

The Impact of Previous Cesarean Delivery on Preterm Birth: A Comprehensive Review

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ABSTRACT

Obstetric complication in preterm birth has significantly affected both mothers and their new-borns; therefore, increasing the incidence for women with previous history of cesarean delivery. It leads to complications, like uterine rupture, cervical insufficiency, and abnormality of the placenta, with a likelihood that increases chances for preterm births. Such pregnancies may also be further sub-classified under spontaneous or medically indicated categories. Spontaneous preterm birth is largely attributed to complications like uterine rupture, that is, with more severe outcomes; however, medically indicated premature birth, mostly due to the mother's health issues or fetal distress, has risks for neonatal respiratory complications. The more cesarean deliveries, the higher is the risk of preterm birth. With multiple repeat cesarean deliveries, the risk of complications like placenta previa and placenta accreta due to cumulative uterine scarring and adhesions increases as well. Short interpregnancy intervals may pose particular risks for preterm birth, especially for intervals under 18 months; complications such as uterine rupture and abnormal placentas contribute to these risks. Obesity and advanced maternal age are maternal variables that enhance the risk of preterm birth following cesarean delivery. Preeclampsia, diabetes, and gestational hypertension are added risks associated with obesity. In order to enhance outcomes for moms and newborns, the report emphasizes early intervention, meticulous risk factor control, and proper birth spacing. To enhance the health of the mother and the baby and reduce the likelihood of preterm delivery in women who have had prior cesarean sections, a better understanding of the complex relationships between these factors is necessary.

Keywords: Cesarean delivery, preterm birth, uterine scarring, maternal health, obstetric outcomes

1. INTRODUCTION

A growing surgical intervention by which babies are delivered through incisions made in the abdomen and uterus, Cesarean delivery (CD) is becoming common in the entire world [1]. According to an estimation of the WHO, "The global rate of cesarean delivery has steadily increased over the past few decades and was an estimated 21% in 2020" and the "highest rates reached in 50%" [2]. The availability of obstetric care and improvements in surgical methods are to blame for this rise, particularly in low- and middle-income nations where cesarean births can save the lives of both the mother and the unborn child. Nevertheless, this trend has some issues [3]. Many high-income countries have seen an increase in non-medically indicated cesareans due to factors such as maternal request, litigation fears, and convenience for both providers and patients [4]. These non-essential operations are part of increasing awareness of the fact that cesarean delivery, though at times inevitable, has long-term consequences for the health of mothers and new-borns. Repeat cesareans are also increasing in prevalence because vaginal birth after cesarean is happening less and less often, since many providers and patients believe that repeat operations are safer [5]. This wave has created a rising number of women with uterine scars, complicated by subsequent pregnancies. It is essential to know how cesarean delivery as practiced around the world can reflect disparities in access to healthcare and even raise issues on overuse and underuse. The balance between those efforts for medical justifications of cesareans with those to try and reduce unnecessary procedures is needed [6]. In order to support evidence-based therapeutic practices, it is important to look at potential long-term connections, such as the link between a history of prior cesarean delivery and preterm birth[7].

Delivery before 37 weeks of pregnancy is known as preterm birth, and it is one of the leading causes of infant morbidity and death worldwide[8]. The WHO reports that about 15 million babies are born preterm annually, representing approximately 10% of all live births worldwide. Even while newborn care has greatly improved over time, preterm delivery problems remain the leading cause of mortality for children under five, particularly

in low- and middle-income nations[9]. There are two types of preterm births: spontaneous and medically recommended. Sometimes spontaneous preterm birth is accompanied by premature rupture of the membranes or preterm labor, but medically indicated preterm birth is brought on by problems like preeclampsia or fetal development limitation that need early delivery in the mother or fetus[10]. Both contribute to long-term health complications, including respiratory distress, developmental delays, and increased risk of chronic diseases in adulthood [11]. The burden of preterm birth is not only health-related but also has economic and emotional costs for families and healthcare systems. The management of preterm infants requires specialized care, often in neonatal intensive care units (NICUs), which can be financially and logistically challenging for many families [12]. Understanding the multifactorial etiology of preterm birth, including genetic, environmental, and medical factors, is necessary to address it. Of these, a history of cesarean delivery has emerged as a potential contributor and has raised the question of whether it contributes to an increased prevalence of preterm births [13]. Because cesarean rates are steadily increasing worldwide, understanding their effect on preterm outcomes is imperative to develop effective prevention strategies and enhance neonatal health.

This has gained considerable attention in research, mainly due to its possible implications for the health of mothers and new-borns[14]. A history of cesarean delivery has an increased risk of uterine scarring, structural anomalies, and complications during subsequent pregnancies, which all may lead to preterm birth [15]. Uterine scarring from cesarean incisions may compromise the fetus by weakening the uterus and predisposing it to rupture or inadequate support in future pregnancies [16]. In addition, this growing upward trend in repeat cesarean births provides a rationale for understanding its impact on delivering multiple pregnancies [17]. Currently, studies have established a relationship between the increased numbers of cesareans and preterm birth, a concern in which questions arise about the balance of benefits and risks about cesarean delivery [18]. Understanding this relationship is crucial for developing care strategies in delivering multiple pregnancies comprehensively. The determination of risk factors involved in cesarean-related preterm birth can aid clinicians in adopting targeted interventions, such as enhanced surgical technique or improved prenatal monitoring, to reduce risks. Such studies may also guide counselling with regard to the long-term implications of cesarean delivery [19]. This is a topic of great concern in the public health sector also, as modifiable risks given the associated preterm birth may lead to its reduction and easing the global burden. Understanding the interplay between cesarean delivery and preterm birth is essential for shaping policies and clinical guidelines that prioritize maternal and neonatal health outcomes [20].

Highlights of the Study

- With a focus on spontaneous and medically indicated preterm deliveries, this study identifies and classifies risk factors for preterm birth.
- Highlights the escalating risk of preterm birth with increasing cesarean deliveries and short interpregnancy intervals, underlining their role in uterine rupture and placental abnormalities.
- Explores the influence of maternal obesity and advanced maternal age on preterm births, linking these factors to complications such as hypertension, diabetes, and preeclampsia.
- Differentiates outcomes of spontaneous versus medically indicated preterm births, showing how interventions can mitigate risks while acknowledging challenges like respiratory complications.
- Provides actionable insights for healthcare professionals, including the importance of proper birth spacing, management of maternal health conditions, and strategies to reduce unnecessary cesarean deliveries.

2. Pathophysiological Mechanisms

The mechanisms through which cesarean delivery predisposes women to preterm birth include changes in the length, strength, and structure at the interface of the uterus and cervix and all the inflammatory processes[21]. Hence, they realize that the scar formation in the uterus due to previous cesarean deliveries affects the structure and the elasticity of the uterus which enhances the chances of implantation abnormality, complications of placenta and spontaneous preterm labour [22]. This refers to cervical incompetency, especially due to surgical trauma or inflammation, where the cervix becomes weak and dilates early, often causing pregnancy loss. Furthermore, infections cause an inflammatory response and/or postoperative inflammation leads to the destruction of the interface between the mother and fetus, as well as the initiation of uterine contractions and preterm labor[23]. These combined processes underscore the importance of anticipatory clinical activity to minimize adverse outcomes in the next pregnancies.

2.1 Uterine Scarring: Impact of Cesarean-Related Uterine Changes on Implantation and Gestation

Cesarean delivery causes uterine scarring that is an extensive pathophysiologic change affecting pregnancy outcomes. Preterm birth is one of the most serious outcomes of this illness, which poses a risk to the fetus's growth as well as the mother's health[24]. The consequences of scar line include its influence on the structural and functional uterus, including implantation events and gestation. Below is an expanded analysis of its impacts under specific subheadings:

2.1.1 Formation and Characteristics of Uterine Scars

Cesarean delivery is associated with incision site healing where the site is closed by fibrotic tissue[25]. Therefore, the normal myometrial tissue differs from scar tissue in that scar tissue has a much lower level of elasticity and contractility and thus cannot grow to accommodate a pregnancy[26]. Fibrosis is a result of serial deposition of collagen forming a scar tissue which is fragile and easily torn due to stresses from the expanding uterus during subsequent pregnancies. These structural flaws are especially devastating if the cesarean wound is not well closed or if there are complications in that area as a result of infections, poor post-surgery care, or other co-existing medical conditions[27].

2.1.2 Impact on Uterine Contractility and Elasticity

Tissue changes resulting from fibrosis cause disability of contractility and the uterine muscle is unable to support such changes associated with gestation. Uterine lining tissues have a typical contour of stretching evenly in order to give the optimum environment for fetal development [28]. However, in scarred areas the extracellular matrix is unable to undertake this expansion; thus, microregions of weakness are formed[29]. This can cause the pressure on the cervix to be higher in some cases while in other lower making it easier for the uterus to rupture or for labour to begin earlier than expected. Scarred tissues are also less sensitive to hormonal changes and this impairs uterine function during pregnancy.

2.1.3 Disruption of Placental Implantation and Function

These include effects on placental implantation, where uterine scarring is one of the essential complications arising from cesarean delivery. They can influence the endometrial architecture and blood supply; especially in the lower segment where most caesarean sections are conducted[30]. By diminishing circulation in the scarred areas, endometrial receptivity creates a poor environment for the appropriate trophoblast adhesion and placenta implantation. This disruption also raises probability of placenta previa (implantation of placenta over cervical opening) and placenta accreta (implantation of the placenta in an abnormal penetration in the myometrium), both of which are correlators to many indicated preterm births[31].

2.1.4 Localized Inflammation and Cellular Abnormalities

Scar tissue formation is directly associated with inflammation that, in many cases, remains localized for an extended period creating a condition of chronic inflammation[32]. This inflammation interferes with normal cellular communication in the endometrium which leads to poor support of the uterus for early pregnancy. Cytokine expression in those regions may stimulate preterm labour because of early activation of inflammation involvement which is a critical factor in spontaneous preterm birth[33]. Furthermore, inflammatory mediators have a devastating effect on the uterine wall and can therefore cause it to rupture or be prone to early contractions.

2.1.5 Increased Risks with Multiple Cesareans

Each subsequent cesarean delivery exacerbates either not only the degree of uterine scarring with the formation of the adherent placenta, but also the risk increases with each following operation step by step[34]. The procedures in question require re-opening of the earlier scar tissue which remains much less elastic and prone to poor healing. In those women with two or more cesareans, the risk of uterine rupture, abnormal placental implantation, and spontaneous preterm labor is increased as compared with women having a single cesarean. These risks justify the rationale for using reasonable decision making in respect to the performance of elective repeat caesareans[35].

2.1.6 Associated Obstetric Complications

Uterine scarring is closely linked with other obstetric complications that increase the risk of preterm birth. For instance:

- Uterine Rupture: Scarred uterine walls are less capable of withstanding the stress of labor, making rupture a serious concern during subsequent pregnancies.
- Cervical Insufficiency: Scarring can weaken the uterocervical junction, contributing to early cervical dilation and preterm delivery.

2.2 Cervical Insufficiency: Effects of Cesarean Surgeries on Cervical Competence

Cervical insufficiency is one of the main causes of preterm birth associated with previous cesarean section. Cesarean operations especially those done involving the lower uterine segment may compromise on the integrity of cervix to support pregnancy up to the full term[36]. This is due partly to direct mechanical injury, inflammation and impaired tissue repair resulting in enhanced susceptibility to spontaneous preterm birth. Below is an expanded analysis under specific subheadings:

2.2.1 Role of the Cervix in Pregnancy Maintenance

During pregnancy, the cervix provides protection for the fetus and ensures that he or she remains lodged within the cavity of the uterus prior to labor[37]. It operates based on a zipper-like mechanism that allows adequacy of tensile strength opposed to any force, without early dilation and effacement. The cervical tissue containing collagen has tensile strength that increases with the growing demands of the pregnancy[38]. When cervical competence is affected, this barrier provides little if any protection and preterm birth is more likely to occur.

2.2.2 Impact of Cesarean-Related Trauma on Cervical Integrity

Cesarean delivery sometimes entails cutting through the lower uterine segment which is in close contact with the cervix. These surgical interventions can cause cervical injury indirectly as a result of mechanical trauma including direct surgery where the cervix is cut or stretched during surgery[39]. This trauma interferes with the usual cytoarchitecture, rendering cervix the ability to become compromised easily by premature dilation/effacement during subsequent pregnancies. Moreover, the structural defects may be worsened by poor healing, or inadequate surgical procedures, thus enhancing the risks[40].

2.2.3 Inflammatory Responses and Cervical Compromise

Cesarean delivery is a surgical procedure, and the process created an inflammatory response that alters cervical competence. In healing there is both cytokine activity and localized inflammation that causes the collagen fibres in the cervix to weaken and lose their elasticity[41]. Inflammation, which tends to be long-standing in cases of infection or inadequate post-operative wound care, serves to weaken cervical tissues still further. These alterations weaken the cervical tissue in response to mechanical forces in pregnancy and increase the risk of preterm labor among women[42].

2.2.4 Cervical Shortening and Its Correlation with Preterm Birth

Cervical shortening is a known phenomenon to be encountered who have had a previous cesarean and has been found to have a strong relationship with preterm labor[43]. This is usually due to pregnancy trauma and inflammation, which predispose the cervix to become weak and incapable of holding the length of pregnancies. Numerous ultrasound and prenatal studies have shown that women who have previously had a cesarean section are more likely to have a short cervix, which has been found to be the primary risk factor for unfavorable pregnancy outcomes[44].

2.2.5 Influence of Short Interpregnancy Intervals

An appropriate gap between pregnancies: the short interpregnancy intervals increases the risks of cervical insufficiency. If the cervix cannot be allowed the time it takes to sufficiently heal, the structure of the cervix after a cesarean is weakened[45]. This inadequate recovery period actually increases the impact of surgical trauma on the cervix and makes the cervix less able to withstand the stresses of pregnancy. It has been established that pregnancies that are conceived closely are likely to be associated with a higher risk of developing spontaneous preterm births hence depicting a need to have appropriate time of recovery[46].

2.2.6 Preventive Strategies for Cervical Insufficiency

For women identified as high-risk due to prior cesarean delivery, preventive measures are crucial. Common interventions include:

- **Cervical Cerclage:** A surgical procedure that reinforces the cervix with sutures to prevent premature dilation. Cerclage has proven effective in reducing preterm birth rates in women with a history of cervical insufficiency.
- **Progesterone Therapy:** Administering progesterone can help reduce inflammation and strengthen cervical tissues, lowering the risk of preterm labor.
- **Regular Cervical Monitoring:** Ultrasound assessments of cervical length during pregnancy can help identify early signs of insufficiency, enabling timely intervention.

2.3 Inflammatory Responses: The Role of Infections and Chronic Inflammation in Increasing Risks of Preterm Labor

Such inflammation, incited by cesarean section, has enormous influence on the emergence of factors that lead to premature birth in future pregnancies[47]. These responses are attributed; to surgical trauma, infections, and changes in immune regulation, which may negatively affect uterine function and fetal implantation. The following gives an elaborate breakdown under the following subtopics.

2.3.1 Postoperative Infections and Their Impact on Uterine Environment

There is always a possibility of introducing microbes into the body through cesarean delivery. This may cause postoperative infections for instance, endometritis, which is an inflammation of the uterine lining by bacteria[48]. Not only does endometritis impact initial postoperative days but also places the uterus at risk of

subsequent inflammation during future pregnancies. The inflammation that occurs as a result of the chronic infection makes it impossible for the uterus to support pregnancy until full term. Also, any infection affecting the pelvis, especially during cesarean delivery, can extend to other tissues such as the fallopian tubes, thus worsening inflammation and likely to cause preterm labor[49].

2.3.2 Role of Chronic Inflammation in Tissue Weakening

Postpartum inflammation caused by cesarean section leads to postsurgical structural and functional alterations in the uterus[50]. As is known, cytokines and chemokines cause alterations in the repair and remodelling of the uterine tissues due to their inflammatory properties. This means that the uterine wall becomes less effective in bearing say mechanical pressure during pregnancy. Endometrial blood vessels also may be affected by chronic inflammation impairing vascular creation and poor placentation and function account for spontaneous PTB[51].

2.3.3 Cytokines and Prostaglandins: Biochemical Mediators of Preterm Labor

Numerous physiological processes contribute to the onset of labor, and inflammation triggers the production of cytokines that are crucial for identifying labor, including prostaglandins, interleukins, and tumor necrosis factor- α . In cases of infection or inflammation that is likely to persist beyond term, the synthesis of these mediators occurs early resulting in preterm uterine contraction and cervical ripening[52]. Prostaglandins in general are said to take a direct part in the process of cervical ripening and in bringing on preterm labor through the stimulation of uterine contractions[53]. Higher levels of these mediators have been found in women with preterm birth due to previous cesarean section carried in the study.

2.3.4 Subclinical Infections: The Silent Risk Factor

Some infections do not have symptoms, but such infections can lead to subclinical infection that initiates chronic low-grade inflammation that persists across pregnancies[54]. Urea plasma urealyticum and Mycoplasma hominis known to cause asymptomatic infections can lead to immune reactions in the uterus. It is a low-grade chronic inflammation which over time causes gradual damage to tissues and makes the mother more vulnerable to such complications as preterm labor in later pregnancies[55].

2.3.5 Exacerbating Factors Influencing Inflammatory Pathways

Influence of some maternal characteristics such as obesity, smoking, and poor prenatal care predisposes the neonate to inflammatory processes[56]. Obesity predisposes uterus to chronic low-grade systemic inflammation and can increase inflammation in uterus. On the other hand, smoking was associated with increase production of pro-inflammatory molecules and suppression of immune function. These infections may be inadequately managed during pregnancy so inflammation continues to worsen, which poses additional risks to women who have had prior cesarean deliveries[57].

2.3.6 Strategies to Mitigate Inflammatory Risks

Inflammation need to be approached comprehensively in order to control risks connected with it. Postoperative infections should be deemed an early diagnosis and appropriate treatment of infections[58]. This can be done by simple postoperative follow up, microbial swabbing, and judicious application of antibiotics. Proper scrupulous aseptic measures during the operation and use of antibiotics to prevent infections during and soon after Caesarean section can be highly effective[59]. Also, enhancing maternal health as a result of obesity and smoking cessation interventions may reduce inflammation.

2.3.7 Advancements in Surgical Techniques and Perioperative Care

Advances in surgical procedures including less invasive method of Caesarian section and changes in the suture management are likely to reduce tissue inflammation[60]. Changes in handling surgical trauma, such as the administration of various anti-inflammatory drugs and circulation management in wound care, may also reduce the number of patients experiencing such inflammatory events.

3. Epidemiological Evidence

Williams et al., [61] considers the method of delivery in the previous term pregnancy when calculating the probability of preterm birth. 16,340 women who attended two UK university teaching maternity units provided the data. Emergency caesarean deliveries at full cervical dilatation were associated with a higher rate of preterm delivery prior to the commencement of spontaneous labor than vaginal births respectively. In comparison to vaginal delivery, elective caesarean sections were shown to be a significant factor in medically justified preterm deliveries following an aOR of 2.30, emergency caesarean sections when the dilatation was less than 4 cm (aOR of 4.68), and between 4 and 9 cm (aOR of 2.43). While second-stage caesarean deliveries contribute to the likelihood of spontaneous preterm birth, first-stage caesarean deliveries during the initial stage of labor or pre-labor are associated with a higher risk of medically recommended preterm birth.

Sapir et al., [62]conduct a retrospective population-based cohort study to determine the effect of cervical suffrage during the second stage of labor on the risk of preterm birth or cervical incompetence in subsequent pregnancies. Data from 78,407 women with subsequent births and 120,147 term first deliveries between 1991 and 2018 were analyzed. Compared to women who had CS for failure to advance during the first stage of labor (4.6%; $p < .026$), women who had previously undergone CS for arrest of descent were more likely to experience a second preterm delivery (7.3%). Multivariable regression verified this link (OR 1.78, 95% CI 1.14–2.76, $p = .011$). Additionally, CS as a result of stoppage of descent was included in Cox regression as a significant risk factor (HR 1.19, 95% CI 1.07–1.31). Uncertainty surrounds the underlying mechanics.

Gemmill et al., [63]assessed national rates of perinatal health indicators in the US from 2015 to 2020, and focused on changes in 2020 in relation to the SARS-CoV-2 pandemic. Interrupted time series approach was used by the researchers to compare observed rates in March to December, 2020 with rates expected according to historic trends. Preterm birth rates fell below expectations in several months, with notable declines in March (observed rate: 9, Relative reduction, with 8 vs. expected rate (10.5, 95% PI 10.2, 10.7) per 100 live births and November. Timing of delivery and birth month showed large declines, consistent with multiple underlying mechanisms. Caesarean delivery rates were however not significantly different.

Blanc et al., [64]evaluated the relationship between gestational age and severe maternal morbidity (SMM) in preterm cesarean deliveries utilizing data obtained from six studies including 45,572 women. There were 3,440 before 26 weeks, 42,132 between 26 and 34 weeks of gestation and 27,800 between 34 and 37 weeks of gestation. SMM occurred in 17.6% of women delivering before 26 weeks and 10.6% between 26 and 34 weeks. In the third analysis, gestational age < 26 weeks was found to be allocative to SMM risk. This association was confirmed in subgroup and sensitivity analyses including gestation at < 25 weeks. The results show that extremely preterm cesareans have a higher SMM risk, and obstetricians and neonatologists must be aware of the associated risk.

Eriksson et al., [65]study of 11 850 Swedish women with a subsequent delivery, fetal station at their first CS was studied as an association with their subsequent risk of PTB. Of these, 1,016 (8.6) were preterm and 5,181 (9.1) of these were preterm in subsequent pregnancy. Women whose births were term but in whom the index CS occurred with a low fetal station (A at or below the ischial spines) were at an increased risk for spontaneous PTB, but not medically indicated PTB. There were increased risks of PTB < 32 weeks and PTB at 32–36 weeks compared to high fetal station. Neither surgical factors such as uterine wall thickness, incision type, or technique of closure had any effect on the risk. The PTB risk increases at low station CS.

Luca et al., [66]presented a study of birth injuries in 62 330 singleton pregnancies cured past 24 completed weeks at a tertiary facility from 2007 to 2017. CS rates increased from 37 to 60%, with preterm deliveries of 10.9%. In 16.2% of cases, birth trauma was detected, without differences between VD and CS. In VD compared to CS, trauma was significantly higher after 28 weeks' gestation, with increasing odds at later gestational ages. No significant difference was however found between preterm VD and CS regarding severe birth trauma, including haemorrhagic, nerve and fracture trauma. CS may decrease overall trauma but does not lower the risk of severe trauma amongst preterm deliveries compared to VD.

Darbandi et al., [67]studied about GDM, which is a common metabolic disease occurring during pregnancy and with enormous impact on perinatal outcomes. To estimate prevalence of GDM and associate unfavourable perinatal outcomes (preterm birth, C-section, stillbirth, abortion, and macrosomia) in a cross-sectional study 3,675 pregnant women were studied from across 11 provinces of Iran. GDM had been found to be strongly associated with higher rates C section and abortion (more than twice that in non-diabetics, $P < 0.001$). GDM was associated with stillbirth 1.8 times and macrosomia seven times. Higher BMI and decreased Chlp Active physical activity all correlated with higher GDP prevalence ($P < 0.001$). Iran is experiencing decline in GDM prevalence, however, this phenomenon with the occurrence of irreversible outcomes including macrosomia emphasizes the necessity of early prevention and intervention strategy.

Letouzey et al., [68], The LOS of preterm babies is not well known, particularly when considering prenatal risk. In this study, 2,052 extremely preterm (28 to 32 +6 weeks gestation) singletons delivered after 72 hours from a nationwide population-based cohort were evaluated for the association between LOS and the etiology of preterm delivery. Of the total number of newborns, 437 had at least one episode of LOS. These comprised 17 preterm labor (1%), 17.9 preterm premature rupture of membranes (PPROM), 20.3 placental abruption, 20.3 isolated hypertensive disorders, 27.5 hypertensive disorders with FGR, and 29.4 isolated FGR. The incidence of LOS varied according to the etiology of preterm delivery. The risks of LOS were significantly increased in infants born after hypertensive disorder, hypertensive disorder with FGR and isolated FGR as compared to preterm labor group. These findings indicate that newborns born very preterm, following hypertensive conditions or FGR, are at extremely high risk for LOS.

Deng et al., [69], The rates of preterm birth in China increased dramatically between 2012 and 2018. Of 96,45,646 live births, 665,244 were preterm, with the rate increasing from 5.9% in 2012 to 6.4% in 2018. Growth of late and very preterm births was significant; moderate preterm rates were stable. We found that for singleton pregnancies, the ARI was increased by 6.4 per cent and multiple pregnancies by 46.8 per cent to 52.7

per cent (ARI 1.9 per cent). The rise in preterm rate could be partly explained by maternal age greater than or equal to 35 years, more antenatal visits, higher complications at birth and the universal two children policy of 2016, which accelerated the rise. While mortality rates for mothers and new born babies have improved over time, preterm birth prevalence continues to rise and requires targeted strategies to reduce prevalence by addressing these changing risk factors.

Salmanov et al., [70], In a retrospective multicentre study in Ukraine (2019–2021), the prevalence and causes of preterm birth in 8,151 pregnant women aged 17–50 were investigated. The study found a high prevalence of preterm births at 27.3%. Term deliveries contributed 72.7% of vaginal deliveries. Preterm birth significantly associated with cervicitis, contributed to 76.3% of preterm cases. Risk factors were a previous history of cervicitis, advanced maternal age, previous preterm labour, and concomitant multiple (e.g., twins or triplets) pregnancies. The study highlights increasing frequency of preterm births in Ukraine as well as the important contribution of cervical infections and inflammation to it. Cervicitis greatly reduces risks for preterm birth if it's caught early and treated. Women with adverse pregnancy outcomes also have a higher risk in subsequent pregnancies emphasizing the importance of close medical care by health care providers for these women.

Koteswari et al., [71] examined 80 pregnant women selected for the study, who were diagnosed with preterm births. Outcomes were influenced by maternal characteristics such as age, social status, education and lifestyle habits. Preterm births were most common for women 17–23 years (49%), and least common for women aged 35–45 years (24%). Very preterm deliveries (36.25%) were associated with alcohol consumption and moderate preterm births were more common among undergraduates (38.75%). Previous abortions (22.5%) and short gestational gaps (<18 months, 41%) also increased risk. Preterm births were 69% by cesarean section. This finding underscores the importance of evaluating and treating risk factors in high risk pregnancies. Maternal and neonatal outcomes can be improved by counselling on harmful habits and on complications associated with them.

In the study of Liu et al., [72], The impact of second stage cesarean sections and protracted second stage labor on the probability of spontaneous preterm birth (sPTB) was evaluated in second pregnancies. A tertiary center's 821 consecutive singleton births of nulliparous women from 2014 to 2017 were the source of the data. Of the participants, 25.2% had a cesarean section and 74.8% gave birth vaginally. Nevertheless, a subsequent sPTB was not linked to a second stage lasting more than two hours. The risk of recurrent sPTB was three times higher for women who experienced sPTB after sPTB, but this difference was not statistically significant. The results of the ensuing studies indicate that second stage cesarean is somewhat, but not statistically significantly, linked to the risk of sPTB, and that protracted second stage labor is not linked to an increased incidence of sPTB. This has important implications for patient counselling as well as for clinical decision making in subsequent pregnancies. Gharacheh et al., [73] examined 1,208,671 Iranian births before and during the COVID19 pandemic (February to September 2020 versus February to September 2019). Data were drawn from the IMAN. C section rates also increased significantly during the pandemic period, from 50.8% pre pandemic. Women who undergo C sections are at increased risk of adverse maternal and neonatal outcomes, including preeclampsia, gestational diabetes, preterm birth, intrauterine growth restriction, low birth weight. The study highlights the need to avoid excessive number of C section especially during the pandemics to improve the maternal and neonatal health outcomes in Iran.

In the study of Rotem et al., [74], VBAC rates among women attempting preterm trial of labor after cesarean (TOLAC) versus term TOLAC were examined at two university affiliated centres (2005–2021). There were 212 (4.4%) preterm (less than 37 weeks) of 4865 second deliveries after prior cesarean and 4653 were term (37 and 42 weeks). Both preterm TOLAC and lower VBAC success were independent predictors of lower VBAC success and there was a significant difference in VBAC success between preterm TOLAC. Increased prevalence for hypertension disorders, diabetes and fertility treatments was found in preterm cases. There was no difference in maternal outcome, including uterine rupture and postpartum haemorrhage, in groups. However, compared to the preterm group, poor neonatal outcomes resulted from preterm, rather than delivery, status.

Table. 1. Summarization of the Epidemiological Evidence

Study	Key Objective	Sample/Scope	Findings	Key Metrics
Williams et al. [61]	Determine the preterm birth risk depending on the delivery method used in a previous term pregnancy.	Data from 16,340 women in two UK maternity units.	Preterm birth more common after emergency CS at full dilation (4.5%) vs vaginal births (2.3%). Elective CS linked to medically indicated preterm births.	aOR 3.29, Elective CS: aOR 2.30, Emergency CS: aOR 4.68 (dilation <4 cm).
Sapir et al. [62]	Effect of 2nd stage	Retrospective	Higher risk of	OR 1.78 (95% CI

	CS on subsequent preterm birth and cervical incompetence.	cohort of 120,147 term first deliveries (1991–2018).	subsequent preterm birth after CS for arrest of descent (7.3%) vs failure to progress (4.6%). Confirmed by multivariable regression.	1.14–2.76, $p = .011$), Cox regression: HR 1.19 (95% CI 1.07–1.31).
Gemmill et al. [63]	Assess changes in perinatal indicators during SARS-CoV-2 pandemic.	National US data (2015–2020).	Preterm birth rates declined in March and November 2020. Caesarean rates were not significantly affected.	Preterm rate observed: 8%; Expected: 10.5 (95% PI 10.2–10.7) per 100 live births.
Blanc et al. [64]	Relationship between gestational age and SMM in preterm CS deliveries.	Data from six studies with 45,572 women.	Extremely preterm cesareans (<26 weeks) associated with higher SMM risk. Subgroup analysis confirmed association.	RR 1.65 (95% CI 1.52–1.78, $I^2 = 40\%$), RR 1.66 (<25 weeks, 95% CI 1.50–1.83, $I^2 = 3\%$).
Eriksson et al. [65]	Association between fetal station during CS and PTB.	Swedish cohort: 11,850 women.	Low fetal station CS linked to higher spontaneous PTB risk.	aOR <32 weeks: 1.73 (95% CI 1.05–2.84), 32–36 weeks.
Luca et al. [66]	Study of birth injuries in singleton pregnancies at a tertiary facility.	62,330 pregnancies (2007–2017).	No significant difference in severe trauma between preterm vaginal delivery and CS, though overall trauma higher in VD after 28 weeks.	CS: 7.5%; VD: 23.4%; aOR 3.3 (95% CI 3.1–3.5).
Darbandi et al. [67]	Prevalence and outcomes of GDM in Iran.	3,675 pregnant women from 11 provinces in Iran.	GDM strongly associated with higher rates of CS, abortion, stillbirth, and macrosomia. Higher BMI and reduced physical activity are risk factors.	CS: 53.19% vs 46.81%; Stillbirth: 1.8x ($P = 0.018$); Macrosomia: 7x ($P < 0.001$).
Letouzey et al. [68]	Examine the connection between LOS in extremely preterm newborns and the etiology of preterm birth.	National cohort: 2,052 infants (28–32 weeks' gestation).	LOS risk significantly higher after hypertensive disorders with/without FGR.	Hypertensive disorders: HR 1.7.
Deng et al. [69]	Trends in preterm birth rates in China (2012–2018).	National Maternal Near Miss Surveillance System: 9,645,646 live births.	Preterm birth rate increased significantly, linked to maternal age, antenatal visits, and the two-child policy.	Annual Rate Increase (ARI): 1.3%; Late Preterm: 1.5%; Very Preterm: 1.8%.
Salmanov et al. [70]	Prevalence and causes of preterm birth in Ukraine (2019–2021).	8,151 women aged 17–50.	High preterm birth prevalence (27.3%). Cervical infections (76.3%) are a	Preterm rate: 27.3% (95% CI: 26–28%), Cervicitis: 76.3% contribution to

			significant risk factor.	preterm cases.
Koteswari et al., [71]	Evaluate risk factors and outcomes of preterm births.	80 pregnant women diagnosed with preterm births at SVS Medical College and Sushrutha Hospital (Sep 2019–Feb 2020).	Preterm births most common among women aged 17–23 (49%). Key risk factors: pre-eclampsia, alcohol consumption, short gestational gaps (<18 months). Cesarean delivery was 69%.	Age group (17–23: 49%, 35–45: 24%), Very preterm births (36.25%), Cesarean rate (69%).
Liu et al., [72]	Assess impact of prolonged second-stage labor and cesarean on sPTB in second pregnancies.	821 singleton deliveries from nulliparous women at a tertiary center (2014–2017).	Prolonged second-stage labor not linked to sPTB. Cesarean sections showed a threefold increased sPTB risk, though not statistically significant.	Vaginal delivery (74.8%), Cesarean section (25.2%), sPTB risk (aOR 0.70, p=0.7).
Gharacheh et al., [73]	Investigate cesarean rates and maternal/neonatal outcomes during COVID-19.	1,208,671 births from the IMNN (Feb–Aug 2019 vs. Feb–Aug 2020).	C-section rates increased during the pandemic. Higher adverse outcomes: pre-eclampsia (3.0% vs. 1.3%), preterm birth (11.6% vs. 6.9%), low birth weight (11.2% vs. 7.8%).	C-section rate (52.9%), Preterm birth (11.6%), Low birth weight (11.2%).
Rotem et al., [74]	Compare VBAC success rates between preterm and term TOLAC deliveries.	4865 second deliveries after prior cesarean at two centres (2005–2021): Preterm (212) vs. Term (4653).	Preterm TOLAC associated with lower VBAC success (57.5% vs. 79.7%). Maternal outcomes similar, but neonatal outcomes poorer in preterm cases due to prematurity.	VBAC success (Preterm: 57.5%, Term: 79.7%), Prevalence of hypertension and diabetes in preterm cases.

4. Risk Factors and Modifiers: A Detailed Analysis

Considering a combination of maternal, obstetric, and healthcare system factors, understanding the various factors which increase the risk of preterm birth after a cesarean delivery is necessary [75]. They are interrelated and play a role in further complications in subsequent pregnancies are preterm labor.

4.1 Maternal Factors: Age, Pre-existing Conditions, and Health Status

From a maternal perspective, pregnancy outcomes are majorly determined by maternal factors like age, pre-existing health conditions and maternal health and lifestyle with or without a history of previous cesarean delivery [76]. Such factors tipped into preterm pregnancy risk, when not taken care of or addressed, can compound those risks in the next pregnancy.

4.1.1 Age:

A key determinant of pregnancy outcome is maternal age, and there is an increased risk of a wide variety of complications related to pregnancy and the new born in older women [77]. The risks from cesarean deliveries are compounded by age-based changes of the reproductive system in women over age 35. The ability of the uterus to carry a pregnancy diminishes as women age, because efficiency of the contractions becomes weaker. Additionally, the cervical function is less robust, and uterine healing after cesarean may take longer, resulting in

an increased risk of uterine rupture or placental abnormal attachment in later pregnancies[78]. For example, women over 35 are more likely to develop gestational diabetes, a condition that can result in the baby being too big (macrosomia) and necessitating delivery by cesarean. As a result, these complications increase the risk for preterm birth in future pregnancies[79]. Additionally, older women may have a reduced ovarian reserve necessitating assisted reproductive techniques, which may further complicate pregnancy and delivery.

4.1.2 Pre-existing Conditions:

Compared to vaginal birth, women with risk factors such as diabetes, hypertension, thyroid issues, and autoimmune illnesses are significantly more likely to give birth prematurely following a cesarean section. These conditions can interfere in the normal functioning of the reproductive system, raise systemic inflammation and damage the vascular integrity of the uterus, all of which increases the probability of preterm labor[80].

- **Hypertension and Preeclampsia:** Impaired placental function or restricted fetal growth can occur in chronic hypertension, or preeclampsia, both of which are characterized by high blood pressure[81]. It also means these conditions are more likely to lead you to having a cesarean delivery, which in turn increases the chances of complication of future pregnancies, such as preterm birth. Early labor is associated with high chances for uterine dysfunction and poor placental perfusion, and both can be caused by elevated blood pressure[82].
- **Diabetes:** Women with diabetes before pregnancy or who develop gestational diabetes are also at a much greater risk of preterm birth. Diabetes that isn't well controlled can cause infection, poor wound healing, and an inflammatory response, which can all contribute to an earlier onset of labor. Also, elevated blood sugar can degrade the structural integrity of the cervix[83].
- **Thyroid Disorders:** Hormonal imbalance, though, can occur due to disorders such as hypothyroidism or hyperthyroidism as it is important for healthy pregnancy. Thyroid dysfunctions may have an impact upon the uterine tone and thus increase the risk of preterm contractions and labor[84].
- **Autoimmune Diseases:** Placental insufficiency and inflammatory responses contributing to preterm birth are more likely under conditions such as lupus, rheumatoid arthritis, or antiphospholipid syndrome[85].

4.1.3 Health Status and Lifestyle Factors:

After a cesarean delivery, the overall health and lifestyle choices of the woman during pregnancy strongly affect pregnancy outcomes. Preterm birth may or may not be exacerbated or mitigated by a range of health behaviours.

- **Obesity:** Pregnancy is one of the most important risk factors for obesity. Besides these complications, it is associated with hypertension, gestational diabetes and a higher need for cesarean delivery[86]. An increase in inflammation, hormonal imbalances, and poor cervical and uterine health all feed into the preterm birth risk and can be caused by obesity[87]. This excess adiposity also can affect immune function and, thereby, increase the likelihood of infections, which trigger preterm labor.
- **Smoking:** Smoking during pregnancy is associated with preterm birth. Pregnancy and smoking are linked with placental blood flow abnormalities, a decrease in fetal oxygen supply, and increases in all of the maternal uterine environment inflammatory processes[88]. They can also make uterine incisions that heal slower, opening the door to further compromising the health of the uterus in subsequent pregnancies[89].
- **Alcohol Consumption:** Preterm birth is strongly associated with alcohol use during pregnancy. Alcohol may inhibit fetal development causing uterine and cervical dysfunction and predisposing to early labor. Alcohol also increases inflammatory processes, which in turn make women more likely to have a preterm birth[90].
- **Lack of Prenatal Care:** Regular prenatal care is one of the most important things to prevent preterm birth. Women who don't get as much prenatal care are more likely to have undiagnosed conditions, like infections, hypertension or diabetes, that increase the risk of preterm labor. This allows us to catch things when they are happening early, which means you can get regular screenings and treatments that can prevent or mitigate the complications that cause preterm birth[91]. Prenatal care also provides missed opportunities to teach about lifestyle modifications such as nutrition, other factors that impact pregnancy outcomes, and lack of prenatal care plays a role.
- **Mental Health:** A factor too often overlooked in pregnancy outcomes is maternal mental health. Depression and anxiety can be dangerous for women who are going to have a baby, and the chances of preterm birth are increased if this goes untreated. Poor nutrition, inadequate self-care, and increased stress all can disrupt normal course of pregnancy and may be caused by these conditions. In addition, women with mental health disorders may be more likely to miss out on prenatal care, and be less able to follow medical advice, increasing the risk of adverse pregnancy outcomes[92].

4.1.4 Nutritional Status and Dietary Factors:

Nutritional status is another significant factor that determines the outcome of pregnancy. Preterm labor, anemia, and intrauterine growth restriction are among the consequences of eating a poor diet deficient in vital nutrients including folic acid, calcium, iron, and protein[93]. Furthermore, a preterm delivery is predicted by gestational

diabetes and hypertension, which are increased by maternal obesity and excessive weight gain throughout pregnancy[94].

4.2 Obstetric Factors: Number of Prior Cesareans, Type of Uterine Incision, and Surgical Technique

Important determinants of subsequent pregnancy outcome are obstetric factors including number of prior cesareans, type of uterine incision and surgical technique during cesarean delivery[95]. The number of cesarean deliveries increases the risk of complications, and some incisions and types of surgery can directly decrease the chances that the uterus will be able to carry a pregnancy to term. This understanding is key to risk management of repeat cesarean delivery and preterm birth.

4.2.1 Number of Prior Cesareans:

The single most important obstetric risk factor for preterm births in subsequent pregnancies is the number of previous cesarean deliveries[96]. This increased incidence of complications of a previous cesarean section, such as uterine scarring and damage to the cervix, increases the risk for preterm birth. Repeated surgeries increase the amount of scar tissue in the uterine muscle and can make the uterine muscle not work as well to contract properly during labor raising the odds of preterm labor or rupture of the uterus[97].

- **Uterine Scarring:** When making an incision in the uterus during each cesarean delivery, scar tissue is created. In time, the scar tissue overcrowds and the wall of the uterus weakens. Offering serious scarring it makes the mucosa in the uterus more receive the physical load during childbirth and more chance of rupture of the mucosa during the later phases of pregnancy when the mucosa is stressed[98].
- **Adhesions and Placental Issues:** Cesarean deliveries also increase the chance of having adhesions or have other placental problems, including placenta previa and placenta accreta. They are known to increase the risk of preterm birth by interfering with the normal implantation process or by causing bleeding, both of which can precipitate early labor. If the placenta accreta case, preterm delivery may be needed to prevent life threatening haemorrhage in the mother[99].
- **Increased Risk with Multiple Cesareans:** They found women who deliver two or more times by cesarean delivery are at a greater risk of having a preterm baby in their next pregnancy[100]. Complications that occur with multiple cesareans include abnormalities of fetal positioning, inadequate progression towards a vaginal delivery, and an increased risk of premature labor.

4.2.2 Type of Uterine Incision:

The risk of subsequent pregnancies is largely dependent on the type of cesarean delivery incision: a uterine incision made to deliver a baby. The most common incisions are transverse incision and Vertical incision [101]. This decision also affects strengthening and healing of uterine wall as well as the risk for uterine rupture, or other complications when pregnant next.

- **Transverse Incision:** The incision most commonly and preferred used in cesarean deliveries is horizontal to the lower portion (the transverse incision). This incision heals better and is less likely to cause uterine rupture during later pregnancies. Women with the transverse incision are also less likely to suffer complications brought by the scar tissue in a successive pregnancy, for example, a higher risk for an early term delivery[102]. The incision is low placed so that it doesn't cut major blood vessels and the scar will remain stronger and more resilient.
- **Vertical Incision (Classical):** The upper segment of the uterus is usually incised by the vertical incision (i.e. the classical incision). Less often today, but still occasionally, this incision is used where there is no choice but to make a transverse incision because of the position of the fetus or instances of failed labor[103]. A greater risk of rupture of the uterus is associated with the vertical incision especially in subsequent pregnancies during labor. A vertical incision scars the tissue less well, and the risk rises as the uterus stretches in later pregnancies. Women who have a classical incision are more likely to have a cesarean in future pregnancies, and are at greater risk for developing complications, such as experiencing preterm birth.
- **Low Vertical Incision:** This variant is usually performed with a lower vertical incision (a less frequent disease), in case of impossibility to perform the classical vertical incision, but absence of necessity for a transverse incision. Generally speaking, a lower risk than the classical incision of uterine rupture continues to attach a greater risk than the transverse incision[104].

4.2.3 Surgical Technique:

Another important determinant of future pregnancy outcome is the surgical technique the patient undergoes when a cesarean delivery is performed. The risk of complications following a cesarean delivery has been decreased through advances in cesarean surgical techniques[105]. However, such manipulation can increase the risk of problems in subsequent pregnancies, for example preterm birth, through suboptimal techniques, such as inadequate suture, excessive scarring or infection.

- **Precise Suturing and Bleeding Control:** In modern times, however, more precise suturing and better control of bleeding are stressed. Cesarean sections are usually safe when done by skilled surgeons with fewer complications in wound healing and related scarring. If, however, suturing is not carried out correctly or bleeding is not controlled enough, dehiscence (partial opening of the scar) or infection can develop, increasing the risk of future complications such as uterine rupture or infection in subsequent pregnancies[106].
- **Infection and Healing Complications:** Complications of infection after or during a cesarean delivery are common and can lead to such as scar tissue formation, uterine adhesions, or improper healing at the site of the uterine incision. However, poorly healed incisions are more likely to tear or rupture in subsequent pregnancies and can contribute to a large increased risk of preterm birth[107]. Examination following a procedure has a higher risk of postoperative infections, such as endometritis, which can be associated with chronic inflammation and could not be the ideal environment for continuing a pregnancy to full term.
- **Excessive Scarring:** If the scar tissue forms too heavily as a result of cesarean surgery, it can disrupt the usual function of the uterus and cervix in subsequent pregnancies. Uterine overactivity and contractions that result in preterm labor may be caused, in part, by scar tissue that makes the uterine walls and cervix less flexible[108].
- **Surgical Expertise and Experience:** The risk with complications in cesarean section is very low, however, and depends to a greater extent on the skill and experience of the surgeon delivering the baby. More experienced surgeons are more apt to better handle complicated cases, minimize damage to the uterus and its tissues and make sure that the uterine incision is closed properly[109]. On the other hand, less experienced surgeons could be more likely of having trouble where you can approach the suturing the wrong way, or you can injure surrounding organs and that could lead to complications like uterine rupture or infection with future pregnancy.

4.3 Healthcare System Factors: Variations in Care Access and Monitoring During and After Pregnancy

Factors related to healthcare system have a major impact on pregnancy outcome for women with history of Cesarean delivery. But some of the best ways to prevent preterm birth and some of the other complications that can occur during pregnancy and after include having access to quality healthcare, thorough monitoring during pregnancy, and receiving adequate postpartum care. Delay in the detection of risk, or in the providing of appropriate care, increases greatly the risk of adverse outcomes, such as preterm birth, infection, or uterine rupture[110].

4.3.1 Access to Care:

Maternal and fetal health are in large part determined by the availability and quality of healthcare available before, during, and after pregnancy. Complications such as preterm birth are more common if lack of access to healthcare leads to women having limited access—geographic, financial or social—to care, especially after a cesarean delivery. Prenatal care must be properly taken to monitor the pregnancy's progress and screen for any problems that might occur during.

- **Prenatal Care:** Undiagnosed conditions such as gestational hypertension, preeclampsia, diabetes or infections that have not been there are all conditions that can lead to preterm birth following a cesarean and not being treated with prenatally[111]. Women may miss regular check-ups, screenings and tests in regions where there is limited healthcare access which could identify these conditions. Complications occur often because of delayed detection or lack of timely intervention and can be prevented with better monitoring which may lead to early labor.
- **Infections and Complications:** Management of infections and other complications after a cesarean delivery may also be affected by access to care. One example is that women with poor access to healthcare may not seek appropriate treatment for post cesarean infections, or not get follow up care to monitor the healing of the uterine scar[112]. Uterine scarring, which may cause problems such as uterine rupture or preterm birth in subsequent pregnancies, is more likely if there is a chronic infection or insufficient healing of an injury to the uterus.
- **Health Inequities:** Social determinants of health, including, for instance, socioeconomic status, education, and ethnicity, can make access to quality care even more difficult. Research has demonstrated there are barriers to prenatal and postnatal care for some women from lower socioeconomic backgrounds, or from specific ethnic groups[113].

4.3.2 Monitoring During Pregnancy:

History of cesarean delivery in women have markedly increased risks and must be closely and frequently monitored for subsequent pregnancies. Cervical insufficiency, uterine rupture or infections can first be recognized early, so healthcare providers can prevent or treat such complications and hence reduce the risk of preterm birth.

- **Ultrasound Monitoring:** To evaluate the condition of the cervix, placenta and uterus, routine ultrasound exams are very necessary[114]. A weakened cervix increases the risk of preterm labor, so it is important to monitor the cervix for shortening or other signs of insufficiency. If cervical insufficiency is found, early interventions such as cervical cerclage (a type of stitch placed in the cervix to close it) can be used to try and lengthen the pregnancy.
- **Placenta Positioning and Uterine Health:** A repeat ultrasound performed each month at 20- and 28-weeks' appointment can assess the position of the placenta in the uterus. Imaging can identify conditions like placenta previa or placenta accreta (placenta that grows on top of, or into, the uterine muscle) that are more common in women who've previously had cesarean delivery and can be appropriately managed to avoid preterm birth or other complications. Other important monitoring is the overall health of the uterus [115].
- **Cervical Length Measurement:** Cervical length measured by transvaginal ultrasound is an important method for identifying who in women is at risk for preterm birth[116]. Well established is the fact that cervical length is shortened in a population with increased risk of preterm labor and that monitoring this shortening may assist the healthcare provider in intervening early. Lifestyle modifications, bed rest or progesterone supplementation may be interventions to reduce the risk of preterm birth in women with shortened cervix.
- **Management of Pre-existing Conditions:** But ongoing monitoring is also important to recognize and manage pre-existing conditions that can help lead to preterm birth, like diabetes, hypertension, or thyroid disorders. Regular blood tests, blood pressure monitoring and glucose screenings help identify that there is a problem early so that providers can make appropriate changes and minimize the risk for complications that may result in preterm birth[117].

4.3.3 Postpartum Care and Family Planning:

Risks for future pregnancies are also managed after a cesarean delivery, just as much as the period immediately following. Postpartum care should include not only the immediate care of the mother, but interventions to prevent intrauterine infections, scarring, or adhesions that might otherwise impair future pregnancies.

- **Postoperative Monitoring:** Special care is needed for women who've had a cesarean delivery, because of the risk of infection, haemorrhage, or poor wound healing[118]. Without adequate follow up care, other issues can go undetected that can lead to scarring, adhesions, or other long-term problems that can complicate any future pregnancy.
- **Infection and Scar Tissue Management:** Chronic inflammation that ensues from the infections that can develop during or after Cesarean delivery may cause scar tissue or adhesions. These complications can alter the function of the uterus and increase the risk of preterm birth at the next pregnancy. The most important thing to do is to prevent the infection from getting worse and not heal properly[119].
- **Family Planning and Optimal Spacing:** Most of the complications such as uterine rupture, preterm birth and low birth weight are related to short interpregnancy interval which is less than 18 months[120]. Women should be educated about the risks of short interval (less than 12 months) and be provided family planning counselling by healthcare providers to space pregnancies optimally. Conversations need to be had and methods discussed based on the need and preference of the individual.
- **Counselling on Birth Plans:** Women with a history of cesarean are at risk of subsequent complications (those involving the placenta or the uterus during delivery) including placental abnormalities or uterine rupture. Such counselling should involve discussing the option of a vaginal birth after a cesarean versus a repeat cesarean, along with associated risks and benefits. Providing individually tailored guidance in these options can allow informed decisions regarding future pregnancies and reduce the risk of preterm births[121].
- **Psychosocial support:** Alongside physical care, a woman who has given birth via a cesarean may need support to help process trauma or any emotional distress during her birth[122]. Mental health accounts for a sizeable proportion of general maternal health. The psychological or emotional well-being of the patient can also benefit the pregnancy by ensuring future pregnancy outcomes are in the best state possible.

5. Findings and Discussion

5.1 Findings

Findings from several studies have been uniformly consistent in demonstrating an increased risk of preterm birth among women with a history of cesarean delivery. This risk is further magnified by several factors such as the number of previous cesareans, type of uterine incision, and gestation between pregnancies.

5.1.1 Spontaneous vs. Medically Indicated Preterm Birth:

Studies show that among women who have had a previous cesarean delivery, preterm births are usually classified into two types: spontaneous and medically indicated. The spontaneous type of preterm birth, which is delivered without medical induction, is associated with more serious complications, including uterine rupture or

cervical insufficiency. These complications are more common among women who have had previous cesarean deliveries, especially those who have had multiple cesareans. Medical preterm deliveries, on the other hand, are usually intended and are based on concerns like complications with the mother's health or the fetus. Although medically indicated preterm deliveries are essential for the safety of both the mother and the baby, they also increase the risk of negative outcomes, including respiratory distress for the infant.

5.1.2 Rising Risk with Increased Cesareans and Short Interpregnancy Intervals:

A significant finding is that risks of preterm birth are positive in proportion to a woman's numbers of cesarean deliveries. Such relates to the cumulative risk of uterine scarring, adhesions, and complications including placenta previa and placenta accreta. Having numerous cesarean sections when multiparous raises the chance of difficulties in subsequent pregnancies, which frequently leads to premature babies. Short interpregnancy intervals (less than 18 months) are another significant risk factor that increases the chance of preterm delivery. This raises the possibility of uterine rupture as well as other issues such placental anomalies that might result in an early birth. Patients who get pregnant within a short time after a cesarean are at high risk of these outcomes, and therefore proper birth spacing is important.

5.1.3 Maternal Obesity and Advanced Maternal Age:

Obesity and advanced maternal age are additional maternal variables that raise the chance of preterm delivery. Preterm birth risk can be increased by problems such as gestational hypertension, diabetes, and preeclampsia, all of which have been linked to obesity. A higher chance of needing a cesarean delivery and a higher risk of medical problems that might lead to premature birth are also linked to advanced maternal age.

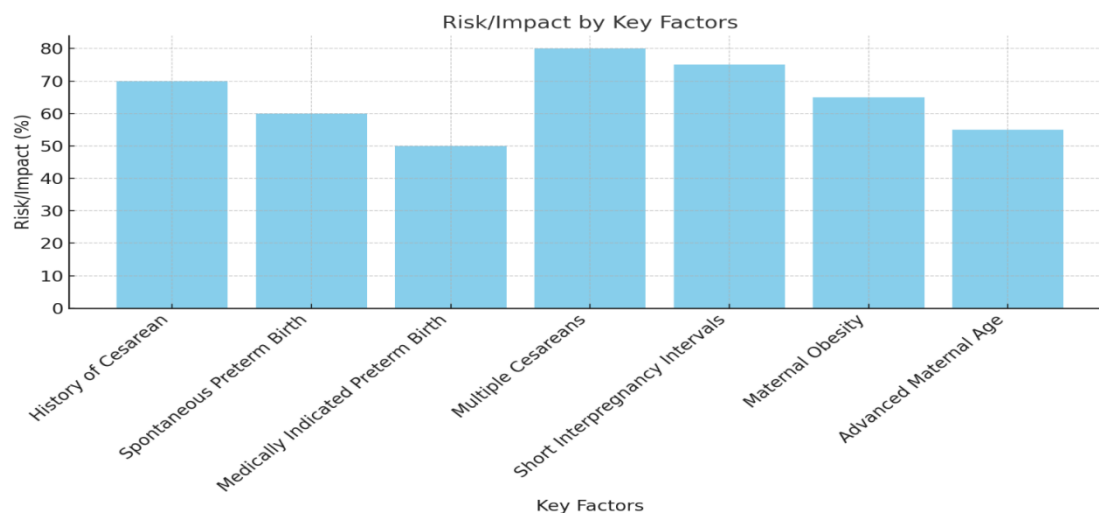


Fig. 1. Risk/ Impact by Key Factors

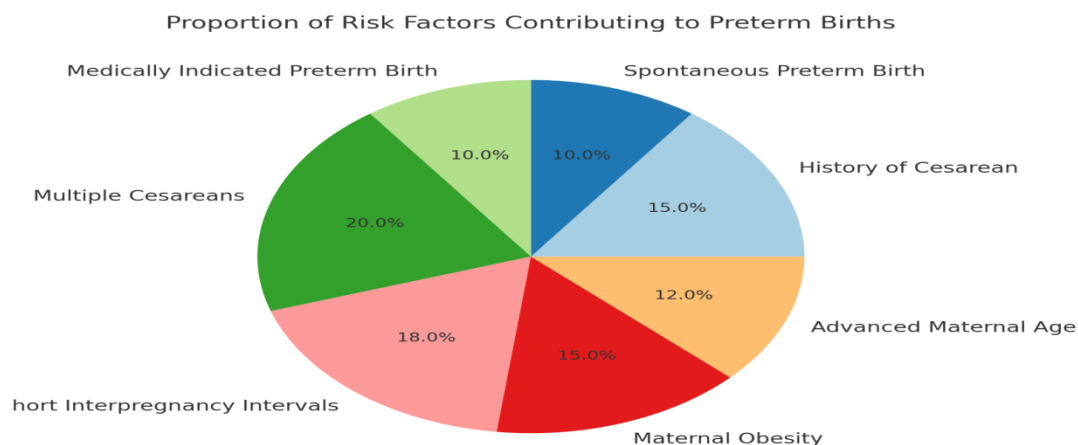


Fig. 2. Proportion of Risk Factors Contributing to Preterm Births

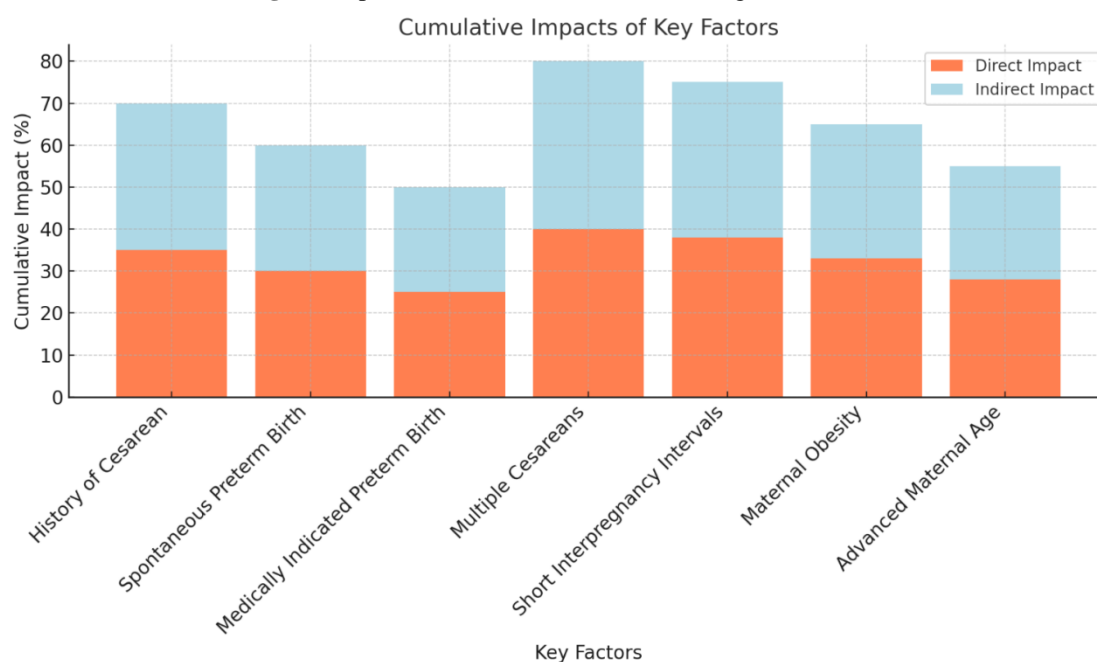


Fig. 3. Cumulative Impacts of Key Factors

5.2 Discussion

The study's conclusions have important therapeutic ramifications that call for measures to lower the risk of preterm birth in women with a history of cesarean delivery, improving the standard of care provided by the healthcare system.

5.2.1 Clinical Implications

Even though cesarean deliveries are often inevitable for the sake of maternal and fetal health, especially in cases of complications, the long-term risks associated with multiple cesareans should not be ignored. Providers should consider the risks and benefits of cesarean deliveries, especially for women who have had prior cesareans, to minimize the long-term consequences such as uterine rupture and preterm birth. These have also brought attention to the customized attention needed for cesarean previous women. Therefore, monitoring should be keen especially on the woman and her fetus before any complications begin such as insufficiency cervix and tear of the uterine thereby leading to their interventions to counter preterm.

5.2.2 Preventive Measures:

Proper addressing of modifiable risk factors such as short interpregnancy intervals could contribute significantly toward a decrease in preterm birth cases. Inappropriate family planning counselling, provision of contraception methods to women, and educating them would significantly help decrease the short gaps between pregnancies and therefore prevent related complications, especially uterine rupture. Maternal obesity is another modifiable risk factor that should be addressed in prenatal care. Encouragement of weight management before and during pregnancy and the provision of resources for managing gestational conditions like diabetes and hypertension.

5.2.3 Surgical Improvements:

Innovations in surgical techniques can help reduce the risks associated with cesarean deliveries. For example, studies show that single-layer closure of the uterine incision is linked to lower chances of adhesions, scar tissue development, and uterine rupture in subsequent pregnancies. To reduce the risk of problems after cesarean births, obstetricians' surgical training and proficiency must be improved. It will lessen the chance of infections, scarring, and other issues that might raise the chance of premature delivery in future pregnancies.

5.2.4 Health Disparities:

The various pregnancy outcomes, especially preterm birth rates, differ significantly between different socioeconomic and geographic populations underlines a call for targeted interventions in underserved populations. Women residing in poor socioeconomic areas or those without access to healthcare may find it difficult to receive prenatal and postnatal care on time, putting them at risk for complications and preterm delivery. The issues of health disparities would also be resolved through enhancing access to quality care while also educating and assisting women in underprivileged communities. Public health efforts that would work to increase the availability of prenatal care, distribute knowledge about the healthy practices during pregnancy, and support family planning may be able to help decrease overall rates of preterm birth and other complications. Further, outreach programs that will provide financial and logistical support to women who may have barriers to access healthcare can help ensure that more women receive the care they need before, during, and after pregnancy.

6. Conclusion and Future Studies

The study shows that cesarean delivery history is linked to a higher chance of preterm birth in a subsequent pregnancy. This relationship is complicated and depends on a number of variables, including the number of previous cesarean deliveries, the type of surgical incision, and maternal characteristics like age and health. The study's findings stress the need for the implementation of preventive measures, such as proper interpregnancy spacing, addressing the risks to the health of mothers like obesity and smoking, and developing surgical techniques that will cause minimal damage to the uterus. The clinical guidelines need to be more stringent, and prenatal care must be more personalized in order to counteract the dangers posed by cesarean deliveries. This strategy necessitates interdisciplinary work in the areas of risk prediction tools, surgical practice advancements, and a deeper comprehension of the genetic and epigenetic elements that would otherwise influence pregnancy outcomes. To improve mother and fetal health outcomes and lower the incidence rate of preterm birth after cesarean delivery, obstetrics, genetics, and epidemiology research and collaboration must constantly be advanced.

Longitudinal studies are required to evaluate the outcomes of caesarean delivery on future pregnancies. Such studies follow up women with a history of cesarean deliveries over several years and will allow researchers to evaluate the cumulative effect of multiple cesareans on preterm birth. Newer surgical techniques, such as single-layer closure and improved suturing, can decrease the adverse effects of uterine damage and complications. Individualized risk prediction algorithms for women with a history of cesarean birth are necessary for better prenatal treatment. In order to enhance prevention and treatment, future studies should concentrate on examining genetic and epigenetic markers that could be involved in the association between preterm birth and cesarean delivery.

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