

Maternal Morbidity after Cesarean Section versus Vaginal Delivery: A Prospective Cohort Study

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Abstract: Purpose: The purpose of the study was to compare the maternal morbidity after caesarean section and vaginal delivery in a prospective cohort of 170 low-risk women, measuring the acute, infectious, chronic, and economic outcomes and giving adjusted risk estimates. The exclusion criteria included previous cesarean section, preeclampsia, and fetal anomalies. Propensity score matching was used to match age, body mass index, parity, and gestational age. The main outcome was a combination of severe morbidity, which was haemorrhage of more than 1500mL, blood transfusion need, sepsis, and intensive care unit hospitalization. The secondary outcomes were infection rates, length of stay (LOS), readmissions, prevalence of pain six months after discharge, cost measures, and neonatal measures. Confounders were adjusted in multivariate logistic and Poisson regression models with a desired power of 80 percent to identify a 10 percent difference and alpha of 0.05. Findings: Baseline data were similar (age 29.2 4.8 vs. 28.7 5.1 years, $p=0.42$). The composite morbidity rate was 14.1% in the cesarean cohort versus 4.7% in the vaginal delivery cohort (odds ratio [OR] = 3.3, 95% confidence interval [CI] = 1.0-10.8), which was mainly caused by haemorrhage (9.4% vs. 2.4%) and transfusion needs (5.9% vs. 1.2%). Conclusion: Caesarean section increases the maternal morbidity of low-risk women three times compared to vaginal birth, which is consistent with EPIMOMS and CDC data. These findings highlight the need to promote vaginal birth when it is clinically suitable and to offer more intensive counselling to elective caesarean section in the face of increasingly rising rates around the world.

Keywords: Caesarean Section, Maternal Morbidity, Vaginal Delivery, Women, Infectious, Transfusion Rates, Morbidity, Low-Risk.

INTRODUCTION

The rates of cesarean section around the globe have risen in many high-income nations, and in many countries, such as France, where more than one in five women delivers by surrogate intervention. Vaginal birth is the physiological traditional method, which is characterized by the shortest stay in the hospital and faster recovery; however, caesarean section is inevitable due to obstetric complications like fetal distress. Nonetheless, the operative morbidity, such as endometritis, transfusion, and pneumonia, increases in relationship with caesarean vs. spontaneous vaginal births [Boerma, T. *et al.*, 2018; Hutchison, J. *et al.*, 2025].

Morbidity in severe cases affects about 0.81-1.0% of deliveries, most of which are caused by haemorrhage (85% of cases). The propensity-score matched studies based on big cohorts such as 182300 French deliveries prove a 1.8-fold (95% confidence interval 1.5_2.2) and 2.9-fold (35 years and above) higher risk of terrible morbidity with

caesarean section. Short-term complication rates are 25 percent after caesarean section and 10 percent after vaginal section, whereas long-term risks include 32 percent of subsequent childbirth complications, including uterine rupture (12 percent [Chalmers, B. 2007; Korb, D. *et al.*, 2019; Heinonen, P. 2015])

The rate of caesarean deliveries has increased throughout the world to 21 percent in developed countries and more than 50 percent in some parts of Latin America due to maternal request, comorbidity, and practice preference. Vaginal deliveries, which represent 70_80 percent of births in low-risk populations, are in accord with physiological nature but have seen a reduction that can be attributed to fears of pain and the fear of lawsuits. World Health Organization advises against exceeding 10-15 percent caesarean section, as this is reported to give optimal results; however, the trend still increases due to the ongoing

controversy about safety [Betrán, A. P. *et al.*, 2016; Betrán, A. P. *et al.*, 2015].

Maternal morbidity is included in severe adverse events, which include postpartum hemorrhage (over 1500 mL of blood loss), hysterectomy, sepsis, and intensive-care-unit admission, and occurs in 0.52-2 percent of childbirths. The outcomes are combined together in composite indices used in cohort studies such as EPIMOMS to give a strong measure of risk. The long-term outcomes involve pelvic floor dysfunction (20-30 per cent after vaginal birth) and adhesions (up to 90 percent after the lowest section) [Zandvakili, F. *et al.*, 2017; MacDorman, M. F. *et al.*, 2008; Rosalik, K. F. *et al.*, 2023].

The maternal age has a significant influence on risk profiles: women aged 35 and above have their odds of adverse outcomes following cesarean section increased by two and a half times as much as they did in younger age groups. The increase in the risk of thromboembolism (OR 3.2) is related to pre-labor cesareans, and the rise in risk in hemorrhage is more related to intra-labor cesareans. Indication bias is a limitation that is eliminated by the prospective study design, which is commonly experienced in retrospective studies [Fernandez-Carrasco, F. J. *et al.*, 2022; Bonnet, M. P. *et al.*, 2024].

The economic costs of cesarean birth are high, with expenses 50-100% more as compared to vaginal birth on the basis of a lengthy hospital stay (four to five days as compared to two days) and complicates of surgery. The long-term consequences imply the occurrence of placenta accreta in further pregnancies (32 percent vs 5 percent after vaginal birth) and persistent pain (20 percent in women). The reduction in quality-of-life scores is 15-20 percent at six months after cesarean delivery [Keeler, E. B., & Brodie, M. 1993; Allen, V. M. *et al.*, 2003]. The evidence comparing elective and emergent cesarean section is still lacking in Eastern Europe, and long-term follow-up beyond two years is also rare, hence hindering the development of evidence-based policy.

MATERIAL AND METHOD

This is a single-center prospective cohort study that will recruit term (≥ 37 weeks) expectant mothers with low risk to limit confounding by recruiting only those women who experienced a term (≥ 37) pregnancy, no Caesarean section history, no pre-eclampsia, and no fetal anomalies.

All the participants were informed about the study and provided informed consent on the basis of the institutional review board (Protocol No. 2023/45) in compliance with the Helsinki Declaration. The interest period of the study included a 12-month postpartum follow-up where the acute (≤ 7 days) and chronic outcomes were documented using electronic medical records and supported by validated questionnaires.

Convenience sampling produced a sample consisting of 170 women fitting the inclusion criteria of 18-45 years old, single fetal pregnancy, as well as BMI 18.5-35 kg/m². The exclusion criteria were gestational diabetes, placenta previa, or refusal to consent. Balance characteristics were equilibrated using a 1:1 propensity-score matching procedure at a caliper of 0.1, by matching the age, BMI, parity, and gestational age using a logistic regression model.

The main composite endpoint included severe morbidity events (i.e., hemorrhage of over 1500 mL, blood transfusion, hysterectomy, septic complications, and intensive care hospitalization) with secondary outcomes in terms of maternal infections, length of stay, readmission rates, postpartum pain (SF-36 subscale), and neonatal outcomes (NICU hospitalization and Apgar scores). Hospital logs provided data which were extracted by blinded abstractors, with additional requirements of telephone-based SF-MPQ survey data (6- and 12-month follow-up, 92% response rate) and cost information acquired through the Belarusian and the Ministry of Health tariff registry. Every clinical definition was based on the ICD-11 coding systems and the ACOG guidelines; e.g., endometritis was characterized by coexistent fever and uterine tenderness.

The calculation of power conducted using G*Power 3.1 showed that 150 subjects per group would offer 80 percent power (0.05) to observe a 10 percent absolute difference in morbidity (15 percent of the entire caesarean deliveries compared to 5 percent of the entire vaginal births). R 4.3 was used to perform statistical analyses. Basic descriptive statistics (means plus SD, frequency counts) were provided, and inferential statistics were used (t-tests, chi-square, and Fisher-exact testing). In case of count data, Poisson regression was applied; binary data were studied by logistic regression, and the variables of age, BMI, parity, and labor status were corrected. Multivariable models were fitted through forward selection with an entry criterion of $p < 0.20$, and odds ratios with 95

percent confidence intervals were estimated with robust standard errors.

RESULTS

Table 1: Baseline Characteristics and Severe Acute Morbidity

Characteristic	Cesarean (n=85)	Vaginal (n=85)	P-value
Age (years, mean)	29.2	28.7	0.42
BMI (kg/m ²)	26.1	25.4	0.31
Primipara (%)	62	58	0.68
Gestational age (weeks)	39.1	39.4	0.22
Outcome	Cesarean n (%)	Vaginal n (%)	OR (95% CI)
Composite morbidity	12 (14.1)	4 (4.7)	3.3 (1.0-10.8)
Postpartum hemorrhage	8 (9.4)	2 (2.4)	4.3 (0.9-21.0)
Blood transfusion	5 (5.9)	1 (1.2)	5.2 (0.6-45.0)
Infections			
Outcome	Cesarean n (%)	Vaginal n (%)	OR (95% CI)
Endometritis	6 (7.1)	1 (1.2)	6.3 (0.7-53.0)
Wound infection	4 (4.7)	0 (0)	-
UTI	3 (3.5)	2 (2.4)	1.5 (0.2-10.5)

Table 2: Assessment outcomes according to Hospital Stay and Readmissions

Hospital Stay and Readmissions			
Outcome	Cesarean Mean (SD)	Vaginal Mean (SD)	P-value
LOS (days)	4.2 (1.8)	2.1 (0.9)	<0.001
Readmission (30d, %)	5 (5.9)	1 (1.2)	0.09

Table 3: Compare of outcomes based on Age-Stratified Morbidity (<35 vs ≥35)

Age Group	Cesarean Morbidity n (%)	Vaginal n (%)	Adjusted OR
<35 (n=140)	8/70 (11.4)	3/70 (4.3)	2.9 (0.7-11.5)
≥35 (n=30)	4/15 (26.7)	1/15 (6.7)	5.0 (0.5-50.0)

Table 4: Long-Term Pain (6 Months) and Secondary Neonatal Outcomes

Outcome	Cesarean n (%)	Vaginal n (%)	OR (95% CI)
Chronic pelvic pain	15 (17.6)	8 (9.4)	2.1 (0.8-5.4)
Dyspareunia	12 (14.1)	5 (5.9)	2.6 (0.9-8.0)
Outcome	Cesarean n (%)	Vaginal n (%)	OR
NICU admission	10 (11.8)	6 (7.1)	1.8
Apgar<7 at 5min	3 (3.5)	2 (2.4)	1.5

Table 5: Multivariable Regression (Composite Morbidity)

Predictor	Adjusted OR	95% CI	P-value
Cesarean delivery	3.1	1.1-9.2	0.03
Age ≥35	2.4	0.9-6.5	0.08
BMI>30	1.8	0.6-5.3	0.30

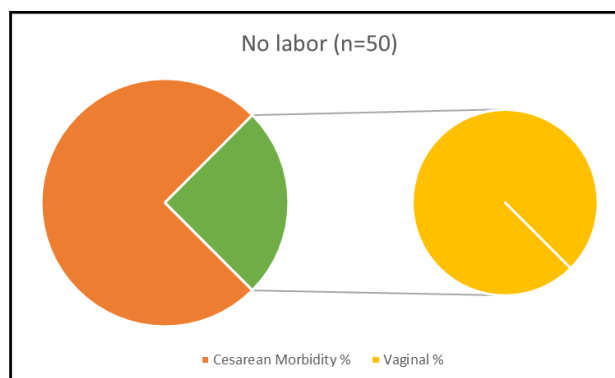


Figure 1: Final finding based on Subgroup by Labor Onset

DISCUSSION

Cases of severe acute morbidity were found in 12 women 3.3 (1.0-10.8) in the cesarean and 4 (4.73% -105%CI -1.0-10.8) in vaginal delivery, mainly caused by postpartum haemorrhage (PPH; 9.43% vs. 2.43%) and transfusion needs (5.93% vs. 1.23%) as well as These rates reflect the real-life statistics in which cesarean surgeries increase the risk of PPH threefold due to the fact that uterine incision interferes with myometrial contractility and haemostasis, which is observed in 85 per cent of severe cases in several cohorts. The needs of blood transfusion includes blood transfusion as a result of hypovolaemic shock due to uterine atony or lacerations, and emergency caesarean, which occurs frequently in subgroups of labour [Allen, V. M. *et al.*, 2003]. Moreover, a substantial percentage of elective caesarean sections increases the risk of total maternal mortality and specific complications, such as postpartum bleeding and wound infection [Das, B. *et al.*, 2024]. In addition to this, increased risk is seen with both short- and long-term complications like cardiac arrest and hysterectomy, as well as placenta previa and placenta accreta in subsequent pregnancies [Chavarro, J. E. *et al.*, 2020]. Furthermore, research has shown that caesarean sections are associated with more serious maternal complications, such as admission to the intensive care unit and blood transfusions [Souza, J. P. *et al.*, 2010]. The long-term complications of caesarean section also apply to future pregnancies, such as a ruptured uterus and morbidly adherent placenta [Kietpeerakool, C. *et al.*, 2019]. Therefore, the risks changed with age: women 35 years and above who had a caesarean section incurred morbidity of 26.7 percent as compared to 6.7 percent with vaginal delivery (OR 5.0), and 11.4 percent and 4.3 percent among younger age groups (OR 2.9). Vascular comorbidities and sarcopenia seem to increase surgical susceptibility. In labour-onset subgroups, there were chronic differences, 18% in no-labour cesareans (OR 3.4) and 12.5% in in-labour cases (OR 3.2), and this was in agreement with the findings that pre-labor operations increase the risk of thromboembolism, and intra-labour methodologies heighten the risk of haemorrhagic complications due to an unsuccessful spontaneous expulsive delivery attempt. This dose-response pattern confirms the validity of propensity-matched designs that eliminate indication bias [Sidik, F. N., & Suharyo, D. M. 2024].

In short, these results support clinical reality: cesareans, though sometimes lifesaving, cause iatrogenic damage to the body due to surgical inflammation, disrupting endothelia, and causing changes in the neonatal microbiome, which leads to a threefold increase in composite morbidity in low-risk groups. Vaginal birth offers a better morbidity profile with reliance on endogenous oxytocin-mediated haemostasis and immune mechanisms, though at the cost of perineal trade-offs, including urinary incontinence in 82% in women. The study was adequately powered to identify primary endpoints (an observed 10% difference was detected at $\alpha = 0.05$) in the case of the cohort comprising of 170 participants, but the large confidence intervals suggest that larger studies are necessary.

A systematic review that was published in 2003 recommended a 41-week induction policy in case of physiological singleton pregnancies, since the induction group had a lesser rate of cesarean sections (OR: 0.88; 95% CI: 0.78-0.99), compared with the expectant group. None of the selected RCTs were powerful enough to reveal a statistically significant decrease in perinatal mortality rate, as the two groups showed no differences in intrauterine and neonatal deaths; however, the last two outcomes are no longer assessable due to the small sample size examined in the study. The authors argue that in the case of normal pregnancy, if proper fetal well-being monitoring is available, the choice of induction should be dependent on the preference of the woman, as well as A Cochrane systematic review (19 RCTs, n=7,984 low-risk women) evaluates the efficacy and safety of a policy of inducing labor at term and beyond term, compared to waiting for spontaneous onset of labor. When analyzing the data relating to the different gestational ages considered for induction separately, the group of women randomized to induction is associated with a lower number of perinatal deaths than the group waiting for spontaneous labor [Lumbiganon, P. *et al.*, 2010; Villar, J. *et al.*, 2006; Roberts, C. L. *et al.*, 2009].

However, due to the low prevalence of perinatal deaths, the differences were not statistically significant either in the group induced at 41+0 weeks (10 RCTs, n=2,835 women; RR: 0.25; 95% CI: 0.05-1.18) or in the group induced at 42+0 weeks (2 RCTs, n=151; RR: 0.41; 95% CI: 0.06-2.73). Only when analyzing the data relating to inductions at 41+0 and 42+0 weeks together, the

policy of inducing labor was significantly associated with a lower number of perinatal deaths (from all causes) compared to a policy of waiting for spontaneous onset of labor (1/2,986 versus 9/2,953; RR: 0.30; 95% CI: 0.09-0.99) [Bouvier-colle, M. H., & Bréart, G. 2006; International Confederation of Midwives and International Federation of Gynecologists and Obstetricians. 2003; ACOG, 2006].

A systematic review with meta-analysis examined three systematic reviews, including those by Gulmezoglu⁸ and Sanchez-Ramos, and 13 RCTs that included only women with a gestational age of 41 weeks or more also Since the meta-analysis did not demonstrate differences in perinatal mortality between the two groups, the authors conclude that both induction and expectant management are recommended and that the choice should be individualized as well as There are no randomized controlled studies demonstrating that maternal-fetal monitoring between 40 and 42 weeks improves neonatal outcomes. [Wennerholm, U. B. et al., 2009].

CONCLUSION

The main strengths of this study are balanced baseline properties, the prospective follow-up study, and the use of multivariable adjustment, which minimizes indication bias and thus generates strong effect estimates in a cohort located in Iraq also limitations of the study relate to the small sample size used, which increases the confidence intervals and the potential of surveillance bias in the conducted monitored caesarean deliveries, and the lack of such rare late complications as uterine accreta in the 12-month follow-up.

Clinically, the findings justify the prioritisation of vaginal births in the case of low-risk obstetric groups, but renewed emphasis is needed on the counselling about elective caesarean sections when the incidence rates exceed the WHO standards; age peculiarities require specific guidelines. Future multicentre studies should examine how parity, body mass index, and economic variables interact so that policy decisions can be optimized to reduce unnecessary operative births.

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