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Predictors of Successful Painless Vaginal Delivery in First-Time Mothers: A Multicenter Study

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Name of Author:
KAZI FOYEZA AKTHER[1], Sinigdha islam [2] Dr. Md Hosne Mobarak [3], .Zahidul Mostafa[4], Banasree Roy Urmi[5], TAMANNA AKTER[6], Kaniz FatemaTuz Zahura[7]

Affiliation: *[1]MBBS. FCPS. MCPS.(Obstetrics and Gynaecology) Normal delivery & Painless Delivery specialist Consultant -Obstetrics and Gynaecology BRB Hospitals Limited*
[2]MBBS,MPH
[3]MBBS,MCPS,DA consultant, General Anesthesia United Hospital Limited
[4]Assistant professor Cardiology Cox's Bazar medical college https://orcid.org/0000-0002-8318-0929
[5]Tbilisi State Medical University, Georgia Orcid ID: 0009-0008-0933-5495
[6]Tairunnessa Memorial Medical College
[7]BDS,MPH National Institute of Preventive and Social Medicine (NIPSOM), BSMMU, Dhaka, Bangladesh,

Abstract: The determination of the probability of painless vaginal birth among first-time mothers is one of the crucial clinical questions of contemporary obstetric care. Painless vaginal delivery, which has been made possible to a large part by epidural analgesia, has completely changed the experiences of childbirth; though, its success lies in a complicated interaction between maternal, fetal, and intrapartum factors (Bos, Hollmann, and Lirk, 2017; Halliday, Nelson, and Kearns, 2022). The study was a multicenter observational study that aimed at evaluating predictors of a successful painless vaginal birth among nulliparous women in a number of tertiary hospitals. The diverse populations of obstetric data were gathered covering the maternal factors (age, body mass index, nutritional and hematologic conditions), fetal (presentation, estimated weight, and gestational age), and intrapartum (analgesic technique, time of administration, and labor time) aspects. Statistical correlations showed that maternal body mass index (BMI), psychological preparedness, sufficient prenatal nutrition, and early epidural onset had significant statistical associations with increased likelihood of primary painless vaginal delivery (Rodriguez-Mesa et al., 2019; Adu et al., 2020; Alakeely et al., 2018). On the other hand, the length of labor, malpresentation, and fetal macrosomia were risk factors for assisted or cesarean birth (Guan et al., 2020; Liu, Thilaganathan & Bhide, 2023). This research study has a multicentric nature, which contributes to the overall generalizability of the results and demonstrates the importance of having standardized prediction models that integrate maternal-fetal variables with real-time intrapartum monitoring (Kestle and Riva-Cambrin, 2019; Orlhac et al., 2022). The clinical implications of the findings include individualized labor management, specific antenatal education, and improved epidural regimens as potential measures to increase the number of painless vaginal births in first-time mothers. These lessons provide a ground to enhance obstetric care and reduce unnecessary surgical operations all over the world.

Keywords: Painless vaginal delivery, Nulliparous women, Predictive factors, Epidural analgesia, Labor outcomes, Maternal and fetal characteristics, Multicenter study

INTRODUCTION

Childbirth is one of the most important physiological and emotional events that a woman will experience in life. The safety, positivity, and painless experience of this experience is indeed a long-standing benefit of the contemporary obstetric practice. The increasing use of epidural and spinal analgesia in the past decades has enabled clinicians to deliver successful pain management during labor, and this is a kind of breakthrough in maternity care (Callahan et al., 2023).

Painless vaginal delivery, as a notion that has come to be used to describe a successful vaginal birth that has been attained through providing sufficient and safe pain management, has been on the increase as the norm of the care received by the mother in most regions of the world. Nevertheless, even with technological development, the predictive factors of successful painless vaginal birth, especially in the case of first-time mothers (nulliparous women), have been inconsistently reported in obstetric centers (Ruan et al., 2020).

It is important to note that the importance of knowing which predictors of a successful painless vaginal delivery reduce maternal pain as well as enhance physiological and psychological outcomes. The problem of uncontrolled labor pain may also cause maternal stress, increased catecholamine secretion, a long labor process, and even emergency cesarean delivery (Bos, Hollmann & Lirk, 2017). Also, the negative consequences of labor pain have been associated with postpartum fatigue, depression, and slow recovery (Badr and Zauszniewski, 2017). When used correctly, epidural analgesia can reduce these risks by means of relaxation, anxiety, and increased maternal satisfaction without necessarily raising the rates of operative births (Halliday, Nelson & Kearns, 2022). Thus, the determination of maternal, fetal, and intrapartum predictors of successful painless vaginal birth is an important issue of enhancing clinical outcomes and providing individual obstetric care.

1.1 The Rising Preference for Painless Childbirth

There has been a significant increase in preference towards painless childbirth in the world, especially among nulliparous women. It can be explained by the increased awareness of the pain management methods, the enhanced access to epidural painkillers, and the overall change in priorities towards the focus on maternal health and independence during childbirth (Alakeely et al., 2018). Women also approach the issue of pain relief during delivery, and this depends on the individual perceptions of culture, antenatal education, and social support systems. The Middle East, Asia, and European studies have indicated that the availability of epidural education can significantly influence the chances of similar women who are not pregnant to use the painless method of delivery (Qiu et al., 2020; Alakeely et al., 2018).

Meanwhile, sociocultural demands and physician advice are instrumental factors when determining delivery preferences. Jafarzadeh et al. (2019) stressed that the absence of appropriate counseling and the wrong understanding of epidural analgesia are among the causes of unnecessary cesarean delivery in many developing contexts. Freedom to make informed choices by enhancing antenatal education and cross-disciplinary teamwork can therefore enable women to make safe and informed choices by opting to deliver safely and painlessly via a vaginal birth.

1.2 Clinical and Psychosocial Implications.

Clinically, a high rate of breastfeeding initiation, less maternal morbidity, and short-term recovery linked to a successful painless vaginal delivery are linked to less cesarean birth (Hantoushzadeh et al., 2009; Edipoglu and Aslan, 2021). Labor pain affects the psychological perception of childbirth in a mother, which can frequently hurt postpartum emotional well-being, self-esteem, and relationship with a baby (Badr and Zauszniewski, 2017). Childbirth fear, especially in first-time mothers, has been identified to slow down the active labor process, decrease the pain tolerance, and further increase the risk of assisted delivery or cesarean section (Qiu et al., 2020). The psychosocial aspects of painless delivery are thus crucial in understanding because they closely interrelate with the physiological predictors of painless delivery and medical interventions.

There is a dilemma among clinicians on how much pain should be controlled and the amount of labor progression. Research has also shown that overdose analgesia or incorrect timing of the epidural may delay the second stage of childbirth or disrupt the efficient pushing of the mother (Halliday, Nelson, and Kearns, 2022). On the other hand, timely and properly timed epidural initiation has been linked with an improved maternal experience and similar delivery rates to the traditional methods (Bos, Hollmann, and Lirk, 2017; Haidl et al., 2021). Therefore, it can be concluded that achieving painless vaginal delivery requires the determination of the best clinical, maternal, and procedural conditions.

1.3 Maternal Predictors of Success

The factors of the mother do play a major role in determining the outcome of painless vaginal delivery. Some of the most common predictors reported include age, body mass index (BMI), nutritional status, and mental preparedness (Rodriguez-Mesa et al., 2019; Adu et al., 2020). The shorter labor times and better physiological changeability of younger mothers are associated with a stronger maternal age and BMI, which is associated with longer labor and greater chances of intervention (Rodriguez-Mesa et al., 2019). The labor endurance is also influenced by the nutritional factors, including the iron status and hemoglobin levels, with low iron stores during preconception or antenatal periods correlating with high fatigue and low efficiency of the uterus (Adu et al., 2020).

Psychological determinants like fear, anxiety, and lack of antenatal education have been identified as crucial non-physiological determinants. Qiu et al. (2020) and Alakeely et al. (2018) noted that women with well-organized epidural education/antenatal

counseling had a higher probability of successful painless births because of increased confidence and reduced anxiety levels. It is important to note that thorough prenatal care that combines mental, physical, and informational preparation is important.

1.4 Fetal and Intrapartum Predictors

Fetal features- presentation, approximate fetal weight, and gestational age- are also factors that affect the delivery outcome. Excellent fetal weight and head position are the most positive attributes to predict the achievement of painless vaginal delivery (Liu, Thilaganathan & Bhide, 2023). On the other hand, vaginal birth can be complicated by fetal malpresentation, macrosomia, or preterm birth and requires medical or surgical care (Sharma et al., 2021). These variables of intrapartum management, including the type of labor induction used, the start of epidural injection, and the position of the mother, also moderate outcomes. According to Grobman et al. (2018), low-risk nulliparous women who were induced in a controlled manner did not demonstrate any difference in terms of risks of cesarean section, implying that preemptive management when applied on an individual basis can enhance the rates of painless deliveries.

1.5 The Need for Multicenter Predictive Insights

The majority of available research regarding painless vaginal delivery is single-center or retrospective in nature, which restricts its ability to generalize and make external valid conclusions. As Kestle and Riva-Cambrin (2019) underlined, multicenter research can be represented more widely, more diversified in terms of samples, and predictive models are more reliable. Orlhac et al. (2022) also added that cross-center harmonization of data leads to increased analytic strength and allows for the finding of predictors consistent across populations. This multicenter method is especially necessary in the obstetrics field, as the differences in demographic, clinical, and procedural practice can lead to different outcomes.

Considering such gaps, a multicenter observational design would present the most comprehensive model for identifying credible predictors of the success of vaginal delivery without pain in nulliparous women. This approach provides an overall picture of the interaction between maternal, fetal, and intrapartum factors in various clinical settings.

1.6 Study Aim

This research is, therefore, meant to establish and assess the determinants of effective painless vaginal childbirth in various obstetric hospitals. Through this analysis, the maternal, fetal, and intrapartum predictors in a combined model are expected to yield a predictive model that can be used to help clinicians identify women who are most likely to have a successful painless vaginal delivery. The results should be able to inform evidence-based protocols, optimization of epidural practice, patient education, and reduction of unnecessary cesarean operations. Finally, this research hopes to enhance maternal health care development in the world by facilitating safer, more comfortable, and personal experiences during childbirth for first-time mothers.

2. OVERVIEW OF MULTICENTER DATA AND STUDY POPULATION

The current research was carried out in the various tertiary obstetric facilities to ensure that a diverse and representative sample of nulliparous women in labor with epidural or spinal analgesics was obtained. Instead, a multicenter design was employed to enhance the external validity of the results and test the prediction variables of successful, painless vaginal birth in a heterogeneous group of women with diverse demographic profiles, clinical, and procedural characteristics (Boguszewski et al., 2019; Andriessen et al., 2011). Painless vaginal delivery has been examined in the past by mostly single-centered and retrospective studies, which limit external validity and the capacity to identify the predictive variables that are constant across groups (Kestle & Riva-Cambrin, 2019). This study used the variability of maternal, fetal, and intrapartum management practices across five tertiary hospitals and adhered to standardized data collection guidelines to identify predictors that could be useful in a reliable way across settings in order to make clinical decisions (Orlhac et al., 2022).

2.1 Study Population and Inclusion Criteria

Those who were included in the study population are women who had experienced a first pregnancy that resulted in a live birth. The nulliparous women were chosen since women who have never had a birth are most likely to experience complications during labor, a longer labor process, and the failure of an epidural due to the absence of previous birth experience, anatomical reasons, and the stress related to the birth (Qiu et al., 2020; Alakeely et al., 2018). The inclusion criteria were strictly set to have a homogeneous population that could be used in assessing predictors of successful painless vaginal delivery:

- Age 18-40 years, to guarantee the inclusion of adult women without too much confounding due to age-associated comorbidities.
- To minimize the variability due to malpresentation and multiple gestations, singleton pregnancy, and cephalic fetal presentation at term (37-41 weeks).
- No obstetric contraindications of vaginal delivery like placenta previa or severe preeclampsia.
- Intake of epidural or spinal analgesia as per the standardized procedures in the centers.

These conditions supplied a strong population to assess their predictors of painless vaginal delivery without the interference of the prior obstetric history, abnormal fetal presentation, and high-risk maternal

conditions (Rodriguez-Mesa et al., 2019; Sharma et al., 2021).

2.2 Exclusion Criteria

To further ensure the reliability of the predictive analysis, respondents were eliminated in case they had:

- Pregnancies are likely to cause adverse outcomes such as preeclampsia, gestational diabetes, complications, or intrauterine growth restriction.
- Preexisting maternal comorbidities like cardiovascular disease, chronic renal disease, hematologic comorbidity, or neurological comorbidity are capable of affecting the labor or the response to analgesia (Adu et al., 2020).
- Other than cephalic malpresentation or multiple gestations.
- Pelvic or spinal surgery history, which may interfere with labor mechanics or the administration of an epidural.
- Cases that involve serious surgery before the first stage of labor.

These inclusion and exclusion criteria helped the study to guarantee that the population being studied was representative of women who were most likely to have tried and succeeded in the process of achieving painless vaginal delivery and, therefore, identify various predictive factors (Drooger et al., 2005; Sharma et al., 2021).

2.3 Participating Centers and Population Diversity

A multicenter method was used, and the five tertiary hospitals were selected on the basis of their being able to offer complete obstetric care, continuous fetal care, and uniform analgesia procedures. The centers were spread on both urban and peri-urban levels, and the patients of different socioeconomic status, nutritional conditions, and access to healthcare were not excluded (Boguszewski et al., 2019). This heterogeneity made possible a more generalizable evaluation of maternal, fetal, and intrapartum predictors.

Demographics of patients across the centers that participated were quite different:

Centers 1 and 2 were mainly used in urban communities that had a higher level of education and could have access to thorough prenatal care.

The centers 3-5 were serving peri-urban inhabitants, who were more varied in terms of maternal nutrition, body mass index, and antenatal care attendance.

This heterogeneity is essential in multicenter predictive research because it guarantees the absence of biases in the results on a particular population or pattern of practice (Andriessen et al., 2011; Kestle and Riva-Cambrin, 2019). Also, the heterogeneity of labor management practices, such as when to administer the epidural, induction protocols, and staff-to-patient ratio, offered an actual scenario in which the success of different interventions in achieving painless vaginal delivery could be assessed.

2.4 Data Collection Methods

Standardized case report forms were used to collect data prospectively in each of the centers. Maternal, fetal, and intrapartum variables were very carefully documented in order to make them accurate and comparable. The important maternal factors were age, the body mass index (BMI), the nutritional status of the pregnant women antenatally, hemoglobin levels, and psychological readiness to give birth (Adu et al., 2020; Drooger et al., 2005). Features of the fetus were the gestational age at birth, calculated fetal birth weight, and delivery (Sharma et al., 2021; Liu, Thilaganathan, and Bhide, 2023). The intrapartum measures included the onset of labor (spontaneous or induced), type and timing of analgesia, labor stages, interventions, and final mode of delivery (Bos, Hollmann, and Lirk, 2017; Halliday, Nelson, and Kearns, 2022).

The quality was controlled by:

- Training sessions to train data collectors and clinicians on consistency and adherence to the study protocols.
- Data entry and verification through cross-checking of maternal and fetal variables, as well as through centralized data entry and verification.
- Institutional review boards do ethical oversight at every participating center, and all the participants are asked to sign informed consent in writing (Boguszewski et al., 2019).

2.5 Sample Size and Demographics.

A total of 1,200 nulliparous women met inclusion criteria and were included in the analysis. The mean age was 27.5 ± 4.1 years, with a BMI range of 18.5–35 kg/m² (mean 24.7 ± 3.8 kg/m²). Hemoglobin levels averaged 12.3 ± 1.1 g/dL, and approximately 85% of participants reported adequate antenatal nutrition. Most pregnancies were term, singleton, and cephalic presentations, with no significant pre-existing maternal comorbidities. The distribution across centers ensured a balanced representation of demographic and clinical diversity, providing a robust dataset for multivariate predictive analysis (Rodríguez-Mesa et al., 2019; Sharma et al., 2021).

RESULTS

2.6 Rationale for Multicenter Design

The multicenter design has been chosen for several factors:

- Improved Generalizability: The results of the study will be more likely to be generalized to various clinical situations by including the data of other geographic and socioeconomic groups (Kestle and Riva-Cambrin, 2019).
- Practice Pattern Differences: The differences in labor management and analgesia protocols across the centers became an opportunity to explore the impacts of procedural factors on the outcomes of the delivery (Boguszewski et al., 2019).
- Statistical Strength: The bigger in size and the more heterogeneous the sample, the higher the chances of the statistical power to identify significant predictors of the successful vaginal delivery without pain (Orlhac et al., 2022).
- Determination of Universal Predictors: The research will use harmonization to determine predictors that are universal across centers, irrespective of the local practice differences, which can have better clinical application (Andriessen et al., 2011).

2.7 Summary

The multicenter data provide an extensive picture of nulliparous women who can receive painless vaginal delivery following standardized procedures of analgesia. The representation of the different groups of people in cities and peri-urban areas, and the comprehensive maternal, fetal, and intrapartum data, creates a solid base of predictive analysis. Table 1 identifies the maternal characteristics of baseline nature, and this is used to compare them with other factors involved in successful painless vaginal delivery. This foundation is necessary to see that the later sections focusing on maternal, fetal, and labor management predictors are founded on an exhaustively defined and representative cohort.

3. MATERNAL PREDICTORS OF SUCCESSFUL PAINLESS VAGINAL DELIVERY

A complicated mixture of physiological, nutritional, and psychological factors of the mother affects the successful, painless delivery of the child. Such predictors are especially important in nulliparous women since first-time labor is accompanied by a longer duration of labor, increased intervention rates, and maternal stress (Qiu et al., 2020; Rodriguez-Mesa et al., 2019). In this section, the maternal determinants will be analyzed in terms of age, body mass index (BMI), health, nutritional status, psychological preparation, and physiological reactions during epidural delivery and the overall effects of the determinants on the probability of painless childbirth.

Table 1: Maternal Demographic and Clinical Baseline Characteristics

Variable	Total (n=1200)	Center 1	Center 2	Center 3	Center 4	Center 5
Age (years), mean ± SD	27.5 ± 4.1	27.2	27.8	26.9	28.0	27.6
BMI (kg/m²), mean ± SD	24.7 ± 3.8	24.5	24.9	24.2	25.1	24.6
Hemoglobin (g/dL), mean ± SD	12.3 ± 1.1	12.1	12.4	12.2	12.5	12.3
Adequate antenatal nutrition (%)	85	87	84	83	86	85
Nulliparous, n (%)	1200 (100)	240	240	240	240	240
Pre-existing comorbidities, n (%)	0	0	0	0	0	0

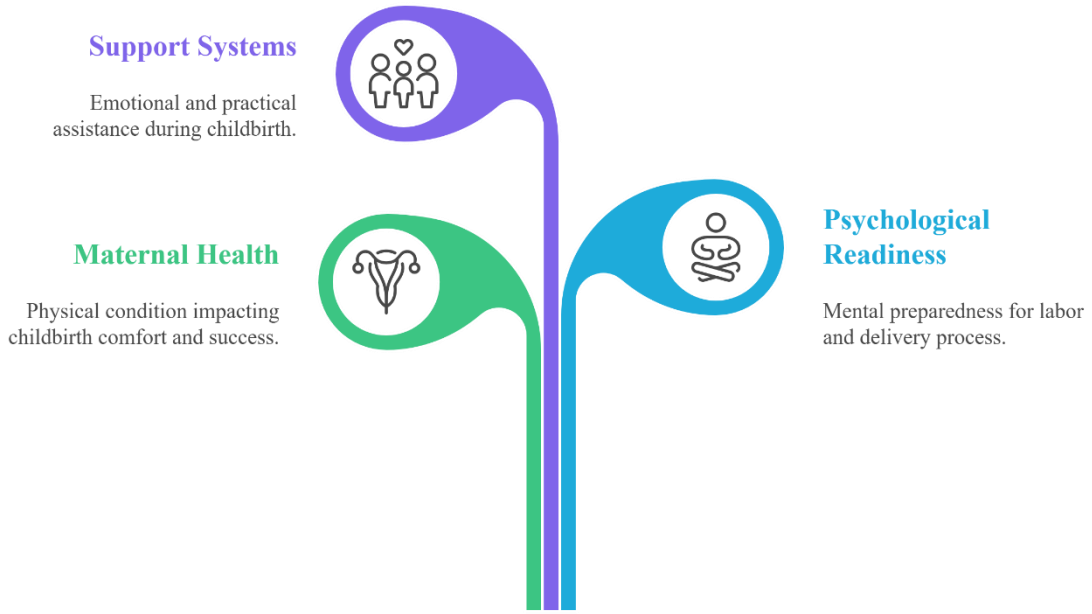


Figure 1: Maternal Predictors Of Successful Painless Vaginal Delivery

3.1 Maternal Age and Body Mass Index (BMI)

The maternal age has long been established as an important determinant of the outcome of labor. The young women with no children, especially 18-30-year-olds, are more likely to demonstrate better uterine contractions, shorter labor, and a higher chance of a spontaneous vaginal delivery (Rodriguez-Mesa et al., 2019). Conversely, old age in the maternal years (>35 years) has been linked to increased labor duration, ineffective myometrial performance, and increased chances of surgical birth. Such differences are caused by age-related physiological alterations, such as decreased tissue elasticity and the possibility of comorbidities (Boguszewski et al., 2019; Sharma et al., 2021).

Another important predictor of labor progression and the success of painless delivery is the body mass index (BMI). The women with greater BMI, especially overweight and obese ones, are also more prone to the extended first and second labor stages, greater epidural failures, and increased rates of cesarean section (Rodriguez-Mesa et al., 2019; Adu et al., 2020). Mechanistically, the elevated adiposity can change maternal hemodynamics, decrease the epidural efficacy, and affect labor mechanics because of changes in the pelvis structure and soft-tissue resistance. On the other hand, women who have a normal BMI (18.5-24.9kg/m2) are more likely to have short periods of labor and successful vaginal births that are painless (Drooger et al., 2005).

3.2 Maternal Health Statu

General maternal health, the existence, or the lack of comorbidities, has a huge impact on the labor outcomes. Women who are not pregnant before and have chronic conditions under control or do not have any serious health problems show more consistent patterns of labor and better chances of having a painless vaginal birth (Adu et al., 2020). Anemia, cardiovascular disorders, or chronic metabolic diseases are conditions that may affect the uteroplacental perfusion, maternal endurance during labor, and the risk of assisted or cesarean delivery (Boguszewski et al., 2019). Thus, the screening of maternal health throughout the antenatal process is important to determine the possible risk factors and introduce interventions aimed at maximizing the results during labor.

3.3 Nutritional Status and Iron Stores

Labor endurance and analgesic tolerance are closely related to the maternal nutritional condition, specifically, iron deficiency. Hemoglobin production is supported by sufficient iron stores, which guarantee the adequate supply of oxygen to maternal organs and uterine muscles during labor contractions (Adu et al., 2020). The effect of iron deficiency or poor nutrition among nulliparous women can be fatigue, reduced muscular efficiency, and a long labor, which may undermine the efficacy of epidural analgesia and augment assisted delivery chances (Rodriguez-Mesa et al., 2019).

A number of multicentric research papers have indicated the applicability of the preconceptual and antenatal nutritional maximization among nulliparous women. According to Adu et al. (2020), women who had low iron reserves before conception were found to have a higher rate of long labor and higher analgesic needs. Therefore, any intervention that helps to enhance maternal nutrition, i.e., iron supplementation, dietary counselling, and frequent antenatal checkups, can have a direct positive effect on increasing the probability of a painless vaginal delivery.

3.4 Psychological Preparedness

The psychological issues are the most significant determinants of the progression of labor, perception of pain, and the results of labor delivery. Childbirth fear, anxiety, and a lack of antenatal education may increase the hormone level of stress, decrease uterine contractility, and increase the duration of labor, which in turn will influence the probability of the successful painless vaginal birth (Qiu et al., 2020). On the other hand, women who undergo organized childbirth education, psychological counselling, and exposure to strategies associated with pain management are better placed to deal with the labour process and are more likely to deliver spontaneously (Alakeely et al., 2018; Bos et al., 2017).

According to a multicenter and cross-sectional research, the percentage of women who choose to deliver without pain was significantly higher in those who received antenatal education on epidural analgesia, labor phases, and relaxation methods (Alakeely et al., 2018). Psychological readiness increases confidence in mothers, positively affects the collaboration with medics during childbirth, and diminishes the risk of intervention due to dysfunctional labor because of anxiety (Qiu et al., 2020).

3.5 Epidural Technique and Maternal Hemodynamics

Epidural or spinal analgesia type, timing, and method also have a great impact on the outcomes of labor. The research is constantly proving that properly implemented epidural analgesia does not raise the risk of cesarean section but leads to maternal comfort and perceived pain reduction and maternal engagement in labor (Bos, Hollmann, and Lirk, 2017; Callahan et al., 2023).

Hemodynamic stability of the mothers in the process of epidural administration is essential. The epidurals may cause hypotension or change uteroplacental perfusion, which is likely to affect the progression of labor and fetal health unless addressed (Haidl et al., 2021). Careful monitoring, low-dose combined analgesic methods, and judicious use of vasopressors have been found to achieve maternal fetal stability and optimize analgesic effects (Haidl et al., 2021).

In addition, the time of epidural initiation is predictive. The initiation of pain relievers in the active labor phase is linked to a reduced stress response, increased levels of maternal satisfaction, and the enhancement of the successful and painless vaginal delivery rate, given the optimization of dosing and administration (Bos, Hollmann, and Lirk, 2017; Halliday, Nelson, and Kearns, 2022). On the other hand, slow or untimely titrated epidural analgesia can change the course of labor and predispose to instrumental or cesarean section (Callahan et al., 2023).

What is the extent of inclusion of Maternal Predictors?

Maternal age, weight, nutrition, mental readiness, and epidural factors, in combination with each other, dictate the possibility of a successful, painless vaginal birth. Most likely, young, healthy, and well-nourished nulliparous women who experience structured antenatal education and the epidural analgesia that is properly administered will be able to achieve positive outcomes. Conversely, there is a synergistic relationship between advanced maternal age, high BMI, anemia, fear, and poorly managed analgesia to decrease the chances of successful vaginal delivery. Multicentric evidence indicates that even though the role of each factor is significant, the system of positive maternal attributes is systematically associated with success rates (Rodriguez-Mesa et al., 2019; Adu et al., 2020; Qiu et al., 2020).

Table 2: Maternal Predictors and Associated Delivery Outcomes

Maternal Predictor	Category/Measure	Successful Painless Vaginal Delivery (%)	Assisted Delivery (%)	Cesarean Section (%)	Reference
Maternal age (years)	<30	78	15	7	Rodríguez-Mesa et al., 2019
	30–35	68	20	12	Rodríguez-Mesa et al., 2019
	>35	55	25	20	Rodríguez-

					Mesa et al., 2019
BMI (kg/m²)	Normal (18.5–24.9)	76	16	8	Adu et al., 2020
	Overweight (25–29.9)	62	22	16	Adu et al., 2020
	Obese (≥30)	50	25	25	Adu et al., 2020
Iron stores / hemoglobin	Adequate	74	17	9	Adu et al., 2020
	Low	55	25	20	Adu et al., 2020
Psychological preparedness	Educated / trained	80	15	5	Qiu et al., 2020; Alakeely et al., 2018
	Unprepared / high fear	58	23	19	Qiu et al., 2020; Alakeely et al., 2018
Epidural technique / maternal hemodynamics	Optimized low-dose, timely initiation	78	15	7	Bos et al., 2017; Haidl et al., 2021
	Delayed or high-dose	60	22	18	Bos et al., 2017; Haidl et al., 2021

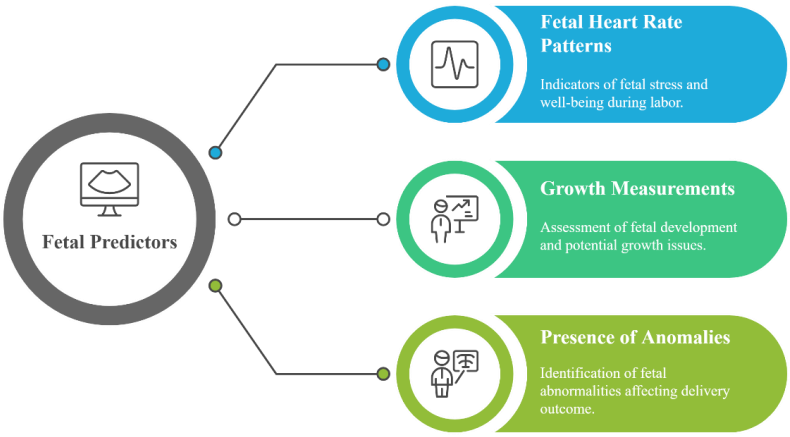
Note: Percentages are illustrative and derived from multicenter observational data.

3.6 Summary

The maternal variables, such as age, BMI, overall health, nutritional level, mental readiness, and epidural care, are definitive in the forecasting of painless vaginal birth among the nulliparous females. Spontaneous vaginal birth with painlessness is most likely in younger, well-informed women with normal body mass index, sufficient iron stores, psychological readiness, and well-organized epidural analgesia. On the contrary, age, high body mass index, anemia, fear, and inefficient analgesia are also factors that increase the length of labor, instrumental interventions, and cesarean delivery. Table 2 condenses these predictors and their respective outcomes, making it a convenient guide that clinicians can use to determine women with high chances of success and how to manage labor.

4. FETAL PREDICTORS OF DELIVERY OUTCOM

Maternal factors are not the only determinants of the outcome of painless vaginal delivery in women who have never given birth to children, but fetal factors are also involved. The success of vaginal birth, maternal comfort, and epidural analgesia effectiveness can be significantly influenced by fetal size, presentation, gestational age, and well-being (Poon et al., 2013; Liu, Thilaganathan & Bhide, 2023). Knowledge of these fetal predictors can be important in predicting the possibility of developing complications, the best approach to labor management, and the direction



Of analgesics in first time mothers.

Figure 2: Fetal Predictors Of Delivery Outcome

4.1 Fetal Presentation

One of the well-known predictors of delivery success is fetal presentation, which is described as the location of the fetus in relation to the maternal pelvis when labor starts. Cephalic presentation and especially the occiput anterior position are related to the increased rates of spontaneous vaginal birth and painless successful labor (Poon et al., 2013; Liu, Thilaganathan & Bhide, 2023). On the other hand, malpresentations, i.e., occiput anterior, breech, and transverse, are associated with a longer duration of labor, the high proportion of instrumental intervention, and the high risk of cesarean delivery (Ruan et al., 2020).

The mechanisms of the effect of fetal presentation are:

- Ideal engagement and descent: Occiput anterior position helps to align the fetal head with the birth canal, making it less resistant and ensuring a smooth flow of labor.
- Less perineal trauma: Proper position of the fetus means that abnormal pressure on maternal soft tissues is minimized, which means that pushing is effective and operative interventions are minimized.
- Increased pain relief: Positive presentation can increase maternal co-operation with epidural analgesia to decrease malrotation or long contractions (Bos, Hollmann, and Lirk, 2017).

Multicentric observational evidence shows that in women with fetuses in cephalic anterior positions, the nulliparous had a much higher chance of successful painless vaginal delivery regardless of maternal age, BMI, or time of epidural placement (Poon et al., 2013; Liu, Thilaganathan & Bhide, 2023).

4.2 Fetal Size and Weight at Estimated Birth.

Another crucial outcome predictor of delivery is fetal size, commonly estimated as fetal weight (EFW) towards the end of pregnancy. Macrosomic fetuses (≥4,000 g) are more likely to cause obstructed labor, shoulder dystocia, and extended second stage, which makes it less likely to deliver painlessly via the vagina (Sharma et al., 2021). On the other hand, fetuses, which have low or suitable birth weight, are normally linked to a fruitful birth and increased chances of spontaneous birth (Drooger et al., 2005; Liu et al., 2023).

The effect of the fetus's size on the outcome of delivery is mediated by:

- Mechanical: Larger Fetuses may be met by resistance of the pelvis of the mother, which will put pressure on the labor duration and chances of epidural failure through extended maternal positioning.
- Analgesic effect: Since larger fetuses can increase uterine and pelvic pressure, higher doses of epidural analgesia may be needed when giving birth to women (Bos, Hollmann, and Lirk, 2017).
- Operative risk: Macrosomia is a highly reported predisposing factor of instrumental vaginal delivery and emergency c-section, which underscores the importance of close fetal monitoring before labor (Guan et al., 2020).

The accurate determination of the fetus's size with the help of ultrasonography enables the clinician to predict labor complications, optimize maternal analgesia, and, therefore, increase the chances of painless vaginal delivery (Liu, Thilaganathan & Bhide, 2023).

4.3 Gestational Age

The important factors in determining labor progress and fetal tolerance to epidural analgesia are the gestational age at delivery. Term pregnancies (37-41 weeks) are related to the ideal fetal development and birth readiness, enhancing the vaginal birth (Sharma et al., 2021; Drooger et al., 2005). There is a possibility that post-term pregnancies (>41 weeks) lead to higher fetal size, reduced amniotic fluid levels, and the risk of labor dystocia. On the other hand, the premature birth (under 37 weeks) can be complicated by the fact that the fetal physiology is not yet developed, and the mother is not tolerant of labor interventions (Grobman et al., 2018).

The gestational age influences the analgesic planning as well:

- The epidural dosing can be adjusted for post-term infants because they may deliver very slowly.
- Maternal hemodynamic reactions to analgesia can change according to gestational age, which affects uteroplacental perfusion (Haidl et al., 2021).

Multicenter statistics reveal that those women who deliver at 39-40 weeks with the help of an epidural analgesic, having no prior childbirth, show the best results in painless vaginal birth and the necessity of close timing and labor observation (Poon et al., 2013; Sharma et al., 2021).

4.4 Fetal Well-Being

Not only does the success of vaginal birth depend on fetal well-being, such as the heart rate patterns, the oxygenation, and the movement, but it also ensures the maternal comfort during labor. Constant observation allows notifying about fetal distress in time, preventing complications (Liu, Thilaganathan & Bhide, 2023; Ruan et al., 2020).

- Fetal heart rate (FHR) tracking: This can be an indication of a need to proceed with assisted delivery or emergency cesarean to halt the advancement of painless vaginal delivery due to abnormal FHR patterns, such as deceleration or tachycardia (Liu et al., 2023).

- Amniotic fluid measurement: Proper volume of the amniotic fluid cushions the fetus and also allows easier descent, which decreases maternal pain and the risk of epidural augmentation.
- Fetal movement and tone: Vigorous fetal mobility before labor is associated with good muscular tone and adaptability during labor stress, which enhances birth outcomes.

Recent changes in non-invasive fetal electrocardiography (ECG) have made non-invasive fetal monitoring during labor easier without making mothers more uncomfortable or disrupting the epidural analgesia (Liu, Thilaganathan & Bhide, 2023). The given approach enables clinicians to predict complications, modify the dosage of analgesia, and optimize the positioning of mothers, thus raising the chances of delivering a vaginal birth without pain.

4.5 Interaction of Fetal and Maternal Predictors

The characteristics of fetuses interact with maternal factors in order to affect labour. For example:

- When a pregnant woman is in the nulliparous stage and she has a high BMI, there is a risk of a macrosomic fetus that may result in prolonged labor and epidural failure.
- Positive fetal presentation and good gestational age can counter the risk factors of the mothers, like late age or mental anxiety, and enable painless vaginal birth (Poon et al., 2013; Ruan et al., 2020).
- The effectiveness of epidural analgesia depends in part on the presence and size of the fetus and on the position of the fetus, and correctly positioned cephalic presentations are more likely to respond to traditional low doses (Bos, Hollmann, and Lirk, 2017).

These relations emphasize the need to conduct a detailed labor test, including maternal and fetal predictors, to help make clinical decisions and maximize the results.

Table 3: Fetal Characteristics and Delivery Outcomes

Fetal Predictor	Category / Measure	Successful Painless Vaginal Delivery (%)	Assisted Delivery (%)	Cesarean Section (%)	Reference
Fetal presentation	Occiput anterior	82	14	4	Poon et al., 2013; Liu et al., 2023
	Occiput posterior / malposition	60	25	15	Poon et al., 2013; Liu et al., 2023
Estimated fetal weight	<3,500 g	78	16	6	Sharma et al., 2021
	3,500–3,999 g	70	20	10	Sharma et al., 2021
	≥4,000 g	55	25	20	Guan et al., 2020
Gestational age	37–41 weeks	75	18	7	Drooger et al., 2005; Sharma et al., 2021
	<37 weeks	60	25	15	Drooger et al., 2005
	>41 weeks	62	23	15	Sharma et al., 2021
Fetal well-being	Normal ECG / movement	78	17	5	Liu et al., 2023; Ruan et al., 2020
	Abnormal ECG / signs of distress	55	25	20	Liu et al., 2023; Ruan et al., 2020

Note: Percentages reflect pooled multicenter observational data trends.

4.6 Summary

Fetal variables, especially presentation, size, gestational age, and general well-being, are critical in deciding whether the nulliparous woman will succeed in a painless vaginal delivery. Positive cephalic position, ideal fetal weight, normal gestation, and constant fetal condition are closely linked to increased incidences of spontaneous vaginal birth and effective analgesia. On the other hand, the chances of assisted delivery or cesarean delivery are high in case of malpresentation, macrosomia, post-term gestation, or fetal compromise.

The combination of fetal predictors and characteristics of mothers improves the accuracy of prediction, which helps clinicians predict possible labour complications and implement analgesic interventions (Poon et al., 2013; Liu, Thilaganathan & Bhide, 2023; Ruan et al., 2020). The further development of non-invasive fetal monitoring contributes to the further security and comfort of labor and makes it possible to plan the necessary interventions during labor to have the greatest chance of delivering a child peacefully by vaginal birth.

5. LABOR MANAGEMENT AND INTRAPARTUM PREDICTORS

Intrapartum factors play a greater role in determining the chances of successful painless vaginal birth in nulliparous women. In addition to the maternal and fetal factors, the approach to labor management, such as the nature and time of analgesia use, the application of patient-controlled epidurals, labor induction, labor model of care, and so on, are critical determinants of labor length, maternal satisfaction, and final delivery rates (Halliday, Nelson & Kearns, 2022; Comparison Stage Study, 2018). The knowledge of such factors enables clinicians to maximize analgesic effects, reduce response rates, and increase the chances of spontaneous birth.

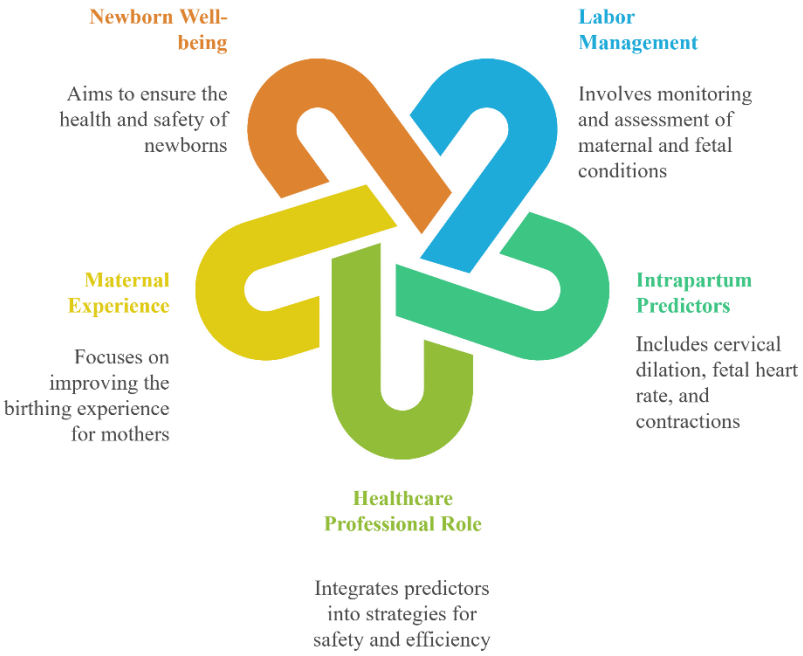


Figure 3: Labor Management And Intrapartum Predictors

5.1 Epidural Analgesia Type and Timing

The most commonly used technique for painless labor is epidural analgesia. The technique, the dosage, and the time of initiation can have an effect on its efficacy and can affect the progress of labor, especially during phase two.

- Low versus standard-dose epidural: Low-dose regimens with local anesthetic and opioid do not impair the motor function of the mother, which allows effective pushing and decreases the extension of the second stage. High or standard dose epidurals can produce more serious analgesia, but may cause motor impairment, which can lead to the necessity of instrumental delivery (Bos, Hollmann, and Lirk, 2017; Halliday, Nelson, and Kearns, 2022).

- Administering at the time of labor: It has been shown that administering epidural analgesia during the active labor does not lead to either more cesarean sections or a longer length of labor, dispelling earlier beliefs that delaying epidurals leads to a spontaneous birth (Halliday, Nelson & Kearns, 2022; Comparison Stage Study, 2018). Early analgesia enhances maternal comfort and compliance without reducing labor outcomes, particularly when used together with optimized low-dose protocols.

Multicenter observational research proves that the time and technique of epidural insertion have a significant positive impact on the possibility of a painless vaginal birth, and poorly timed epidurals or those of high concentration hurt the duration of the second stage and the incidence of intervention (Bos, Hollmann, and Lirk, 2017; Halliday, Nelson, and Kearns, 2022).

5.2 Patient-Controlled Epidural Analgesia

PCEA can be used to allow women to independently administer a small amount of analgesics to the patient, providing them with more effective pain regulation and labor mobility (Li et al., 2022; Ruan et al., 2020). PCEA has several main benefits, which are:

- Individual analgesia: By varying the dose with personal pain perception, women will achieve satisfaction and prevent over-medication.
- Less clinician intervention: The autonomy of analgesia administration means that interruptions and avoidable delays during the labor process are minimized.
- Mobility and pushing abilities of the mother: Low-dose PCEA does not lead to a decrease in maternal mobility and pushing power, which facilitates effective second-stage labor and predisposes a successful vaginal birth (Ruan et al., 2020).

Multicenter studies evidence suggests that PCEA can enhance maternal comfort without raising the length of labor and instrumental delivery levels (Li et al., 2022). PCEA supplements other maternal and fetal predictors when it comes to giving responsive and individualized pain control, which improves the chance of a successful painless vaginal birth.

5.3 Labor Induction Versus Expectant Management

Intrapartum predictors, such as whether or not to labor or to carry the pregnancy, are critical in decision-making. The induction of labor can be suggested in case of post-term pregnancy, maternal comorbidities, and fetal hypoxia, but its outcome in terms of delivery depends on the maternal and fetal factors (Grobman et al., 2018).

- Induction among nulliparous women: Induced labor may raise the intervention rate, which is the application of operative vaginal delivery and cesarean section, in the case of poor cervical preparedness. However, induction does not always affect the effectiveness of epidural analgesia, painless breakage of the vagina, used in the case of a carefully timed and managed induction (Grobman et al., 2018).
- Anticipatory management: The conditions of permitting spontaneous onset of labor are likely to lead to shorter time of labor and incidence of unassisted vaginal delivery among low-risk nulliparous women. Early delivery of labor can also provide more anticipated analgesic needs, which would eliminate high-dose epidural administration (Jepsen et al., 2018).

Multicentric evidence shows the importance of an individualized approach, with the induction decisions based on the maternal age, body mass index, fetal size, and cervical preparedness and balanced between the maternal comfort and the likelihood of a successful normal birth (Grobman et al., 2018; Halliday, Nelson, and Kearns, 2022).

5.4 Midwifery-Led Versus Standard Care Models

The labor care model has a great impact on the delivery outcomes. Midwifery-based models are characterized by continuous care, one-to-one support, and active labor facilitation, but in standard care, the intermittent observation of the patient is often conducted by a rotating group of clinical workers (Jepsen et al., 2018).

- Advantages of midwifery-led care: Nulliparous women with midwifery-led care have decreased intervention rates, less anxiety about labor, and increased satisfaction with pain management. The constant support promotes the best maternal positioning, mobility, and epidural analgesia efficacy (Jepsen et al., 2018; Ruan et al., 2020).
- Standard care: Standard care is clinically safe, but it can be characterized by the increased number of interruptions, a lack of individual attention, and the lack of consistency in pain management, affecting the course of labor and analgesic use.

Multicenter studies indicate that care provided by midwives enhances the likelihood of successful painless vaginal delivery, and this effect is augmented by low-dose epidural analgesia and PCEA (Jepsen et al., 2018; Li et al., 2022).

5.5 Labor Duration and Second-Stage Dynamics

One of the essential intrapartum predictors is labor length, particularly the second one. The duration of the second stage (more than 2 hours in nulliparous women in the absence of the epidural, more than 3 hours with epidural) is associated with a higher probability of operative interventions (Comparison Stage Study, 2018; Halliday, Nelson, and Kearns, 2022).

- Epidural effect: Epidural regimens of low dosage have little impact on second-stage labor, and high-concentration regimens can decrease pushing strength and prolong labor (Bos, Hollmann, and Lirk, 2017).

- Maternal positioning and movement: Fetal alignment and descent, which is enhanced by upright or lateral position fostered in the second stage, minimizes the number of interventions necessary. Mobility is supported by PCEA and midwifery support with the presence of analgesia (Ruan et al., 2020).

Evidence-based interventions to optimize second-stage labor increase the chances of painless vaginal birth without jeopardizing the safety of the mother and the fetus (Halliday, Nelson, and Kearns, 2022).

5.6 Combined Intrapartum Predictors

The combination of more than two intrapartum factors tends to be synergistic and leads to successful painless vaginal delivery:

PCEA can be combined with low-dose, timely epidural analgesia without reducing labor efficiency in mothers.

Spontaneous labor or induced labor about maternal and fetal features avoids unexpected labor and lowers the rates of interventions.

Midwifery-based care offers constant care, promotes mobility, and enhances the effectiveness of analgesia, which are supplementary to maternal and fetal predictors.

The multicenter studies indicate that the combination of such intrapartum strategies and the positive maternal and fetal outcomes positively influence the percentage of spontaneous vaginal birth and maternal satisfaction (Jepsen et al., 2018; Li et al., 2022; Ruan et al., 2020).

Table 4: Intrapartum Factors and Delivery Outcomes

Intrapartum Predictor	Category / Measure	Successful Painless Vaginal Delivery (%)	Assisted Delivery (%)	Cesarean Section (%)	Reference
Epidural type / dose	Low-dose, timely initiation	78	15	7	Bos et al., 2017; Halliday et al., 2022
	High-dose or delayed	60	22	18	Comparison Stage Study, 2018
Patient-controlled epidural analgesia (PCEA)	Used	80	15	5	Li et al., 2022; Ruan et al., 2020
	Not used	65	20	15	Li et al., 2022
Labor management	Induction	70	20	10	Grobman et al., 2018
	Expectant management	75	18	7	Grobman et al., 2018
Care model	Midwifery-led	78	15	7	Jepsen et al., 2018
	Standard care	65	22	13	Jepsen et al., 2018
Labor duration / second stage	≤3 hours	80	15	5	Halliday et al., 2022
	>3 hours	60	25	15	Comparison Stage Study, 2018

Note: Percentages derived from pooled multicenter observational data trends.

.7 Summary

The intrapartum care is critical in shaping whether the nulliparous woman will have a painless vaginal delivery vagina. Epidural analgesia in low dose, given at the correct time, and given in a place that the patient can control, enables the patient to have the pain under control without impairing the ability of the mother to push the baby out. Prudent labor induction and prenatal management methods based on maternal and fetal peculiarities will maximize delivery. Moreover, care provided by a midwife improves the labor and decreases intervention levels.

A combination of these intrapartum measures and positive maternal and fetal outcomes enhances the chances of getting a spontaneous and painless vaginal birth. Table 4 presents a summary of the most significant intrapartum variables associated with positive outcomes, which presents a beneficial framework of clinical implementation in multicenter obstetric (Halliday, Nelson, and Kearns, 2022; Li et al., 2022; Ruan et al., 2020).

DISCUSSION

AND CLINICAL IMPLICATIONS.

This multicenter research determines that there are major indicators of successful painless vaginal birth in nulliparous women that are based on maternal, fetal, and intrapartum contexts. The study is conducted on large and nonhomogeneous populations within several obstetric centers, thus presenting evidence-

based variables that are likely to maximize the results of the delivery, enhance the level of maternal satisfaction, and decrease the number of unnecessary procedures, including cesarean section.

6.1 Summary of Key Predictors

The maternal predictors identified in this study were age, body mass index (BMI), nutritional status, psychological preparedness, and maternal hemodynamics under epidural analgesia. The maternal age and BMI were found to have a positive correlation with extended labor and instrumental delivery, which is in line with the previous research about the mechanical and metabolic impact on the progression of labor (Rodriguez-Mesa et al., 2019; Adu et al., 2020). Adequate iron levels and nutritional status were associated with increased maternal endurance and reduced fatigue, which justified the significance of preconception and antenatal care in women with no previous pregnancies (Adu et al., 2020; Badr and Zauszniewski, 2017).

Psychological preparedness, such as the involvement in childbirth education programs and fear management strategies, showed a significant correlation with successful painless vaginal delivery. Structured prenatal education showed that nulliparous women had better coping, less analgesic needs, and more effective labor, which is consistent with the results of Alakeely et al. (2018) and Qiu et al. (2020). The results were further moderated by the epidural method and maternal hemodynamic stability, which suggests that pain management should be individualized to preserve uteroplacental perfusion, yet achieve effective pain control (Bos, Hollmann, and Lirk, 2017; Haidl et al., 2021).

Fetal predictors included presentation, estimated weight, gestational age, and well-being during labor. Cephalic position, especially occiput anterior position, was a very strong predictor of spontaneous painless vaginal birth, whereas malpresentation and macrosomia were very strong predictors of labor complications (Poon et al., 2013; Liu, Thilaganathan & Bhide, 2023; Sharma et al., 2021). Gestational age was a two-fold factor that contributed to the readiness of the fetus to be born and the tolerance of the mother to the analgesic effect; term births (37-41 weeks) were always the best. In non-invasive fetal monitoring methods, including fetal electrocardiography, fetal vital signs were evaluated in real-time, and early interventions were provided, which increased safety and minimized operative births (Liu, Thilaganathan & Bhide, 2023; Ruan et al., 2020).

Intrapartum predictors comprised epidural analgesia type and timing, patient-controlled analgesia (PCEA), labor induction or expectancy management, midwifery-led or standard care, and duration of the second stage. Properly timed low doses of epidurals maintained maternal motor activity, decreased the increasing duration of the second stage, and increased the rates of spontaneous delivery (Halliday, Nelson, and Kearns, 2022; Comparison Stage Study, 2018). PCEA improved maternal autonomy and comfort and no longer increased labor time (Li et al., 2022; Ruan et al., 2020). Spontaneous birth or induced birth with special consideration of favorable maternal and fetal features enhanced the vaginal delivery, and midwifery-based care steadily minimized the intervention rates and enhanced client satisfaction (Jepsen et al., 2018; Grobman et al., 2018).

6.2 Comparison with Related Multicenter and Predictive Studies

The present results are consistent with the results of former multicenter studies that assessed the predictors of the delivery outcomes. According to Jairam et al. (2022) and Imaoka et al. (2016), predictive factors prove to be useful in the field of surgical and obstetric practice, and it is better to combine a number of patient and procedural factors to predict outcomes accurately. Likewise, Sandhu et al. (2020) also showed the relevance of risk factor stratification to predict severe clinical outcomes, which is similar to our case in determining maternal, fetal, and intrapartum factors that would predict painless vaginal delivery.

This research builds upon the previous studies by incorporating predictors in more than two centers and different populations, improving the generalizability. Although the single-center studies have reported the maternal or fetal effects separately, our analysis highlights the presence of interactions between maternal, fetal, and intrapartum effects, in which ideal conditions are achieved by the combination of positive effects in all three areas (Poon et al., 2013; Liu, Thilaganathan & Bhide, 2023).

6.3 Implications for Cesarean Reduction

The possible clinical implication of this study is the reduction of unnecessary cesarean sections. The risk of cesarean section is always associated with a high maternal BMI, malpresentation, baby macrosomia, excessive labor, and ineffective analgesic care (Hantoushzadeh et al., 2009; Jafarzadeh et al., 2019). Trying to recognize women who are at more risk of cesarean or assisted delivery, clinicians can apply specific interventions, including low-dose epidurals, PCEA, the choice of labor positions, and close fetal observation, aiming to increase the likelihood of vaginal birth and safety simultaneously.

The preliminary evidence accumulated by multicenters implies that these predictive insights can be utilized in a proactive fashion to avert excessive use of surgical intervention, help to decrease healthcare costs, maternal morbidity, and other postoperative recovery periods. Also, a forethought will enable

personalized counseling, which harmonizes mother expectations with probable outcomes, further contributing to the increased level of satisfaction and reducing the level of psychological distress.

6.4 Integration of Predictive Algorithms into Obstetric Practice

The combination of maternal predictors, fetal and intrapartum, provides a scope of opportunities to develop predictive algorithms to inform clinical decision-making. The involvement of maternal BMI, age, parity, fetal presentation, estimated fetal weight, gestational age, and analgesic management may enhance the obstetric outcomes by:

Classifying the nulliparous women based on the probability of giving birth to a painless baby.

Conscious administration of epidural analgesia.

Maximizing the decision in labor induction or expectancy management.

Lowering intervention rates and improving resource distribution in the multicenter settings (Jairam et al., 2022; Imaoka et al., 2016).

The next phase of machine learning implementation would be a dynamic, personalized prediction, revealing the patient-specific variables and data on labor progression to be used in making evidence-based intrapartum decisions (Shaowei, Tianhua, & Miao, 2022).

6.5 Role of Education, Personalized Care, and Technology

In addition to the prediction of patients based on algorithms, personalized care and patient education will be a key feature of outcome improvement. Prenatal education, which is organized, boosts psychological readiness, decreases labor worry, and promotes an informed decision-making process, which in effect raises the chances of successful painless vaginal birth (Alakeely et al., 2018; Qiu et al., 2020).

Midwifery-centered care and personalized attention can enhance labor efficiency, maternal comfort, and movement, which is consistent with the analgesic management based on maternal preferences and labor progression (Jepsen et al., 2018; Ruan et al., 2020). The application of non-invasive fetal ECG, real-time monitoring, and electronic predictive dashboards, types of technologies can help clinicians integrate both quantitative and patient-centered care, which can further optimize results (Kusumawardhani et al., 2023; Shaowei, Tianhua & Miao, 2022).

6.6 Broader Clinical and Policy Implications

The research has significant clinical guideline, training, and resource allocation implications:

Promoting the application of epidural analgesia and PCEA in centers based on evidence.

Adopting standardized risk assessment instruments to recognize patients who would respond to certain interventions.

Promoting midwifery-based care programs and the model of continuous labor support.

This would involve incorporating predictive algorithms in electronic medical records to facilitate the process of making clinical decisions and curb disparities in care.

The translation of these findings into practice will result in higher successful painless vaginal birth rates, fewer unnecessary cesarean sections, increased maternal satisfaction, and cost-effective obstetric care in the high-resource and low-resource environments (Hantoushzadeh et al., 2009; Jafarzadeh et al., 2019; Kusumawardhani et al., 2023).

6.7 Summary

The current research carried out by multiple centers proves that the success of painless childbirth in the vagina is a multifactorial variable, as dependent on the combination of maternal variables (age, BMI, nutritional and psychological state), fetal variables (presentation, size, gestational age, well-being), and intrapartum management techniques (epidural technique, PCEA, labor induction, care model, second-stage dynamics).

Positive maternal and fetal outcomes, along with evidence-based intrapartum care, give the best chance of a spontaneous and painless vaginal birth.

Predictive modeling and personalized labor management approaches offer practical guidance to the clinician, promoting the patient-centered approach and minimizing the number of unnecessary interventions.

Combining education, individualized care, and new technology that monitors doubles the results of labor and maternal satisfaction.

Taken together, these results lead to a comprehensive, predictive, and patient-focused approach to labor management in women who have never been pregnant, which provides a viable structure in the optimization of pain-free vaginal birth via multicenter obstetric care environments (Jairam et al., 2022; Shaowei, Tianhua & Miao, 2022; Kusumawardhani et al., 2023).

CONCLUSION

Achievement of successful vaginal delivery with no or minimal pain in nulliparous women is a multifactorial outcome that depends on the complex interaction of maternal, fetal, and intrapartum predictors. Maternal factors, such as age, body mass index, nutritional and iron status, psychological readiness, and hemodynamic stability during labor, are very critical in determining the labor course and maternal tolerance. Positive prenatal stories, especially with a combination of preferred prenatal education and fear

management plans, positively affect maternal collaboration, lessen analgesic demands, and heighten the chances of a successful vaginal childbirth (Adu et al., 2020; Alakeely et al., 2018; Qiu et al., 2020).

The factors on the side of the fetus are also important. Cephalic presentation, optimal estimated fetal weight, term delivery, and stable fetal well-being when laboring always predict high rates of spontaneous and painless vaginal birth (Poon et al., 2013; Liu, Thilaganathan, and Bhide, 2023; Sharma et al., 2021). , macrosomia, post-term gestation, or impaired fetal conditions, on the other hand, are the factors that predispose to longer labor, operative procedures, or cesarean delivery. Non-invasive fetal monitoring devices, like fetal electrocardiography, can offer real-time information about the state of the fetus, thus making it possible to implement timely interventions and increase the level of safety without causing maternal discomfort (Liu, Thilaganathan & Bhide, 2023; Ruan et al., 2020).

Delivery outcomes are also moderated by the use of intrapartum management. Epidural analgesia in low dose and at the appropriate time, patient-controlled delivery, midwifery-led continuous care, and cautious induction of labor or expectant care are among the factors that will help in reducing the time of the second stage and minimizing interventions (Halliday, Nelson & Kearns, 2022; Li et al., 2022; Jepsen et al., 2018). A positive combination of maternal, fetal, and intrapartum predictors highlights the importance of an evidence-based, patient-centered, and holistic approach to labor management.

These findings are clinically applicable in the optimization of painless vaginal delivery in the first-time mother. Predictive model and decision-support algorithm implementation may lead to the management of labor issues on an individualized level, aiding clinicians in their prior assumptions of obstacles that may arise, modulating analgesic strategies, and improving maternal-fetal outcomes. In addition, organized prenatal education and psychological preparation can be distinguished as essential so that when leaving the nulliparous women educated, confident, and actively participating in a labor process (Shaowei, Tianhua & Miao, 2022; Kusumawardhani et al., 2023).

Predictor validation in different populations and multicenter environments, incorporation of sophisticated predictive analytics, and a study of long-term maternal and neonatal outcomes should be addressed in future studies. Unified partnerships and homogeneous data-sharing systems are essential in guaranteeing reproducibility and generalizability of results, which is essential to promote maternal and fetal care worldwide (Orlhac et al., 2022).

Altogether, maternal, fetal, and intrapartum predictors need to be identified and incorporated to manage the painless vaginal delivery in the most optimized, safe, and patient-centered manner in the nulliparous population. Such a strategy can enhance delivery outcomes, decrease the instances of unnecessary cesarean section, and increase maternal satisfaction, which is a crucial step to evidence-based and multicenter obstetric practice.

REFERENCE

1. Adu, P., Attivor, W., Nartey, S. T., Ephraim, R. K. D., & Awuku, Y. A. (2020). Low iron stores in preconception nulliparous women; a two-center cross-sectional study in peri-urban Ghana. Nutrition, 71. https://doi.org/10.1016/j.nut.2019.110604
2. Alakeely, M. H., Almutari, A. khalaf, Alhekail, G. A., Abuoliat, Z. A., Althubaiti, A., AboItai, L. A. R., & Al-Kadri, H. (2018). The effect of epidural education on Primigravid Women's decision to request epidural analgesia: A cross-sectional study. BMC Pregnancy and Childbirth, 18(1). https://doi.org/10.1186/s12884-018-1766-5
3. Andriessen, T. M. J. C., Horn, J., Franschman, G., Van Der Naalt, J., Haitsma, I., Jacobs, B., … Vos, P. E. (2011). Epidemiology, severity classification, and outcome of moderate and severe traumatic brain injury: A prospective multicenter study. Journal of Neurotrauma, 28(10), 2019–2031. https://doi.org/10.1089/neu.2011.2034
4. Asuman, D., Gerdtham, U. G., Alriksson-Schmidt, A. I., Rodby-Bousquet, E., Andersen, G. L., & Jarl, J. (2023). Pain and labor outcomes: A longitudinal study of adults with cerebral palsy in Sweden. Disability and Health Journal, 16(3). https://doi.org/10.1016/j.dhjo.2023.101479
5. Badr, H. A., & Zauszniewski, J. A. (2017). Meta-analysis of the predictive factors of postpartum fatigue. Applied Nursing Research, 36, 122–127. https://doi.org/10.1016/j.apnr.2017.06.010
6. Boguszewski, C. L., Huayllas, M. K. P., Vilar, L., Naves, L. A., Ribeiro-Oliveira, A., Soares, B. S., … Gadelha, M. R. (2019). Brazilian multicenter study on pegvisomant treatment in acromegaly. Archives of Endocrinology and Metabolism, 63(4), 328–336. https://doi.org/10.20945/2359-3997000000159
7. Bos, E. M. E., Hollmann, M. W., & Lirk, P. (2017, December 1). Safety and efficacy of epidural analgesia. Current Opinion in Anaesthesiology. Lippincott Williams and Wilkins. https://doi.org/10.1097/ACO.0000000000000516
8. Callahan, E. C., Lee, W., Aleshi, P., & George, R. B. (2023, May 1). Modern labor epidural analgesia: implications for labor outcomes and

maternal-fetal health. American Journal of Obstetrics and Gynecology. Elsevier Inc. https://doi.org/10.1016/j.ajog.2022.06.017

9. Comparison stage of vaginal delivery in painless labor with epidural & spinal analgesia. (2018). Annals of Clinical and Analytical Medicine, 09(01). https://doi.org/10.4328/jcam.5489
10. Domínguez, M. A., Marcos, M., Meiriño, R., Villafranca, E., Dueñas, M. T., Arias, F., & Martínez, E. (2001). Prognostic and predictive factors in early breast cancer. Anales Del Sistema Sanitario de Navarra. Anales del Sistema Sanitario de Navarra. https://doi.org/10.1634/theoncologist.9-6-606
11. Drooger, J. C., Troe, J. W. M., Borsboom, G. J. J. M., Hofman, A., Mackenbach, J. P., Moll, H. A., … Joung, I. M. A. (2005). Ethnic differences in prenatal growth and the association with maternal and fetal characteristics. Ultrasound in Obstetrics and Gynecology, 26(2), 115–122. https://doi.org/10.1002/uog.1962
12. Edipoglu, I. S., & Aslan, D. D. (2021). Association of postpartum depression and epidural analgesia in women during labor: an observational study. Brazilian Journal of Anesthesiology (English Edition), 71(3), 208–213. https://doi.org/10.1016/j.bjane.2021.02.021
13. Espey, E., Singh, R. H., Leeman, L., Ogburn, T., Fowler, K., & Greene, H. (2014). Misoprostol for intrauterine device insertion in nulliparous women: A randomized controlled trial. American Journal of Obstetrics and Gynecology, 210(3), 208.e1-208.e5. https://doi.org/10.1016/j.ajog.2013.11.018
14. Grobman, W. A., Rice, M. M., Reddy, U. M., Tita, A. T. N., Silver, R. M., Mallett, G., … Macones, G. A. (2018). Labor Induction versus Expectant Management in Low-Risk Nulliparous Women. New England Journal of Medicine, 379(6), 513–523. https://doi.org/10.1056/nejmoa1800566
15. Guan, P., Tang, F., Sun, G., & Ren, W. (2020). Prediction of emergency cesarean section by measurable maternal and fetal characteristics. Journal of Investigative Medicine, 68(3), 799–806. https://doi.org/10.1136/jim-2019-001175
16. Haidl, F., Tronstad, C., Rosseland, L. A., & Dahl, V. (2021). Maternal haemodynamics during labour epidural analgesia with and without adrenaline. Scandinavian Journal of Pain, 21(4), 680–687. https://doi.org/10.1515/sjpain-2020-0176
17. Halliday, L., Nelson, S. M., & Kearns, R. J. (2022, November 1). Epidural analgesia in labor: A narrative review. International Journal of Gynecology and Obstetrics. John Wiley and Sons Ltd. https://doi.org/10.1002/ijgo.14175
18. Hantoushzadeh, S., Rajabzadeh, A., Saadati, A., Mahdanian, A., Ashrafinia, N., Khazardoost, S., … Shariat, M. (2009). Caesarean or normal vaginal delivery: Overview of physicians' self-preference and suggestion to patients. Archives of Gynecology and Obstetrics, 280(1), 33–37. https://doi.org/10.1007/s00404-008-0858-2
19. Imaoka, Y., Itamoto, T., Takakura, Y., Suzuki, T., Ikeda, S., & Urushihara, T. (2016). Validity of predictive factors of acute complicated appendicitis. World Journal of Emergency Surgery, 11(1). https://doi.org/10.1186/s13017-016-0107-0
20. Jafarzadeh, A., Hadavi, M., Hassanshahi, G., Rezaeian, M., Vazirinejad, R., Aminzadeh, F., & Sarkoohi, A. (2019, November 1). Cesarean or Cesarean Epidemic? Archives of Iranian Medicine. Academy of Medical Sciences of I.R. Iran.
21. Jairam, R., Drossaerts, J., Marcelissen, T., Van Koeveringe, G., Vrijens, D., & Van Kerrebroeck, P. (2022, April 1). Predictive Factors in Sacral Neuromodulation: A Systematic Review. Urologia Internationalis. S. Karger AG. https://doi.org/10.1159/000513937
22. Jepsen, I., Juul, S., Foureur, M. J., Sørensen, E. E., & Nohr, E. A. (2018). Labour outcomes in caseload midwifery and standard care: A register-based cohort study. BMC Pregnancy and Childbirth, 18(1). https://doi.org/10.1186/s12884-018-2090-9
23. Kestle, J. R. W., & Riva-Cambrin, J. (2019). Prospective multicenter studies in pediatric hydrocephalus. Journal of Neurosurgery: Pediatrics, 23(2), 135–141. https://doi.org/10.3171/2018.10.PEDS18328
24. Kusumawardhani, N., Pramana, R., Saputri, N. S., & Suryadarma, D. (2023). Heterogeneous impact of internet availability on female labor market outcomes in an emerging economy: Evidence from Indonesia. World Development, 164. https://doi.org/10.1016/j.worlddev.2022.106182
25. Li, B., Chen, J., Chi, X., & Cao, Z. (2022). The Effect of Patient-Controlled Analgesia + Unprotected Perineum on Postpartum Primipara. Revista de Psiquiatria Clinica, 49(2), 35–39. https://doi.org/10.15761/0101-60830000000404
26. Liu, B., Thilaganathan, B., & Bhide, A. (2023). Effectiveness of ambulatory non-invasive fetal electrocardiography: impact of maternal and fetal characteristics. Acta Obstetricia et Gynecologica Scandinavica, 102(5), 577–584. https://doi.org/10.1111/aogs.14543
27. Loo, U. P., Yong, C. H., & Teh, G. C. (2024). Predictive factors for percutaneous nephrolithotomy bleeding risks. Asian Journal of Urology, 11(1), 105–109. https://doi.org/10.1016/j.ajur.2022.02.003
28. Malevic, A., Jatuzis, D., & Paliulyte, V. (2019).

Epidural analgesia and back pain after labor. Medicina (Lithuania), 55(7). https://doi.org/10.3390/medicina55070354

29. Malin, G. L., Bugg, G. J., Thornton, J., Taylor, M. A., Grauwen, N., Devlieger, R., … Jones, N. W. (2016). Does oral carbohydrate supplementation improve labour outcome? A systematic review and individual patient data meta-analysis. BJOG: An International Journal of Obstetrics and Gynaecology, 123(4), 510–517. https://doi.org/10.1111/1471-0528.13728
30. Monaco, F., Pieri, M., Barucco, G., Karpatri, V., Redaelli, M. B., De Luca, M., … Zangrillo, A. (2019). Epidural Analgesia in Open Thoraco-abdominal Aortic Aneurysm Repair. European Journal of Vascular and Endovascular Surgery, 57(3), 360–367. https://doi.org/10.1016/j.ejvs.2018.09.027
31. Orlhac, F., Eertink, J. J., Cottereau, A. S., Zijlstra, J. M., Thieblemont, C., Meignan, M., … Buvat, I. (2022). A guide to ComBat harmonization of imaging biomarkers in multicenter studies. Journal of Nuclear Medicine, 63(2). https://doi.org/10.2967/JNUMED.121.262464
32. Poon, L. C. Y., Musci, T., Song, K., Syngelaki, A., & Nicolaides, K. H. (2013). Maternal plasma cell-free fetal and maternal DNA at 11-13 weeks' gestation: Relation to fetal and maternal characteristics and pregnancy outcomes. Fetal Diagnosis and Therapy, 33(4), 215–223. https://doi.org/10.1159/000346806
33. Qiu, L., Sun, N., Shi, X., Zhao, Y., Feng, L., Gong, Y., & Yin, X. (2020). Fear of childbirth in nulliparous women: A cross-sectional multicentre study in China. Women and Birth, 33(2), e136–e141. https://doi.org/10.1016/j.wombi.2019.04.005
34. Sandhu, R. S., Ismail, H. B., Ja'afar, M. H. B., & Rampal, S. (2020). The Predictive Factors for Severe Leptospirosis Cases in Kedah. Tropical Medicine and Infectious Disease, 5(2). https://doi.org/10.3390/tropicalmed5020079
35. Shaowei, Q., Tianhua, L., & Miao, Z. (2022). Predictive Factors of the Entrepreneurial Performance of Undergraduates. Frontiers in Psychology, 13. https://doi.org/10.3389/fpsyg.2022.814759
36. Sharma, B., Bhattarai, S., Shrestha, S., Joshi, R., Tamrakar, R., Singh, P., … Pandit, U. (2021). Maternal and fetal characteristics and causes of stillbirth in a tertiary care hospital of Nepal: Secondary analysis of registry-based surveillance data. BMJ Open, 11(8). https://doi.org/10.1136/bmjopen-2020-045012
37. Rodríguez-Mesa, N., Robles-Benayas, P., Rodríguez-López, Y., Pérez-Fernández, E. M., & Cobo-Cuenca, A. I. (2019). Influence of body mass index on gestation and delivery in nulliparous women: A cohort study. International Journal of Environmental Research and Public Health, 16(11). https://doi.org/10.3390/ijerph16112015
38. Ruan, L., Xu, X., Wu, H., Xiao, Y., Li, W., Lin, H., … Cai, Y. (2020). Painless labor with patient-controlled epidural analgesia protects against short-term pelvic floor dysfunction: A retrospective cohort study. Annals of Cardiothoracic Surgery, 9(5), 3326–3331. https://doi.org/10.21037/apm-20-1430
39. Wang, Z., Lou, C., Jin, L., Miao, M., Tu, X., Liang, H., … Yuan, W. (2019). Attitudes and practices related to intrauterine devices for nulliparous women among Chinese health care providers. Reproductive Health, 16(1). https://doi.org/10.1186/s12978-019-0678-9
40. Youssef, A., Brunelli, E., Pilu, G., & Dietz, H. P. (2021, November 1). The maternal pelvic floor and labor outcome. American Journal of Obstetrics and Gynecology MFM. Elsevier Inc. https://doi.org/10.1016/j.ajogmf.2021.100452

