The impact of maternal age on pregnancy outcomes & mode of delivery: a focus on cesarean section & vaginal delivery rates.

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Abstract

Background: The global trend toward delayed childbearing has raised concerns about its impact on pregnancy outcomes, particularly regarding the mode of delivery. Advanced maternal age is associated with an increased risk of obstetric complications, influencing a significant rise in cesarean section (CS) rates. This study investigates the relationship between maternal age and delivery outcomes, with a focus on CS and vaginal delivery rates across 16 countries with diverse healthcare systems.

Methods and Materials: A retrospective analysis of public health data from 2.7 million women in 16 countries was conducted. Participants were stratified into three maternal age groups: <20 years, 20–34 years, and ≥34 years. Variables analyzed included parity, smoking status, previous cesarean delivery, use of assisted reproductive technology (ART), and mode of delivery. Country-specific healthcare policies and cultural factors were also considered to contextualize differences in delivery practices.

Results: The study revealed a clear increase in cesarean section rates with maternal age, particularly among women aged ≥34. Vaginal delivery remained the most common method overall but declined significantly in older age groups. Nordic countries maintained high vaginal delivery rates (80–90%) and low CS rates (<25%) across all age groups. In contrast, countries like Ghana and China showed marked increases in CS rates among older mothers. Factors such as ART use, obstetric complications, and healthcare policy differences contributed to variations.

Conclusion: Maternal age is a significant predictor of delivery mode, with advanced age correlating with higher CS rates due to physiological risks and systemic healthcare factors. However, variations across countries highlight the influence of healthcare models and cultural attitudes. Encouraging evidence-based practices, enhancing preconception care, and supporting patient-centered decision-making may help balance safety with reduced medicalization of childbirth for older mothers.

Introduction

In recent decades, a notable demographic shift toward delayed childbearing has emerged, significantly altering obstetric practice and outcomes. As more women opt to conceive later in life, advanced maternal age has increasingly been recognized as a critical factor influencing pregnancy outcomes and the choice of delivery mode. The escalation in maternal age correlates with heightened risks for a spectrum of obstetric complications, including hypertensive disorders, gestational diabetes, and placental abnormalities, that predispose these pregnancies to require cesarean delivery as opposed to a vaginal birth. This trend is not merely a reflection of clinical necessity; it also highlights the evolving preferences of patients and providers in the context of modern reproductive medicine.

The growing prevalence of cesarean sections among older pregnant individuals can be attributed to both intrinsic physiological changes associated with aging and extrinsic factors such as medico-legal considerations and the increased availability of elective surgical delivery options. Consequently, understanding the interplay between maternal age and mode of delivery is imperative for optimizing both maternal and neonatal outcomes. This article aims to critically evaluate how advanced maternal age influences pregnancy outcomes and delineates the factors contributing to the rising cesarean section rates compared to vaginal deliveries.

Evidence from recent studies indicates a stepwise increase in cesarean delivery rates with advancing maternal age, with significant implications for maternal morbidity, recovery, and subsequent pregnancies (Boerma et al., 2018). Furthermore, research has consistently shown that older maternal age is associated with increased perinatal risks, including preterm birth and low birth weight, necessitating a more cautious approach to delivery management (Carbillon et al., 2020). As the demographic landscape continues to evolve, this synthesis of current evidence highlights the need for tailored clinical strategies to balance the benefits and risks inherent in both cesarean and vaginal delivery modes for older mothers.

Literature Review

Caesarean section

Cesarean section (CS) is a surgical procedure to deliver a fetus through an abdominal incision (laparotomy) followed by a uterine incision (uterotomy), regardless of whether the fetus is alive or dead [3]. Historically, this procedure was primarily performed when the mother was deceased

or dying, aiming to save the infant. Its evolution, from a perilous, post-mortem intervention to a routine, life-saving operation, reflects advancements in medical knowledge, societal norms, and global health priorities. Concurrently, the rise in maternal age at first birth, driven by socioeconomic, educational, and cultural factors, has reshaped pregnancy outcomes and delivery practices.

Historical evolution of cesarean section

The origins of the C-section date back to ancient times, with references found in various cultures and mythologies. For instance, Greek mythology recounts how Apollo extracted Asclepius, the god of medicine, from his mother's abdomen. In the 16th century, documented cases began to emerge, but the procedure was fraught with high maternal mortality due to infections, hemorrhage, and lack of anesthesia. Significant milestones that improved the safety and outcomes of C-sections include:

1.   Introduction of Uterine Suturing: In 1882, Max Sänger advocated for suturing the uterine incision, reducing hemorrhage and improving maternal survival rates.

2.   Transverse Incision Technique: Ferdinand Adolf Kehrer introduced the low transverse incision in 1881, minimizing bleeding and enhancing healing.

3.   Advancements in Asepsis and Anesthesia: The late 19th and early 20th centuries saw the adoption of antiseptic techniques and the development of safer anesthetic methods, significantly reducing the risks associated with surgery.

4.   Antibiotics and Blood Transfusions (Mid-20th Century): This started with the discovery of penicillin in 1923 and the widespread use of blood transfusions post World War II to address sepsis and hemorrhage, which were the leading causes of death (Vladic Stjernholm, 2018).

5.   Misgav Ladach Technique (1994): This is a modified method which reduced operation time with minimal dissection and rapid delivery, thus making CS more efficient and less risky (Carbillon et al., 2020).

These developments, among others, have contributed to the evolution of the C-section into a relatively safe procedure when medically indicated (Sewell, 1993).

Indicators of CS

The choice to perform a cesarean section is based on a comprehensive assessment of both maternal and fetal factors, as well as the medical skills available and consent from the mother or

couple. These indicators are further classified as absolute indicators (where a cesarean section must be performed) or relative indicators (where cesarean section is considered as a mode of delivery, especially when there are two or more factors present making vaginal delivery not a viable option).

Maternal Indications

Maternal indications are categorized into groups based on relative or absolute criteria, as mentioned earlier. Because vaginal birth carries a significant risk of maternal or fetal morbidity and mortality, absolute maternal indications require cesarean delivery.

Advanced Age Primiparous women (over 35 years) are more likely to experience fetal distress and extended labour, which may lead to an elective C-section. Comorbidities often worsen with age, making surgery even more necessary to achieve optimal results (Lean et al., 2017). There is also a decrease in uterine muscle elasticity and contractility, which can lead to dystocia and uterine dysfunction. They are likely to experience prolonged first and second stages of labour (Boerma et al., 2018). There is also a higher risk of fetal malpresentation, fetal macrosomia and placental insufficiency. Another concern to note is the decrease in fertility with increasing age, prompting the use of Assisted Reproductive Technologies (ART), which is associated with placental abnormalities and fetal growth disorders (Damhuis et al., 2021).

Contracted Pelvis. A diagonal conjugate measurement of less than 7.5 cm indicates a constricted pelvis, which is a serious anatomical restriction that makes vaginal birth unsafe. This disorder raises the risk of obstructed labour and fetal discomfort and is frequently associated with malnutrition or congenital abnormalities. Research shows that a large percentage of emergency C-sections in low-resource settings, when prenatal imaging may be scarce, are caused by cephalopelvic disproportion due to a contracted pelvis (Cunningham et al., 2022).

Prior classical cesarean section, compared to the <1% risk linked with low-segment incisions (LSCS), a vertical uterine incision from a prior conventional C-section confers a 4–9% risk of uterine rupture in subsequent pregnancies. Because of the increased risk of uterine rupture, vaginal birth after cesarean (VBAC) is contraindicated in certain situations. Thus, mothers are more likely to undergo CS after this procedure for subsequent deliveries. (ACOG, 2020)

Prior History of Uterine Rupture. During labour, women who have experienced a previous uterine rupture or who have high-risk conditions such as uterine scars due to surgical

interventions like CS run the risk of dying. To prevent recurrence, which is linked to 6–10% perinatal death, a repeat C-section is required. This highlights the importance of customized risk assessment in prenatal care.

Total placenta previa. Placenta previa is a complication of pregnancy where implantation of the placenta occurs at the lower section of the uterus. Total placenta previa is where the placenta is implanted over the cervical opening, thus making subsequent vaginal delivery of the fetus impossible. A C-section is required when the placenta completely covers the cervical os in order to stop catastrophic bleeding during cervical dilatation. The risk of placenta accreta spectrum diseases, especially in women who have had previous uterine scarring, exacerbates placenta previa and calls for multidisciplinary delivery planning (Silver, 2021).

Inertia in the uterus or dysfunctional labour. This is when there are insufficient contractions despite oxytocin augmentation, which is a sign of primary uterine inertia, which frequently calls for a C-section. In these situations, prolonged labour raises the possibility of maternal fatigue and fetal deterioration, necessitating prompt medical attention (Grobman et al., 2018).

Active genital Herpes Simplex Virus (HSV) infection. Cesarean section (CS) is a proven method of preventing neonatal transmission when there is an active genital Herpes Simplex Virus (HSV) infection during pregnancy, especially at the time of delivery. If lesions exist at the outset of labour, cesarean birth lowers the risk of neonatal HSV transmission from 50% to less than 2%. Acyclovir and Valacyclovir are examples of antiviral therapies used to prevent viral shedding and lesion recurrence starting at 36 weeks of pregnancy.

Previous Perineal Injury. In subsequent pregnancies, a history of severe perineal injury, such as fourth-degree obstetric tears, is a clear sign that a cesarean section (CS) is necessary. These increase the likelihood of pelvic floor dysfunction, persistent discomfort, and fecal incontinence by affecting the anal sphincter and rectal mucosa. Although healed rips may not automatically rule out vaginal delivery, CS may choose to avoid aggravating symptoms if there is still pelvic floor injury or scarring. In order to prevent physical and mental suffering, women who have had traumatic deliveries in the past frequently choose elective cesarean sections (MacArthur et al., 2011).

Fibroids or tumours obstructing the birth canal, total placenta previa, placental abruption with extensive bleeding and an undilated cervix, cervical malignancy, eclampsia, severe preeclampsia and unsuccessful labour induction are additional absolute indicators.

However, individual clinical judgement is needed for relative maternal indications. These include a history of a low-segment cesarean section, an advanced maternal age (old primipara), a slightly restricted pelvis (Grade I–II, conjugate vera 9.5–7.5 cm), and maternal comorbidities such as diabetes and heart disease.

Fetal indications

Just like maternal indicators, fetal indicators can be classified as relative or absolute indicators. Some of these indicators prompting the use of CS are stated below.

Fetal malpresentation is ranked as the third-most common indication of CS globally in 2023, accounting for about 17% of cases. The word "presentation" refers to what part of the fetus is overlying the exit route, which is the pelvic inlet. The ideal situation is the cephalic presentation, where the fetal head is overlying the pelvic inlet with the chin tucked to the chest when pregnancy is close to term. However, sometimes babies are not aligned in the right position due to certain factors, causing challenges during labour, which may endanger the life of the mother and fetus if delivered vaginally. Cesarean section is the most used alternative when vaginal delivery is deemed too risky due to the type of malpresentation (Pattinson et al., 2017). Another alternative is the external cephalic version (ECV), which is a noninvasive procedure that involves manipulation of fetal position through the abdominal wall when the baby is close to term by careful massage and rotation of the fetus by a skilled doctor under ultrasound guidance. Success rate is about 60% according to studies, and it is a viable option to improve vaginal delivery in singleton pregnancies (Rosman et al., 2012).

Cephalopelvic Disproportion (CPD) is a complication of pregnancy characterized by a mismatch in the size of the fetus as compared to the passage for vaginal delivery. Thus, when the fetus is too big (macrosomia) or the patient has a contracted pelvis, it makes vaginal delivery dangerous or impossible. Depending on the degree of contracted pelvis, CS may be the only option to safely deliver the fetus (Cunningham et al., 2022).

Macrosomia is another issue, particularly in pregnancies complicated by gestational diabetes, which disproportionately affects older mothers (Damhuis et al., 2021). It is characterized by

excessive fetal growth, typically measured by absolute birth weight rather than gestational age. It is a relative indicator of CS (Mohammadbeigi et al., 2013).

Umbilical Cord Prolapse is an unpredictable pregnancy complication where the umbilical cord comes out of the uterus with or before the presenting part of the baby. It is most common in pregnancies with fetal malpresentation and multiple pregnancies (Holbrook & Phelan, 2013). Management requires the quick restoration of the blood supply to the fetus by lifting the presenting part of the fetus so it does not obstruct blood flow through the cord, and emergency cesarean section to deliver the fetus. This is an absolute indication for CS (Lore, 2017).

Multiple pregnancy is another issue of concern when it comes to the choice of delivery. It is a relative indication of CS, and if other indicators like fetal malpresentation are present, then CS is preferred over vaginal delivery (Fiolna & McEwan, 2023).

Fetal Anomalies, also referred to as birth defects, congenital anomalies, and congenital diseases, are structural or functional defects that arise during intrauterine development or while the fetus is still within the womb. The abnormality may be identified during pregnancy or at birth and may impact one or more bodily components. Hydroencephalus is one of such fetal anomalies where there is a buildup of fluid in the fetal head (specifically the ventricles of the brain), causing fetal head enlargement, making vaginal delivery impossible or dangerous for the fetus (Fiolna & McEwan, 2023).

Aim of Study

The study mainly investigates:

1.   Influence of maternal age on C-section and vaginal delivery rates

The primary aim is to investigate the correlation between maternal age and the choice of delivery mode. This focus stems from the recognition that advanced maternal age (≥34 years) is associated with heightened risks of obstetric complications such as fetal malpresentation, macrosomia, placental insufficiency, and reduced uterine contractility. This aim underscores the need to distinguish between physiological age-related risks and provider-driven interventions, which collectively shape delivery outcomes.

2.   Compare age-stratified outcomes across 16 countries with diverse healthcare systems.

A secondary aim is to analyze how healthcare policies, cultural practices, and systemic factors modulate the relationship between maternal age and delivery mode. The study emphasizes

comparative analysis across 16 countries, including high-CS regions and low-CS nations. This aim addresses the hypothesis that healthcare system structures such as midwife-led care, non-incentivized reimbursement for CS, and evidence-based protocols can mitigate unnecessary surgical interventions even for older mothers.

3.   Highlight some key factors affecting pregnancy outcomes across age groups, such as smoking status, parity, previous C-section and the use of assisted reproductive technology (ART) The third aim focuses on isolating confounding variables that intersect with maternal age to influence delivery decisions. These include smoking status, parity, prior CS history, and ART utilization. The study also examines how parity differences, such as multiparity in younger women, contribute to lower intervention rates, as experienced uterine muscles may facilitate vaginal birth. This aim aligns with broader efforts to balance maternal autonomy with clinical safety, particularly as older mothers increasingly seek personalized care plans that minimize unnecessary interventions.

Materials and Methods

This study employed a retrospective analysis of publicly available data from 16 countries to evaluate the relationship between maternal age, pregnancy outcomes, and mode of delivery. The 16 countries are Ghana, Australia, the United Kingdom, China, Denmark, Finland, Iceland, Norway, Sweden, Spain, the Netherlands, Canada, Cameroon, Iran, Ireland and Israel.

The study focused on comparative analysis of diverse geographic, economic, and sociodemographic factors such as smoking status, parity and any previous CS for previous pregnancy. Publicly accessible national health databases and institutional repositories provided data from 1999 to 2021, covering 2,716,966 women. Participating institutions provided ethical permission, and patient anonymity was ensured using these datasets.

Three maternal age groups were created from the stratified study population:

Group 1 (G1) <20 years

Group 2 (G2) 20–34 years

Group 3 (G3) ≥34 years

Incomplete records on delivery manner or social deprivation status were among the exclusion criteria. The following variables were examined: mother age, parity, smoking status, history of

previous cesarean sections (CS), use of ART, and method of delivery (vaginal, CS, or instrumental). Qualitative comparisons of healthcare policies and cultural practices were used to contextualize geographic and sociodemographic differences.

Exclusion criteria included women with missing data on social deprivation or mode of delivery. This approach enabled a thorough analysis of global patterns, taking into account the diversity of demographics and healthcare systems. The lack of information on pregnancies that ended before 24 weeks and possible variations in data collection methods between nations were among the limitations.

Results

Significant differences in cesarean section (CS) and vaginal delivery rates across mother age groups were found in the study, with notable variances influenced by healthcare, cultural, and geographic factors. Overall, vaginal delivery is the highest mode of delivery across all 16 countries, regardless of age, followed by cesarean section, and then instrumental delivery.
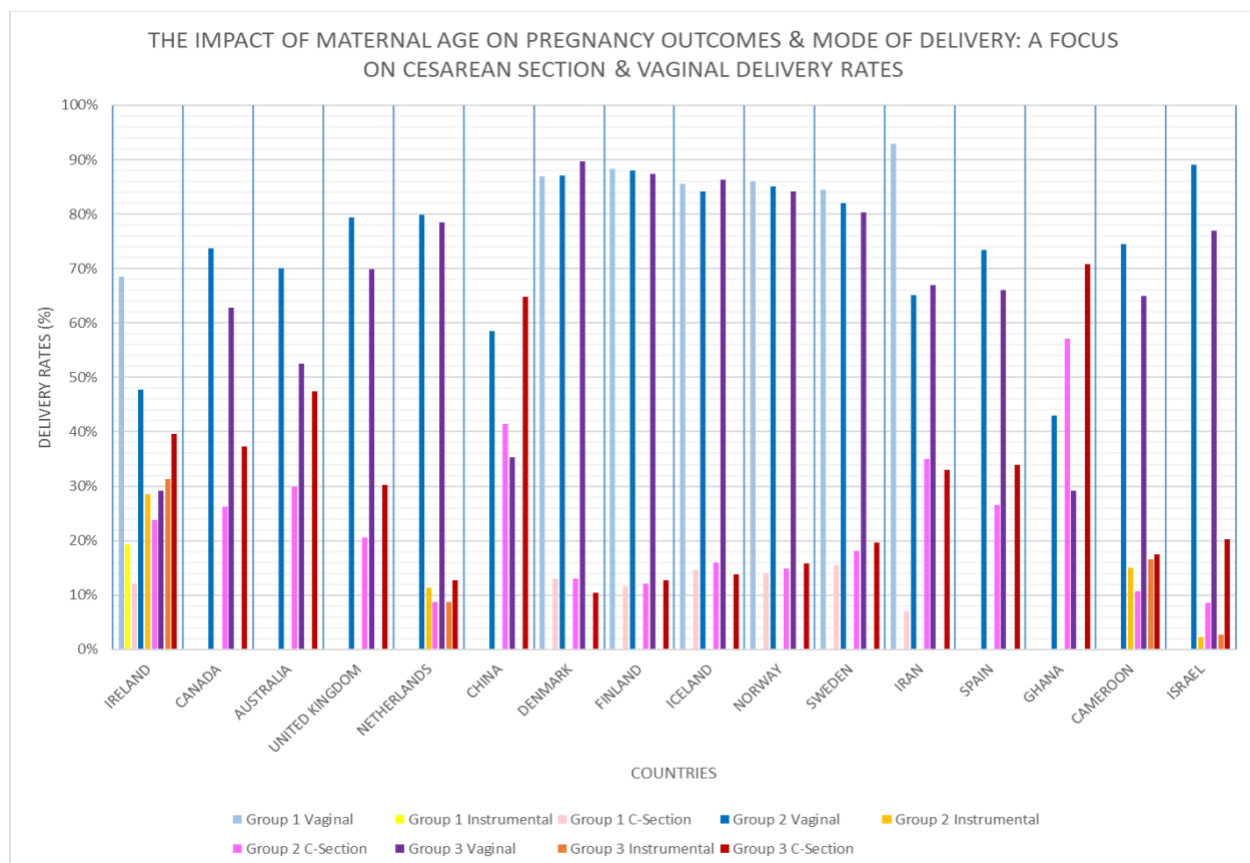
Figure 1 – The bar chart above shows the complete representation of the results according to country, mode of delivery as well as age group.

This chart shows that vaginal deliveries are the most common in all countries, with Ghana reporting the lowest rates at 38%, China at 41%, and Ireland at 48%. There is also a steady increase in the rates of C-section delivery as the woman ages especially women in age Group 3.
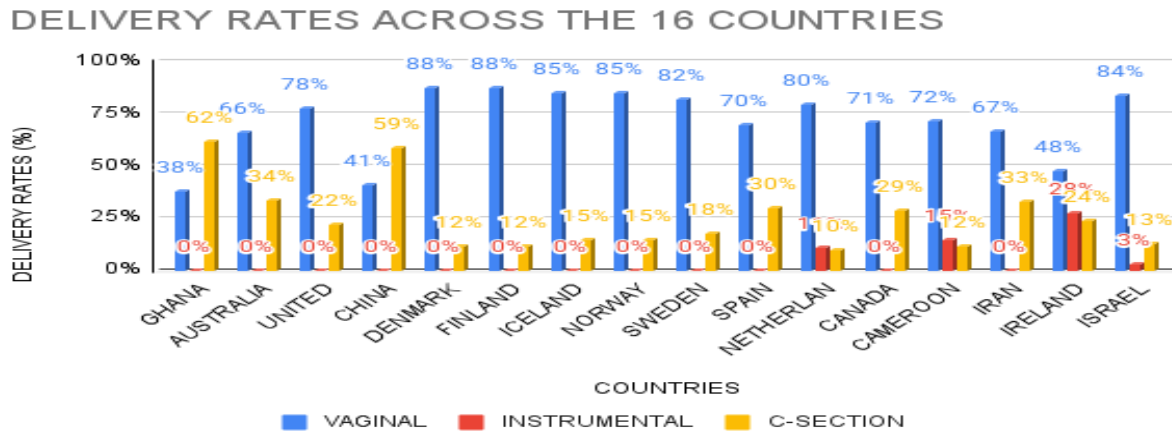

DELIVERY RATES ACROSS THE 16 COUNTRIES

Figure 2 – The bar chart above shows the delivery rates (%) of the dataset according to mode of delivery in each country.

Without taking into account the different age groups of the women in each country, we observe the highest rates of delivery in vaginal delivery, followed by Cesarean delivery and then Instrumental delivery. The lowest vaginal deliveries (<50%) is observed in Ghana (38%), China (41%) and Ireland (48%). This shows a dominance in natural births over the other modes of delivery in most countries considered for this study.
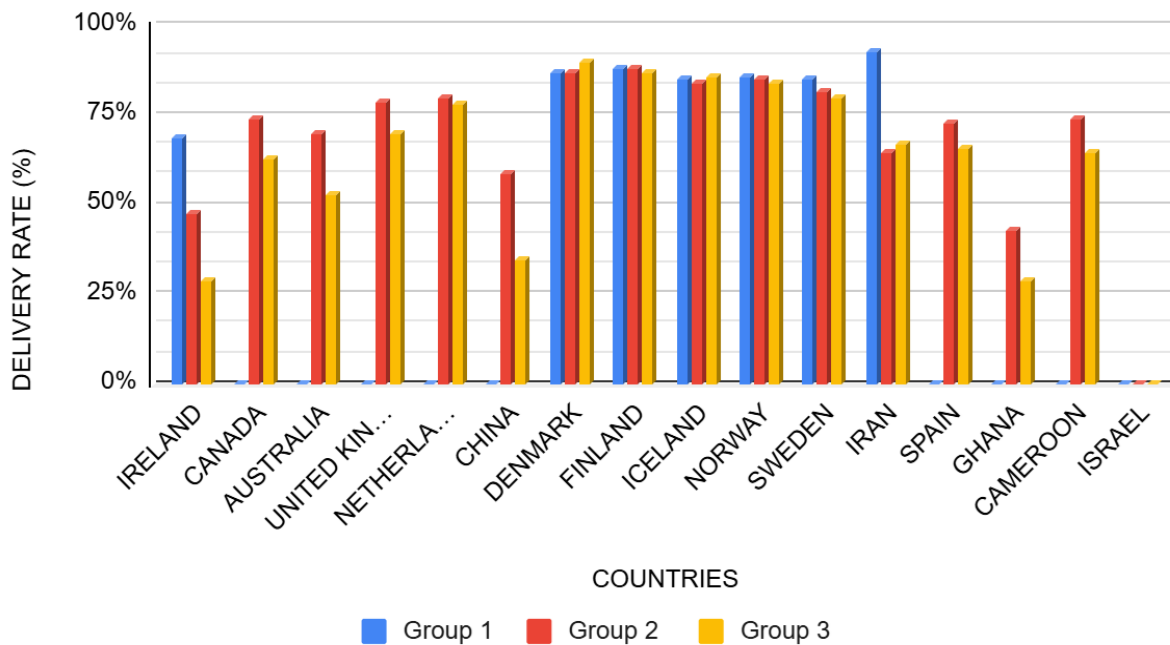
Rate of Vaginal delivery in the 16 countries

Figure 3 – The chart above shows the delivery rate of vaginal delivery in the 16 countries.
The chart illustrates a consistent declining trend in vaginal delivery rates with increasing maternal age. Younger mothers (Group 1) generally exhibit higher rates of vaginal delivery compared to their older counterparts, particularly when compared to women aged >34 years (Group 3). This aligns with the clinical knowledge that women in Group 3 have a greater risk of obstetric complications like fetal malpresentation, fetal macrosomia, placental insufficiency and uterine dysfunction as compared to younger women in Group 1 (Sheen et al., 2018).

Nordic countries such as Denmark, Finland, Iceland, Norway, and Sweden maintained high rates of vaginal delivery across all age groups, often exceeding 80%. These countries are known for their evidence-based obstetric protocols, low intervention rates, and midwife-led care models that, when clinically appropriate, encourage vaginal birth regardless of the mother's age (Euro-Peristat Report, 2021). On the other hand, vaginal delivery rates in nations like China, Ghana and Ireland sharply fall with age. This may reflect a more conservative approach to older maternal age, possibly due to medical or legal concerns and increased obstetric complications (Reddy et al., 2017).
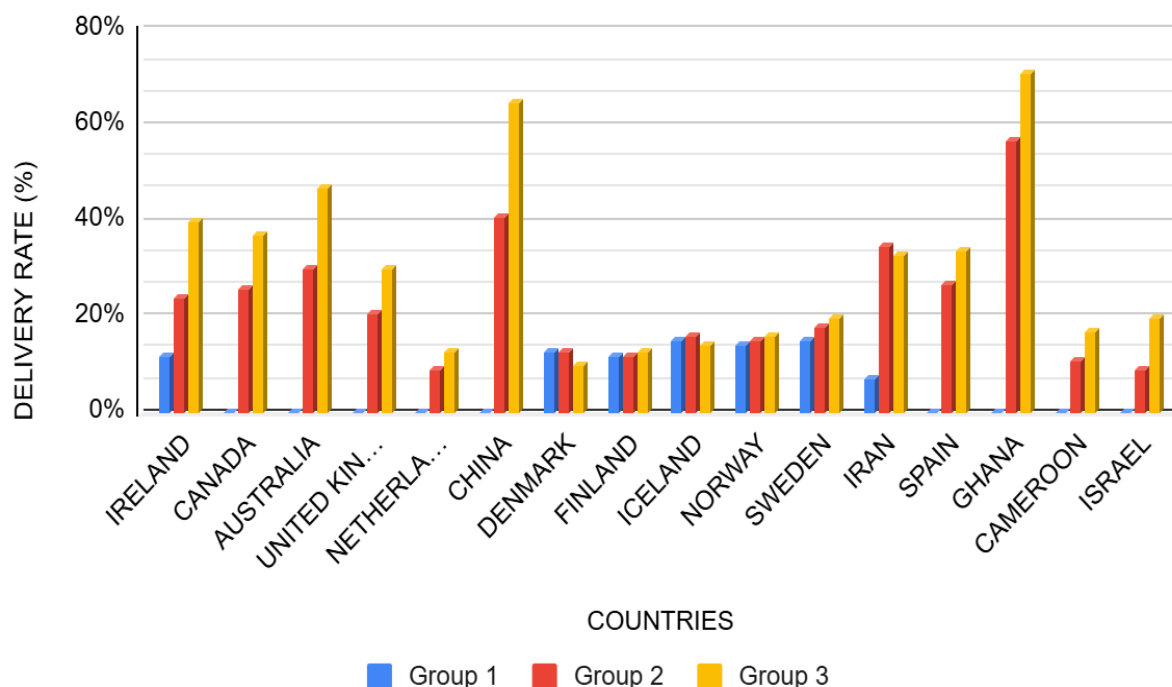
Figure 4: *The charts illustrate a comparative analysis of CS delivery trends across 16 countries.*

An increasing CS rate is observed in most countries from Group 1 to Group 3, which is consistent with the literature that the rate of CS is highest in older women. The CS rate in Group 3 (≥35 years) surpassed 30% in most countries, except in Nordic countries. The highest increase is observed in Ghana (71%) and China (65%) in Group 3. Western nations, such as Ireland, Canada, and Australia, exhibit moderate to high CS rates in Group 3, ranging from approximately 40% to over 50%. Interestingly, Ghana and Cameroon exhibit high CS rates, particularly in Group 3, with rates rising to nearly 70% in Ghana. This may reflect delayed access to care, late presentation with complications, or increasing maternal age due to sociocultural shifts (Boerma et al., 2018).

In contrast, Nordic countries maintained relatively low CS rates across all age groups, generally below 25%.

Conclusion

Maternal age has a substantial and complex impact on the course of pregnancy and childbirth, with significant implications for contemporary obstetric practice. According to this study, the risk of a cesarean section (CS) increases with maternal age. This tendency is similar throughout the majority of the nations evaluated, and it is most noticeable for women over 34 (Group 3). Aging-related physiological realities, such as decreased uterine contractility, increased comorbidity, and higher rates of placental and fetal malpresentation, combine to make vaginal birth less practical and less common in this population. Additionally, older women's increased use of assisted reproductive technologies (ART) increases obstetric risk and frequently calls for surgical delivery (Ayenew, 2021).

This correlation isn't always seen, though. Interestingly, Nordic nations like Sweden, Norway, Finland, Iceland, and Denmark continue to have low CS rates (10–20%) and high vaginal delivery rates (80–90%) for all maternal age groups. A deep-seated preference for natural delivery, non-incentivized reimbursement mechanisms for CS, and excellent midwifery support are just a few examples of the systemic, cultural, and policy-level elements that may be important in influencing the clinical threshold for surgical intervention.

Ultimately, these observations underscore for clinicians the importance of opposing a one-size-fits-all approach and supporting laws that prioritize safety without unnecessarily medicalizing childbirth. The risks and advantages of both cesarean sections and vaginal deliveries could be balanced by enhancing maternal counselling, encouraging VBAC when it is safe, and improving preconception health in older women. Ultimately, obstetric procedures and healthcare systems must adapt to the changing demographics of mothers. Through the utilization of global best practices and their adaptation to local conditions, we can promote safer deliveries, minimize needless interventions, and preserve the independence and well-being of women of all ages. Social norms and economic practices must also be adapted to allow families the opportunity to have children early in life, rather than only when they are both advanced in age (Vladic Stjernholm, 2018).

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