | Chan 2013 | Primi            | 78       | 4       | 5.12 | 252     | 23      | 9.12 | 0.28    |
| Urge UI at 7 years   | Li 2019   | Primi            | 543      | 22      | 4.05 | 572     | 45      | 7.86 | 0.007   |

**Table 11.** Postpartum Any UI (SUI/ UUI), Storage and Voiding disorders (Lower Urinary Tract Symptoms).

| Maternal Outcomes  | Study ID  | Study population | Cesarean |         |      | Vaginal |         |       | p-value |
|--------------------|-----------|------------------|----------|---------|------|---------|---------|-------|---------|
|                    |           |                  | Total    | Numbers | %    | Total   | Numbers | %     |         |
| Any UI at 2 months | Chan 2013 | Primi            | 78       | 7       | 8.8  | 252     | 67      | 26.6  | <0.005  |
| Any UI at 6 months | Chan 2013 | Primi            | 78       | 11      | 14.1 | 252     | 65      | 25.79 | 0.04    |

**Continued**

|                          |           |       |     |    |       |     |     |       |       |
|--------------------------|-----------|-------|-----|----|-------|-----|-----|-------|-------|
| Any UI at 12 months      | Chan 2013 | Primi | 78  | 11 | 14.1  | 252 | 79  | 31.34 | 0.004 |
| Storage LUTS* at 7 years | Li 2019   | Primi | 543 | 78 | 14.36 | 572 | 135 | 23.6  | 0.001 |
| Voiding LUTS* at 7 years | Li 2019   | Primi | 543 | 5  | 0.92  | 572 | 19  | 3.32  | 0.006 |

**Table 12.** Mixed Urinary Incontinence (SUI + UUI) in Primi Population

| Maternal Outcomes     | Study ID  | Study population | Cesarean |         |      | Vaginal |         |      | p-value |
|-----------------------|-----------|------------------|----------|---------|------|---------|---------|------|---------|
|                       |           |                  | Total    | Numbers | %    | Total   | Numbers | %    |         |
| Mixed UI at 2 months  | Chan 2013 | Primi            | 78       | 0       | 0    | 252     | 16      | 6.34 | 0.03    |
| Mixed UI at 6 months  | Chan 2013 | Primi            | 78       | 2       | 2.56 | 252     | 12      | 4.76 | 0.54    |
| Mixed UI at 12 months | Chan 2013 | Primi            | 78       | 4       | 5.12 | 252     | 18      | 7.14 | 0.57    |

**Stress Urinary Incontinence (SUI)**

Three prospective observational studies [10] [11] [35] assessed SUI at various time points. Chan *et al.* (2013) found consistently lower rates of SUI in the CS group across all assessment periods: at 2 months (5/78 [6.4%] vs 56/252 [22.2%]), at 6 months (10/78 [12.8%] vs 62/252 [24.6%]), and at 12 months (11/78 [14.1%] vs 74/252 [29.4%]).

Eftekhari *et al.* (2006) distinguished between elective and emergency CS at 4 months postpartum in primigravida. SUI occurred in 33/309 (10.7%) women following elective CS compared to 57/357 (15.96%) women after VD. However, emergency CS showed higher rates with 9/36 (25%) women experiencing SUI.

Long-term follow-up data from Li *et al.* (2019) at 7 years postpartum showed persistent differences: 36/543 (6.62%) women in the CS group had SUI compared to 93/572 (16.26%) in the VD group. Validated questionnaires were used in all studies: PFIQ [10], ICIQ [11], and a locally validated tool in Iran [35].

**Urge Urinary Incontinence (UUI)**

UUI was less common overall but showed similar patterns. Chan *et al.* (2013) reported rates at 2 months (2/78 [2.56%] CS vs 27/252 [10.7%] VD), 6 months (3/78 [3.84%] CS vs 15/252 [5.95%] VD), and 12 months (4/78 [5.13%] CS vs 23/252 [9.13%] VD). Li *et al.* (2019) found UUI at 7 years in 22/543 (4.05%) women after CS versus 45/572 (7.87%) after VD.

**Mixed and Any Urinary Incontinence**

Chan *et al.* (2013) also assessed combined incontinence types, consistently showing lower rates in the CS group. Any urinary incontinence at 2 months occurred in 7/78 (8.97%) women after CS compared to 67/252 (26.59%) women after VD.

**Instrumental Delivery and Incontinence**

Chen *et al.* (2020) noted specific risks associated with instrumental VD, finding that 28.3% of primigravid women with instrumental VD developed stress urinary incontinence, while 11.6% developed urge urinary incontinence.

### Fecal Incontinence (FI) (Table 13)

**Table 13.** Fecal Incontinence (FI) in CS versus VD in Primipara.

| Maternal Outcomes   | Study ID  | Study population | Cesarean |         |      | Vaginal |         |      | p-value |
|---------------------|-----------|------------------|----------|---------|------|---------|---------|------|---------|
|                     |           |                  | Total    | Numbers | %    | Total   | Numbers | %    |         |
| FI at 2 months      | Chan 2013 | Primi            | 78       | 1       | 1.28 | 252     | 19      | 7.53 | 0.14    |
| FI at 6 months      | Chan 2013 | Primi            | 78       | 1       | 1.28 | 252     | 12      | 4.76 | 0.31    |
| FI at 12 months     | Chan 2013 | Primi            | 78       | 2       | 2.56 | 252     | 12      | 4.76 | 0.74    |
| Any FI at 2 months  | Chan 2013 | Primi            | 78       | 1       | 1.28 | 252     | 16      | 6.3  | 0.14    |
| Any FI at 6 months  | Chan 2013 | Primi            | 78       | 1       | 1.28 | 252     | 11      | 4.3  | 0.31    |
| Any FI at 12 months | Chan 2013 | Primi            | 78       | 2       | 2.5  | 252     | 11      | 4.3  | 0.74    |

One prospective study [10] evaluated fecal incontinence (FI) in primigravida using the Colorectal Anal Distress Inventory Incontinence Questionnaire. At 2 months postpartum, FI occurred in 1/78 (1.28%) women in CS group compared to 19/252 (7.54%) in the VD group. At 6 months, rates were 1/78 (1.28%) women experiencing FI in CS group versus 12/252 (4.76%) in VD group, and at 12 months, 2/78 (2.56%) versus 12/252 (4.76%) respectively. While consistently lower in the CS group, the differences were not statistically significant in this study [36].

### Postpartum Infective morbidity (follow up at 10 days) (Table 14)

**Table 14.** Postpartum Infective morbidity (follow up at 10 days).

| Maternal Outcomes       | Study ID     | Study population | Cesarean |         |      | Vaginal |         |      | p-value |
|-------------------------|--------------|------------------|----------|---------|------|---------|---------|------|---------|
|                         |              |                  | Total    | Numbers | %    | Total   | Numbers | %    |         |
| Urinary Tract Infection | Ghahiri 2015 | Primi            | 300      | 10      | 3.33 | 300     | 12      | 4    | 0.66    |
| Wound Infection         | Ghahiri 2015 | Primi            | 300      | 8       | 2.66 | 300     | 5       | 1.66 | 0.4     |
| Fever                   | Ghahiri 2015 | Primi            | 300      | 11      | 3.66 | 300     | 7       | 2.33 | 0.34    |

Ghahiri *et al.* [16] assessed postpartum urinary and wound infections and fever in primigravida. Ten days after delivery, urinary tract infection (UTI) occurred in 3.33% of women following cesarean section (CS) and 4% after vaginal delivery (VD) showing no significant difference. Wound infection occurred in 2.66% of CS and 1.61% of VD cases, postpartum fever in 3.6% of CS and 2.3% of VD [16].

### Need for Blood Transfusion

In a single observational study (n = 600), blood transfusion was required in 4.7% of VD and 1.3% of CS cases, with no significant difference (p = 0.17) [31].

### Maternal Outcomes in Subsequent Pregnancies (Table 15)

Chen *et al.* (2020) provided comprehensive data on subsequent pregnancy out-

comes among 8208 women (2998 with prior CS and 5210 with prior VD).

**Table 15.** Maternal outcomes in subsequent pregnancies.

| Maternal Outcomes  | Study ID  | Study population | Cesarean |         |      | Vaginal |         |     | p-value |
|--|-----------|------------------|----------|---------|------|---------|---------|-----|---------|
|  |           |                  | Total    | Numbers | %    | Total   | Numbers | %   |         |
| Risk of PPH in 2nd pregnancy (Elective CS versus VD)                       | Chen 2020 | Primi            | 2998     | 28      | 1    | 5210    | 31      | 0.6 | <0.001  |
| Risk of PPH in 2nd pregnancy (Emergency CS versus VD)                      | Chen 2020 | Primi            | 2998     | 2       | 0.06 | 5210    | 31      | 0.6 | <0.001  |
| Risk of placenta previa in 2nd pregnancy (Elective CS versus VD)           | Chen 2020 | Primi            | 2998     | 48      | 1.6  | 5210    | 47      | 0.9 | <0.001  |
| Risk of placenta previa in 2nd pregnancy (Emergency CS versus VD)          | Chen 2020 | Primi            | 2998     | 9       | 1    | 5210    | 47      | 0.9 | <0.001  |
| Risk of placenta accreta/increta in 2nd pregnancy (Elective CS versus VD)  | Chen 2020 | Primi            | 2998     | 37      | 1.23 | 5210    | 26      | 0.6 | <0.001  |
| Risk of placenta accreta/increta in 2nd pregnancy (Emergency CS versus VD) | Chen 2020 | Primi            | 2998     | 7       | 0.23 | 5210    | 26      | 0.6 | <0.001  |

### Placental Complications

Placenta previa in the subsequent pregnancy occurred in 48/2998 (1.60%) women with prior elective CS compared to 47/5210 (0.90%) women with prior VD.

Placenta accreta or increta was observed in 37/2998 (1.23%) women with prior elective CS, 7/2998 (0.23%) women with prior emergency CS, and 26/5210 (0.50%) women with prior VD, indicating nearly a threefold higher rate following elective CS.

### Postpartum Hemorrhage Risk

In subsequent pregnancies, PPH occurred in 28/2998 (0.93%) women with prior elective CS compared to 31/5210 (0.59%) women with prior VD.

### Primary Neonatal Outcomes (Tables 16-18)

**Table 16.** Neonatal Deaths within 1 month of delivery

| Neonatal Outcomes | Study ID     | Study population | Cesarean |         |      | Vaginal |         |   | p-value |
|-------------------|--------------|------------------|----------|---------|------|---------|---------|---|---------|
|                   |              |                  | Total    | Numbers | %    | Total   | Numbers | % |         |
| Neonatal Death    | Ghahiri 2015 | Primi            | 300      | 10      | 3.33 | 300     | 12      | 4 | 0.66    |

**Table 17.** APGAR scores in newborns.

| Maternal Outcomes       | Study ID     | Study population | Cesarean    | Vaginal     | p-value |
|-------------------------|--------------|------------------|-------------|-------------|---------|
|                         |              |                  | Mean ± SD   | Mean ± SD   |         |
| Mean APGAR at 1 minute  | Ghahiri 2015 | Primi            | 8.95 ± 0.22 | 8.57 ± 1.13 | <0.001  |
| Mean APGAR at 5 minutes | Ghahiri 2015 | Primi            | 9.97 ± 0.17 | 9.68 ± 0.95 | <0.001  |

**Table 18.** Risk of low birth weight & preterm birth in subsequent pregnancy.

| Neonatal Outcomes   | Study ID  | Study population | Cesarean |         |     | Vaginal |         |     | p-value |
|---|-----------|------------------|----------|---------|-----|---------|---------|-----|---------|
|   |           |                  | Total    | Numbers | %   | Total   | Numbers | %   |         |
| Risk of preterm birth in 2nd pregnancy<br>(Elective CS versus VD)     | Chen 2020 | Primi            | 2998     | 80      | 2.6 | 5210    | 208     | 3.9 | 0.379   |
| Risk of preterm birth in 2nd pregnancy<br>(Emergency CS versus VD)    | Chen 2020 | Primi            | 2998     | 17      | 0.5 | 5210    | 208     | 3.9 | 0.379   |
| Risk of low birth weight in 2nd pregnancy<br>(Elective CS versus VD)  | Chen 2020 | Primi            | 2998     | 55      | 1.8 | 5210    | 94      | 1.8 | 0.142   |
| Risk of low birth weight in 2nd pregnancy<br>(Emergency CS versus VD) | Chen 2020 | Primi            | 2998     | 7       | 0.2 | 5210    | 94      | 1.8 | 0.142   |

In a retrospective cohort study of primigravida, neonatal mortality within the first month was slightly lower in the cesarean section (CS) group (3.33%) than in the vaginal delivery (VD) group (4%) though the mean Apgar scores were significantly lower Apgar scores at 1 and 5 minutes in the VD group [31] (Table 17).

*None of the seven studies reported secondary neonatal outcomes.*

#### Neonatal Outcomes in Subsequent Pregnancies

Chen *et al.* (2020) found no association between previous cesarean deliveries and preterm birth, low birth weight in subsequent pregnancies [8]. Two studies [8] [35] had limited data on emergency cesarean sections and three studies reported greater than 10% loss to follow-up, resulting in bias due to missing data.

#### Risk of Bias Assessment

The overall risk of bias across the included studies was found to be “serious” using the ROBINS-I tool (Figure 1, Figure 2). The most critical domain was bias due to confounding, which was rated as serious in all seven studies, reflecting the inherent limitations of non-randomized designs. Bias due to missing data was also a significant concern, with several studies rated as having a serious or moderate risk due to high participant drop-out rates with limited sensitivity analysis. Finally, the risk of bias in the measurement of outcomes was moderate in most studies, often due to the use of self-reported questionnaires for outcomes like inconti-

nence.

#### **GRADEPRO Summary of Findings Table [Annexure VI]**

GRADE evaluation for maternal and neonatal outcomes showed low to moderate certainty of evidence in this systematic review. A detailed GRADE Summary of Findings (SoF) table, which outlines the certainty of evidence for each primary and secondary outcome, is available in **Annexure VI** of the supplementary material.

## **4. Discussion**

This systematic review examined maternal and neonatal outcomes following CS and VD among primigravida in LMICs. Seven observational studies were included for the review.

Two studies included in our review reported varying **episiotomy rates** ranging from 20% to 96%. While first and second-degree perineal tears were found at 15.47% and 3.96% [10] in our review, other studies from LMICs reported third and fourth-degree tears occurred at rates of 0.13% and 0.14% [36] [37]. A study on pelvic floor muscle morphology revealed that levator ani elasticity was significantly lower after vaginal delivery compared to CS ( $p < 0.05$ ) [38]. A prospective cohort study from the UK highlighted a significant association between episiotomy and perineal infection (OR 4.04, 95% CI 1.44 - 11.37,  $p < 0.05$ ) among 1360 nulliparas [39]. Another retrospective study from Israel revealed that only 0.09% of episiotomies required re-suturing, with vulvovaginal hematoma being the most common complication [40]. A systematic review and meta-analysis of 74 studies from 41 LMICs found that 46% of vaginal births involved an episiotomy, with primiparous women having the highest rates (62%), compared to 33% in mixed parity populations and 25% in multiparous women [9]. Despite global recommendations for restricted use, episiotomies remain routine in LMICs.

Obstetric Fistula studies in Ethiopia and Sub-Saharan Africa found a very high prevalence of fistula following VD compared to CS at 43% after CS compared to 84% after VD [41]. Uterine rupture and cervical lacerations are significant risks associated with vaginal delivery after cesarean (VBAC). A study in the Czech Republic found that women undergoing VBAC were more likely to experience cervical lacerations than nulliparous women (21.2% vs 12.9%,  $p = 0.01$ ) [42]. Furthermore, a systematic review of observational studies from the USA, Canada, and Ireland revealed a 2.7-fold increased risk of uterine rupture following VD after CS (VBAC). The WHO Multi-country Survey identified significantly higher odds of uterine rupture in LMICs (AOR 3.88, 95% CI 2.00 - 7.43) compared to high-income countries [43].

One study in our review reported a non-significant reduction in **preterm birth** risk following elective CS [8]. A systematic review of cohort studies from HICs found no significant difference in preterm birth risk between subsequent pregnancies following CS and VD (RR = 1.1, 95% CI: 1.01 - 1.2) [44]. CS has been linked to a higher risk of placenta previa and placenta accreta both in high and

low-income countries. A systematic review by Keag *et al.* (2018) found a 74% increase in placenta previa following CS compared to VD (OR 1.74, 95% CI 1.62 - 1.87) [7]. Similarly, the odds of placenta accreta were nearly three times higher in women with CS compared to VD (OR 2.95, 95% CI 1.32 - 6.6). In most reports, severe PPH is significantly more prevalent following CS compared to VD. Yusof *et al.* (2019) reported a higher incidence of PPH in CS compared to VD (60% vs 20.3%,  $p = 0.001$ ) in a cohort of 75 primigravid women [6].

A case-control study comparing Cesarean delivery on maternal request (CDMR) and VD found that hemorrhagic complications were more common in CDMR compared to VD (5.8% vs 1.25%,  $p < 0.0001$ ) [45]. Data on venous thromboembolism (VTE) in LMICs were not available in our review. However, a systematic review of 28 retrospective cohorts from HICs found a nearly fourfold increased risk of VTE in CS compared to VD (OR = 3.7, 95% CI = 3 - 4.6) [46]. Two randomized controlled trials on primigravida with eclampsia found that mode of delivery influenced maternal complications. One study reported an increased risk of pulmonary edema (RR: 1.47, 95% CI: 0.25 - 8.61), pneumonia (RR: 1.63, 95% CI: 0.40 - 6.66), and need for ventilatory support (RR: 3.29, 95% CI: 0.45 - 34.49) with CS [47]. Another trial found a higher prevalence of maternal complications, including postpartum anemia, wound infection, puerperal sepsis, and burst abdomen in women who underwent CS (32% vs 8%,  $p = 0.01$ ) [46].

Studies on breastfeeding difficulties following CS and VD were inconsistent. A Swedish cohort study [49] found that planned CS was twice as likely to lead to mastitis compared to VD (OR = 2, 95% CI = 1.9 - 2.2). A Bangladeshi study on breastfeeding complications found that CS was associated with more issues like sore nipples and engorgement (OR = 8.5, 95% CI = 5.8 - 12.49) [50]. Satisfaction with Delivery Mode varied across studies. A Canadian cross-sectional survey (2020) indicated higher satisfaction rates with elective and emergency CS compared to VD (OR 9.03; 95% CI 2.80 - 29.10) [51]. Conversely, a study in Ethiopia found 65.6% of women were satisfied with VD, while 57.2% expressed satisfaction with CS [52]. A systematic review by Barca *et al.* [53] and Handa *et al.* [12] reported significantly higher odds of Pelvic Organ Prolapse in spontaneous VD compared to CS (OR = 8 & 5.6 respectively). Wound Infection rates following CS were higher than VD in several studies. Systematic reviews from high-income countries found 61% higher wound infection rates in CS compared to VD [20]. Several observational studies from LMICs documented inconsistent findings regarding maternal mortality. Harrison *et al.* (2015) reported a higher maternal mortality rate in CS (232 per 100,000 deliveries) compared to VD (96 per 100,000 deliveries) in a study spanning India, Pakistan, Kenya, Zambia, Guatemala, and the Democratic Republic of Congo [15]. The global WHO survey found a three-fold increased risk of maternal death in CS without medical indications compared to spontaneous VD (OR 3.21, 95% CI 0.78 - 13.2) [18].

Neonatal outcomes following CS versus VD have been mixed. While CS is often considered safer for obstetric complications, it may pose risks for neonatal health.

One study included in our review reported an 18% lower neonatal death rate in the CS group compared to VD [16]. However, Adewale *et al.* (2023) found no significant difference in neonatal mortality between the two delivery modes [20]. Other studies, suggest a higher neonatal mortality rate with CS, particularly when performed without medical indications [15]. Neonates born by CS, especially elective CS without labor, are at a higher risk of respiratory distress syndrome, transient tachypnea, and other respiratory complications [14] [54]. Neonates born by CS also have a higher likelihood of being admitted to NICU due to respiratory complications or low Apgar scores. CS generally carries a lower risk of birth injuries.

The strengths of this review is unique in synthesizing evidence from LMICs, as most existing systematic reviews predominantly focus on high-income countries (HICs). The strengths of this review include its rigorous methodology, with a registered protocol which minimized bias by adhering to predefined eligibility criteria, extensive search across multiple databases and reduced potential bias by contacting authors for unpublished data.

The limitations include observational studies which is inherently prone to bias. Furthermore, the review's restriction to English-language publications presents a limitation. While this decision was made to ensure data accuracy and methodological consistency, and was guided by resource constraints for translation, it may have introduced a language bias by potentially excluding relevant studies from non-Anglophone LMICs. Moreover, none of the studies directly compared the outcomes of planned versus emergency CS or explored specific indications for CS, making it challenging to draw definitive conclusions on how different factors affect maternal and neonatal outcomes. Additionally, due to the low number of studies and the variable quality of evidence, the conclusions must be interpreted with caution, especially when comparing to outcomes in HICs. Publication bias cannot be ruled out, as the inclusion of unpublished studies was dependent on the authors' responses.

However, the findings from this review are valuable in enhancing our understanding of the outcomes of different delivery modes in LMICs including critical gaps in research and further investigation into the factors that influence maternal and neonatal outcomes across different regions.

## 5. Conclusion

Cesarean delivery in LMICs is associated with a higher risk of severe postpartum hemorrhage and longer hospital stays compared to vaginal delivery (VD), higher risks of placental complications (placenta previa and accreta) in subsequent pregnancies, although urinary and fecal incontinence risks are lower. VD is associated with higher rates of perineal injuries. These findings underscore the place of vaginal delivery in LMICs, emphasizing the need for careful counseling, informed decision-making, and policy development to ensure women are fully aware of risks associated with both delivery methods, fostering shared decision-making in

clinical practice and improving maternal and neonatal health outcomes.

### Author Contributions

All Authors: Formulation of PICO, concept;

VS: Literature search;

AGR, AS: Periodic assessment of project progress;

AGR, UD, AK: Independently screened titles and abstracts;

AGR, UD, AK: Full text Appraisal;

KS, UD, NP: Data extraction;

SKN: Statistical analysis.

### Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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## Supplementary Materials

Supplementary (**Annexures**) is available online at:

<https://drive.google.com/file/d/1D3yO2iF1tAmIXjkxh6Jxpf9tkU3dxn1P/view?usp=sharing>