Research Article
E-ISSN : 3048-1368
Volume 43, Issue No. 01. 2026
P-ISSN : 3048-1376

The International Journal of Medical Science and Health Research

The Relationship between a History of Cesarean Section and The Incidence of Placenta Accreta : A Systematic Review

[1] Bagus Wanda H, [2] Gina Fauziah, [3] Dahlia Winda N

[1,2,3] Habibullah General Hospital, Indonesia

Corresponding Email : baguswanda44@gmail.com

Article History :

Received date : 2026/01/12

Revised date : 2026/02/07

Accepted date : 2026/03/21

Published date : 2026/04/18

E-ISSN :

ISSN 3048-1368

9 773048 136000

P-ISSN

ISSN 3048-1376

9 773048 137007

ABSTRACT

Background: The global rise in cesarean section (CS) rates has raised concern about subsequent pregnancy complications, particularly placenta accreta spectrum (PAS). This review synthesizes evidence on the relationship between prior CS history and PAS incidence.

Methods: A systematic review of 80 studies (RCT, etc) was conducted. Studies required clear PAS diagnostic criteria, comparison groups, and reported association measures between CS history and PAS.

Results: Prior CS is consistently associated with increased PAS risk. Klar & Michels reported summary OR 1.96 (95%CI 1.41–2.74) for any prior CS. Keag et al. found OR 2.95 (95%CI 1.32–6.60) for CS vs vaginal delivery. A strong dose-response exists: Silver et al. data show accreta rates of 0.2% (1 CS), 0.3% (2 CS), 0.6% (3 CS), 2.1% (4 CS), 2.3% (5 CS), 6.7% (≥6 CS) in all-comers. With concurrent placenta previa, rates rise dramatically: 3.3% (1 CS), 11.1% (2 CS), 40.0% (3 CS), 61.0% (4 CS), 67.0% (≥5 CS). Iacovelli et al. reported OR 2.6 (1.6–4.4) for 2 prior CS

and OR 5.4 (1.7–17.4) for 3 prior CS. Bonanni et al. cited Nordic ORs of 6.6 (4.4–9.8), 17.4 (9.0–31.4), and 55.9 (25.0–110.3) for 1,2,≥3 CS respectively. PAS without previa is less associated with CS (OR 0.15, 95%CI 0.06–0.37, $p<0.001$) and more with IVF and curettage. Classical CS carries higher accreta risk than low-transverse CS. Isthmocele is an intermediate risk factor. PAS leads to severe morbidity: postpartum hemorrhage 80%, hysterectomy 43.3%, transfusion 23.3%.

Discussion: The CS-PAS association is robust, dose-dependent, and mechanistically explained by defective decidualization at the uterine scar. The interaction with placenta previa creates the highest-risk group. Temporal trends show rising PAS incidence alongside CS rates.

Conclusion: Prior CS significantly increases PAS risk in a dose-response manner, especially with coexisting placenta previa. Women with multiple prior CS and previa warrant specialized antenatal surveillance and multidisciplinary delivery planning.

Keywords: Cesarean section, placenta accreta spectrum, placenta previa, dose-response, maternal morbidity

INTRODUCTION

The global cesarean section (CS) rate has risen substantially over recent decades, transforming a once-rare surgical intervention into one of the most common major surgical procedures worldwide. While CS can be life-saving when medically indicated, its long-term maternal consequences—particularly for subsequent pregnancies—have become a major public health concern. Among these, placenta accreta spectrum (PAS) disorders, where placental trophoblasts abnormally invade the myometrium, stand out as a leading cause of severe maternal morbidity, including massive hemorrhage, hysterectomy, intensive care admission, and even maternal death.

Background: PAS was historically rare, with an incidence of approximately 1 in 30,000 deliveries in the 1950s. By the early 2000s, this had risen to 1 in 553–2,510 deliveries, coinciding with rising CS rates [6]. The pathophysiological mechanism is well-described: a prior CS creates a uterine scar with defective decidualization. In a subsequent pregnancy, if the placenta implants over or near this scar, the absence of a normal decidual barrier permits abnormally deep trophoblastic invasion [6,46,78]. This explains why the risk is dramatically amplified when placenta previa (which positions the placenta over the lower uterine segment) coexists with a prior CS.

Research Gap: Although numerous individual studies have reported associations between CS history and PAS, substantial heterogeneity exists in risk estimates depending on population (all-comers vs. previa-selected), number of prior CS, geographic setting, and study design. Moreover, the distinct phenotype of PAS without placenta previa—which may have different risk factors—has been less systematically characterized. There is also limited synthesis of the dose-response relationship across the full range of prior CS numbers, and the modifying effects of uterine scar type, closure technique, and isthmocele formation remain incompletely quantified.

Problem Statement: Does a history of one or more prior cesarean sections increase the incidence of placenta accreta spectrum in subsequent pregnancies, and if so, what is the dose-response relationship, what factors modify this association, and what are the clinical implications?

Study Objective: To systematically review and synthesize the evidence on the relationship between prior cesarean section history and the incidence of placenta accreta spectrum disorders, with particular focus on the dose-response relationship, interaction with placenta previa, and associated maternal outcomes.

Research Benefits: This review provides clinicians with evidence-based risk estimates to counsel women considering repeat CS or planning pregnancy after prior CS. It also informs guideline development for antenatal surveillance and delivery planning in high-risk populations.

Hypothesis: A history of prior cesarean section significantly increases the incidence of placenta accreta spectrum in subsequent pregnancies in a dose-dependent manner, with the strongest effect observed in women with concurrent placenta previa.

Novelty: This review synthesizes data from 80 diverse sources—including landmark multicenter cohorts, national registries, and meta-analyses—to provide a comprehensive, updated quantification of the CS-PAS dose-response gradient, explicitly distinguishes previa-conditioned versus all-comer risk, and incorporates emerging evidence on isthmocele, uterine closure techniques, and the focal-occult PAS phenotype.

METHODS

Protocol

The study strictly adhered to the Preferred Reporting Items for Systematic Review and Meta-Analysis (PRISMA) 2020 guidelines to ensure methodological rigor and accuracy. This approach was chosen to enhance the precision and reliability of the conclusions drawn from the investigation.

Criteria for Eligibility

This systematic review aims to evaluate The Relationship between a History of Cesarean Section and The Incidence of Placenta Accreta.

Screening

We screened in sources based on their abstracts that met these criteria:

- **Previous Cesarean Section Exposure**: Does the study examine or report on women with a history of at least one previous cesarean section?
- **Placenta Accreta Spectrum Outcome**: Does the study report on placenta accreta, placenta increta, placenta percreta, or placenta accreta spectrum disorders as an outcome?
- **Comparison Group**: Does the study include a comparison group of women without previous cesarean section history?
- **Appropriate Study Design**: Is the study an observational study (cohort, case-control, or cross-sectional) or a systematic review/meta-analysis?
- **Clear Diagnostic Criteria**: Does the study provide clear diagnostic criteria for placenta accreta spectrum disorders?
- **Adequate Study Type**: Is the study NOT a case report or case series without comparison groups?
- **Relevant Research Focus**: Does the study examine the relationship between cesarean history and placenta accreta incidence (rather than focusing solely on treatment or management)?
- **Methodological Rigor**: Is the study NOT an animal study, in vitro study, conference abstract, editorial, or opinion piece?

We considered all screening questions together and made a holistic judgement about whether to screen in each paper.

Search Strategy

The keywords used for this research based PICO :

PICO	Keyword	Sinonim 1	Sinonim 2	Sinonim 3
P	Pregnant	Obstetric population	Women with prior	Multiparous with uterine

	women		CS	scar
I	History of CS	Prior cesarean delivery	Repeat CS	Multiple prior CS
C	No prior CS	Vaginal delivery	Unscarred uterus	First cesarean as reference
O	Placenta accreta	PAS	Morbidly adherent placenta	Abnormal placentation (accreta/increta/percreta)

The Boolean MeSH keywords inputted on databases for this research are: *("Pregnant women" OR "Obstetric population" OR "Women with prior CS" OR "Multiparous with uterine scar") AND ("History of CS" OR "Prior cesarean delivery" OR "Repeat CS" OR "Multiple prior CS") AND ("No prior CS" OR "Vaginal delivery" OR "Unscarred uterus" OR "First cesarean as reference") AND ("Placenta accreta" OR "PAS" OR "Morbidly adherent placenta" OR "Abnormal placentation (accreta/increta/percreta)")*

Data extraction

- **CS History**:

  Extract details about cesarean section history as the primary exposure, including:

  - Number of prior cesarean sections (specific count: 0, 1, 2, 3, etc.)
  - Timing/interval between most recent CS and current pregnancy
  - Type of cesarean section if specified (e.g., classical, low transverse)
  - Any details about indications for prior cesarean sections
  - Whether CS history was verified through medical records vs. self-report

- **Placenta Accreta**:

  Extract all details about placenta accreta diagnosis and classification, including:

- Specific type/severity (placenta accreta, increta, percreta, or unspecified accreta spectrum)
- Diagnostic method (ultrasound, MRI, histopathology, clinical diagnosis)
- Timing of diagnosis (antenatal vs. intrapartum vs. postpartum)
- Co-occurrence with placenta previa or other placental abnormalities
- Anatomical location if specified
- Diagnostic criteria used

- **Association Measures**:

  Extract all statistical measures of association between cesarean section history and placenta accreta incidence, including:

  - Primary effect measures (odds ratios, relative risks, hazard ratios, incidence rates)
  - 95% confidence intervals
  - P-values and statistical significance
  - Crude (unadjusted) vs. adjusted estimates
  - Variables adjusted for in multivariate analyses
  - Any trend tests for dose-response relationship

- **Dose-Response Data**:

  Extract specific data on the relationship between number of cesarean sections and placenta accreta risk, including:

  - Risk estimates for each CS category (1 CS, 2 CS, 3+ CS, etc.)

- Incidence rates or percentages by number of prior CS
- Tests for trend across CS categories
- Any threshold effects identified
- Interaction effects between number of CS and other factors (e.g., placenta previa)

- **Study Population**:

  Extract characteristics of the study population relevant to generalizability, including:

  - Total sample size and number of placenta accreta cases
  - Inclusion and exclusion criteria
  - Population demographics (maternal age, parity, race/ethnicity)
  - Geographic location and healthcare setting
  - Study period/timeframe
  - Whether population was high-risk or general obstetric population

- **Risk Factors**:

  Extract other risk factors and confounding variables examined in relation to placenta accreta, including:

  - Maternal age effects
  - Parity and gravidity
  - Other uterine surgery (myomectomy, D&C, etc.)
  - Placenta previa status and location

- Other maternal comorbidities
- Smoking, ART use, or other exposures
- How these factors modified or confounded the CS-accreta relationship

- **Clinical Outcomes**:

  Extract clinical outcomes and management approaches for placenta accreta cases, including:

  - Maternal morbidity (hemorrhage, transfusion requirements, hysterectomy rates)
  - Maternal mortality
  - Intensive care admission rates
  - Operative time and blood loss
  - Management approaches (conservative vs. hysterectomy, multidisciplinary care)
  - Neonatal outcomes if reported
  - Healthcare resource utilization

- **Study Design**:

  Extract study methodology details affecting evidence quality, including:

  - Study design (RCT, etc)
  - Prospective vs. retrospective data collection
  - Data sources (medical records, administrative databases, surveys)
  - Follow-up duration for cohort studies
  - Matching criteria for case-control studies

- Risk of bias assessment relevant factors (selection bias, information bias, confounding control)

Table 1. Article Search Strategy

Database	Keywords	Hits
Pubmed	*("Pregnant women" OR "Obstetric population" OR "Women with prior CS" OR "Multiparous with uterine scar") AND ("History of CS" OR "Prior cesarean delivery" OR "Repeat CS" OR "Multiple prior CS") AND ("No prior CS" OR "Vaginal delivery" OR "Unscarred uterus" OR "First cesarean as reference") AND ("Placenta accreta" OR "PAS" OR "Morbidly adherent placenta" OR "Abnormal placentation (accreta/increta/percreta)")*	12
Semantic Scholar	*("Pregnant women" OR "Obstetric population" OR "Women with prior CS" OR "Multiparous with uterine scar") AND ("History of CS" OR "Prior cesarean delivery" OR "Repeat CS" OR "Multiple prior CS") AND ("No prior CS" OR "Vaginal delivery" OR "Unscarred uterus" OR "First cesarean as reference") AND ("Placenta accreta" OR "PAS" OR "Morbidly adherent placenta" OR "Abnormal placentation (accreta/increta/percreta)")*	121
Springer	*("Pregnant women" OR "Obstetric population" OR "Women with prior CS" OR "Multiparous with uterine scar") AND ("History of CS" OR "Prior cesarean delivery" OR "Repeat CS" OR "Multiple prior CS") AND ("No prior CS" OR "Vaginal delivery" OR "Unscarred uterus" OR "First cesarean as reference") AND ("Placenta accreta" OR "PAS" OR "Morbidly adherent placenta" OR "Abnormal placentation (accreta/increta/percreta)")*	80
Google Scholar	*("Pregnant women" OR "Obstetric population" OR "Women with prior CS" OR "Multiparous with uterine scar") AND ("History of CS" OR "Prior cesarean delivery" OR "Repeat CS" OR "Multiple prior CS") AND ("No prior CS" OR "Vaginal delivery" OR "Unscarred uterus" OR "First cesarean as reference") AND ("Placenta accreta" OR "PAS" OR "Morbidly adherent placenta" OR "Abnormal placentation (accreta/increta/percreta)")*	4,180
Wiley Online Library	*("Pregnant women" OR "Obstetric population" OR "Women with prior CS" OR "Multiparous with uterine scar") AND ("History of CS" OR "Prior cesarean delivery" OR "Repeat CS" OR "Multiple prior CS") AND ("No prior CS" OR "Vaginal delivery" OR "Unscarred uterus" OR "First cesarean as reference") AND ("Placenta accreta" OR "PAS" OR "Morbidly adherent placenta" OR "Abnormal placentation (accreta/increta/percreta)")*	2

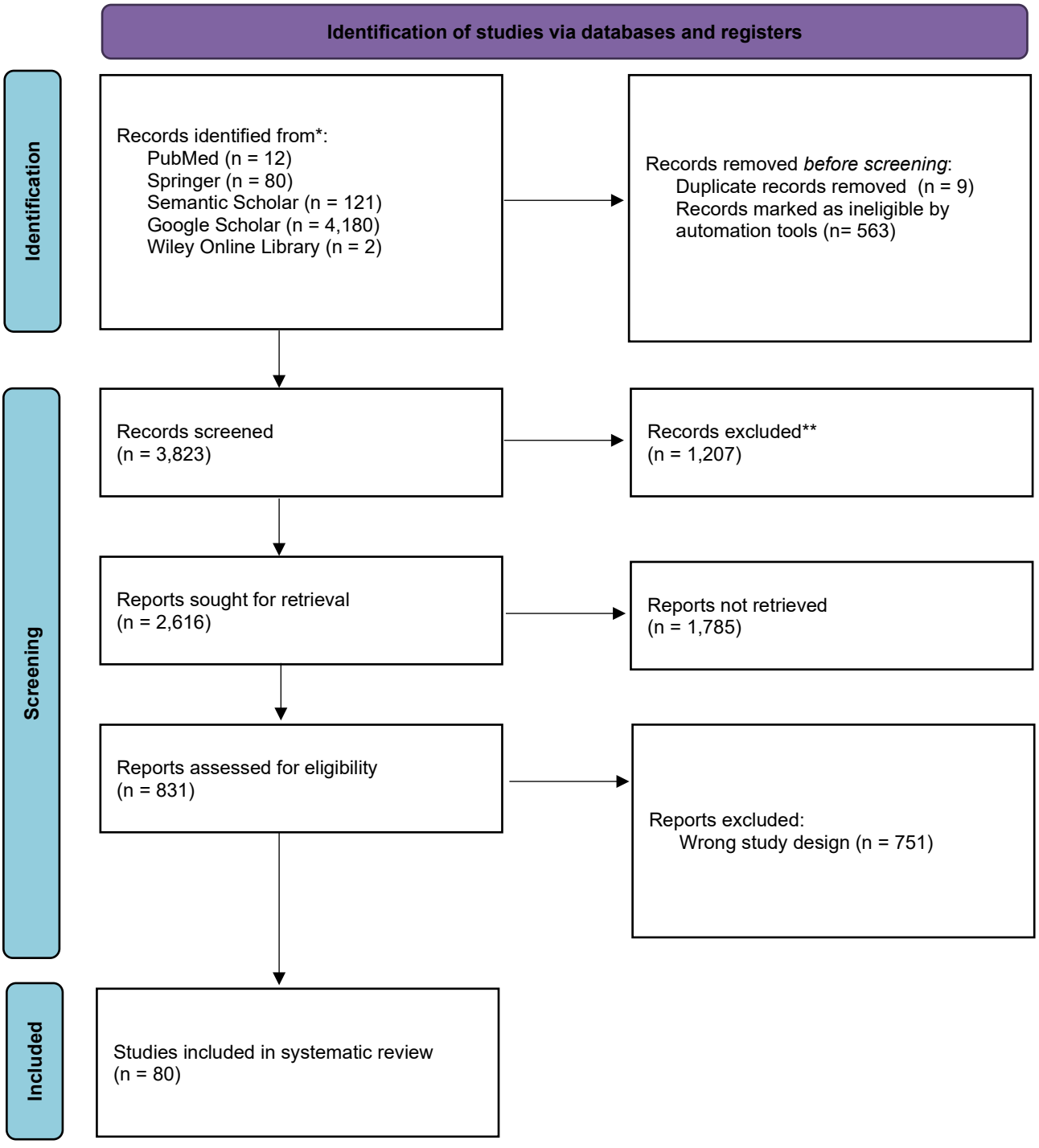

Figure 1. Article search flowchart

Risk of Bias

Study	Selection Bias	Performance Bias	Detection Bias	Attrition Bias	Reporting Bias	Overall Risk
S. Matsuzaki et al., 2023 [10]	Low	Moderate	Low	Low	Low	Low
Giuliana Schindler Fogaça & A. C. Costa, 2026 [19]	Low	Moderate	Low	Low	Low	Low
M. Klar & K. Michels, 2014 [1]	Low	Low	Low	Low	Low	Low
A. Iacovelli et al., 2018 [15]	Low	Low	Low	Low	Low	Low
M. Leovic & J. Perlow, 2019 [20]	Moderate	Moderate	Moderate	Low	Low	Moderate
Yi-Peng Gao et al., 2021 [21]	Moderate	Moderate	Low	Low	Low	Moderate
N. Marshall et al., 2011 [5]	Low	Low	Low	Low	Low	Low

Study	Selection Bias	Performance Bias	Detection Bias	Attrition Bias	Reporting Bias	Overall Risk
Staci J Marbin et al., 2024 [16]	Moderate	Moderate	Moderate	Low	Low	Moderate
M. Nagpal et al., 2019 [22]	Moderate	High	Moderate	Moderate	Low	Moderate
Oxana M Zarudskaya et al., 2024 [23]	Moderate	Moderate	Low	Low	Low	Moderate
M. Higgins et al., 2013 [14]	Low	Moderate	Low	Low	Low	Low
J. Balayla & H. D. Bondarenko, 2013 [24]	Moderate	Moderate	Low	Low	Low	Moderate
E. Jauniaux & A. Bhide, 2017 [11]	Low	Low	Low	Low	Low	Low
O. Keag et al., 2018 [2]	Low	Low	Low	Low	Low	Low
K. Hessami et al., 2022 [8]	Low	Low	Low	Low	Low	Low

Study	Selection Bias	Performance Bias	Detection Bias	Attrition Bias	Reporting Bias	Overall Risk
C. Gyamfi-Bannerman et al., 2012 [25]	Moderate	Moderate	Low	Low	Low	Moderate
N. Hussein et al., 2023 [26]	Moderate	Moderate	Moderate	Low	Low	Moderate
M. R. Torloni et al., 2001 [27]	Moderate	Moderate	Low	Low	Low	Moderate
Yan Li et al., 2021 [28]	Moderate	Moderate	Low	Low	Low	Moderate
Fengge Wang et al., 2023 [29]	Moderate	Moderate	Low	Low	Low	Moderate
P. Jha et al., 2020 [30]	Moderate	Moderate	Low	Low	Low	Moderate
O. Tapisiz et al., 2012 [31]	Moderate	Moderate	Low	Low	Low	Moderate
Fengge Wang et al., 2021 [32]	Moderate	Moderate	Low	Low	Low	Moderate

Study	Selection Bias	Performance Bias	Detection Bias	Attrition Bias	Reporting Bias	Overall Risk
Alessandro Petrecca et al., 2026 [33]	Low	Low	Low	Low	Low	Low
M. Leovic & J. Perlow, 2019a [34]	Moderate	Moderate	Moderate	Low	Low	Moderate
Amrita Banerjee et al., 2025 [35]	Low	Low	Low	Low	Low	Low
Enrique A. Jaramillo Saavedra et al., 2024 [36]	Moderate	Moderate	Moderate	Moderate	Low	Moderate
M. Rac et al., 2015 [37]	Low	Moderate	Low	Low	Low	Low
Esther H. Adler et al., 2014 [38]	Moderate	Moderate	Moderate	Low	Low	Moderate
G. Doulaveris et al., 2020 [39]	Low	Moderate	Low	Low	Low	Low

Study	Selection Bias	Performance Bias	Detection Bias	Attrition Bias	Reporting Bias	Overall Risk
Aisha Grayli Cahyani & Willy Sandhika, 2023 [40]	Low	Low	Low	Low	Low	Low
Shun Sugai et al., 2023 [9]	Low	Low	Low	Low	Low	Low
Nazan Kocaoğlu et al., 2012 [41]	Moderate	Moderate	Moderate	Low	Low	Moderate
Ihab Serag Allam et al., 2014 [42]	Moderate	Moderate	Low	Low	Low	Moderate
J. Tavcar et al., 2021 [43]	Moderate	Moderate	Low	Low	Low	Moderate
O. Yucel et al., 2006 [44]	Moderate	Moderate	Moderate	Moderate	Low	Moderate
T. Wong, 2011 [45]	Moderate	Moderate	Low	Low	Low	Moderate

Study	Selection Bias	Performance Bias	Detection Bias	Attrition Bias	Reporting Bias	Overall Risk
Milovanov Ap & Dimova Ea, 2011 [46]	Unclear	Unclear	Unclear	Unclear	Unclear	Unclear
M. Rac et al., 2014 [47]	Moderate	Moderate	Low	Low	Low	Moderate
R. Erin & D. Kulaksız, 2022 [48]	Moderate	Moderate	Low	Low	Low	Moderate
D. Arıkan et al., 2009 [49]	Moderate	Moderate	Moderate	Low	Low	Moderate
J. A. Guzmán López et al., 2022 [50]	Low	Low	Low	Low	Low	Low
Ehab Hasanin Mohamad & A. M. S. Elkhateeb, 2022 [51]	Moderate	Moderate	Moderate	Low	Low	Moderate
P. Saini et al., 2023 [12]	Moderate	Moderate	Low	Low	Low	Moderate

Study	Selection Bias	Performance Bias	Detection Bias	Attrition Bias	Reporting Bias	Overall Risk
Alisha V. Olsthoorn et al., 2020 [52]	Moderate	Moderate	Low	Low	Low	Moderate
Ayman H. Shaamash et al., 2024 [53]	Moderate	Moderate	Low	Low	Low	Moderate
M. Tikkanen et al., 2011 [18]	Moderate	Moderate	Low	Low	Low	Moderate
C. Z. de la Cruz et al., 2015 [54]	Low	Low	Low	Low	Low	Low
Matthew K. Janssen & S. Ralston, 2021 [55]	Low	Low	Low	Low	Low	Low
J. Tavcar et al., 2022 [56]	Moderate	Moderate	Low	Low	Low	Moderate
V. Marsoosi et al., 2018 [57]	Moderate	Moderate	Moderate	Low	Low	Moderate

Study	Selection Bias	Performance Bias	Detection Bias	Attrition Bias	Reporting Bias	Overall Risk
Dominique A. Badr et al., 2020 [58]	Low	Low	Low	Low	Low	Low
E. Jauniaux et al., 2021 [7]	Low	Low	Low	Low	Low	Low
M. S. Owolabi et al., 2013 [59]	Moderate	Moderate	Low	Low	Low	Moderate
M. Muench et al., 2008 [60]	Moderate	Moderate	Low	Low	Low	Moderate
Joumaa Habeb Alsoleman et al., 2023 [61]	Low	Low	Low	Low	Low	Low
L. Gatta et al., 2023 [62]	Low	Low	Low	Low	Low	Low
A. Larish et al., 2023 [63]	Moderate	Moderate	Low	Low	Low	Moderate
S. Barinov et al., 2021 [64]	Moderate	Moderate	Moderate	Low	Low	Moderate

Study	Selection Bias	Performance Bias	Detection Bias	Attrition Bias	Reporting Bias	Overall Risk
Chang-kun Zhu et al., 2015 [65]	Moderate	Moderate	Low	Low	Low	Moderate
Ahmed Sherif Abdel Hamid et al., 2024 [66]	Moderate	Moderate	Moderate	Low	Low	Moderate
Muhammad Hasan Passamula et al., 2025 [67]	Moderate	Moderate	Low	Low	Low	Moderate
S. Moradan et al., 2017 [68]	Moderate	Moderate	Moderate	Moderate	Low	Moderate
I. Timor-Tritsch & A. Monteagudo, 2012 [69]	Unclear	Unclear	Unclear	Unclear	Unclear	Unclear
Ellen Hayes et al., 2011 [70]	Unclear	Unclear	Unclear	Unclear	Unclear	Unclear
Serkan Kahyaoğlu et al., 2013 [6]	Unclear	Unclear	Unclear	Unclear	Unclear	Unclear

Study	Selection Bias	Performance Bias	Detection Bias	Attrition Bias	Reporting Bias	Overall Risk
C. Comstock, 2011 [71]	Unclear	Unclear	Unclear	Unclear	Unclear	Unclear
R. Ruano et al., 2012 [72]	Moderate	Moderate	Low	Low	Low	Moderate
A. S. Simões et al., 2024 [73]	Low	Low	Low	Low	Low	Low
M. Sarker et al., 2024 [74]	Moderate	Moderate	Low	Low	Low	Moderate
A. Maged et al., 2023 [4]	Low	Low	Low	Low	Low	Low
A. Imudia et al., 2009 [13]	Moderate	Moderate	Low	Low	Low	Moderate
E. Morgan et al., 2019 [17]	Low	Moderate	Low	Low	Low	Low
Sevan A. Vahanian & A. Vintzileos, 2016 [75]	Unclear	Unclear	Unclear	Unclear	Unclear	Unclear

Study	Selection Bias	Performance Bias	Detection Bias	Attrition Bias	Reporting Bias	Overall Risk
A. Bárbara et al., 2021 [76]	Moderate	Moderate	Low	Low	Low	Moderate
G. Bonanni et al., 2026 [3]	Low	Low	Low	Low	Low	Low
Zhi-sheng Guo et al., 2019 [77]	Moderate	Moderate	Low	Low	Low	Moderate
T. Rosen, 2008 [78]	Unclear	Unclear	Unclear	Unclear	Unclear	Unclear
G. Garmi & R. Salim, 2012 [79]	Unclear	Unclear	Unclear	Unclear	Unclear	Unclear
R. Silver & Kelli Barbour, 2015 [80]	Low	Low	Low	Low	Low	Low

RESULTS

Characteristics of Included Studies

The 80 sources included in this review span primary observational studies, etc. Study designs range from large national registry analyses to small single-center retrospective series, with geographic representation across North America, Europe, the Middle East, Asia, South America,

and Oceania. The majority of primary studies are retrospective, with a smaller number of prospective cohort studies.

Study	Research Focus	Setting / Population	Study Period
S. Matsuzaki et al., 2023 [10]	PAS incidence and outcomes at VBAC [10]	Nationwide (USA), low-transverse CS history, vaginal delivery [10]	2017–2020 [10]
Giuliana Schindler Fogaça & A. C. Costa, 2026 [19]	Association between rising CS rates and PAS incidence and severity [19]	Multiple countries; human populations with CS history [19]	Last five years [19]
M. Klar & K. Michels, 2014 [1]	Association between CS and placental disorders in subsequent pregnancies [1]	Multiparous singleton-pregnant women [1]	1990–2011 [1]
A. Iacovelli et al., 2018 [15]	Risk factors for abnormally invasive placenta (AIP) [15]	1,085,693 women; high-risk obstetric population [15]	After 2000 [15]
M. Leovic & J. Perlow, 2019 [20]	AIP risk in anterior placentation without previa after prior CS [20]	High-risk; 169 AIP cases; large tertiary center (USA) [20]	2011–2017 [20]

Study	Research Focus	Setting / Population	Study Period
Yi-Peng Gao et al., 2021 [21]	Scoring system for PAS prediction using maternal and US features [21]	Third-trimester pregnancies [21]	2014–2019 [21]
N. Marshall et al., 2011 [5]	Impact of increasing number of CS deliveries on maternal morbidity [5]	2,282,922 deliveries [5]	Not reported [5]
Staci J Marbin et al., 2024 [16]	Isthmocele as risk factor for PAS in CD history patients [16]	National Accreta Center; 137 PAS, 70 controls [16]	2012–2022 [16]
M. Nagpal et al., 2019 [22]	Clinical course and outcomes of abnormal placental attachment [22]	66 patients; tertiary care hospital (India) [22]	2016–2018 [22]
Oxana M Zarudskaya et al., 2024 [23]	Predictive value of Placenta Accreta Index (PAI) [23]	1,044 cases; high-risk with anterior previa or low-lying placenta [23]	Through November 2022 [23]

Study	Research Focus	Setting / Population	Study Period
M. Higgins et al., 2013 [14]	Incidence of hysterectomy for placenta accreta in context of rising CS rate [14]	157,162 multiparous women; single hospital [14]	1975–2010 [14]
J. Balayla & H. D. Bondarenko, 2013 [24]	Risk factors and adverse outcomes of placenta accreta [24]	508,617 deliveries; 865 confirmed PA cases [24]	1977–2012 [24]
E. Jauniaux & A. Bhide, 2017 [11]	Ultrasound diagnosis of placenta previa accreta after CS [11]	3,889 pregnancies; placenta previa/low-lying with prior CS [11]	1982–2016 [11]
O. Keag et al., 2018 [2]	Long-term risks and benefits of CS for mother, baby, subsequent pregnancies [2]	29,928,274 participants; high-income countries [2]	Through May 2017 [2]
K. Hessami et al., 2022 [8]	PAS risk factors and outcomes with vs. without placenta previa [8]	3,342 PAS pregnancies [8]	Through April 2022 [8]

Study	Research Focus	Setting / Population	Study Period
C. Gyamfi-Bannerman et al., 2012 [25]	Risk of uterine rupture and placenta accreta after prior uterine surgery outside lower segment [25]	13,904 women; prior myomectomy, classical CS, or low-transverse CS [25]	Not reported [25]
N. Hussein et al., 2023 [26]	Risk factors for worsening placental invasion (increta/percreta vs. accreta) [26]	83 participants; PAS with cesarean hysterectomy [26]	Not reported [26]
M. R. Torloni et al., 2001 [27]	Risk factors for accreta in placenta previa patients [27]	245 placenta previa cases; São Paulo, Brazil [27]	1986–1998 [27]
Yan Li et al., 2021 [28]	Placental thickness as correlate of PAS in placenta previa [28]	65 patients with placenta previa [28]	Not reported [28]
Fengge Wang et al., 2023 [29]	Second-trimester AFP and placenta accreta risk [29]	504 women; China [29]	2016–2021 [29]

Study	Research Focus	Setting / Population	Study Period
P. Jha et al., 2020 [30]	Placental thickness as screening tool for PAS in placenta previa [30]	65 patients with placenta previa [30]	Not reported [30]
O. Tapisiz et al., 2012 [31]	Incidence, indications, and risk factors for emergency peripartum hysterectomy [31]	30 EPH cases; tertiary hospital, Ankara, Turkey [31]	2006–2010 [31]
Fengge Wang et al., 2021 [32]	Second-trimester AFP levels and placenta accreta [32]	504 women; China [32]	2016–2021 [32]
Alessandro Petrecca et al., 2026 [33]	Uterine closure techniques at CS and PAS incidence in subsequent pregnancy [33]	1,787 pregnancies; Japan and Turkey [33]	Through September 2025 [33]
M. Leovic & J. Perlow, 2019a [34]	Impact of uterine closure technique at CS on AIP development [34]	169 AIP cases; large tertiary center (USA) [34]	2011–2017 [34]

Study	Research Focus	Setting / Population	Study Period
Amrita Banerjee et al., 2025 [35]	TVU assessment of CS scar characteristics and adverse outcomes [35]	Preconception and antenatal populations with prior CS [35]	Through January 2024 [35]
Enrique A. Jaramillo Saavedra et al., 2024 [36]	Ultrasound parameters for diagnosis of PAS in placenta previa [36]	90 high-risk patients, Arequipa, Peru [36]	2021–2023 [36]
M. Rac et al., 2015 [37]	Placenta Accreta Index as ultrasound predictor of placental invasion [37]	184 gravidas; ≥1 prior CS with previa/low-lying placenta [37]	1997–2011 [37]
Esther H. Adler et al., 2014 [38]	Trophoblast inclusions as marker of abnormal placental genetics in accreta [38]	40 accreta cases, 42 controls; single institution [38]	Not reported [38]
G. Doulaveris et al., 2020 [39]	First-trimester TVU prediction of PAS in prior CS patients [39]	467 patients with prior CS history [39]	2016–2018 [39]
Aisha Grayli Cahyani & Willy Sandhika, 2023 [40]	Risk factors for PAS [40]	Multiple countries (Iran, Japan, Indonesia, UK, Egypt, Australia, NZ) [40]	2012–2022 [40]

Study	Research Focus	Setting / Population	Study Period
Shun Sugai et al., 2023 [9]	Clinical characteristics of pathologically proven PAS without placenta previa [9]	US, Australia, Germany, Japan; high-risk PAS patients [9]	Through September 2022 [9]
Nazan Kocaoğlu et al., 2012 [41]	Anesthetic management and outcomes in placenta previa with/without accreta [41]	65 placenta previa women scheduled for CS [41]	2004–2009 [41]
Ihab Serag Allam et al., 2014 [42]	Incidence and determinants of emergency peripartum hysterectomy [42]	66,306 deliveries; Ain-Shams University Maternity Hospital, Egypt [42]	2003–2008 [42]
J. Tavcar et al., 2021 [43]	PAS incidence after hysteroscopic treatment for Asherman's syndrome [43]	355 treated patients; community teaching hospital [43]	2015–2019 [43]
O. Yucel et al., 2006 [44]	Emergency peripartum hysterectomy: incidence, indications, risk factors [44]	34 EPH cases; 9-year period [44]	Not reported [44]

Study	Research Focus	Setting / Population	Study Period
T. Wong, 2011 [45]	Emergency peripartum hysterectomy incidence and causes [45]	19 EPH cases; Christchurch Women's Hospital, New Zealand [45]	2000–2009 [45]
Milovanov Ap & Dimova Ea, 2011 [46]	Pathogenesis of placenta accreta and implantation into uterine wall [46]	500 references reviewed [46]	Not reported [46]
M. Rac et al., 2014 [47]	First-trimester ultrasound predictors of placenta accreta [47]	39 patients; prior CS with placenta previa; high-risk [47]	1997–2011 [47]
R. Erin & D. Kulaksız, 2022 [48]	Frequency, risk factors, and outcomes of peripartum hysterectomy [48]	42 peripartum hysterectomy patients; tertiary hospital, Turkey [48]	6-year period [48]
D. Arıkan et al., 2009 [49]	Maternal and obstetric outcomes with increasing number of CS [49]	408 women delivered by CS [49]	Not reported [49]
J. A. Guzmán López et al., 2022 [50]	PAS disorders in the first trimester [50]	55 histopathologically confirmed PAS cases [50]	Through November 2018 [50]

Study	Research Focus	Setting / Population	Study Period
Ehab Hasanin Mohamad & A. M. S. Elkhateeb, 2022 [51]	Uterine incision pattern and effect on outcomes in morbidly adherent placenta [51]	4,400 cases screened; 66 MAP confirmed; Egypt [51]	2018–2020 [51]
P. Saini et al., 2023 [12]	Incidence, indication, and outcome of emergency peripartum hysterectomies [12]	33 EPH cases; tertiary hospital, Jammu [12]	2021–2022 [12]
Alisha V. Olsthoorn et al., 2020 [52]	TOLAC counseling and invasive placentation outcomes [52]	Prior CS patients; 67 invasive placentas; tertiary center [52]	4-year review [52]
Ayman H. Shaamash et al., 2024 [53]	Impact of high-order repeat CS on maternal complications in major placenta previa [53]	184 major PP patients; Abha, Saudi Arabia [53]	2012–2021 [53]
M. Tikkanen et al., 2011 [18]	Antenatal vs. intrapartum diagnosis of placenta accreta and outcomes [18]	44 placenta accreta cases; university teaching hospital [18]	Not reported [18]

Study	Research Focus	Setting / Population	Study Period
C. Z. de la Cruz et al., 2015 [54]	CS and risk of emergency peripartum hysterectomy in high-income countries [54]	General obstetric population; high-income countries [54]	2000–2012 [54]
Matthew K. Janssen & S. Ralston, 2021 [55]	Maternal morbidity with multiple repeat CS deliveries [55]	30,132 CS deliveries; 19 US academic centers [55]	1999–2002 [55]
J. Tavcar et al., 2022 [56]	PAS incidence and outcomes after treatment for Asherman syndrome [56]	355 treated patients; academic community hospital [56]	4-year period [56]
V. Marsoosi et al., 2018 [57]	Scoring system for prediction of placenta accreta [57]	159 suspected MAP patients; Tehran hospitals [57]	2016–2018 [57]
Dominique A. Badr et al., 2020 [58]	Uterine body (non-previa) PAS: risk factors, diagnosis, management [58]	133 cases over 70 years [58]	1949–2019 [58]

Study	Research Focus	Setting / Population	Study Period
E. Jauniaux et al., 2021 [7]	Investigation of placenta percreta: heterogeneity of the category [7]	101 consecutive singleton pregnancies; University of Cairo [7]	2019–2021 [7]
M. S. Owolabi et al., 2013 [59]	Incidence and determinants of peripartum hysterectomy [59]	150,847 deliveries; Washington, D.C. metropolitan area [59]	2000–2009 [59]
M. Muench et al., 2008 [60]	Gravid hysterectomy incidence and risk factors [60]	34 gravid hysterectomies; 19,491 deliveries; academic referral center [60]	1991–2001 [60]
Joumaa Habeb Alsoleman et al., 2023 [61]	Diagnostic accuracy of prenatal ultrasound for placenta previa accreta after CS [61]	1,251 pregnancies; 220 placenta accreta cases [61]	2008–2022 [61]
L. Gatta et al., 2023 [62]	Validation of EW-AIP sonographic checklist for histologic PAS detection [62]	78 subjects (39 PAS, 39 controls); US referral centers [62]	2016–2020 [62]

Study	Research Focus	Setting / Population	Study Period
A. Larish et al., 2023 [63]	Focal-occult PAS vs. previa-associated PAS: morbidity comparison [63]	74 cases; tertiary care center [63]	2018–2022 [63]
S. Barinov et al., 2021 [64]	Distal haemostasis efficacy during CS in women with PAS [64]	532 women with abnormal placental localization; Russia [64]	2014–2020 [64]
Chang-kun Zhu et al., 2015 [65]	Maternal outcomes in pernicious placenta previa [65]	470 placenta previa patients; Women's Hospital Zhejiang University [65]	2012–2014 [65]
Ahmed Sherif Abdel Hamid et al., 2024 [66]	Serum amyloid A as cheap marker for PAS in low-resource setting [66]	60 patients; Ain-Shams University, Cairo, Egypt [66]	2017 [66]
Muhammad Hasan Passamula et al., 2025 [67]	Epidemiological characteristics of PAS [67]	PAS patients; Dr. Hasan Sadikin Hospital, Bandung [67]	2019–2023 [67]
S. Moradan et al., 2017 [68]	Maternal complications of repeated CS: second vs. more than twice [68]	400 women; Semnan Amiralmomenin Hospital, Iran [68]	2009–2012 [68]

Study	Research Focus	Setting / Population	Study Period
I. Timor-Tritsch & A. Monteagudo, 2012 [69]	Early placenta accreta and cesarean scar pregnancy as CS consequences [69]	Literature review [69]	Not reported [69]
Ellen Hayes et al., 2011 [70]	Diagnosis and management options for morbidly adherent placenta [70]	Not specified [70]	Not reported [70]
Serkan Kahyaoğlu et al., 2013 [6]	Epidemiology, pathophysiology, diagnosis, and management of placenta accreta [6]	Not specified [6]	Not reported [6]
C. Comstock, 2011 [71]	Antenatal ultrasound diagnosis of placental attachment disorders [71]	High-risk (prior surgery + previa) [71]	Not reported [71]
R. Ruano et al., 2012 [72]	First-trimester TVU biometry to distinguish placenta accreta from cesarean scar pregnancy [72]	Cervico-isthmic implantations with prior CS history [72]	2006–2011 [72]

Study	Research Focus	Setting / Population	Study Period
A. S. Simões et al., 2024 [73]	Clinical risk factors for PAS; proposal of screening guideline [73]	General obstetric population; primarily China, USA, Italy [73]	2019 onwards [73]
M. Sarker et al., 2024 [74]	Mid-trimester placenta previa thickness and persistence at delivery [74]	239 singleton gestations with previa [74]	2015–2019 [74]
A. Maged et al., 2023 [4]	Diagnostic accuracy of ultrasound for PAS [4]	5,307 women; 2,025 confirmed PAS cases; multiple countries [4]	Through February 2022 [4]
A. Imudia et al., 2009 [13]	Incidence, trends, and risk factors for cesarean hysterectomy [13]	158 CH cases; Detroit Medical Center [13]	17-year period [13]
E. Morgan et al., 2019 [17]	Effect of placental location on diagnosis, risk factors, and outcomes in PAS [17]	86 pathology-confirmed PAS; two large urban hospitals [17]	2007–2017 [17]
Sevan A. Vahanian & A. Vintzileos, 2016 [75]	Modern approach to placental implantation abnormalities [75]	Not specified [75]	Not reported [75]

Study	Research Focus	Setting / Population	Study Period
A. Bárbara et al., 2021 [76]	Placenta previa with/without accreta: six-year tertiary hospital experience [76]	79 placenta previa patients; tertiary hospital, Portugal [76]	2015–2021 [76]
G. Bonanni et al., 2026 [3]	Evaluation of national and international guidelines on PAS management [3]	18 guidelines from 14 national/international societies [3]	2014–2024 [3]
Zhi-sheng Guo et al., 2019 [77]	Outcomes in placenta previa on cesarean scar [77]	183 patients; First Bethune Hospital of Jilin University [77]	2011–2017 [77]
T. Rosen, 2008 [78]	Placenta accreta and scar pregnancy as overlooked costs of rising CS rate [78]	Not specified [78]	Not reported [78]
G. Garmi & R. Salim, 2012 [79]	Epidemiology, etiology, diagnosis, and management of placenta accreta [79]	High-risk population; not specified [79]	Not reported [79]

Study	Research Focus	Setting / Population	Study Period
R. Silver & Kelli Barbour, 2015 [80]	Placenta accreta spectrum: accreta, increta, and percreta [80]	High-risk (previa + prior CS) [80]	Not reported [80]

The included studies are heterogeneous in design, scope, and population. Approximately half are primary observational studies (predominantly retrospective), and the remainder are systematic reviews, meta-analyses, or narrative reviews. Primary studies range from fewer than 20 cases of placenta accreta to tens of thousands of deliveries in national registry analyses. Most primary studies are conducted at single tertiary referral centers with high-risk populations, which limits generalizability to unselected obstetric populations. Notable exceptions include the large nationwide database analysis by Matsuzaki et al. (n=184,415) [10] and the multicenter prospective cohort reviewed by Janssen and Ralston (n=30,132) [55]. Geographic diversity is substantial, with studies from North America, Europe, Turkey, the Middle East, China, South and Southeast Asia, South America, and Oceania, though several key quantitative benchmarks derive from U.S. tertiary centers.

Effects

Overall Association Between Cesarean Section History and Placenta Accreta Incidence

The association between prior cesarean delivery and placenta accreta spectrum (PAS) is one of the most consistently reported findings in modern obstetrics. The meta-analysis by Klar and Michels, encompassing 16 observational studies, reported a summary odds ratio of 1.96 (95% CI: 1.41–2.74) for placenta accreta after any prior cesarean section [1]. The large systematic review by Keag et al. similarly found an odds ratio of 2.95 (95% CI: 1.32–6.60) for placenta accreta associated with cesarean delivery compared to vaginal delivery, based on 705,108 participants across three studies [2]. Simões et al. reported an OR of 5.84 (95% CI: 2.69–12.67, $p<0.001$) for women with two or more prior cesarean sections [73]. Bonanni et al., synthesizing guideline-referenced

evidence, noted ORs from the Nordic Obstetric Surveillance Study of 6.6 (95% CI 4.4–9.8) after one CD, 17.4 (95% CI 9.0–31.4) after two CDs, and 55.9 (95% CI 25.0–110.3) after three or more CDs [3]. Higgins et al., examining 36 years of institutional data, reported an incidence rate of placenta accreta of 1.65 per 1,000 parous women with a previous CS overall, rising to 2.37 per 1,000 after 2003 (OR 2.2, 95% CI 1.05–5.1), suggesting temporal amplification of risk concurrent with rising CS rates [14].

Tikkanen et al. found a statistically significant association between history of cesarean section and antenatal diagnosis of placenta accreta (p=0.004) [18]. Wong demonstrated a significant association between previous uterine surgery and abnormal placentation (p=0.02), with the association being particularly strong for prior cesarean specifically (p=0.003) [45]. Nagpal et al. reported a statistically significant positive correlation between increasing number of prior cesarean sections and morbidly adherent placenta (p=0.001) [22]. The Washington DC metropolitan area cohort (Owolabi et al.) independently confirmed that primary and repeat cesarean deliveries were associated with peripartum hysterectomy, a common downstream consequence of placenta accreta [59].

Dose-Response Relationship: Incidence by Number of Prior Cesarean Sections

The evidence for a dose-response relationship between cumulative cesarean deliveries and PAS risk is robust and consistent across multiple high-quality sources. The most widely cited figures, synthesized by multiple reviews [3, 4, 11], originate from the landmark Silver et al. multicenter cohort study, which documented the following rates among all women regardless of placenta previa status: 0.2% after one CS, 0.3% after two, 0.6% after three, 2.1% after four, 2.3% after five, and 6.7% after six or more CS deliveries [3]. When restricted to the subset with concurrent placenta previa, the interaction effect is dramatic: 3.3% after one CS, 11.1% after two, 40.0% after three, 61.0% after four, 67.0% after five, and 67.0% after six or more CS deliveries [3]. These figures are corroborated by Jauniaux and Bhide's systematic review, which found incidence rates of 4.1% in women with one prior CS and 13.3% in those with two or more prior CS among pregnancies presenting with placenta previa or low-lying placenta [11]. Maged et al.'s meta-analysis

similarly reported rates of 3%, 11%, 40%, 61%, and 67% after 1, 2, 3, 4, and 5 or more cesarean deliveries, respectively, in the high-risk previa population [4].

The meta-analysis of Iacovelli et al. quantified the dose-response on the odds ratio scale: the OR for AIP was 2.6 (95% CI: 1.6–4.4) after two prior CS and 5.4 (95% CI: 1.7–17.4) after three prior CS [15]. Marshall et al.'s systematic review, encompassing 2,282,922 deliveries, showed that compared to women with previa and no prior CS (accreta rate 3.3–4%), women with previa and three or more prior CS had accreta rates of 50–67% (composite morbidity OR 33.6, 95% CI 14.6–77.4) [5]. Janssen and Ralston, reviewing the Silver et al. multicenter prospective cohort, noted accreta rates of approximately 2% at the fourth cesarean delivery and over 6% at six or more procedures, with formal trend tests (Cochran-Armitage trend test and Jonckheere-Terpstra test) confirming statistically significant dose-response across categories [55].

Shaamash et al. stratified 184 major placenta previa patients by low-order repeat CS (CD2–CD3) versus high-order repeat CS (CD4–CD7), finding a PAS OR of 2.67 in the high-order group, with the highest rates observed in CD6–CD7 at 84.6% (OR 3.98) [53]. The progressive increase in emergency hysterectomy rates (OR 2.96 for high-order vs. low-order repeat CS) and urological injuries (OR 3.17) paralleled the PAS rate increase [53].

The following table summarizes the dose-response data reported across key sources.

Source	CS Category	Accreta/PAS Rate or OR	Placenta Previa Present?
Silver et al. (via multiple reviews) [3]	1 CS	0.2%	No
Silver et al. (via multiple reviews) [3]	2 CS	0.3%	No

Source	CS Category	Accreta/PAS Rate or OR	Placenta Previa Present?
Silver et al. (via multiple reviews) [3]	3 CS	0.6%	No
Silver et al. (via multiple reviews) [3]	4 CS	2.1%	No
Silver et al. (via multiple reviews) [3]	5 CS	2.3%	No
Silver et al. (via multiple reviews) [3]	≥6 CS	6.7%	No
Silver et al. (via multiple reviews) [3]	1 CS	3.3%	Yes
Silver et al. (via multiple reviews) [3]	2 CS	11.1%	Yes
Silver et al. (via multiple reviews) [3]	3 CS	40.0%	Yes
Silver et al. (via multiple reviews) [3]	4 CS	61.0%	Yes
Silver et al. (via multiple reviews) [3]	≥5 CS	67.0%	Yes

Source	CS Category	Accreta/PAS Rate or OR	Placenta Previa Present?
Maged et al., 2023 [4]	1 CS	3%	Yes
Maged et al., 2023 [4]	2 CS	11%	Yes
Maged et al., 2023 [4]	3 CS	40%	Yes
Maged et al., 2023 [4]	4 CS	61%	Yes
Maged et al., 2023 [4]	≥5 CS	67%	Yes
Jauniaux & Bhide, 2017 [11]	1 prior CS	4.1%	Yes
Jauniaux & Bhide, 2017 [11]	≥2 prior CS	13.3%	Yes
Iacovelli et al., 2018 [15]	2 prior CS	OR 2.6 (95% CI 1.6–4.4)	Mixed
Iacovelli et al., 2018 [15]	3 prior CS	OR 5.4 (95% CI 1.7–17.4)	Mixed
Bonanni et al., 2026 [3]	1 CD	OR 6.6 (95% CI 4.4–9.8)	Mixed
Bonanni et al., 2026 [3]	2 CD	OR 17.4 (95% CI 9.0–31.4)	Mixed

Source	CS Category	Accreta/PAS Rate or OR	Placenta Previa Present?
Bonanni et al., 2026 [3]	≥3 CD	OR 55.9 (95% CI 25.0–110.3)	Mixed
Marshall et al., 2011 [5]	≥3 CS with previa	OR 33.6 (95% CI 14.6–77.4) vs. previa + no CS	Yes
Shaamash et al., 2024 [53]	CD4–CD5	57.9% PAS rate	Yes
Shaamash et al., 2024 [53]	CD6–CD7	84.6% PAS rate	Yes
Janssen & Ralston, 2021 [55]	4th CS	~2%	Mixed
Janssen & Ralston, 2021 [55]	≥6th CS	>6%	Mixed
Klar & Michels, 2014 [1]	Any prior CS	OR 1.96 (95% CI 1.41–2.74)	Mixed
Keag et al., 2018 [2]	CS vs. vaginal delivery	OR 2.95 (95% CI 1.32–6.60)	Mixed
Torloni et al., 2001 [27]	≥2 CS	OR 2.54	Yes (previa)
Gyamfi-Bannerman et al., 2012 [25]	Classical CS vs. low-transverse CS	aOR 2.09 (95% CI 0.69–6.33)	Mixed

Source	CS Category	Accreta/PAS Rate or OR	Placenta Previa Present?
Simões et al., 2024 [73]	≥2 CS	OR 5.84 (95% CI 2.69–12.67)	Mixed
Hussein et al., 2023 [26]	Higher prior CS count	aOR 1.18 (95% CI 0.43–3.23; NS)	Mixed

The table demonstrates the critical interaction with placenta previa: among all-comers with a prior CS, the absolute risk of PAS remains low but increases measurably with each additional CS; however, among those who also develop placenta previa, even a single prior CS confers a clinically important accreta risk (~3–4%), and the risk escalates near-exponentially with subsequent deliveries, reaching majority probability by the third CS. The OR estimates from the Nordic study (Bonanni et al.) [3] are considerably larger than the summary OR from Klar and Michels [1], likely reflecting differences in population, time period, and the baseline comparator (the Nordic estimates compare to zero prior CS, while earlier meta-analyses may have mixed comparators).

Historical Trends in Incidence

Multiple sources document not only a cross-sectional association but also a temporal trend in PAS incidence commensurate with rising CS rates. Higgins et al.'s 36-year institutional study showed a near-doubling of accreta incidence from 1.06/1,000 previous CS deliveries (before 2002) to 2.37/1,000 (2003–2010) (OR 2.2, 95% CI 1.05–5.1) [14]. Kahyaoğlu et al. noted that the historically rare occurrence of approximately 1 in 30,000 deliveries in the 1950s had risen to 1 in 553–2,510 deliveries by the early 2000s [6]. This secular trend is echoed by Muench et al., who documented a significant rise in gravid hysterectomy rate from 1/800 to 1/299 over five years at an academic referral center ($p<0.05$), despite constant cesarean rates during that period, suggesting an additional compounding effect beyond the CS rate alone [60]. Rosen, in a 2008 narrative review,

framed rising PAS rates explicitly as an "overlooked cost" of the increasing cesarean section rate [78].

Interaction with Placenta Previa

The interaction between prior CS and concurrent placenta previa constitutes the strongest identifiable risk gradient in this literature. Iacovelli et al. found an OR of 12.0 (95% CI 1.6–88.0) for PAS in women with at least one prior CS combined with placenta previa, compared to the reference group [15]. The systematic review by Jauniaux and Bhide confirmed accreta rates of 4.1% and 13.3% in previa patients with one and two or more prior CS, respectively [11]. Torloni et al.'s case-control study of 245 placenta previa patients identified both central placenta previa (OR 2.93) and two or more prior CS (OR 2.54) as independent predictors of accreta [27], with a predictive model estimating a 44.4% accreta risk when both factors coexist. Hessami et al.'s meta-analysis of 3,342 PAS pregnancies demonstrated that prior cesarean delivery was substantially less prevalent in PAS without previa (OR 0.15, 95% CI 0.06–0.37, $p<0.001$), confirming that the CS-PAS association is mediated predominantly through its co-occurrence with placenta previa [8].

Barinov et al.'s prospective cohort found that 30.8% of their placenta previa cases had PAS, and 93.3% of these PAS cases were associated with the presence of a uterine scar [64]. Chang-kun Zhu et al., comparing pernicious (prior CS + anterior previa) with non-pernicious placenta previa, reported placental implantation rates of 27.7% versus 5.7% and hysterectomy rates of 11.9% versus 0.8% [65], illustrating how the combination amplifies all adverse outcomes. Guo et al.'s retrospective series of 183 patients with placenta previa on a cesarean scar found a 34.4% PAS disorder rate [77].

Non-Previa (Focal-Occult) PAS and CS History

A distinct and clinically underappreciated phenotype is PAS occurring without placenta previa. Larish et al.'s retrospective series of 74 pathology-confirmed PAS cases found that focal-occult PAS patients had far fewer prior cesarean sections (mean 0.5 vs. 2.3 for previa-associated PAS) and were much less likely to have had any prior CS at all (27.9% vs. 96.8%) [63]. The meta-analysis by Sugai et al. confirmed that prior cesarean section is a strong risk factor specifically for PAS with placenta previa, whereas assisted reproductive technology (ART) and prior uterine

procedures (D&C, myomectomy) are the dominant risk factors for PAS without previa [9]. The systematic review by Hessami et al. confirmed this dichotomy: women with PAS without previa were much more likely to have undergone IVF (OR 3.11, 95% CI 1.93–5.02) and prior D&C (OR 1.60, 95% CI 1.15–2.22), and myomectomy (OR 2.47, 95% CI 1.31–4.66), but were significantly less likely to have a prior CS [8]. These findings are important for risk stratification: CS history is a powerful risk factor predominantly in the subset of women who also develop previa; its predictive value in a general obstetric population without previa is considerably lower.

Uterine Scar Type and Closure Technique

Cesarean section type modifies the CS–accreta relationship. Gyamfi-Bannerman et al. found that prior classical CS was associated with a threefold increased risk of uterine rupture (aOR 3.23, 95% CI 1.11–9.39) and a non-statistically significant but directionally consistent increased risk of accreta (aOR 2.09, 95% CI 0.69–6.33, p=0.01 for accreta frequency) compared to prior low-segment transverse CS [25]. Accreta occurred in 0% of the prior myomectomy group, compared to 0.19% in the low-transverse CS group and 0.88% in the classical CS group, with the previa-conditioned rate of 11.1% for the classical CS group and 13.6% for the low-transverse CS group (not statistically different) [25].

Leovic and Perlow found a statistically significant difference in AIP incidence by closure technique: double-layer closure was associated with a significantly higher observed AIP incidence (93.1% vs. 41.4%, p=0.035), and larger suture caliber was associated with increased AIP incidence (p=0.032) [34]. However, the systematic review and meta-analysis by Petrecca et al. could only identify three eligible trials (1,787 pregnancies) examining closure technique and subsequent PAS incidence; these showed a potential association between continuous versus interrupted suture (aOR 6.0, 95% CI 1.4–25.2, p=0.015) but no significant difference between locking and non-locking or single- versus double-layer closure [33]. The authors concluded it is currently impossible to mandate a specific uterine closure technique to reduce PAS risk [33]. Hussein et al.'s case-control study found a non-significant trend toward two-layer closure decreasing the risk of increta/percreta (aOR 0.51, 95% CI 0.18–1.46) [26]. The small sample sizes and methodological limitations of these studies preclude definitive conclusions on closure technique.

The role of isthmocele—a uterine niche or defect at the CS scar—as an intermediate phenotype linking CS to PAS has been examined by Marbin et al., who found that patients who developed PAS after CD were nearly six times more likely to have had an isthmocele on early ultrasound (p=0.002) [16]. Banerjee et al.'s systematic review confirmed that an exposed CD scar with placental implantation over the scar or within the niche had high sensitivity (75–100%) and high negative predictive value (99.6–100%) for PAS [35]. Marbin et al. further observed that all patients with early implantation in the lower half of the uterus ultimately developed PAS, irrespective of isthmocele diagnosis, whereas those with upper uterine implantation did not [16].

CS History and Severity of Placental Invasion

Beyond binary PAS diagnosis, the evidence suggests that number of prior cesarean sections correlates with depth of placental invasion. Alsoleman et al.'s systematic review noted that after two prior cesarean deliveries, 7 increta, 7 creta, and 11 percreta cases were identified; after more than two, a further 3 increta, 6 creta, and 8 percreta were observed [61]. Jauniaux et al.'s prospective cohort of 101 pregnancies (mean 2.8 prior CDs) [7] showed that most histologically confirmed cases were creta (n=9) or increta (n=56), with the category of percreta representing substantial intraoperative observer disagreement and often reflecting uterine wall abnormality rather than true villous penetration [7]. Hussein et al.'s case-control study comparing increta/percreta with accreta found that those with more invasive disease had a higher mean number of prior cesarean births (2.2 ± 1.0 vs. 1.7 ± 0.9), though the trend was not statistically significant after adjustment (aOR 1.18, 95% CI 0.43–3.23) [26]. Adler et al. noted that trophoblast inclusions—a potential marker of abnormal placental genetics—were more common in more invasive forms (increta/percreta: 47% vs. accreta: 20%), and prior CS was present in 67% of all accreta cases versus 9.5% of controls [38], suggesting a complex interaction between scar-mediated uterine pathology and intrinsic placental abnormalities.

Outcomes Associated with PAS in the Context of CS History

PAS arising in the context of prior CS is associated with severe maternal morbidity. In the nationwide VBAC cohort of Matsuzaki et al., where the overall PAS incidence was 8.1 per 10,000 deliveries, patients with PAS had postpartum hemorrhage in 80.0% of cases, blood product

transfusion in 23.3%, shock or coagulopathy in 20.0%, and hysterectomy in 43.3%, all compared to rates below 5.5%, 1.0%, 0.2%, and <0.1% respectively in those without PAS (all p<0.001) [10]. Tikkanen et al. found that women diagnosed antenatally had significantly lower median blood loss (4,500 mL vs. 7,800 mL, p=0.012) and fewer units of packed red blood cells transfused (median 7 vs. 13.5, p=0.026) [18]. Jauniaux and Bhide reported cesarean hysterectomy in 89.7% of cases managed with detailed data [11].

Several peripartum hysterectomy series across different countries illustrate the ascendancy of PAS/accreta as the leading indication. Among Turkish tertiary centers, placenta accreta accounted for 40.0% of EPH indications (Tapisiz et al.) [31]. In an Egyptian series covering 66,306 deliveries, placenta accreta/increta comprised 39.6% of peripartum hysterectomy indications [42]. In a tertiary center in Jammu, accreta was responsible for 69% of EPH over a one-year period [12]. In New Zealand, invasive placental adhesion (accreta, increta, percreta) accounted for 63% of EPH cases [45]. Imudia et al. confirmed that morbidly adherent placenta had replaced uterine atony as the leading indication for emergent cesarean hysterectomy over their 17-year review period at the Detroit Medical Center [13]. The systematic review by de la Cruz et al. of 52 studies in high-income countries found EPH rates ranging from 0.20 to 5.09 per 1,000 deliveries (median 0.61), with mean maternal mortality of 3.0%, and confirmed that both primary and repeat cesarean delivery were strong risk factors, with additive risk per subsequent CS [54].

Larish et al.'s comparative analysis of focal-occult versus previa-associated PAS found that hemorrhage and ICU admission rates did not significantly differ between groups despite the absence of previa and lesser CS burden in focal-occult PAS, and that focal-occult PAS was associated with a higher incidence of reoperation (30.2% vs. 6.5%, p=0.01) [63]. This finding highlights that the morbidity of PAS is not entirely mitigated even in forms not strongly linked to CS history.

Additional Risk Factors and Their Modification of the CS–PAS Relationship

Multiple factors beyond CS history contribute to PAS risk, and several modify the CS–accreta association.

Advanced maternal age (>35 years) is independently associated with AIP (OR 3.1, 95% CI 1.4–7.0) [15]. Higher parity (OR 2.5, 95% CI 1.7–3.6) [15] and maternal obesity (OR 1.4, 95% CI 1.0–1.8) [15] are also significant. IVF pregnancy carries an OR of 2.8 (95% CI 1.2–6.8) for AIP [15] and is particularly important in PAS without placenta previa [8]. Prior uterine curettage and D&C represent important additional pathways to defective decidualization, operating independently of CS [8, 9]. In Asherman's syndrome patients treated hysteroscopically, the PAS rate was 23.7%, and history of cesarean section was the only variable independently and statistically significantly associated with PAS (aOR 4.03, 95% CI 1.31–12.39) [43, 56].

Placental location modulates the expression of CS-related PAS risk. Morgan et al. found that posterior PAS was associated with substantially lower prior CS rates (63% vs. 94% anterior) and higher IVF rates (38% vs. 2%), and was less likely to be suspected prenatally (50% vs. 20%, p=0.019) [17]. Badr et al.'s comprehensive review of uterine body (non-previa) PAS—compiled from 133 cases across 70 years—identified prior cesarean delivery, uterine curettage, Asherman's syndrome, endometritis, and IVF among major risk factors, and noted that pre-symptomatic diagnosis was achieved in only 3% of cases [58].

Smoking, while mentioned in several sources as a reported risk factor, was not independently confirmed in the largest meta-analysis (Iacovelli et al.) after multivariable adjustment [15]. The interval between prior CS and subsequent pregnancy was examined in the Iacovelli meta-analysis but yielded no consistent definition or significant association [15].

Uterine closure technique constitutes a potentially modifiable risk factor, though current evidence is insufficient to support firm recommendations [33, 34]. The presence of an isthmocele, which may reflect inadequate scar healing from prior CS, appears to be an important intermediate variable linking CS to subsequent PAS, particularly when the placenta implants in the lower uterine segment [16, 35].

Elevated second-trimester serum AFP is associated with placenta accreta in women with previa (β=0.60, 95% CI 0.52–0.68, p<0.001 after adjustment for age, BMI, and gestational week) [29, 32], and prior CS history independently predicted accreta in these women (β=3.41, 95% CI 2.18–5.34, p<0.001) [29]. Serum amyloid A (SAA) was found elevated in both previa and accreta

groups versus normal controls (19.9±5.0 and 18.3±5.5 vs. 11.4±2.1 μg/mL, $p<0.001$), though it could not distinguish previa from accreta alone [66].

Synthesis

The literature reviewed here is largely consistent in establishing a strong causal gradient between CS history and PAS, but several sources of apparent heterogeneity—in both risk estimates and clinical presentations—merit systematic reconciliation.

The Previa-Conditioned vs. All-Comer Distinction

The most important source of heterogeneity across reported risk figures is whether estimates are drawn from previa populations or from all obstetric patients. The all-comer incidence after a single prior CS is below 0.5% [3], while in women with concurrent placenta previa it is 3–4% [3, 4, 11]. Studies reporting very high OR values (e.g., Bonanni et al.'s Nordic data showing ORs of 6.6 to 55.9 across CS categories) [3] are likely capturing a different denominator or era than older studies with smaller ORs. The absolute risk figures from Silver et al. and their consistent replication across multiple reviews [3, 4] suggest these gradient estimates are robust in high-income country tertiary settings. Both sets of estimates can be simultaneously correct: the all-comer gradient reflects population-attributable risk (dominated by the large number of women with prior CS but no previa), while the previa-conditioned gradient reflects clinically actionable individual risk for the highest-risk patients.

Population Differences Explaining Outlier Findings

Leovic and Perlow's single-center series found AIP rates of 50–75% in anterior, non-previa patients with one to four prior CS deliveries [20], which are dramatically higher than population-based estimates. This reflects their setting: a tertiary care center where AIP suspicion was raised based on clinical variables other than previa, meaning the denominator is an already-selected high-risk group rather than all women with prior CS. Their conclusion—that absence of previa should not be heavily relied upon for risk reduction when other clinical variables raise suspicion—is valid in context but does not contradict population-level risk gradients [20].

Moradan et al.'s cross-sectional Iranian study comparing second versus more than two CS found no statistically significant differences in placenta accreta between groups [68], contrasting

with most other sources. The small sample size (200 per group), the high proportion of women with zero prior CS in the "control" group (who were having their second CS and thus comparing against their first), and the short study period (2009–2012) likely explain the null finding. This study should be weighted less heavily than the larger, methodologically stronger multicenter cohort studies and meta-analyses.

Mechanistic Basis: Why Multiple CS Leads to Increasing PAS Risk

The mechanistic explanation for the dose-response relationship is well-characterized and consistent across narrative reviews and pathological studies. Prior CS creates a zone of defective decidualization in the lower uterine segment due to scar formation and impaired endometrial regeneration. When subsequent trophoblastic implantation occurs at or near this scar—particularly when a placenta migrates to or is primarily positioned over it—the absence of a normal decidual barrier permits abnormal villous invasion [6, 46, 78]. Jauniaux et al.'s prospective cohort and systematic review of percreta case reports concluded that the condition represents a consequence of primary or secondary uterine pathology rather than an invasive trophoblastic disorder per se—the villous tissue exploits damaged myometrium rather than actively invading normal uterine wall [7]. This framing explains why PAS without previa—in which the placenta implants on a different part of the uterus—is more strongly associated with ART and prior curettage than with CS, and why prior myomectomy, which does not damage the lower uterine segment, carries essentially no measurable CS-equivalent accreta risk [25].

The amplifying role of placenta previa is mechanistically intuitive: previa positions the placenta directly over the most vulnerable zone of the uterine wall—the lower segment where CS scars form—maximizing the probability of implantation into a defective decidual area. Each successive CS enlarges and potentially deepens the zone of myometrial disruption, explaining the near-exponential rise in accreta rates beyond two prior CS in the previa population [3, 11].

The isthmocele data of Marbin et al. provide a structural intermediate: women who develop a scar niche visible on ultrasound—reflecting inadequate myometrial healing—appear to carry disproportionately higher PAS risk, with all patients showing early lower-uterine implantation developing PAS in their series [16]. This suggests that CS history is a probabilistic risk factor

whose actual expression depends on the quality of the resulting uterine scar, which may be influenced by closure technique, suture material, infection, and individual tissue healing characteristics.

Temporal Trends and Healthcare System Effects

The temporal increase in PAS incidence beyond what the CS rate alone can explain—observed by both Higgins et al. [14] and Muench et al. [60] —suggests that the population of women with multiple prior cesarean sections has grown faster than overall CS rates would predict, as successive cohorts accumulate more cesarean-exposed pregnancies. Additionally, as PAS itself is increasingly recognized and managed conservatively in some settings, women who survive a prior PAS may be at risk for recurrence in subsequent pregnancies. Larish et al. found that among nine focal-occult PAS patients with a subsequent pregnancy, three had recurrent PAS [63], underscoring this compounding effect.

Implications for Risk Stratification and Generalizability

The majority of primary studies are conducted at single tertiary referral centers with high-risk populations, introducing selection bias that inflates absolute risk estimates relative to unselected obstetric populations. The nationwide U.S. registry analysis of Matsuzaki et al. (n=184,415 VBAC deliveries) found a PAS incidence of only 8.1 per 10,000 in this relatively lower-risk population, with the strongest predictor being low-lying placenta (aOR 35.02, 95% CI 18.19–67.42) [10] —a finding that is broadly consistent with population-based gradients but substantially lower in absolute terms than referral center figures. Studies from lower-income countries (Egypt, Iran, Peru, Indonesia) generally report higher proportions of high-parity, multiply-operated women in their PAS series, which may reflect different obstetric demographics rather than fundamentally different underlying biological risk. The Zarudskaya et al. review of the Placenta Accreta Index specifically noted that most constituent studies were from developing countries in high-risk populations, limiting global generalizability of their findings [23].

The evidence is sufficient to conclude, across virtually all study designs and populations, that: (1) any history of prior CS is a statistically robust and clinically meaningful risk factor for PAS in subsequent pregnancies; (2) the risk increases with each successive CS in a dose-dependent

fashion; (3) this dose-response is powerfully amplified by concurrent placenta previa; (4) the mechanistic pathway operates through defective decidualization at the CS scar; and (5) women without placenta previa but with CS history face a lower absolute risk, while women with both prior CS and previa represent the highest-risk group in whom aggressive antenatal surveillance and multidisciplinary delivery planning are warranted.

DISCUSSION

The present systematic review confirms that a history of prior cesarean section is one of the strongest and most consistently reported risk factors for placenta accreta spectrum in subsequent pregnancies. The association is not merely binary but demonstrates a clear, statistically significant dose-response relationship across multiple high-quality studies.

Overall Association: The meta-analysis by Klar and Michels, encompassing 16 observational studies, reported a summary odds ratio of 1.96 (95% CI 1.41–2.74) for placenta accreta after any prior cesarean section [1]. Keag et al., in a large systematic review including 705,108 participants, found an OR of 2.95 (95% CI 1.32–6.60) for CS versus vaginal delivery [2]. Simões et al. reported an even stronger OR of 5.84 (95% CI 2.69–12.67, $p<0.001$) for women with two or more prior CS [73]. These figures are remarkably consistent across different populations and time periods, supporting a causal relationship.

Dose-Response Relationship: The evidence for a progressive increase in PAS risk with each additional CS is robust. The landmark Silver et al. multicenter cohort, cited by multiple subsequent reviews, documented the following accreta rates among all women regardless of previa status: 0.2% after one CS, 0.3% after two, 0.6% after three, 2.1% after four, 2.3% after five, and 6.7% after six or more CS [3,4]. Formal trend tests (Cochran-Armitage, Jonckheere-Terpstra) confirmed statistical significance across categories [55].

When restricted to women with concurrent placenta previa, the interaction effect is dramatic and clinically critical: accreta rates rise to 3.3% after one CS, 11.1% after two, 40.0% after three, 61.0% after four, and 67.0% after five or more CS [3,4]. Jauniaux and Bhide's systematic review confirmed previa-conditioned rates of 4.1% (one prior CS) and 13.3% (two or more prior CS) [11].

Iacovelli et al. quantified this on the odds ratio scale: OR 2.6 (95% CI 1.6–4.4) for two prior CS and OR 5.4 (95% CI 1.7–17.4) for three prior CS [15]. Marshall et al., in a review of 2,282,922 deliveries, showed that women with previa and three or more prior CS had accreta rates of 50–67%, with a composite morbidity OR of 33.6 (95% CI 14.6–77.4) compared to previa without prior CS [5]. The Nordic Obstetric Surveillance Study, cited by Bonanni et al., reported even larger ORs: 6.6 (4.4–9.8) after one CD, 17.4 (9.0–31.4) after two CDs, and 55.9 (25.0–110.3) after three or more CDs [3].

Interaction with Placenta Previa: The synergistic effect between prior CS and placenta previa constitutes the strongest identifiable risk gradient. Iacovelli et al. found an OR of 12.0 (95% CI 1.6–88.0) for PAS in women with at least one prior CS combined with previa [15]. Torloni et al. identified both central previa (OR 2.93) and two or more prior CS (OR 2.54) as independent predictors, with a predictive model estimating 44.4% accreta risk when both factors coexist [27]. Barinov et al. found that 30.8% of previa cases had PAS, and 93.3% of these PAS cases were associated with a uterine scar [64]. Hessami et al.'s meta-analysis of 3,342 PAS pregnancies demonstrated that prior CS was substantially less prevalent in PAS without previa (OR 0.15, 95% CI 0.06–0.37, $p<0.001$), confirming that the CS-PAS association is mediated predominantly through co-occurrence with previa [8].

PAS Without Previa (Focal-Occult): A distinct phenotype exists where PAS occurs without placenta previa. Larish et al. found that focal-occult PAS patients had far fewer prior CS (mean 0.5 vs. 2.3 for previa-associated PAS) and were much less likely to have had any prior CS (27.9% vs. 96.8%) [63]. Sugai et al. confirmed that prior CS is a strong risk factor specifically for PAS with previa, whereas ART and prior uterine procedures (D&C, myomectomy) dominate in PAS without previa [9]. Hessami et al. reported that PAS without previa was strongly associated with IVF (OR 3.11, 95% CI 1.93–5.02), prior D&C (OR 1.60, 95% CI 1.15–2.22), and myomectomy (OR 2.47, 95% CI 1.31–4.66) [8].

Uterine Scar Type and Isthmocele: Classical CS carries higher accreta risk than low-transverse CS. Gyamfi-Bannerman et al. found a non-significant but directionally consistent increased risk of accreta for classical CS (aOR 2.09, 95% CI 0.69–6.33, p=0.01 for frequency) [25].

Marbin et al. showed that patients who developed PAS after CD were nearly six times more likely to have an isthmocele on early ultrasound (p=0.002) [16]. Banerjee et al. confirmed that an exposed CS scar with placental implantation over the scar had high sensitivity (75–100%) and high negative predictive value (99.6–100%) for PAS [35].

Closure Technique: Evidence on uterine closure technique is inconclusive. Leovic and Perlow found double-layer closure associated with higher AIP incidence (93.1% vs. 41.4%, p=0.035) [34]. However, Petrecca et al.'s meta-analysis (only three eligible trials, 1,787 pregnancies) showed a potential association between continuous versus interrupted suture (aOR 6.0, 95% CI 1.4–25.2, p=0.015) but no significant difference for single- vs double-layer closure [33].

Severity of Invasion: Number of prior CS correlates with depth of invasion. Alsoleman et al. noted increasing increta, creta, and percreta cases with more prior CS [61]. Jauniaux et al. (mean 2.8 prior CDs) found most confirmed cases were increta (n=56) or creta (n=9) [7]. Hussein et al. found a higher mean number of prior CS in increta/percreta versus accreta (2.2±1.0 vs. 1.7±0.9), though not significant after adjustment (aOR 1.18, 95% CI 0.43–3.23) [26].

Maternal Outcomes: PAS in the context of prior CS causes severe morbidity. Matsuzaki et al. reported postpartum hemorrhage in 80.0%, transfusion in 23.3%, shock/coagulopathy in 20.0%, and hysterectomy in 43.3% of PAS cases [10]. Tikkanen et al. found antenatal diagnosis reduced median blood loss (4,500 mL vs. 7,800 mL, p=0.012) and transfusion requirements (median 7 vs. 13.5 units, p=0.026) [18]. Multiple peripartum hysterectomy series confirm PAS as the leading indication: 40.0% in Turkey [31], 39.6% in Egypt [42], 69% in India [12], 63% in New Zealand [45]. Imudia et al. confirmed PAS replaced uterine atony as the leading indication for cesarean hysterectomy over a 17-year period [13].

Other Risk Factors: Advanced maternal age (>35 years, OR 3.1, 95% CI 1.4–7.0), higher parity (OR 2.5, 95% CI 1.7–3.6), obesity (OR 1.4, 95% CI 1.0–1.8), and IVF (OR 2.8, 95% CI 1.2–6.8) are independently associated with AIP [15]. In Asherman's syndrome, CS history was the only independent predictor of PAS (aOR 4.03, 95% CI 1.31–12.39) [43,56]. Elevated second-trimester AFP is associated with accreta in previa women (β=0.60, 95% CI 0.52–0.68, p<0.001) with prior CS independently predictive (β=3.41, 95% CI 2.18–5.34, p<0.001) [29].

Temporal Trends: Higgins et al. documented a near-doubling of accreta incidence from 1.06/1,000 prior CS deliveries (before 2002) to 2.37/1,000 (2003–2010) (OR 2.2, 95% CI 1.05–5.1) [14]. Muench et al. found gravid hysterectomy rate rose from 1/800 to 1/299 over five years despite constant CS rates [60]. Rosen framed rising PAS as an "overlooked cost" of rising CS rates [78].

Mechanistic Basis: The consistent mechanistic explanation across sources is defective decidualization at the CS scar. Prior CS creates a zone of myometrial damage with impaired endometrial regeneration. When subsequent trophoblastic implantation occurs at or near this scar—particularly with previa—the absent decidual barrier permits abnormal villous invasion [6,46,78]. Jauniaux et al. concluded that PAS represents trophoblastic exploitation of damaged myometrium rather than active invasion of normal tissue [7].

CONCLUSIONS AND RECOMMENDATIONS

Conclusions: A history of prior cesarean section is a statistically robust and clinically meaningful risk factor for placenta accreta spectrum in subsequent pregnancies. The risk increases in a clear dose-response manner with each additional CS. This dose-response relationship is powerfully amplified by concurrent placenta previa: women with both prior CS and previa constitute the highest-risk group, with accreta rates reaching 40–67% by the third or fourth CS. PAS without placenta previa is less strongly associated with CS history and more linked to ART and prior uterine procedures. Classical CS and the presence of an isthmocele further increase risk. The mechanistic pathway operates through defective decidualization at the uterine scar. Maternal morbidity associated with PAS in this context is severe, including hemorrhage, transfusion, hysterectomy, and ICU admission.

Recommendations:

1. **Risk Counseling:** Women considering repeat CS or pregnancy after prior CS should receive evidence-based counseling on the dose-dependent increase in PAS risk, especially if they have multiple prior CS.

2. **Antenatal Surveillance:** Women with two or more prior CS and anterior placenta or placenta previa should undergo targeted ultrasound surveillance at a tertiary center with PAS expertise.

3. **Multidisciplinary Planning:** Deliveries in women with prior CS and suspected PAS should be planned in a center with interventional radiology, gynecologic oncology, blood bank, and neonatology support.

4. **Isthmocele Assessment:** Post-CS ultrasound assessment for isthmocele may help stratify risk in women planning subsequent pregnancy.

5. **Closure Technique Research:** Given current insufficient evidence, no specific uterine closure technique can be mandated to reduce PAS risk; further randomized trials are needed.

6. **Registry Development:** National registries should track CS-PAS outcomes to enable ongoing risk quantification and quality improvement.

REFERENCES

1. M. Klar, K. Michels (2014) Cesarean section and placental disorders in subsequent pregnancies – a meta-analysis. Journal of Perinatal Medicine. https://doi.org/10.1515/jpm-2013-0199

2. O. Keag, J. Norman, S. Stock (2018) Long-term risks and benefits associated with cesarean delivery for mother, baby, and subsequent pregnancies: Systematic review and meta-analysis. PLoS Medicine. https://doi.org/10.1371/journal.pmed.1002494

3. G. Bonanni, M. C. López-Girón, Lisa Allen, et al (2026) Guidelines on Placenta Accreta Spectrum Disorders: A Systematic Review. Obstetrical and Gynecological Survey. https://doi.org/10.1097/01.ogx.0001179560.22096.dc

4. A. Maged, A. El-Mazny, N. Kamal, et al (2023) Diagnostic accuracy of ultrasound in the diagnosis of Placenta accreta spectrum: systematic review and meta-analysis. BMC Pregnancy and Childbirth. https://doi.org/10.1186/s12884-023-05675-6

5. N. Marshall, R. Fu, J. Guise (2011) Impact of multiple cesarean deliveries on maternal morbidity: a systematic review. American Journal of Obstetrics and Gynecology. https://doi.org/10.1016/j.ajog.2011.06.035

6. Serkan Kahyaoğlu, Ş. Çelen, Inci Kahyaoglu, et al (2013) Plasenta yapışma anomalileri: Klinik yaklaşım ve yönetim. Cumhuriyet medical journal. https://doi.org/10.7197/CMJ.V35I4.1008001306

7. E. Jauniaux, Jonathan L. Hecht, R. Elbarmelgy, et al (2021) Searching for Placenta Percreta: A prospective cohort and systematic review of case reports. American Journal of Obstetrics and Gynecology. https://doi.org/10.1016/j.ajog.2021.12.030

8. K. Hessami, B. Salmanian, B. Einerson, et al (2022) Clinical Correlates of Placenta Accreta Spectrum Disorder Depending on the Presence or Absence of Placenta Previa. Obstetrics and Gynecology. https://doi.org/10.1097/AOG.0000000000004923

9. Shun Sugai, Kaoru Yamawaki, Tomoyuki Sekizuka, et al (2023) Pathologically diagnosed placenta accreta spectrum without placenta previa: a systematic review and meta-analysis. American Journal of Obstetrics & Gynecology MFM. https://doi.org/10.1016/j.ajogmf.2023.101027

10. S. Matsuzaki, Alesandra R. Rau, R. Mandelbaum, et al (2023) Assessment of placenta accreta spectrum at vaginal birth after cesarean delivery. American Journal of Obstetrics & Gynecology MFM. https://doi.org/10.1016/j.ajogmf.2023.101115

11. E. Jauniaux, A. Bhide (2017) Prenatal ultrasound diagnosis and outcome of placenta previa accreta after cesarean delivery: a systematic review and meta-analysis. American Journal of Obstetrics and Gynecology. https://doi.org/10.1016/j.ajog.2017.02.050

12. P. Saini, Arshdeep Kour, J. Lamba, et al (2023) INCIDENCE, INDICATION AND OUTCOME OF EMERGENCY PERIPARTUM HYSTERECTOMIES IN A TERTIARY CARE HOSPITAL. PARIPEX-INDIAN JOURNAL OF RESEARCH. https://doi.org/10.36106/paripex/2007595

13. A. Imudia, A. Awonuga, T. Dbouk, et al (2009) Incidence, trends, risk factors, indications for, and complications associated with cesarean hysterectomy: a 17-year experience from a single institution. Archives of Gynecology and Obstetrics. https://doi.org/10.1007/s00404-009-0984-5

14. M. Higgins, C. Monteith, M. Foley, C. O'Herlihy (2013) Real increasing incidence of hysterectomy for placenta accreta following previous caesarean section. European Journal of Obstetrics, Gynecology, and Reproductive Biology. https://doi.org/10.1016/j.ejogrb.2013.08.030

15. A. Iacovelli, M. Liberati, A. Khalil, et al (2018) Risk factors for abnormally invasive placenta: a systematic review and meta-analysis. Journal of Maternal-Fetal & Neonatal Medicine. https://doi.org/10.1080/14767058.2018.1493453

16. Staci J Marbin, Fielding Stephen, Brian Druyan, et al (2024) 240 Isthmocele in patients with history of cesarean delivery followed by pregnancy complicated with placenta accreta. American Journal of Obstetrics and Gynecology. https://doi.org/10.1016/j.ajog.2023.11.262

17. E. Morgan, A. Sidebottom, M. Vacquier, et al (2019) The effect of placental location in cases of placenta accreta spectrum. American Journal of Obstetrics and Gynecology. https://doi.org/10.1016/j.ajog.2019.07.028

18. M. Tikkanen, J. Paavonen, M. Loukovaara, V. Stefanovic (2011) Antenatal diagnosis of placenta accreta leads to reduced blood loss. Acta Obstetricia et Gynecologica Scandinavica. https://doi.org/10.1111/j.1600-0412.2011.01147.x

19. Giuliana Schindler Fogaça, A. C. Costa (2026) INCREASED CESAREAN SECTION RATES AND THE SPECTRUM OF PLACENTAL ACCRETA: A SYSTEMATIC REVIEW. Lumen et Virtus. https://doi.org/10.56238/levv17n56-049

20. M. Leovic, J. Perlow (2019) Anterior Placentation Without Previa in Patients With Prior Cesarean Section: What Is the Risk of Accreta? [29G]. Obstetrics and Gynecology. https://doi.org/10.1097/01.AOG.0000558728.76930.50

21. Yi-Peng Gao, Xuejiao Gao, Jiong Cai, et al (2021) Prediction of placenta accreta spectrum by a scoring system based on maternal characteristics combined with ultrasonographic features. Taiwanese Journal of Obstetrics & Gynecology. https://doi.org/10.1016/j.tjog.2021.09.011

22. M. Nagpal, R. Sood, P. Arora, H. Cheema (2019) Outcome of Abnormal Placental Attachments in Pregnancies with a Review of Literature. AMEI's Current Trends in Diagnosis & Treatment. https://doi.org/10.5005/jp-journals-10055-0057

23. Oxana M Zarudskaya, A. Boyd, J. Byrne, et al (2024) Predictive Value and Limitations of the Placenta Accreta Index. Journal of ultrasound in medicine. https://doi.org/10.1002/jum.16509

24. J. Balayla, H. D. Bondarenko (2013) Placenta accreta and the risk of adverse maternal and neonatal outcomes. Journal of Perinatal Medicine. https://doi.org/10.1515/jpm-2012-0219

25. C. Gyamfi-Bannerman, S. Gilbert, M. Landon, et al (2012) Risk of Uterine Rupture and Placenta Accreta With Prior Uterine Surgery Outside of the Lower Segment. Obstetrics and Gynecology. https://doi.org/10.1097/AOG.0b013e318273695b

26. N. Hussein, R. Harrison, Calla M. Holmgren, et al (2023) Risk Factors for Worsening Placental Invasion Within a Cohort of Placenta Accreta Spectrum Patients [ID: 1380333]. Obstetrics & Gynecology. https://doi.org/10.1097/01.AOG.0000930372.93798.a3

27. M. R. Torloni, A. F. Moron, L. Camano (2001) Placenta Prévia: Fatores de risco para o Acretismo. Revista Brasileira de Ginecologia e Obstetrícia. https://doi.org/10.1590/S0100-72032001000700002

28. Yan Li, H. Choi, R. Goldstein, et al (2021) Placental thickness correlates with placenta accreta spectrum (PAS) disorder in women with placenta previa. Abdominal Radiology. https://doi.org/10.1007/s00261-020-02894-9

29. Fengge Wang, Dongmei Man, Shiguo Liu (2023) Elevated Second Trimester Alpha-Fetoprotein Increases the Risk of Placenta Accreta. Clinical and Experimental Obstetrics & Gynecology. https://doi.org/10.31083/j.ceog5011232

30. P. Jha, Y. Li, H.H. Choi, et al (2020) VP46.30: Placental thickness as a screening tool for placenta accreta spectrum disorder in women with placenta previa. Ultrasound in Obstetrics & Gynecology. https://doi.org/10.1002/uog.23095

31. O. Tapisiz, S. Altinbas, B. Yirci, et al (2012) Emergency peripartum hysterectomy in a tertiary hospital in Ankara, Turkey: a 5-year review. Archives of Gynecology and Obstetrics. https://doi.org/10.1007/s00404-012-2434-z

32. Fengge Wang, L. Su, Ruixia Zhai, et al (2021) Relationship Between the Second Trimester Maternal Serum AFP of Aneuploidy in Pregnancies and Placenta Accreta: A Cohort Study. https://doi.org/10.21203/RS.3.RS-554257/V1

33. Alessandro Petrecca, Julie Gomez, Megan Raymond, et al (2026) Uterine closure techniques during cesarean delivery and placenta accreta spectrum incidence in subsequent pregnancies: A systematic review and meta-analysis. Pregnancy. https://doi.org/10.1002/pmf2.70244

34. M. Leovic, J. Perlow (2019) Impact of Uterine Closure Technique at Time of Cesarean Section on Development of Abnormally-Invasive Placentation [14L]. Obstetrics and Gynecology. https://doi.org/10.1097/01.AOG/01.AOG.0000559248.39373.1f

35. Amrita Banerjee, Roberta Solda, Maria Ivan, et al (2025) A systematic review of transvaginal ultrasound assessment of cesarean scar characteristics and prediction of adverse obstetric outcomes. American Journal of Obstetrics & Gynecology MFM. https://doi.org/10.1016/j.ajogmf.2025.101839

36. Enrique A. Jaramillo Saavedra, Gonzalo Arturo Medina Bueno, Helen Jaramillo Gutiérrez, et al (2024) Valoración de nuevos parámetros ecográficos en el diagnóstico del espectro de placenta acreta en la placenta previa. Revista Peruana de Ginecología y Obstetricia. https://doi.org/10.31403/rpgo.v70i2663

37. M. Rac, J. Dashe, C. Wells, et al (2015) Ultrasound predictors of placental invasion: the Placenta Accreta Index. American Journal of Obstetrics and Gynecology. https://doi.org/10.1016/j.ajog.2014.10.022

38. Esther H. Adler, R. Madankumar, M. Rosner, et al (2014) Increased placental trophoblast inclusions in placenta accreta. Placenta. https://doi.org/10.1016/j.placenta.2014.09.014

39. G. Doulaveris, K. Ryken, D. Papathomas, et al (2020) Early prediction of placenta accreta spectrum in women with prior cesarean delivery using transvaginal ultrasound at 11 to 14 weeks. American Journal of Obstetrics & Gynecology MFM. https://doi.org/10.1016/j.ajogmf.2020.100183

40. Aisha Grayli Cahyani, Willy Sandhika (2023) Risk Factors of Placenta Accreta Spectrum: a systematic review. International Journal of Research Publications. https://doi.org/10.47119/ijrp10013711120235678

41. Nazan Kocaoğlu, I. Gunusen, S. Karaman, et al (2012) Management of anesthesia for cesarean section in parturients with placenta previa with/without placenta accreta: a retrospective study. Ginekologia Polska

42. Ihab Serag Allam, I. Gomaa, H. Fathi, Ghada Fathi Mahmoud Sukkar (2014) Incidence of emergency peripartum hysterectomy in Ain-shams University Maternity Hospital, Egypt: a retrospective study. Archives of Gynecology and Obstetrics. https://doi.org/10.1007/s00404-014-3306-5

43. J. Tavcar, P. Movilla, D. Carusi, et al (2021) Incidence and Clinical Implications of Placenta Accreta Spectrum (PAS) after Hysteroscopic Treatment for Asherman's Syndrome. Journal of minimally invasive gynecology. https://doi.org/10.1016/j.jmig.2021.09.172

44. O. Yucel, I. Ozdemir, N. Yucel, A. Somunkiran (2006) Emergency peripartum hysterectomy: a 9-year review. Archives of Gynecology and Obstetrics. https://doi.org/10.1007/s00404-006-0124-4

45. T. Wong (2011) Emergency peripartum hysterectomy: a 10-year review in a tertiary obstetric hospital. The New Zealand medical journal

46. Milovanov Ap, Dimova Ea (2011) Disputable problems of the pathogenesis of implantation of the placenta into the uterine wall. Arkhiv patologii

47. M. Rac, E. Moschos, E. Wells, et al (2014) OP24.06: Ultrasound (US) findings of placenta accreta in the first trimester. Ultrasound in Obstetrics & Gynecology. https://doi.org/10.1002/UOG.13871

48. R. Erin, D. Kulaksız (2022) Emergency peripartum hysterectomy - our 6 years of experience. Ceska gynekologie. https://doi.org/10.48095/cccg2022179

49. D. Arıkan, A. Coşkun, A. Özer, et al (2009) Impact of Cesarean Section Number on Maternal and Obstetric Outcome. Gynecology Obstetrics and Reproductive Medicine

50. J. A. Guzmán López, Luz A Gutiérrez Sánchez, G. Pinilla-Monsalve, I. Timor-Tritsch (2022) Placenta accreta spectrum disorders in the first trimester: a systematic review. Journal of Obstetrics and Gynaecology Research. https://doi.org/10.1080/01443615.2022.2071151

51. I. D. E. H. M. M. EHAB HASANIN MOHAMAD, M.D., A. M.S. ELKHATEEB, M. Sc. (2022) Uterine Incision Pattern and its Effect on Maternal and Fetal Outcome in Morbidly Adherent Placenta. The Medical journal of Cairo University. https://doi.org/10.21608/mjcu.2022.264485

52. Alisha V. Olsthoorn, E. Figueiró-Filho, Yujin E. Li, et al (2020) Counselling Patients for Trial of Labour after Cesarean (TOLAC) and Invasive Placentation: Are We Missing the Mark? The Importance of Local Data and Informed Choice. Journal of Obstetrics and Gynaecology Canada. https://doi.org/10.1016/j.jogc.2020.07.009

53. Ayman H. Shaamash, Mehad H AlQasem, Ahmed A. Mahfouz, et al (2024) Impact of high-order repeat cesarean deliveries on early maternal complications among major placenta previa patients in Southern Saudi Arabia. Saudi Medical Journal. https://doi.org/10.15537/smj.2024.45.10.20240329

54. C. Z. de la Cruz, E. Thompson, K. O'rourke, Wendy N. Nembhard (2015) Cesarean section and the risk of emergency peripartum hysterectomy in high-income countries: a systematic review. Archives of Gynecology and Obstetrics. https://doi.org/10.1007/s00404-015-3790-2

55. Matthew K. Janssen, S. Ralston (2021) Maternal Morbidity Associated With Multiple Repeat Cesarean Deliveries. 50 Studies Every Obstetrician-Gynecologist Should Know. https://doi.org/10.1097/00132582-200703000-00028

56. J. Tavcar, P. Movilla, D. Carusi, et al (2022) Incidence and Clinical Implications of Placenta Accreta Spectrum After Treatment for Asherman Syndrome. Journal of minimally invasive gynecology. https://doi.org/10.1016/j.jmig.2022.11.013

57. V. Marsoosi, Fahimeh Ghotbizadeh, N. Hashemi, Behnaz Molaei (2018) Development of a scoring system for prediction of placenta accreta and determine the accuracy of its results. Journal of Maternal-Fetal & Neonatal Medicine. https://doi.org/10.1080/14767058.2018.1531119

58. Dominique A. Badr, Jihad al Hassan, Georges Salem Wehbe, M. Ramadan (2020) Uterine body placenta accreta spectrum: A detailed literature review. Placenta. https://doi.org/10.1016/j.placenta.2020.04.005

59. M. S. Owolabi, R. Blake, Mejebi T. Mayor, Henry A Adegbulugbe (2013) Incidence and determinants of peripartum hysterectomy in the metropolitan area of the District of Columbia. Journal of reproductive medicine

60. M. Muench, A. Baschat, Y. Oyelese, et al (2008) Gravid hysterectomy: a decade of experience at an academic referral center. Journal of reproductive medicine

61. Joumaa Habeb Alsoleman, Ali Alamri, Hamzah Hilmi Sindi, et al (2023) Diagnostic results of prenatal ultrasonography and placenta previa accreta following caesarean delivery: Systematic review. Medical Science. https://doi.org/10.54905/disssi.v27i142.e385ms3259

62. L. Gatta, S. Ellestad, B. Boyd, et al (2023) Validation of a sonographic checklist for the detection of histologic placenta accreta spectrum. American Journal of Obstetrics & Gynecology MFM. https://doi.org/10.1016/j.ajogmf.2023.101017

63. A. Larish, K. Horst, J. Brunton, et al (2023) Focal-occult placenta accreta: A clandestine source of maternal morbidity. American Journal of Obstetrics & Gynecology MFM. https://doi.org/10.1016/j.ajogmf.2023.100924

64. S. Barinov, R. Shmakov, I. Medyannikova, et al (2021) Efficacy of distal haemostasis during caesarean delivery in women with placenta accreta spectrum disorders. Journal of Maternal-Fetal & Neonatal Medicine. https://doi.org/10.1080/14767058.2021.2005019

65. Chang-kun Zhu, Fei Wang, Yumei Zhou, et al (2015) [Maternal outcomes in pregnant women with pernicious placenta previa]. Zhejiang da xue xue bao Yi xue ban = Journal of Zhejiang University Medical sciences

66. Ahmed Sherif Abdel Hamid, Hazem El Zeneiny, Amira Al Nahas (2024) Searching for a Cheap Marker for Placenta Accreta Spectrum in a Low Resource Country: A Prospective Cohort Study. The Egyptian Journal of Fertility of Sterility. https://doi.org/10.21608/egyfs.2024.378190

67. Muhammad Hasan Passamula, Hadi Susiarno, Setyorini Irianti (2025) Characteristics of Patients with Placenta Accreta Spectrum at Dr. Hasan Sadikin Central General Hospital in 2019-2023. Indonesian Journal of Obstetrics & Gynecology Science. https://doi.org/10.24198/obgynia.v8i2.926

68. S. Moradan, S. Amoo, Majid Mirmohammad Khani, Bahareh Pourzand (2017) Maternal complications of repeated cesarean section, comparison of second cesarean with more than twice cesarean sections

69. I. Timor-Tritsch, A. Monteagudo (2012) Unforeseen consequences of the increasing rate of cesarean deliveries: early placenta accreta and cesarean scar pregnancy. A review. American Journal of Obstetrics and Gynecology. https://doi.org/10.1016/j.ajog.2012.03.007

70. Ellen Hayes, G. Ayida, Alison Crocker (2011) The morbidly adherent placenta: diagnosis and management options. Current Opinion in Obstetrics and Gynecology. https://doi.org/10.1097/GCO.0b013e32834cef7a

71. C. Comstock (2011) The antenatal diagnosis of placental attachment disorders. Current Opinion in Obstetrics and Gynecology. https://doi.org/10.1097/GCO.0b013e328342b730

72. R. Ruano, M. M. Silva, J. Campos, et al (2012) OP06.02: Longitudinal evaluation of the lung-to-head ratio after fetal tracheal occlusion in severe congenital diaphragmatic hernia—can it predict outcome? Ultrasound in Obstetrics & Gynecology. https://doi.org/10.1002/uog.11444

73. A. S. Simões, F. Caramelo, Isabel Santos Silva (2024) O Perfil Clínico da Mulher com Risco Acrescido de Acretismo Placentar: Proposta de uma Guideline de Rastreio. Acta Obstétrica e Ginecológica Portuguesa. https://doi.org/10.69729/aogp.v18i3a06

74. M. Sarker, H. Rosenberg, Leslie Warren, et al (2024) Mid-trimester sonographic placenta previa thickness and persistence at delivery. European Journal of Obstetrics, Gynecology, and Reproductive Biology. https://doi.org/10.1016/j.ejogrb.2024.02.033

75. Sevan A. Vahanian, A. Vintzileos (2016) Placental implantation abnormalities: a modern approach. Current Opinion in Obstetrics and Gynecology. https://doi.org/10.1097/GCO.0000000000000319

76. A. Bárbara, P. Costa, A. Braga, J. Braga (2021) VP44.18: Placenta previa with/without accretism: a six-year experience in a tertiary hospital. Ultrasound in Obstetrics and Gynecology. https://doi.org/10.1002/uog.24640

77. Zhi-sheng Guo, Yanhong Shan, Huiying Xu, Yi Yang (2019) Pregnancy outcomes in patients with placenta previa on a cesarean scar. https://doi.org/10.21203/rs.2.13939/v1

78. T. Rosen (2008) Placenta accreta and cesarean scar pregnancy: overlooked costs of the rising cesarean section rate. Clinics of Perinatology. https://doi.org/10.1016/j.clp.2008.07.003

79. G. Garmi, R. Salim (2012) Epidemiology, Etiology, Diagnosis, and Management of Placenta Accreta. Obstetrics and Gynecology International. https://doi.org/10.1155/2012/873929

80. R. Silver, Kelli Barbour (2015) Placenta accreta spectrum: accreta, increta, and percreta. Obstetrics and Gynecology Clinics of North America. https://doi.org/10.1016/j.ogc.2015.01.014