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KAIRE SILDVER

Operative deliveries in Estonia and Finland, 1992–2023

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Faculty of Medicine, Institute of Family Medicine and Public Health, University of Tartu, Estonia.

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Supervisors: Dr Piret Veerus, MD, PhD
Department of Epidemiology and Biostatistics, National Institute for Health Development, Tallinn, Estonia;
West-Tallinn Central Hospital, Women's Clinic, Tallinn, Estonia

Research Professor Mika Gissler, PhD
Department of Data and Analytics, Finnish Institute for Health and Welfare THL, Helsinki, Finland;
Region Stockholm, Academic Primary Health Care Centre, Stockholm, Sweden;
Department of Molecular Medicine and Surgery, Karolinska Institute, Stockholm, Sweden

Associate Professor Katrin Lang, MD, PhD
Faculty of Medicine, Institute of Family Medicine and Public Health, University of Tartu, Tartu, Estonia

Reviewers: Professor Helle Karro, MD, PhD
Department of Obstetrics and Gynecology, Institute of Clinical Medicine University of Tartu, Tartu, Estonia;
Tartu University Hospital Women's Clinic, Tartu, Estonia

Associate Professor Kadri Suija, MD, PhD
Faculty of Medicine, Institute of Family Medicine and Public Health, University of Tartu, Tartu, Estonia

Opponent: Professor Piotr Sieroszewski, MD, PhD
Department of Gynaecology and Obstetrics,
Medical University of Łódź, Łódź, Poland

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TABLE OF CONTENTS

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ABBREVIATIONS

APC	annual percentage change
BMI	body mass index
Cl	confidence interval
CS	Caesarean section
CTG	cardiotocography
EAPM	European Association of Perinatal Medicine
EMA	European Midwives Association
EMBR	Estonian Medical Birth Registry
EU	European Union
GDM	Gestational Diabetes Mellitus
GW	gestational week
PAS	placenta accreta spectrum
R1	Robson Classification group 1
R2	Robson Classification group 2
R5	Robson Classification group 5
OASI	obstetric anal sphincter injuries
OR	Odds ratio
OVD	operative vaginal delivery (vacuum and forceps)
SGA	Small for Gestational Age
STAN	ST analysis of foetal electrocardiogram
TGCS	Robson Ten-Group Classification System
VBAC	vaginal birth after caesarean
VE	vacuum extraction
WHO	World Health Organisation

1. INTRODUCTION

Operative deliveries, including Caesarean sections (CS) and operative vaginal deliveries (OVD), play a crucial role in reducing maternal and perinatal morbidity and mortality when medically indicated. (Betran et al., 2016, 2021) Globally, there has been a rise in CS rates over the past few decades, (Betrán et al., 2016) while OVD has become an important intervention in obstetric care. (Horan & Murphy, 2016) In 2022, approximately 3.88 million children were born in the European Union (EU), and more than 1.10 million (~28%) CS were performed across the EU. (Eurostat, 2024b)

Operative delivery can be generally divided into two categories: abdominal operative delivery performed through Caesarean sections (CS) and operative vaginal delivery (OVD). (Low, 2009) Operative delivery can be associated with significant short and long-term maternal and perinatal complications. (Murphy et al., 2020; Sandall et al., 2018; Visser et al., 2018) Therefore, it is essential to maintain a careful balance between benefit and harm by monitoring operative delivery rates in conjunction with maternal and neonatal outcomes. (Murphy et al., 2020; Nedberg et al., 2021; Robson, 2001b; Ye et al., 2014) The World Health Organisation (WHO) declared that the CS rate should be below 15% of total deliveries in 1985. (World Health Organization., 1985) In 2024, the European Association of Perinatal Medicine (EAPM) and the European Midwives Association (EMA) highlighted the high CS rates as a notable public health concern. It stated that CS rates at a national level should be between 15% and 20%. (Ayres-de-Campos et al., 2024) The WHO recommends using the Robson Ten-Group Classification System (TGCS) as a global standard for consistent evaluation and ongoing improvement of obstetric care. It is a reliable tool for assessing, monitoring, and comparing CS rates across healthcare facilities. (World Health Organization., 2020)

OVD is a crucial intervention in obstetric care (Horan & Murphy, 2016) providing an alternative to CS when appropriate conditions are met.(Arditi et al., 2022) Clinical guidelines should support evidence-based decision-making to ensure that operative interventions in the delivery field are used appropriately and effectively. (National Institute for Health and Care Excellence, 2021, 2023)

Estonia and Finland are neighbouring European countries and among the safest countries in Europe to give birth. (Euro-Peristat 2022) Advances in maternity care in Finland include establishing a prenatal care network in the 1940s and developing a central hospital network during the 1960s and 1970s. (Gissler et al., 2000) Estonia was under Soviet occupation from 1940 to 1991. (Habicht et al., 2018) Estonia's healthcare system was organised and controlled according to Soviet rules. In maternity care, strict regulations emphasised hygiene. (Gissler et al., 2000) The year following independence restoration, in 1992, the CS rate in Estonia was 6.5%, with an OVD rate of 0.6%. (Allvee & Karro, 2014) In Finland, during the same year, the CS rate was at 14.6%, while 5.2% of all births ended in OVD. (Heino & Gissler, 2020) The Nordic countries have a lower proportion of

CS than the rest of Europe. (Pyykönen et al., 2017), but by 2023, the CS rate in Finland had risen to 20.1% and the OVD rate to 10.2%. (Hauhio et al., 2024) In Estonia, by 2023, the CS rate had risen to 21.3% and the OVD rate to 5.7%. (The Estonian National Institute for Health Development, n.d.-a)

This study provides an opportunity to compare all operative birth rates over three decades, from 1992 to 2023, in two countries, Estonia and Finland, that began at different starting points. Over this period, Estonia has evolved from a country with poor perinatal outcomes to one with outstanding results, having had an excellent opportunity to follow Finland's example. Monitoring the proportion of CS and OVD together is essential, and international comparisons help identify best practices that can contribute to improving maternal and perinatal outcomes.

2. REVIEW OF LITERATURE

2.1 Operative delivery

2.1.1 Caesarean section

The most common operative delivery method is abdominal operative delivery via CS. (Low, 2009) CS is a surgical intervention performed to deliver a baby instead of through vaginal birth, serving as a crucial life-saving measure for both the mother and the infant in cases of complications arising during pregnancy or childbirth. (Betrán et al., 2007; Wu et al., 2023) A CS is one of the most common surgical procedures in the world. (Field & Haloob, 2016) With any surgical interventions, there is inevitably an increased risk of maternal and perinatal complications. (Merriam et al., 2017; Visser et al., 2009)

CS has been used since ancient times, but for an extended period, it was performed only when the woman was dead or dying in an attempt to save the foetus. The term was first used in obstetrics in the 17th century. Myths, including the association with Julius Caesar, surround its early history. It was only with the introduction of anaesthesia in the 19th century and surgical advances in the 20th century that the procedure became safer. Krönig's longitudinal incision was replaced by Kerr's transverse incision, and the Pfannenstiel incision improved healing. Medical advances such as blood transfusions, antibiotics, oxytocin, anaesthesia, and better postoperative care made CS safe and secured its role in modern obstetrics. The objectives of CS have shifted from rescuing the foetus to ensuring the safety of both mother and child, while also taking into account the mother's preferences. (Todman, 2007)

There are two types of Caesarean sections: planned and emergency. Planned CS is scheduled during pregnancy, with the date set before the onset of labour. The reasons generally pose a risk to the health or life of the mother or foetus. A planned CS must be carefully considered, and the woman must be provided with evidence-based information about both the reasons for scheduling a CS and the risks and benefits. In most cases, a planned CS results from a combination of factors. The factors affecting the likelihood of a planned CS include Gestational Diabetes Mellitus (GDM), (Ramos et al., 2023) foetal growth problems as measured by being Small for Gestational Age (SGA), (Scholz et al., 2024) breech/abnormal position presentation, multiple pregnancies, placenta praevia, placenta accreta spectrum, and mother-to-child transmission of maternal infections such as HIV, hepatitis B, hepatitis C, and herpes simplex. However, the presence of a single risk factor is often insufficient justification for performing a planned CS. (National Institute for Health and Care Excellence, 2021)

An emergency CS is performed during labour in situations where the health or life of the mother or foetus is at risk. The factors affecting the likelihood of an emergency CS are slow progression in labour, cephalopelvic disproportion during labour, suspected uterine rupture, major placental abruption, cord prolapse, and foetal hypoxia. (National Institute for Health and Care Excellence, 2021)

The WHO guideline explicitly states that CS is a life-saving procedure for both the mother and the baby, but only when there is a valid medical indication. (Betran et al., 2016) Nevertheless, there are countries where the mode of delivery is the woman's choice, such as Romania, where the maternal request is listed as one of the indications in the national clinical guidelines for caesarean delivery. (Radu et al., 2024) From an economic perspective, vaginal delivery without interventions is more cost-effective than caesarean delivery. (Bost et al., 2003; Fobelets et al., 2018)

Factors related to increased risk of Caesarean section

Maternal-related risk factors:

Maternal risk factors can be further divided into three categories: Maternal risk factors, factors related to delivery and pregnancy-related risk factors.

As maternal age (≥30 years) increases, the risk of caesarean delivery also rises. The risk increases for both spontaneous and induced labour in both nulliparous and multiparous women. (Bergholt et al., 2020) Over the years, the average age of women at childbirth in the EU has continued to rise, increasing from 29.0 years in 2001 to 31.1 years in 2022. (Eurostat, 2024a) The most significant change in mothers' age in the EU was observed in Estonia, where the mean age increased by 1 year, from 27.2 years to 28.2 years in 2019. (Eurostat, 2021)

An overweight mother's body mass index BMI (≥ 25) increases the risk of caesarean delivery. (Krogh et al., 2023) Mothers' obesity (BMI >30 kg/m2) during pregnancy increased the risk of CS, macrosomia and postpartum weight retention. Although most European countries do not consistently report obesity rates among their pregnant population, the prevalence of maternal obesity ranges from 7% to 25%. (Devlieger et al., 2016)

Women with chronic diseases (respiratory diseases; diseases of the liver, gallbladder, and pancreas (diabetes); diseases of the musculoskeletal system; diseases of the urinary tract; diseases of the eye or ear) have a higher risk of delivering by CS. (Kersten et al., 2014)

Studies show that pregnancy-related risk factors like placenta previa are a risk factor for primary CS. However, a previous CS increases the risk of placenta previa and placenta accreta spectrum in subsequent pregnancies. The more CSs a woman has had, the higher the risk of placenta previa. (Shaamash et al., 2024) Women with gestational hypertension or preeclampsia during pregnancy have a higher risk of delivering by CS. (Van Der Tuuk et al., 2015)

The decision of vaginal delivery after a previous CS (VBAC) depends on the patient's preferences, the likelihood of a successful vaginal birth after CS, and the assessment of risks and benefits. Among the risk factors for subsequent delivery, the most severe is uterine rupture, which can have fatal consequences for both the mother and the baby. (Deshmukh et al., 2024)

Delivery-related risk factors:
The most common indications for CS during delivery (i.e. for emergency CS) are foetal hypoxia, failure to progress, arrest of cervical dilation, fetopelvic or cephalopelvic disproportion, prolonged active phase, arrest of descent, and foetal malposition. At the same time, it has been found that there are several factors that can contribute to the development of dystocia, such as increased maternal BMI, abnormal weight gain during pregnancy, and certain interventions during labour. (Lowe, 2007)

Foetuses are physiologically adapted to cope with labour. However, there are situations where a foetus is at risk of hypoxic injury. Cardiotocography (CTG) is an excellent tool for detecting this, but it is essential to understand the foetal physiological responses during labour and the various mechanisms of hypoxia to intervene promptly and appropriately. (Richmond et al., 2025) CTG monitoring is used excessively nowadays, which may lead risk to complications. (Aanstad et al., 2024) The correct interpretation of CTG is crucial for diagnosing hypoxia, as the false-positive rate must be considered. Misinterpretation increases the number of unnecessary CS. (Doret et al., 2011)

In addition, the desire for epidural anaesthesia as pain relief is increasing. In a multinational study, 19% to 83% of nulliparous women and 10% to 64% of multiparous women used epidural anaesthesia. (Seijmonsbergen-Schermers et al., 2020) While epidural anaesthesia effectively alleviates pain, it can also lead to side effects, such as prolonging the second stage of labour and significantly elevating the risk of CS and OVD. (Fieni et al., 2022) Epidural anaesthesia increases the risk of caesarean delivery in both nulliparous and multiparous women. (Nguyen et al., 2010)

A risk factor for CS also includes operative vaginal deliveries that carry a higher risk of failure. Several factors are associated with an increased likelihood of failure in OVD, including a maternal BMI greater than 30, an estimated foetal weight over 4000g, and an occipito-posterior foetal position. Additionally, OVD failure rates tend to be higher in mid-cavity deliveries or when one-fifth of the foetal head is palpable per abdomen, indicating more challenging delivery conditions. (Horan & Murphy, 2016)

Foetal-related risk factors:
Occiput posterior and occiput transverse positions are the most common foetal malpositions during labour, and they are associated with an increased risk of dystocia and operative delivery. (Blanc et al., 2021) Due to the higher risk of dystocia in breech presentations, caesarean delivery rates during labour are elevated compared to those for infants in cephalic presentations. (Roman et al., 2008) It is important to consider all factors when deciding on a planned CS because of breech presentations. However, it should also be noted that more than half of attempts at vaginal delivery in breech presentation fail and result in an emergency caesarean. (Peeva et al., 2024) At the same time, breech presentations in planned vaginal delivery at term are associated with a higher risk of neonatal

mortality and morbidity (plexus injuries, birth trauma, neurological morbidity and seizures). (Peeva et al., 2024)

Foetal macrosomia increases the risk of CS starting from a foetal weight of $\geq$ 4000g, and the risk increases with the growth of foetal weight. In the case of a macrosomic foetus, it is possible to plan a CS before the onset of labour. However, during vaginal delivery, there is an increased risk of shoulder dystocia, and the risk of emergency CS is also higher compared to a non-macrosomic foetus. (Beta et al., 2019)

Foetal metabolic acidosis and distress are associated with an increased risk of operative delivery, including CS. Accurate interpretation of cardiotocography (CTG) is crucial for diagnosing these conditions, considering the possibility of false positive results. Studies indicate that incorrect CTG interpretation is the primary cause of foetal metabolic acidosis. Since CTG and ST analysis of foetal electrocardiogram (STAN) interpretation is significantly influenced by human factors, regular training sessions and continuous software updates are essential. (Doret et al., 2011) Situations where a foetus is at risk of hypoxic injury, which increases the risk of a caesarean delivery. Possible causes may include umbilical cord compression and/or uteroplacental insufficiency, meconium-stained liquor. (Richmond et al., 2025)

Caesarean section complications to the mother and infant

CS is a surgical procedure and carries short- and long-term risks to mother and child. (Field & Haloob, 2016) Short-term consequences of CS include an increased risk of prolonged hospital stay, postpartum haemorrhage requiring hysterectomy, thromboembolism, major puerperal infection, wound disruption, haematoma, and cardiac arrest (Sandall et al., 2018), secondary postpartum haemorrhage, sepsis, bladder injury, ureter injury, bowel injury, and postoperative ileus. (Field & Haloob, 2016)

The psychological effects of CS remain underexplored. Women who have had CS have reported lower levels of both short and long-term satisfaction with their birth experience. (Sandall et al., 2018) It has been reported that after an emergency CS, the mother has an increased risk of anhedonia (a mother experiences a loss of pleasure or interest), whereas after a planned CS, the risk of developing an anxiety disorder is higher. (Zanardo et al., 2018)

Recovery after CS is often more prolonged and physically demanding compared to vaginal delivery, which can interfere with the early initiation of breastfeeding and hinder the establishment of strong mother-infant bonding. Research indicates that CS remains a significant barrier to breastfeeding in the first hours after birth, primarily due to delayed skin-to-skin contact and the mother's limited mobility following surgery. (Rowe-Murray & Fisher, 2002) These early disruptions can negatively impact milk production and reduce maternal confidence in breastfeeding. Women who deliver via CS are less likely to breastfeed exclusively and tend to breastfeed for shorter durations overall, highlighting the physiological and psychological challenges associated with post-CS recovery. (Prior et al., 2012)

Long-term consequences of CS include caesarean scar niche, pelvic adhesions, small bowel obstruction, abnormal uterine bleeding, dysmenorrhea, chronic pain, sexual dysfunction, and subfertility. (Sandall et al., 2018)

The placenta accreta spectrum (PAS) is an especially severe condition for which caesarean delivery is recommended. This results in significant blood loss and the need for blood transfusions for the woman. PAS can occur with or without placenta previa. Previous CS increase the risk of PAS and is also a risk factor for other complications, such as intraoperative bleeding, emergency hysterectomy, and urinary tract injuries. (Munoz et al., 2024; Shaamash et al., 2024)

Following a CS, subsequent pregnancies carry heightened risks, particularly for hysterectomy due to abnormal placentation, as well as uterine rupture, stillbirth, and preterm birth. The likelihood of complications such as bleeding, the need for blood transfusion, adhesions, intraoperative surgical injuries, and hysterectomy increases with the number of CSs. (Sandall et al., 2018) It is essential to prevent the first CS. (Gei, 2012)

CS is a short-term risk factor for infants and increases the risk of respiratory problems in newborns, especially when performed electively at 37 weeks of gestation. Compared to spontaneous or induced labour, newborns delivered via CS are more likely to experience breathing difficulties due to factors such as delayed clearance of lung fluid and reduced exposure to maternal hormones that help prepare the lungs for respiration. However, this risk gradually decreases as the pregnancy progresses closer to full term. (Yeganegi et al., 2024)

Some studies have identified a link between CS births and characteristics of metabolic syndrome, such as obesity, high blood pressure, type 1 diabetes, asthma, liver function changes, immune system disorders, neurological and stress-related issues, as well as autoimmune gastrointestinal diseases during childhood. The long-term persistence of these early childhood effects is not as thoroughly studied. (Sandall et al., 2018)

The exchange of microbiota between mother and child plays a critical role in developing the infant's immune system and metabolism. The delivery mode significantly impacts the infant's initial microbial colonisation during birth. Vaginally delivered infants are exposed to their mother's vaginal and intestinal microbiota, which facilitates the establishment of beneficial bacteria in the neonate's gut. In contrast, infants born via CS often have delayed microbial colonisation and reduced diversity, acquiring microbes primarily from the skin and hospital environment. (Milani et al., 2017) The CS delivered babies are more susceptible to allergies, asthma, and dermatitis. Postnatally, breastfeeding plays a crucial role in shaping the infant's gut microbiome. Human breast milk contains a complex community of bacteria, including Bifidobacterium and Lactobacillus species, which are instrumental in establishing a healthy gut microbiota in infants. Additionally, human milk oligosaccharides serve as prebiotics, selectively promoting the growth of beneficial bacteria and enhancing the infant's immune system. Establishing a good microbial environment may help develop the intestinal microbiota of infants and young children. (Yang et al., 2021)

2.1.2 Operative vaginal delivery

Operative vaginal delivery (OVD) can be divided into two: vacuum extraction delivery (VE, also known as ventouse delivery) and forceps delivery. (Low 2009) OVD uses instruments to facilitate the delivery of the foetus through the vagina. OVD is an essential component of primary emergency obstetric care and falls within the responsibilities of skilled birth attendants.

The first time the initial English appearances of the short straight forceps were in an essay in 1733 and in *Cases in Midwifery* in 1734. (Low, 2009) Forceps have been a widespread aid in obstetrics. (Dildy et al., 2016) Moreover, their evolution over four centuries includes pelvic curves, axis traction and rotational forceps. (Baskett, 2019) Vacuum-assisted delivery has developed over 150 years, with the modern era beginning in the 1950s with Tage Malmström's vacuum extractor. Evolution includes metal, soft, and hard plastic vacuum extractor cups. (Baskett, 2019) In recent decades, vacuum extraction has gained prominence over forceps delivery, as it is easier to learn and carries a lower risk of maternal trauma. (Merriam et al., 2017) Obstetric training in forceps delivery is steadily declining, and current practices are insufficient to maintain clinical competence. (Dildy et al., 2016)

OVD may be recommended due to foetal, maternal, or combined factors. The decision should rely on clinical judgment, considering maternal and foetal conditions, the woman's preferences, and the obstetrician's expertise. (Murphy et al., 2020) OVD, as an alternative to CS, can only affect the proportion of CS performed in the second stage of labour since the instruments can only be used for a fully dilated cervix. (Murphy et al., 2020)

Factors related to increased risk of operative vaginal delivery
Maternal-related risk factors:

One of the most common maternal factors driving OVD is slow progress in the second stage of labour, which can be caused by a large foetal weight, foetal malposition, and epidural analgesia. Each of these factors is also an independent risk factor for OVD. (Horan & Murphy, 2016)

Other maternal risk factors for OVD include maternal exhaustion or distress, medical conditions that necessitate avoiding prolonged pushing or Valsalva manoeuvres. These conditions include hypertensive crisis, cardiac disease, cerebral vascular disease (especially uncorrected cerebral vascular malformations). (Horan & Murphy, 2016)

Risk factors for OVD are also maternal age > 35 years and weight gain during pregnancy > 16 kg. (Morken et al., 2013) A woman's high BMI with induction is associated with an increased risk of OVD. (Krogh et al., 2023) A maternal BMI $\geq$ 30 is a risk factor for failed OVD and delivery ending with a CS. (Murphy et al., 2020) The 2024 report from Estonia indicates that the prevalence of overweight among women increases with age. However, in the 16–34 age group, the rates of overweight and obesity have risen significantly compared to 2014. In contrast, among women aged 35–44, the prevalence of excess body weight has decreased since 2014, although it remains higher than in the younger age groups. (The Estonian National Institute for Health Development, 2025)In Estonia, less than half of adult women are of normal weight. 30.7% are overweight (BMI 25.0–29.9), while 27.9% are obese (BMI ≥30). (Reile et al., 2024) There is a growing number of women of reproductive age with a high BMI in all age groups, but the postponement of childbirth results in more parturients with a higher BMI.

Delivery-related risk factors:
Delivery risk factors for OVD include prolonged second-stage labour, with different thresholds for nulliparous and multiparous women. In nulliparous women, a lack of continuing progress for three hours in the active and passive second stage with regional anaesthesia, or two hours without regional anaesthesia, is considered a risk factor. For multiparous women, the threshold is two hours with regional anaesthesia or one hour without it. (Horan & Murphy, 2016)

While epidural anaesthesia effectively alleviates pain, it can lead to a prolongation of the second stage of labour and an increased risk of OVD. (Fieni et al., 2022) Epidural anaesthesia increases the risk of OVD in both nulliparous and multiparous women. (Nguyen et al., 2010)

A key factor is whether an OVD can be successfully completed with the use of an instrument or if a CS becomes necessary. Important factors in the decision and success of OVD include parity, BMI, the type of instrument used, a prolonged second stage of labour, macrosomia, and the experience of the midwife or doctor performing the procedure. Factors such as age, ethnicity, type of anaesthesia, use of oxytocin, or induction of labour have not been shown to impact the success of an OVD. (Elfituri et al., 2020)

Foetal-related risk factors:
Foetal risk factors for OVD include foetal distress, which may be indicated by abnormal findings during labour. This can be signalled by pathological cardiotocography (CTG) patterns, abnormal pH levels or elevated lactate in foetal blood samples, and thick meconium in the amniotic fluid. These indicators suggest potential foetal distress or oxygen deprivation, necessitating close monitoring and possible intervention to ensure maternal and foetal well-being. Additional risk factors include oligohydramnios and placental insufficiency, both of which can be associated with foetal heart rate abnormalities on CTG. (Horan & Murphy, 2016)

The position of the foetal head is also a significant risk factor for OVD. Persistent occiput posterior and occiput transverse positions are among the most common malpositions encountered during labour. These abnormal foetal head positions are strongly associated with a prolonged second stage of labour, increased rates of operative interventions, and a higher risk of requiring instrumental assistance for delivery. Malpositions can increase foetal head deflection and suboptimal engagement with the birth canal, all of which may necessitate the use of forceps or vacuum extraction to facilitate delivery. (Blanc et al., 2021)

Using ultrasound helps diagnose the foetal head position and complements clinical examination and OVD decision-making. (Ramphul, 2019)

A foetus with macrosomia, the risk of OVD starting from a foetal weight of ≥ 4000g, is a risk factor for both OVD and failed OVD, which subsequently results in delivery by CS. Foetal macrosomia is associated with a risk of shoulder dystocia and birth trauma. (Beta et al., 2019) The prevalence of high birth weight (≥ 4000g) is relatively more frequent in Northern European countries, including Estonia and Finland. (Euro-Peristat 2022)

Operative vaginal delivery complications to the mother and infant

In comparison to spontaneous vaginal deliveries, OVD has been associated with short-term and long-term maternal and perinatal complications. (Murphy et al., 2020)

The prevalence of obstetric anal sphincter injuries (OASI) is significantly higher in operative vaginal deliveries compared to spontaneous vaginal births, with rates ranging from 1–4% for vacuum-assisted deliveries and 8–12% for those involving forceps. (Murphy et al., 2020) Comparing forceps and vacuum deliveries, the prevalence of OASI is twice as high in forceps deliveries compared to vacuum deliveries. (Fodstad et al., 2024) OVD can be associated with significant maternal complications like a higher incidence of episiotomy: vacuum, 50–60%; and forceps, more than or equal to 90%. (Murphy et al., 2020) Episiotomy during OVD is associated with a 45% reduction in the incidence of OASI compared to OVD without episiotomy. Notably, the prevalence of OASI has declined in vacuum-assisted births even without episiotomy, whereas no similar reduction has been observed in forceps-assisted deliveries. (Fodstad et al., 2024)

OVD is associated with several maternal complications. Significant vulvovaginal tears occur in approximately 10% of vacuum-assisted deliveries and up to 20% of forceps-assisted deliveries. Postpartum haemorrhage is another notable risk, with an incidence ranging from 10% to 40% for both vacuum and forceps deliveries. Additionally, urinary or bowel incontinence is more frequently reported at six weeks postpartum, although these symptoms generally improve over time with recovery and appropriate pelvic floor support. (Murphy et al., 2020)

OVD can be associated with notable perinatal complications. Cephalhaematoma occurs predominantly with vacuum-assisted deliveries, with an incidence of 1–12%, while facial and scalp lacerations are more common with vacuum and forceps, occurring in up to 10% of cases. Retinal haemorrhage is observed more frequently following vacuum use than forceps, with reported rates ranging from 17% to 38%. The incidence of jaundice or hyperbilirubinaemia is similar between vacuum and forceps deliveries, affecting approximately 5–15% of newborns. Subgaleal haemorrhage is a more serious complication primarily linked to vacuum extraction, with a frequency of 3 to 6 per 1000 births. Intracranial haemorrhage, though rare, can occur with both vacuum and forceps, at rates between 5 and 15 per 10,000 deliveries. Cervical spine injuries are infrequent and are mostly associated with Kielland's rotational forceps. Skull fractures and facial nerve palsy, while uncommon, are more often linked to forceps deliveries. Foetal death associated with OVD is infrequent. (Murphy et al., 2020)

2.1.3 Health care system and perinatal care

Evidence- and rights-based national policies, guidelines, and legislation are essential for advancing sexual, reproductive, maternal, and newborn health. While their existence does not ensure effective implementation, they demonstrate government commitment to improving health outcomes and promoting equity. (World Health Organization, 2024)

Clinical practice guidelines are defined as "*...statements that include recommendations intended to optimise patient care, informed by a systematic review of evidence and an assessment of the benefits and harms of alternative care options*." ('Clinical Practice Guidelines We Can Trust', 2011) These guidelines play a crucial role in shaping practices related to operative deliveries. They guide healthcare professionals in managing childbirth by offering clear recommendations and standards. Specifically, guidelines are designed to influence clinical decision-making regarding interventions such as CS or OVD. They establish criteria for when these procedures are appropriate, promote evidence-based practices, ensure their safe use, and ultimately aim to improve maternal and neonatal outcomes. (Murphy et al., 2020)

The long-standing influence of historical ideas on obstetric practice is evident in Craigin's 1916 statement, "once a caesarean, always a caesarean," which was published during a time when CS was a high-risk operation involving a classical uterine incision. His reasoning contradicts modern medical knowledge, but his viewpoint has influenced obstetric practice for generations. (Todman, 2007) Although outdated by current medical standards, this phrase shaped clinical attitudes toward repeat CS for decades. However, modern research and updated guidelines have increasingly questioned the necessity of routine repeat CS, leading to the promotion of vaginal birth after caesarean (VBAC) as a safe option for many women. (Reif et al., 2016)

Caesarean delivery on maternal request is poorly reported. The results are based on unreliable data, making it difficult to distinguish the actual proportion of CS performed at the mother's request. Bad data quality affects the planning and implementation of effective interventions. Accurate and reliable reporting of such data should be a priority in maternal health policies and practices. (Begum et al., 2021)

Experiences from Nordic countries, such as Norway, highlight how well-implemented policies and professional collaboration can maintain low CS rates. A key factor is the strong role of autonomous midwifery care, working in close cooperation with obstetricians. This collaborative model, supported by national guidelines and policies encouraging VBAC and postpartum counselling after traumatic births, contributes to reduced intervention rates and improved outcomes. (Nedberg et al., 2021)

Financial incentives and healthcare payment systems can also significantly influence CS rates. Studies show that when CS procedures are reimbursed at higher rates or when hospital revenue is tied to procedure volume, there is a tendency for increased use of CS, even without medical necessity. Equalising physician reimbursement for vaginal and caesarean births may help reduce CS rates by removing financial bias from clinical decision-making. (Opiyo et al., 2020) However, this appears to be less of a concern in countries like Estonia and Finland, where the insurance systems do not incentivise unnecessary CS for financial reasons.

Finland's health system is decentralised and funded from multiple sources, with municipalities playing the central role since the 1972 law until the 2023 Health Care Reform. Reforms in the 1980s and 1990s increased municipal autonomy, but the 1990s economic crisis reduced state funding and shifted more financial responsibility to municipalities. In 1992, user fees in primary care were reintroduced, marking partial privatisation. The main actors are municipalities, the private sector, the National Health Insurance, and employers, while the framework is defined by the Primary Health Care Act (1972), Specialised Medical Care Act (1991), and Health Care Act (2010). Long-term and elderly care fall under the Social Welfare Act (1982). (Keskimäki et al., 2019)

Estonia offers a valuable example of how health system reform can improve maternal and newborn care. Prior to being occupied by the Soviet Union in 1940, Estonia was on a comparable level with the Scandinavian countries in terms of both economic development and population health indicators. From 1940 to 1991, Estonia was part of the Soviet Union – a period marked by political and economic stagnation, during which population health declined. After regaining independence in 1991, Estonia implemented extensive reforms in its healthcare and social systems, focusing on modernising medical services and improving accessibility. During the early 1990s, a transitional period, life expectancy was significantly lower than it is today, and the burden of injuries and deaths from external causes was high. With the rise in average life expectancy, cardiovascular diseases and cancers have become the leading causes of death. (Habicht et al., 2018) The introduction of the Health Insurance Act in 1992 and the establishment of the Estonian Health Insurance Fund in 2001, based on the principle of solidarity, laid the foundation for a more equitable and effective healthcare system. (Estonian Health Insurance Fund, n.d.) These changes, combined with increased funding and targeted public health policies, have significantly improved maternity care and reduced perinatal mortality. (Gissler et al., 2000) Today, Estonia is among the safest countries in Europe to give birth. (Euro-Peristat, 2022)

To reduce CS rates, region-specific strategies are needed across Europe. Since the factors influencing CS rates vary by region, it is crucial to understand these factors and address the reduction of CS rates throughout Europe based on region-specific strategies. (El Radaf et al., 2025) Using nationwide registries and quality-of-care indicators, such as the Robson classification system, is essential for improving maternal health outcomes and ensuring appropriate clinical practices across obstetric units. As emphasised in the joint statement by Euro-Peristat and the European Board and College of Obstetrics and Gynaecology, better data collection, standardised outcome monitoring, and consistent application of classification tools are critical for effective surveillance and evaluation of interventions like CS and OVD. Such efforts support evidence-based practice and enable meaningful comparisons across regions and health systems to drive improvements in maternity care. (Velebil et al., 2025)

2.2 Operative delivery time trends

2.2.1 Caesarean section time trends

Worldwide, CS rates have increased in recent decades. Globally, the CS rate increased substantially from 7% in 1990 to 21% in 2021, with projections indicating that it may reach approximately 29% by 2030. (Angolile et al., 2023) In 2024, EAPM and EMA stated that CS rates at a country level should be in the 15–20 % range. (Ayres-de-Campos et al., 2024) CS rates are increasing in all world regions, although at different speeds. The most significant increase in CS over the past three decades has occurred in Eastern Asia, Western Asia, and Northern Africa, while the smallest increase has been in sub-Saharan Africa and North America. (Betran et al., 2021)

There are many in low- and middle-income countries in the world where the rate of CS falls below 10%, resulting in a higher risk of underuse. These are mainly located in Sub-Saharan Africa. (Wu et al., 2023) Chad, Niger, Ethiopia, Madagascar and Cameroon have the lowest CS rates, which are less than 5%. (Betran et al., 2021) The countries with the highest CS rates (more than 50%) worldwide include the Dominican Republic, Brazil, Cyprus, Egypt, and Turkey. (Betran et al., 2021)

CS rates in Europe vary significantly, with national and regional averages differing widely, even among countries with similar populations and income levels. (Velebil et al., 2025) The median rate in 2019 in Europe was 26.0% and ranged from 16.4% in Norway to 53.1% in Cyprus. In 2019, the CS rates experienced the most notable increases in Hungary, Poland, Croatia, Ireland, and Scotland. Cyprus's CS rate decreased from 56.9% in 2015 to 53.1% in 2019, remaining the highest CS rate in the EU. (Euro-Peristat, 2018, 2022) The Nordic countries exhibit a lower CS rate than the rest of Europe. (Euro-Peristat, 2022)

While CS rates are increasing, the reasons behind this rise remain unclear. This trend is likely due to multiple factors. (Boatin et al., 2017) The increase in the CS rate is a complex issue; its causes are not only medical but also influenced by factors such as the health care system, health care professionals, women's preferences, society, trends, fashion, and media influence. (Betran et al., 2016) It is known that CS delivery on maternal request also contributes to the global increase in CS delivery rates. Still, its incidence and contribution to the overall increase are not well known due to varying definitions and insufficient reporting. (Ramasauskaite et al., 2023) Globally, the proportion of caesarean deliveries on maternal request varies by country, ranging from 0.2% to 42% of all caesarean deliveries. (Begum et al., 2021)

Although CS are often essential for safeguarding the health of mothers and babies in specific medical cases, their increasing use as elective procedures calls for scrutiny. Following WHO recommendations and promoting a balanced, evidence-based approach to childbirth can help reduce unnecessary surgeries and improve outcomes for mothers and newborns. (Wladimiroff et al., 2025)

Across Europe, CS rates vary widely, shaped by differences in healthcare systems, policies, and professional practices. In the Nordic countries of Denmark, Finland, Iceland, Norway, and Sweden, strong midwifery-led care models and the restriction of CS to medical indications have helped maintain some of the lowest CS rates in Europe, averaging around 16–17%. (Nedberg et al., 2021; Pyykönen et al., 2017)

In contrast, several Southern and Eastern European countries report significantly higher CS rates. Cyprus has the highest rate in Europe at 53.1%. (Euro-Peristat, 2022) While efforts have been made to reduce this figure, progress is hindered by structural challenges. These include a lack of midwives, due to the absence of accredited university midwifery programs, and legislation that permits CS by maternal request. As a result, the entire maternity care system in Cyprus is managed almost exclusively by obstetricians. (Swift et al., 2023) Italy shows a similar trend, with a CS rate of 33%. (Euro-Peristat, 2022) Its maternity care system is highly medicalised, with midwives playing a limited role. In practice, obstetricians have the most influence over the mode of delivery, often shaping women's decisions in favour of CS. (Torloni et al., 2013) Romania presents a comparable picture, with a CS rate of 52.8%, and CS is the woman's choice. (Radu et al., 2024)

At the same time, there are better examples where countries have taken action to reduce the proportion of CS. With a CS rate around 48%, Greece is actively addressing the issue through targeted interventions. A stepped-wedge randomised trial led by the Hellenic Society of Obstetrics & Gynaecology is currently underway in training hospitals and involves between 5,000 and 10,000 births. This initiative seeks to improve control of CS rates in clinical education settings and could serve as a model for other countries facing similar challenges. (Wladimiroff et al., 2025)

2.2.2 Operative vaginal delivery time trends

The trends in OVD have changed significantly over recent decades, influencing obstetric practices in high-, middle-, and low-income countries. OVD is more common in high-income countries than in low- and middle-income countries. (Bailey et al., 2017)

The use of OVD is decreasing in low- and middle-income countries, while the proportion of CS is increasing. CS is significantly more resource-intensive than OVD. It can result in substantial expenses for women and their families, affecting their ability to purchase food and causing long-term financial debt. (Harrison et al., 2019) In these countries, epidural analgesia, CTG monitoring, and often the necessary equipment and skills for OVD are also limited. (Vannevel et al., 2019) The rate of OVD dropped in low- and middle-income countries from 1.6% to 0.3%, whereas the CS rate rose from 6.4% to 14.4%. (Harrison et al., 2019)

The proportion of OVD births in the USA has declined yearly, reaching 3.2% in 2014 compared to 9.01% in 1990. Forceps remains the rarer method, and since 2005, forceps have been used in less than 1% of births. The use of vacuum extraction has also declined each year. (Hamilton et al., 2015)

The rates of OVD also vary across Europe by country. OVD rates are higher in Central Europe. (Wladimiroff et al., 2025) In 2019, the OVD rate (median rate 6.1%) varied from 1.4% in Croatia to 14.4% in Spain. (Euro-Peristat, 2022) In Spain, the OVD was one of the highest in Europe, following Ireland, Luxembourg and France. (Euro-Peristat, 2022) In Turkey (1.0%) and Poland (1.2%), OVD rates are very low, while CS rates are significantly high—55.1% in Poland and 54.8% in Turkey. In contrast, France has a low CS rate (19.3%) but a higher OVD rate of 11.7%, indicating a more balanced approach to obstetric interventions. (Wladimiroff et al., 2025)

The use of OVD methods, such as vacuum extraction and forceps, varies significantly across countries. In many parts of the world, vacuum-assisted delivery has gradually replaced forceps as the preferred method. (Dildy et al., 2016)In the Nordic countries, the use of forceps is particularly low. For example, in 2020, the forceps delivery rate was just 1.3% in Norway and 0.3% in Iceland, with even lower rates reported in Sweden, Finland, and Denmark. (Heino & Gissler, 2020) By contrast, forceps are more commonly used in Western Europe. In Ireland, the average OVD rate was 17.4%, with 13.0% of births involving vacuum assistance and 4.4% ending in forceps deliveries. (Kane et al., 2024) Similarly, in England, forceps remain in use: in 2021/2022, 3.7% of births involved “other forceps” and 3.3% involved “low forceps” deliveries. (Statista, n.d.)

Differences in OVD rates across countries can significantly impact the quality of specialist training in obstetrics, as limited exposure to OVD procedures may hinder trainees’ ability to develop the necessary skills for performing these deliveries. (Wladimiroff et al., 2025) The training of young obstetricians in forceps use has become increasingly limited, and the current methods are insufficient to ensure clinical competence. As a result, the future of forceps-assisted delivery faces a critical choice: either to phase out its teaching entirely in favour of vacuum extraction or to invest in high-fidelity simulation training that allows practitioners to acquire and maintain the necessary proficiency. (Dildy et al., 2016)

2.3 Robson Ten-Group Classification System (TGCS)

In 2001, Dr Michael Robson proposed using the Robson Ten-Group Classification System (TGCS), which categorises the women giving birth according to perinatal outcomes and events in these groups. The Classification is for all women, not only those whom CS delivers. Robson's system is based on obstetric parameters: parity, previous CS, gestational age, the onset of labour, foetal presentation, and the number of foetuses (Figure 1). (Robson, 2001a)

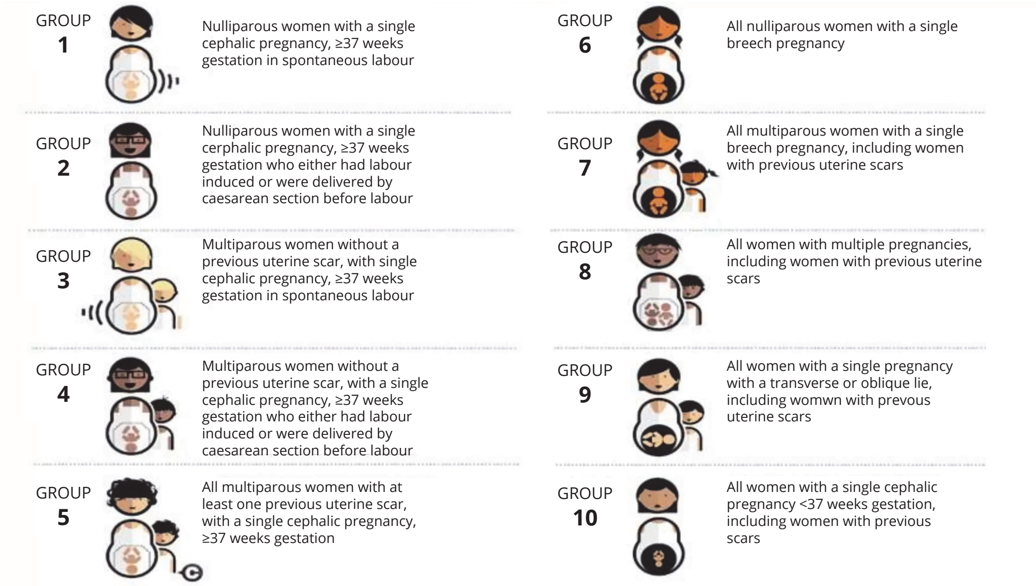


Figure 1. The ten groups of the Robson Classification. (World Health Organization., 2020)

WHO has proposed using TGCS as a global standard for assessing, monitoring and comparing the proportion of CS among different health authorities and countries. (Betran et al., 2016) In 2016, the International Federation of Gynaecology and Obstetrics (FIGO) promoted the standardised gathering of perinatal data by applying the TGCS. (FIGO, 2016) A Euro-Peristat study suggests that each country should undertake an investigation utilising the TGCS to ascertain the CS rate in each country. (Macfarlane et al., 2016)

The TGCS is used for an objective comparison between countries, and monitoring benchmarks within Robson (sub-) groups helps to stabilise overall CS rates. Target values have been established for Robson's sub-groups to evaluate the quality of the country's maternal and perinatal outcomes. However, in some cases, certain groups may need to be further subdivided, while in others, combining groups may provide a more accurate analysis. The rate of R1 (nulliparous, single cephalic, ≥37 weeks, spontaneous labour) can only be meaningfully interpreted when considering the relative size of R1 and R2 (nulliparous, single cephalic, ≥37 weeks, induced or CS before labour). A significant disparity between the sizes of Groups R1 and R2 increases the likelihood that the CS rate in R1 will deviate from the expected target range. The target value for R1 should be under 10%, and for R2, it should be between 20% and 35%. However, by combining Groups R1 and R2, the overall CS rate may align more closely with the recommended benchmark (10–35%), offering a more reliable assessment of obstetric practices. (World Health Organization., 2020)

For group R3 (multiparous, without previous CS, single cephalic, ≥37 weeks, spontaneous labour), the CS rate should not exceed 3.0%. R4 (multiparous, without previous CS, single cephalic, ≥37 weeks, induced or CS before labour) should rarely have a CS rate above 15%. For group R5 (Previous CS, single, cephalic, ≥37 weeks), the target CS rate falls between 50% and 60%. In group R8 (all multiple pregnancies), the expected CS rate is typically around 60%. Group R10 (all single cephalic, <37 weeks) should have a CS rate of approximately 30%. (World Health Organization., 2020)

Groups R1, R2, and R5 significantly affect overall CS rates, collectively accounting for approximately two-thirds of all CS deliveries. Groups 1 and 2 typically represent 35–42% of the total birthing population and account for a significant proportion of births where the initial decision for a CS is made based on clinical assessment. These groups' size and CS rates are closely linked to overall CS practices, making their analysis valuable for identifying the need for interventions and evaluating the effectiveness of clinical management strategies. Group 5 reflects the cumulative impact of CS decisions made in prior years. Past decisions often influence the size of this group in groups 1 and 2, and particularly in facilities where elective repeat CS is preferred over trial of labour. Analysing Group 5 helps assess how well VBAC is supported and reveals the long-term implications of CS trends within the birthing population. This highlights the importance of monitoring and managing these groups to ensure that surgical interventions are medically justified, evaluating CS practices, intervention strategies, and the overall quality of maternity care services. (World Health Organization., 2020)

The Nordic countries (Denmark, Finland, Iceland, Norway, and Sweden) population-based registry study conducted from 2000 to 2011 found that the most significant increase in total CS rates occurred in Groups R1+R2 and R5. (Pyykönen et al., 2017) Data analysis from 28 countries in the Euro-Peristat study reveals that between 2015 and 2019, countries with a CS rate increase of more than 1% primarily saw this rise in Groups R1, R2, R4, and R10. (Amyx et al., 2024)

2.4 Summary of the literature review

Globally, CS rates have been rising steadily over the past few decades. The WHO emphasises that while CS is a life-saving procedure for both mother and baby, it should only be performed when there is a clear medical indication. Unnecessary CS deliveries increase the risk of maternal and neonatal complications and impose significant financial burdens on healthcare systems. At the same time, OVD offers a valuable alternative in specific cases, particularly in the second stage of labour. However, its usage depends on training gaps, resource limitations, and changing obstetric preferences.

It is generally recommended that national CS rates fall within the 15% to 20% range, finding a balance between ensuring access to life-saving interventions and avoiding unnecessary surgical procedures. In Europe, vast regional disparities exist, from medically grounded practices in the Nordic countries to significantly higher rates in Southern and Eastern Europe. However, many countries have exceeded these thresholds, highlighting the need for better clinical oversight.

To support consistent evaluation and ongoing improvement in obstetric care, WHO recommends using the Robson classification system as a global standard for assessing, monitoring, and comparing CS rates across healthcare settings. This system provides valuable insight into the drivers of CS overuse and helps identify opportunities to promote safe, effective vaginal deliveries, including the appropriate use of OVD.

Reducing CS rates in Europe requires region-specific strategies, as the factors influencing these rates vary across countries. To develop practical approaches, it is essential to monitor and evaluate CS and OVD using national registries and quality indicators. Standardised data collection and consistent application of classification systems support evidence-based practices and enable meaningful comparisons between regions, ultimately improving the quality of perinatal care. Safeguarding maternal and neonatal health worldwide requires ensuring that operative deliveries are used judiciously and based on clinical need.

3. AIMS OF THE STUDY

The present study's aim was to analyse the time trends of all operative births in Estonia and Finland from 1992 to 2023.

The specific aims of the study were:

1. To analyse CS time trends in Estonia and Finland.
2. To compare CS time trends using the Robson Ten-Group Classification System between Estonia and Finland.
3. To compare operative vaginal delivery time trends and risk factors between Estonia and Finland.

4. MATERIALS AND METHODS

4.1 Data sources

The Estonian Medical Birth Registry (EMBR) was established in 1991 to collect data on live births and stillbirths, for the organisation of prenatal and postnatal healthcare services, birth statistics, and for epidemiological research on perinatal morbidity and mortality, and the data collection started on January 1, 1992. When creating the EMSR, the Finnish Medical Birth Registry was used as a model. The EMBR collects data for all births in Estonia (birth weight of a child is at least 500g or pregnancy of at least 22 + 0 weeks of gestation, and data on mothers). (Gissler et al., 2000) The source document for collecting the data is the birth card. (Allvee & Karro, 2014) The example of the birth card also came from Finland, which has been slightly modified. The birth card was updated in 1994, 1998 and 2020. (Allvee & Karro, 2014) (The Estonian National Institute for Health Development, n.d.-a) The latest updated birth card in Estonia was implemented on January 1, 2020. (Appendix 1)

The Finnish Medical Birth Registry was established in 1987. The objective is to collect data for developing and organising maternity care, obstetric services, and neonatal care. The revisions to the Registry in 1990, 1996, 2004, and 2017 were geared towards enhancing its reliability. The Finnish Medical Birth Registry collects data for all births in Finland (birth weight of a child is at least 500g or pregnancy of at least 22 + 0 weeks of gestation, and data on mothers). (Finnish Institute for Health and Welfare, n.d.)

The data in the Estonian Medical Birth Registry and the Finnish Medical Birth Registry are obtained from the national birth cards. The content of these two registries is quite similar, which makes international comparisons easy.

4.2 Study sample and variables

4.2.1 Data for years 1992–2016

For papers I and II, anonymised individual birth data were obtained from the Estonian Medical Birth Registry (n = 356 063) and Finnish Medical Birth Registry (n = 1 481 160). All babies born in Estonia and Finland between 1992 and 2016 were included. The following variables were used: mother's age; gestational age; the number of previous births; pregnancy risk factors: earlier Caesarean section; mode of birth: vaginal birth, forceps birth, vacuum extraction, planned CS, other CS; other operations on birth: induction; anaesthesia in the birth: epidural/spinal anaesthesia; the number of foetuses; birthweight; puerperal and postnatal diagnoses: breech presentation, other atypical foetal condition. In the dissertation, figures and tables from Paper I and Paper II using data from the years 1992 to 2016 are the following: Table 4, Table 5, and Figure 9. (Table 1)

4.2.2 Data for years 2017–2023

For paper III, anonymised individual Estonian data from the years 1992–2016, and additionally aggregated data from the Estonian Medical Birth Registry data for the period 2017–2023 were used (In the dissertation, figures/tables from Paper III: Figure 2, Figure 5, Figure 6 and Figure 7). The dissertation uses, in addition, aggregated data from the Estonian Medical Birth Registry and the Finnish Medical Birth Registry, as well as datasets R1, R2, and R5 covering the period 2017–2023. Many figures and tables in the dissertation (Table 2, Figure 3, Figure 4, Figure 8) presented in Papers I and II have been updated with the results from these additional years. In addition, the table previously published in Paper III with Estonian data has been supplemented in the dissertation (Table 3) with an analysis of Finnish data. (Table 1) Updated figures and tables have not been published earlier.

Table 1. Data use in Papers I–III and extended analyses in the Dissertation.

Aim	Paper I, II, III	Dissertation
1. To analyse CS time trends in Estonia and Finland	Paper III: anonymised Estonian data from the years 1992–2016 and aggregated data from the years 2017–2023.	Anonymised Estonian and Finnish data from the years 1992–2016 and aggregated data from the years 2017–2023.
	In the dissertation, figures/tables from Paper III: Figure 2, Figure 5, Figure 6, Figure 7	Additional analysis of Finnish data, Table 3
2. To compare CS time trends using the Robson Ten-Group Classification System between Estonia and Finland.	Paper I: anonymised Estonian and Finnish data from the years 1992–2016.	Anonymised Estonian and Finnish data from the years 1992–2016 and aggregated data from the years 2017–2023.
	In the dissertation, figures/tables from Paper I: Table 4	Updated from the years 2017–2023: Table 2, Figure 3, Figure 4
3. To compare operative vaginal delivery time trends and risk factors between Estonia and Finland.	Paper II: anonymised Estonian and Finnish data from the years 1992–2016.	Anonymised Estonian and Finnish data from the years 1992–2016 and aggregated data from the years 2017–2023.
	In the dissertation, figures/tables from Paper II: Table 5, Figure 9	Updated from the years 2017–2023: Figure 8

4.3 Data definitions

Paper I and II, descriptive characteristics of the study population, and Paper I analysis of the probability of a CS in Estonia compared to Finland were divided into five-year periods: 1992–1996; 1997–2001; 2002–2006; 2007–2011; 2012–2016. In paper III, the descriptive characteristics of the study population and the analysis of the average annual increase of CS were divided into two periods: 1992–2006 and 2007–2023.

The mother's mean age and the baby's birth weight are divided by time periods 1992–1996, 1997–2001, 2002–2006, 2007–2011, 2012–2016, 2017–2023. CS, OVD, all operative births and spinal/epidural anaesthesia are also divided based on the same time periods. (Table 2)

Table 2. Mode of birth, Maternal Age, and Birth Weight in Estonia and Finland, 1992–2023.

	Births, n	Caesarean section, n (%)	Vacuum+ Forceps, n (%)	All operative births, n (%)	Epidural/ Spinal, n (%)	Maternal age mean/ (SD)	Birth weight mean/ (SD)
Estonia							
1992–96	74296	6255 (8.4)	589 (0.8)	6844 (9.2)	374 (0.5)	25.1 (5.5)	3451 (580.5)
1997–01	63076	8925 (14.1)	1505 (2.4)	10430 (16.5)	5118 (8.1)	26.1 (5.6)	3486 (590.4)
2002–06	69525	12578 (18.1)	2477 (3.6)	15055 (21.7)	13207 (19.0)	27.3 (5.7)	3502 (595.0)
2007–11	78778	16693 (21.2)	3548 (4.5)	20241 (25.7)	21146 (26.8)	28.4 (5.7)	3507 (593.8)
2012–16	70388	14351 (20.4)	3275 (4.7)	17626 (25.0)	21189 (30.1)	29.5 (5.5)	3506 (581.2)
2017–23	90473	17848 (19.7)	4782 (5.3)	22630 (25.0)	32730 (36.1)	31.3 (5.5)	3519 (589.3)
Trend p-value	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Finland							
1992–96	320900	50772 (15.8)	16734 (5.2)	67506 (21.0)	64270 (20.0)	28.9 (5.1)	3539 (590.0)
1997–01	286739	47449 (16.5)	16300 (5.7)	63749 (22.2)	91816 (32.0)	29.4 (5.4)	3516 (589.3)
2002–06	286808	48981 (17.1)	20273 (7.1)	69254 (24.2)	124914 (43.6)	29.5 (5.5)	3509 (580.1)
2007–11	301153	50984 (16.9)	25598 (8.5)	76582 (25.4)	163822 (54.4)	29.6 (5.3)	3489 (572.3)
2012–16	285560	47976 (16.8)	25620 (9.0)	73596 (25.8)	168642 (59.1)	30.0 (5.3)	3493 (563.0)
2017–23	325514	59704 (18.4)	31516 (9.7)	91220 (28.1)	220698 (67.8)	31.3 (5.3)	3499 (561.9)
Trend p-value	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001

Statistically significant differences ($p < 0.05$)

The study used the Robson Ten-Group Classification System, which allows for categorising the women giving birth into ten groups and analysing both CS and perinatal outcomes and events in these groups. (Robson, 2001b) Robson classification groups 1, 2, and 5 are the main keys for assessing the quality of obstetric care and analysing CS rates. These groups directly influence the overall CS rate, comprising approximately two-thirds of the total number of CS. (World Health Organization., 2020)

Paper I and Paper III Robson groups are categorised as follows (Figure 2):
R1 Nulliparous, single cephalic, ≥37 weeks, spontaneous labour.
R2 Nulliparous, single cephalic, ≥37 weeks, induced or Caesarean before labour.
R5 Multiparous with previous Caesarean, single cephalic ≥37 weeks. (Robson, 2001b)

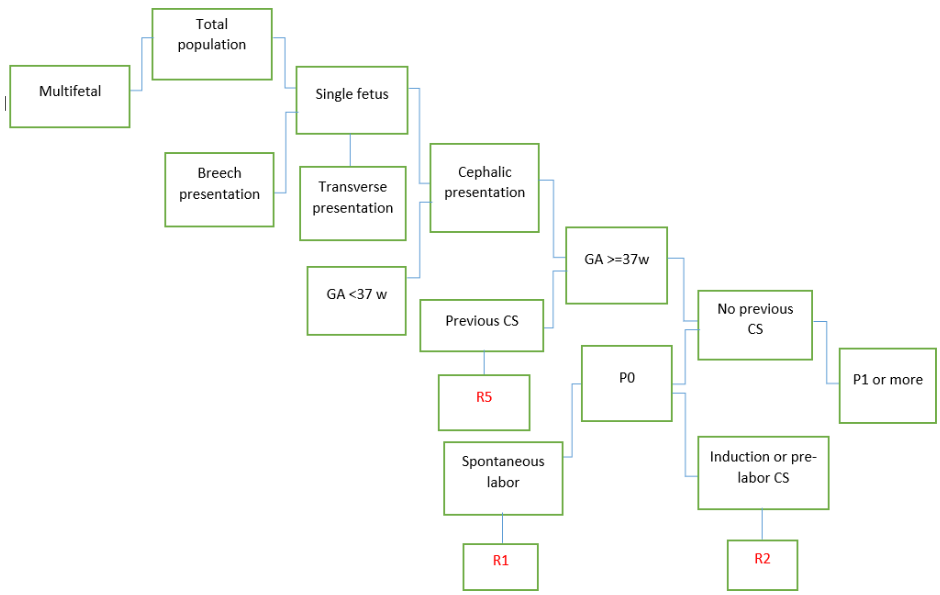


Figure 2. The classification process of women into the Robson groups is R1, R2, and R5. CS, Caesarean section; GA, gestational age; P0, primiparous; P1, multiparous;

4.4 Statistical data analysis

In Paper I, a logistic and linear regression model was used to determine the time trend. The differences between Estonia and Finland for the total CS rate, R1, R2, and R5, were analysed by the adjusted logistic regression model. Total CS rates were adjusted for birthweight, parity, previous CS, gestational age, singleton pregnancy, cephalic position, induction, and mother's age. R1, R2, and R5 rates were adjusted for birthweight and mother's age. Results are presented by odds ratios (OR) and 95% confidence intervals (CI).

In paper II, logistic and linear regression models were used to evaluate longitudinal trends. Joinpoint regression models were used to estimate the change in OVD trends over time, and results are presented in annual percentage change (APC). To identify factors related to OVD, logistic regression models were constructed for Estonia and Finland separately; the models adjusted for year, mother's age (per 10 years' increase), birthweight (per 500g increase), and epidural/spinal anaesthesia use. Logistic regression models were constructed separately for Estonia and Finland to identify CS related factors. Data on epidural/spinal anaesthesia have not been collected in Estonia and Finland using the same standard on CS, and this part has been left out of the model. The model was adjusted for CS, year, mother's age (per 10–year increase), and birthweight (per 500g increase). An interaction term was added to this model to compare Estonia and Finland. Results are presented as odds ratios (OR) with 95% confidence intervals (CI).

In paper III, the R1 and R2 groups are combined (R1+R2). The CS rates were calculated by dividing the number of CS by the total number of births in R1+2 and R5 groups and expressing it as a percentage. Joinpoint regression was used to estimate the change in R1+R2 and R5 groups' CS trends over time, and the results are presented as annual percentage change (APC).

Trends with p-value <0.05 were considered statistically significant. For all papers, the statistical software used was Stata/IC 14 for Windows, and for papers II and III, the Joinpoint Regression Program.

4.5 Ethics statement

The Tallinn Research Ethics Committee of the National Institute for Health Development approved the study (protocol no 2767A on 30.05.2019). The National Institute for Health Development permitted the use of the Estonian anonymised registry data. THL Finnish Institute for Health and Welfare no. THL/712/5.05.00/2018 on 04.10.2018 permitted the use of Finnish anonymised registry data. Finnish Social and Health Data Permit Authority Findata amended the data permit 15.02.2024, no. HL/6086/14.06.00/2023. On 15.02.2024, Findata approved the amendment to the data permit and extended the period of data use. No permission is needed for the use of aggregated data.

5. RESULTS

5.1 Caesarean section trends over time in Estonia and Finland, 1992–2023

As reported in Paper III, between 1992 and 2023, the total number of births in Estonia was 446 536. The proportion of singleton pregnancies decreased from 97.9% to 96.8%. From 1992 to 2006, nearly half (49.3%) of all births were by mothers delivering their first baby. However, by 2007 to 2023, this figure had dropped to 43.6%. The proportion of full-term pregnancies (≥ 37 weeks) remained stable throughout the study period, ranging from 89% to 90%. Over time, both the proportion of induced labours and the number of births following a previous CS increased significantly. A statistical analysis comparing the periods of 1992–2006 and 2007–2023 revealed significant differences in all characteristics, except for cephalic presentation, which showed no change. (Table 3)

In Finland, the total number of births between 1992 and 2023 was 1 798 301. The proportion of singleton pregnancies increased from 96.9% to 98.6%. From 1992 to 2006, 40.6% of all births were first babies, and this proportion slightly increased to 41.8% from 2007 to 2023. The proportion of full-term pregnancies (≥ 37 weeks) remained at around 94% throughout the study period. Additionally, both the proportion of induced labours and the number of births following a previous CS showed significant increases over time. All descriptive characteristics of the study population from 1992 to 2006, compared to those from 2007 to 2023, exhibited statistically significant differences. (Table 3)

Table 3. Numbers of births, descriptive characteristics, 1992–2006 and 2007–2023 in Estonia and Finland.

	ESTONIA			**FINLAND**		
	1992–2006	**2007–2023**	**p–value**	**1992–2006**	**2007–2023**	**p–value**
Births, n	206897	239639		894447	903854	
Parity, Nulliparous, n (%)	101945 (49.3)	104452 (43.6)	< 0.001	363296 (40.6)	378072 (41.8)	< 0.001
Gestational age, ≥ 37w, n (%)	184173 (89.0)	216656 (90.4)	< 0.001	841961 (94.1)	857505 (94.9)	< 0.001
Onset of labour, Induced, n (%)	14536 (7.0)	38630 (16.1)	< 0.001	138836 (15.5)	227501 (26.6)	< 0.001
Multiparous, previous CS, n (%)	7250 (3.5)	24148 (10.1)	< 0.001	90217 (10.1)	99134 (18.9)	< 0.001
Presentation, cephalic, n (%)	198019 (95.7)	229099 (95.6)	0.11	838051 (93.6)	860662 (95.2)	< 0.001
Singleton pregnancy, n (%)	202498 (97.9)	232041 (96.8)	< 0.001	867174 (96.9)	891246 (98.6)	< 0.001

Statistically significant differences ($p < 0.05$)

Papers I and II show that in Estonia, the proportion of CS increased rapidly and exceeded Finland's rate in 2004 and continued to rise until 2007; since then, it has remained relatively stable. In Finland, the proportion of CS was stable during the period 1992–2016. Additional analysis of the years 2017–2023 shows that in Estonia, the proportion of CS remained relatively stable, whereas in Finland, there has been a rapid increase. (Table 2, Figure 3, Figure 8)

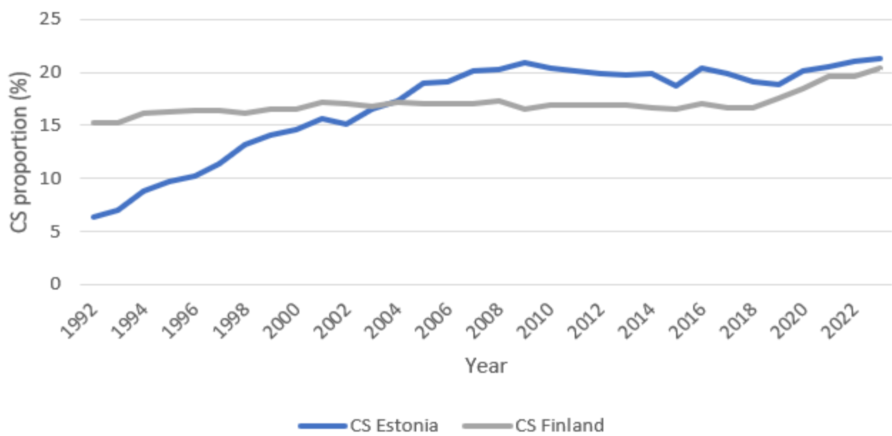


Figure 3. Time trend of CS proportion in Estonia and Finland, 1992–2023.

Papers I and II show that in 1992, the percentage of CS in Estonia (6.5%) and Finland (15.1%) differed considerably. In Estonia, the percentage of CS was increasing, but since 2007, it has remained stable, ranging between 19% and 21%. In Finland, the proportion of CS remained stable for a long time, at around 16%. Additional analysis of the years 2017–2023 shows that by 2023, it had increased to 21.3% in Estonia. In Finland, however, it has risen rapidly since 2019, exceeding 20% (20.1% in 2023). (Figure 3 and Figure 8)

5.2 Caesarean section rates in Estonia and Finland using the Robson Ten-Group Classification System R1, R2 and R5 groups, 1992–2023

In paper I, when the total CS rate in Estonia started to increase in 1992, then the rates for R1 (Nulliparous, single, cephalic, ≥37 weeks, spontaneous labour), R2 (Nulliparous, single, cephalic, ≥37 weeks, induced or CS before labour) and R5 (Previous CS, single, cephalic, ≥37 weeks) also started to increase. After 2007, when the total CS rate stabilised, the rates for R2 and R5 decreased, while that of R1 remained stable until 2016. In Finland, the total CS rate and the rate of R1 remained relatively stable, while rates for R2 and R5 showed a slight downward trend until 2016. (Figure 3, Figure 4)

Additional analysis of the years 2017–2023 shows that when the total CS rate began to rise in Finland, a similar trend was observed in the R1, R2, and R5 groups. In Estonia, during this period, there was a brief decline in the rates of R1, R2, and R5, but it increased again rapidly. (Figure 3, Figure 4)

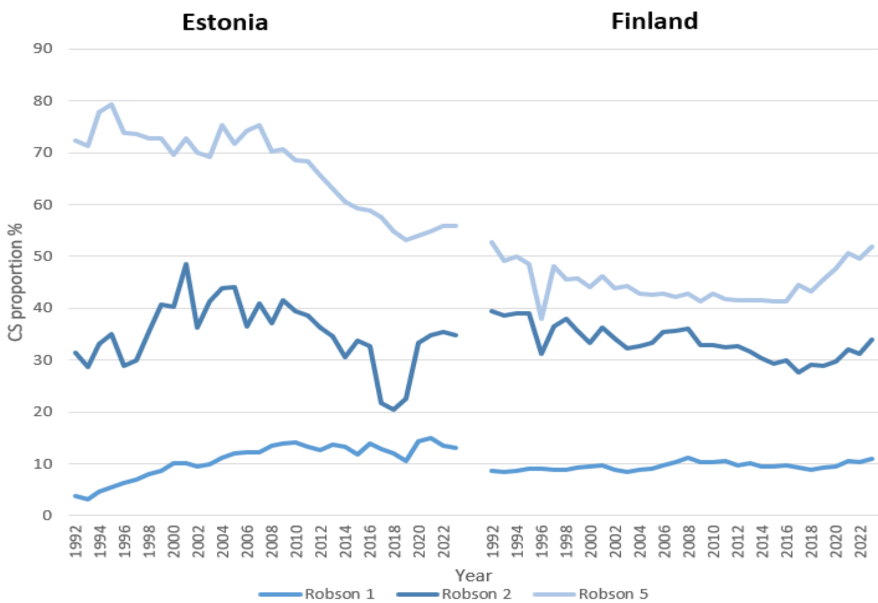


Figure 4. Relative proportion of CS in groups R1, R2 and R5 in Estonia and Finland, 1992–2023.

In Paper I, the starting points for R1 and R2 in 1992 were different in Estonia and Finland. Estonia's initial rates in 1992 (R1: 3.7% and R2: 31.3%) were significantly lower than Finland's (R1: 8.7% and R2: 39.4%). In 2000, Estonia's rate R1 exceeded Finland's R1 rate and continued to increase, remaining consistently higher than the Finnish rate. The R2 rate in Estonia has exhibited considerable volatility over the study period. In contrast, the R2 rate has demonstrated greater stability for Finland over time. The R5 proportions have remained different throughout the study period. In Estonia, R5 fluctuated between 70% and 80% for 18 years, but since 2010, this proportion has decreased sharply. In contrast, the R5 proportion in Finland has generally remained less than 50%. (Figure 4)

Additional analysis as of 2023, Finland's R1 rate stands at 11%, which remains lower than Estonia's corresponding rate of 13%. However, in 2023, the R2 rate in both Estonia and Finland reached the same level of 34%. (Figure 4) When looking at the R1 and R2 rates together, Robson group 1+2 (Nulliparous, single cephalic, ≥37 weeks, spontaneous labour, induced or CS before labour) appears more stable in Estonia. The CS rate increased from 5% to 21% by 2023. (Figure 7) In Estonia, R5 is decreasing to less than 56% by 2023, but in Finland, since 2017, the proportion of R5 has increased to 52% by 2023. (Figure 4)

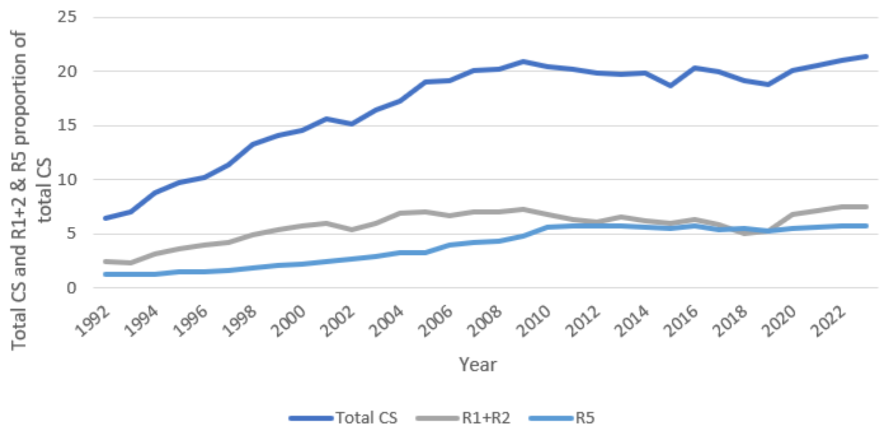


Figure 5. Total CS rate and R1+R2; R5 proportion in Estonia, 1992–2023.

Findings from Paper III indicate that in 2023, CS accounted for 21.3% of all births in Estonia. Since 1992, when the total CS rate began to rise, the proportion of CS in the R1+2 group has also increased. This percentage stabilised from 2004 onwards, at 5–7% of total CS. By 2023, this proportion had reached 7.5%. In the R5 group, the proportion of total CS grew until 2010 and remained within 5% of the total CS rate, reaching 5.7% in 2023. Together, the R1+2 and R5 groups account for over half of all CS. (Figure 5)

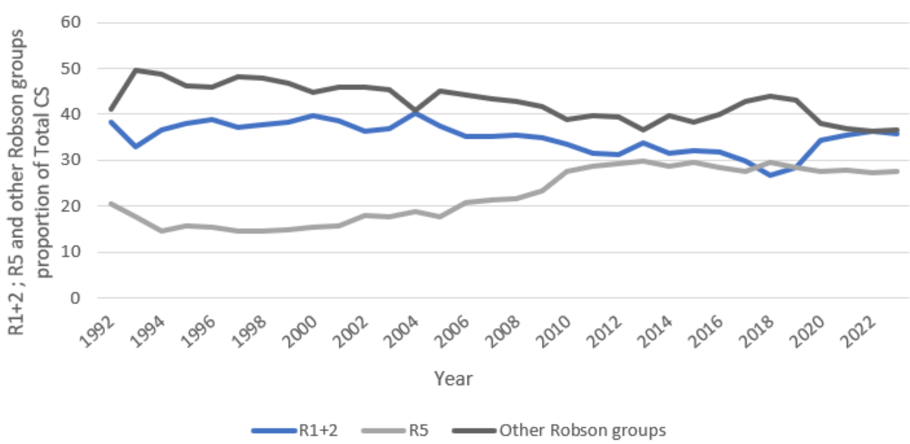
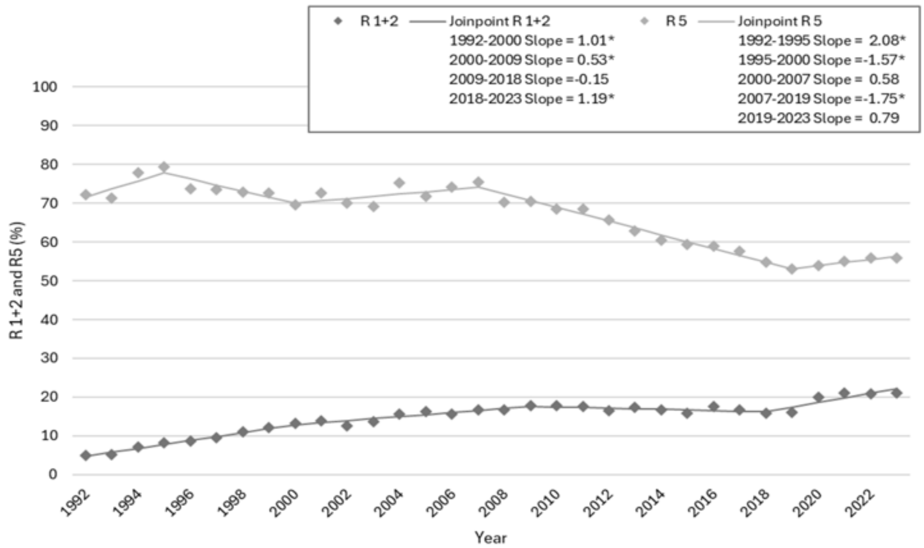


Figure 6. Time trend of R1+R2, R5, and other Robson groups' proportion in Estonia, 1992–2023.

In Estonia (Paper III), CS in all other Robson groups accounted for 40–50% of the total CS rate for a long time, but since 2021, this proportion has fallen below 40%. The proportion of the R1+2 group has been lower than that of other Robson groups throughout the period (except in 2004). However, since 2021, R1+2 has been similar to other Robson groups, accounting for approximately 36%. The R5 group has been on a long-term upward trend of the total CS rate, stabilising at around 27% in recent years. (Figure 6)



* Statistically significant differences ($p < 0.05$)

Figure 7. Time trends of relative proportion of Robson 1+2 and Robson 5 and annual percent change (APC) in Estonia, 1992 to 2023.

In Estonia (Paper III), the percentage of CS birth trends in the Robson groups 1+2 and 5 and the annual percent change (APC) are presented in Figure 7. According to Joinpoint regression, the increase in R1+2 can be divided into four periods. In the first period between 1992 and 2000, the share of R1+2 increased by 1.01% per year. From 2000 to 2009, the increase slowed down in the next period but grew at 0.53% per year. Then, the increase stopped in 2009–2018 and rose again by 1.19% each year until 2023. The changes in the first two time periods and the last period are statistically significant. Changes in R5 can be divided into five periods, and a significant change in the proportion of R5 has occurred in three periods. The share of R5 increased by 2.08% per year in the period 1992–1995, and in the period 1995–2000 decreased by 1.57% per year. After that, the decrease slowed and turned to increase, but from 2007 to 2019, the annual decline remained at 1.75%, and in the last period, it stagnated again. (Figure 7)

Table 4. Probability of a CS in Estonia compared to Finland in 1992–2016 (adjusted by birthweight, parity, previous CS, gestational age, singleton pregnancy, cephalic position, induction, mother's age).

	Finland	**Estonia adjusted OR**				
		1992–1996 95%Cl	**1997–2001 95%Cl**	**2002–2006 95%Cl**	**2007–2011 95%Cl**	**2012–2016 95%Cl**
Total CS [1]	**1 (ref.)**	0.73 (0.71 – 0.76)*	1.35 (1.31 – 1.39)*	1.65 (1.61 – 1.69)*	1.75 (1.71 – 1.79)*	1.52 (1.48 – 1.55)*
R1 [2]	**1 (ref.)**	0.70 (0.65 – 0.74)*	1.27 (1.21 – 1.34)*	1.53 (1.46 – 1.61)*	1.52 (1.46 – 1.59)*	1.52 (1.45 – 1.59)*
R2 [2]	**1 (ref.)**	1.06 (0.97 – 1.16)	1.50 (1.38 – 1.63)*	1.66 (1.54 – 1.79)*	1.49 (1.39 – 1.59)*	1.26 (1.18 – 1.35)*
R5 [2]	**1 (ref.)**	3.04 (2.68 – 3.43)*	3.06 (2.74 – 3.41)*	3.31 (2.78 – 3.16)*	2.97 (2.78 – 3.16)*	2.01 (1.90– 2.13)*

* Statistically significant differences ($p < 0.05$)

[1] Total CS adjusted by birthweight, parity, previous CS, gestational age, singleton pregnancy, cephalic position, induction, and mother's age.

[2] R1;R2;R5 adjusted by birthweight; mother's age.

OR=Odds ratio; R1=Nulliparous, single, cephalic, ≥37 weeks, spontaneous labour; R2=Nulliparous, single cephalic, ≥37 weeks, induced or CS before labour; R5= Multiparous, previous CS, single cephalic, ≥37 weeks;

Findings from Paper I indicate that the total incidence of CS (adjusted by birthweight, parity, previous CS, gestational age, singleton pregnancy, cephalic position, induction, and mother's age) in 1992–1996 for Estonia compared to Finland was OR 0.73 (95% CI 0.71–0.76). After 1996, the odds of CS were higher in Estonia than in Finland, increasing over all five-year periods except in 2012–2016. In the Robson 1 group, the odds of CS (adjusted by birthweight and mother's age) in Estonia in 1992–1996 were 0.70 compared to Finland (95% CI 0.65–0.74). In 1997–2001, the odds of R1 in Estonia surpassed Finland and increased further through the period 2001–2007, then remained relatively constant. In the Robson 2 group, the odds of CS (adjusted by birthweight and mother's age) in Estonia from 1992–1996 were 1.06 (95% CI 0.97–1.16), statistically indistinguishable from Finland. The CS rate increased until 2006, then decreased slightly, yet remained higher than in Finland. In the R5 group (adjusted by birthweight and mother's age), the odds of CS were more than three times higher in Estonia during 1992–2006. After 2007, this disparity narrowed to 2.01 during the period 2012–2016 (95% Cl 1.90–2.13) after adjusting for birthweight and the mother's age. For all periods, the R1 and R5 differences were statistically significant. (Table 4)

5.3 Operative vaginal delivery and risk factors in Estonia and Finland, 1992–2023

Additional analysis shows that operative vaginal delivery (OVD, including both vacuum extractions and forceps) rates in Estonia and Finland increased significantly over time. The total proportion of all operative births increased in Finland and Estonia throughout the entire period and has been approximately 25% of all births in both countries since 2007. However, after 2017, it rose to 28% in Finland. (Table 2)

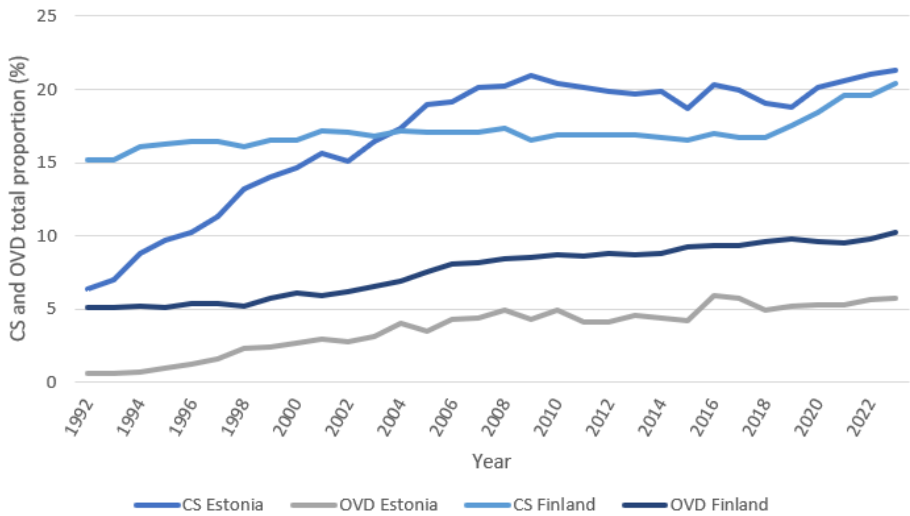


Figure 8. Time trends of total CS and OVD proportion in Estonia and Finland, 1992–2023.

In paper II, in 1992, 0.6% of all births in Estonia and 5,1% of all births in Finland ended with OVD (vacuum or forceps). The total number of CS and OVD in Estonia increased rapidly until 2007. Later, the CS remained stable, and the growth of OVD slowed down. In Finland, the proportion of CS was relatively stable, but OVD increased during the entire period to 2016.

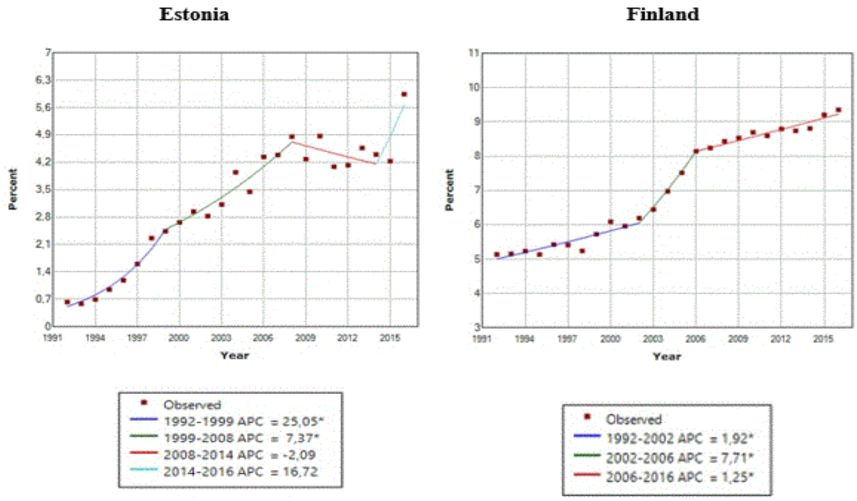
Additional analysis for the years 2017–2023 shows that in Finland, the caesarean section rate began to increase rapidly from 2019, while the rate of operative vaginal delivery rose steadily over the same period, reaching 10.2% of births by 2023. In Estonia, a more modest rise was observed, with OVD reaching 5.7% in 2023 (Figure 8). Forceps deliveries remained marginal throughout, accounting for virtually none of the births in either country, meaning that OVD consisted almost entirely of vacuum-assisted deliveries.

Table 5. OVD and CS risk factors in Estonia and Finland, 1992–2016.

	OVD		CS	
Risk factors	**Estonia aOR (95% CI)**	**Finland aOR (95% CI)**	**Estonia aOR (95% CI)**	**Finland aOR (95% CI)**
Mother's age (per 10 years increase)	0.66 (0.64–0.69)[1]	1.02 (1.01–1.03)[1]	1.53 (1.50–1.56)[2]	1.63 (1.61–1.64)[2]
Birthweight (per 500g increase)	1.11 (1.10–1.13)[1]	1.10 (1.10–1.10)[1]	0.81 (0.80–0.82)[2]	0.77 (0.77–0.78)[2]
Birth year	1.07 (1.07–1.08)[1]	1.03 (1.03–1.03)[1]	1.03 (1.03–1.04)[2]	1.00 (0.99–1.00)[2]
Use of epidural/ spinal anaesthesia	1.32 (1.26–1.38)[1]	3.32 (3.41–3.51)[1]		
Country comparison, adjusted for all variables	0.76 (0.74 –0.78)[3]	1 (ref.)	1.09 (1.07 –1.10)[4]	1 (ref.)

[1] OVD all variables are adjusted for vacuum/forceps and other factors (mother's age (per 10 years increase); birthweight (per 500g increase); use of Epidural/Spinal; Year)
[2] CS all variables are adjusted for Caesarean section and other factors (mother's age (per 10 years increase); birthweight (per 500g increase); Year)
[3] OVD country comparison, adjusted for mother's age (per 10 years increase); birthweight (per 500g increase); use of epidural-spinal; year; vacuum/forceps; country.
[4] CS country comparison, adjusted for mother's age (per 10 years increase); birthweight (per 500g increase); year; Caesarean section; country
aOR – adjusted Odds Ratio

According to Paper II, the mother's age was associated with a decrease in the incidence of OVD in Estonia (aOR 0.66, 95% CI 0.64–0.69). In Finland, however, the incidence of OVD increased with the mother's age. An increase in the baby's birthweight was associated with an increase in the incidence of OVD in Estonia and Finland (in Estonia aOR 1.11, 95% CI 1.10–1.13 and in Finland aOR 1.10, 95% CI 1.10–1.11). The most influential predictor appears to be the use of epidural/spinal anaesthesia as a pain relief method. Epidural/spinal anaesthesia increased the incidence of OVD in Estonia by 32% (aOR 1.32, 95% CI 1.26–1.38) and in Finland more than three times (aOR 3.46, 95% CI 3.41–3.51). A cross-country comparison showed that in Estonia, the incidence of OVD was 24% lower (aOR 0.76, 95% CI 0.74–0.78) than in Finland. (Table 5)



* Statistically significant differences ($p < 0.05$)

Figure 9. Proportion of OVD from all births, OVD from 1992–2016 in Estonia and Finland, Joinpoint regression lines, and annual percent changes (APC).

Findings from Paper II indicate that the increase in OVD in Estonia can be divided into four periods. In the first period between 1992 and 1999, the share of OVD increased by 25.05% per year. In the next period, from 1999–2008, the increase slowed down but continued to grow at 7.37% per year. Then the growth stopped until 2014, and then it turned upward again. The changes in the first two time periods are statistically significant. A significant change in the proportion of OVD has also occurred in Finland over the past 25 years. The share of OVD has increased throughout the period. The changes can be divided into three periods. The share of OVD increased by 1.92% every year from 1992 to 2002. Further, in 2002–2006, the increase was faster, and the share of OVD increased by 7.71% per year. After that, the increase slowed down, and the annual increase remained at 1.25%, but still, for all time periods, the change is statistically significant. (Figure 9)

6. DISCUSSION

This thesis provides a comprehensive overview of the time trends of all operative births (CS and OVD) in Estonia and Finland from 1992 to 2023, using different methodological approaches, including Joinpoint regression and logistic regression models.

The CS rate in Estonia increased rapidly until 2007. Throughout the entire period, there has been an increase in the number of labour inductions, epidural/spinal analgesia, maternal age, birth weight, and previous CS, all of which influence the CS and OVD rate. However, despite these factors, the CS remained stable after 2007. Since 2004, the proportion of CS in Estonia has consistently exceeded the rate in Finland. In Finland, the CS rate remained stable for an extended period, maintaining a level close to 16%. However, beginning in 2019, a notable upward trend emerged. By 2023, the CS rates in Finland and Estonia had become similar, the change in Estonia being from 6.5% in 1992 to 21.3% in 2023, and in Finland from 15.1% to 20.1%.

The CS rates of groups R1, R2, and R5 in Estonia showed an upward trend parallel with an overall increase in CS rates. After the total CS rate stabilised, the rate for the R1 group remained stable, while the rates in groups R2 and R5 began to decline. In contrast, Finland's R1, R2 and R5 rates remained relatively stable until 2019, when they started to rise. A similar trend was observed in the total CS rate in Finland. The number of OVDs has shown an upward trend in both countries. The rate of OVD in Finland has consistently been approximately twice as high as that in Estonia throughout the study period. Over the study period, the overall proportion of operative births increased steadily both in Finland and Estonia.

6.1 Strengths and limitations

This is the most comprehensive study to examine the time trends of operative births in Estonia and Finland, to compare them, and to analyse CS trends based on the TGCS using data from three decades. A strength of the study was the use of data from the Estonian and Finnish Medical Birth Registries spanning over three decades; the data covers all births in both countries. Data is collected using the birth card. In Estonia, data collection using the birth card began on January 1, 1992, following the example of Finland (The Estonian National Institute for Health Development, n.d.-a), which allows direct data comparisons. The birth card was changed in Estonia in 1994, 1998, and 2020, and in Finland in 1990, 1996, 2004, and 2017. However, these changes did not influence the composition of the data analysed in this thesis. The Estonian Medical Birth Registry and Finnish Medical Birth Registry data quality have been researched several times. In Estonia, registry data were reabstracted on a large scale and compared with birth records, and it was found that the data were mostly of high quality. (Karro et al., 2008) The Finnish Institute for Health and Welfare regularly evaluates the quality of the Medical Birth Registry data, particularly perinatal statistics. According to their assessment, the overall data quality of the registry was very good. (Gissler & Haukka, 2004; The Finnish Institute for Health and Welfare (THL), 2025)

The limitation of this study is that it was not possible to control for various other factors that affect the proportion of CS and OVD births, such as maternal characteristics, including BMI. (Bjorklund et al., 2022; Horan & Murphy, 2016) and mother's chronic diseases.(Kersten et al., 2014) Additionally, studies have shown that the use of epidural anaesthesia (Fieni et al., 2022; Horan & Murphy, 2016) and CTG significantly impacts the number of OVD and CS. (Doret et al., 2011)However, this study did not examine their relationship and interaction with other factors contributing to CS and OVD.

One of the limitations of this study is that it focuses only on Robson groups 1, 2, and 5. Although these groups significantly impact the overall number of CS births, analysing all ten groups and subgroups can provide a complete overview of CS rates. This study did not analyse R2 subgroups separately, and although the rate of induced labour has increased.

The challenge of comparing registry data across different countries is that not all data can be directly compared. For instance, the data collection methods for epidural and spinal anaesthesia differ between Estonia and Finland, making it impossible to analyse epidural anaesthesia separately (Table 5). Individual-level data were sourced from Medical Birth Registries covering the period from 1992 to 2016. Due to changes in the conditions for obtaining and merging additional data, some results are only available until 2016. However, it was possible to add aggregated data from both Medical Birth Registries, allowing several tables and figures to be updated for the period from 2017 to 2023. Additionally, studies on the quality of registry data are pretty outdated and should be conducted more frequently.

6.2 Caesarean section rates and trends

Delivery rates have significantly declined over the decades, and by 2050, over 75% of countries will have fertility rates too low to sustain their populations, rising to 97% by 2100. (GBD 2021 Fertility and Forecasting Collaborators, 2024) The total fertility rate has decreased in Europe; the same is true in Estonia and Finland. In the last few years, both Estonia and Finland have had a record-low birth rate in their history. (Eurostat, 2023)

Global CS rates have risen from 7% in 1990 to 21% today, with projections reaching 29% by 2030 amid both overuse and unmet needs. (Angolile et al., 2023) The Nordic countries are good examples of their CS rates compared to other EU countries. (El Radaf et al., 2025) In Estonia, the reasons for the quick rise of the total CS rate at the beginning of the period may have occurred for historical reasons; the Republic of Estonia was occupied by Russia and a part of the Soviet Union from World War II until 1991. Soviet laws and regulations strictly controlled maternity care. Indications for CS were strongly regulated. Since Estonia regained its independence in 1991, the Estonian healthcare system has constantly changed, and technical equipment and medical education have improved. (Gissler et al., 2000) Changes have been achieved in Estonia in the last 30 years, and the perinatal care indicators are excellent. In Estonia, the perinatal mortality rate was 3.4/1000 in 2023. (The Estonian National Institute for Health Development, n.d.-b) The rapid development in maternity care has been supported by the following public health policy reforms in 1991–1994, establishing a solidarity-based Health Insurance Fund. (Estonian Health Insurance Fund, n.d.)

In Estonia and Finland, a CS is performed mainly for medical reasons, and VBAC is strongly encouraged. The target value for R1 (Nulliparous, single, cephalic, ≥37 weeks, spontaneous labour) should be under 10%.(World Health Organization., 2020) The Estonian R1 rate has been above the target value since 2004, ranging between 11% and 15%. The R1 rate for Finland has remained close to 10% throughout the study period. The CS rates in the Nordic countries are the lowest in Europe. (El Radaf et al., 2025) In Sweden, the CS proportion of Group R1 was 7.3%. (Savchenko et al., 2022) The CS proportion in Norway was 7.7%. (Laine et al., 2023)

The target value for R2 (Nulliparous, single, cephalic, ≥37 weeks, induced or CS before labour) should be between 20% and 35%. (World Health Organization., 2020) R2 rate is affected by the number of planned CS and inductions. According to Euro-Peristat 2019 data, the lowest planned CS rates in Europe were in Estonia (6.2%) and Finland (7.2%). (Euro-Peristat, 2022) If we look at these data over time, the proportion of induced births has increased significantly in Finland and Estonia (Table 3). Finland has a well-functioning maternity care system that enables early identification and management of high-risk pregnancies. The increase in the number of labour inductions can be partly explained by changes in the profile of pregnant women–they are more often obese, older, and more frequently diagnosed with GDM. At the same time, labour induction has been associated with a lower risk of emergency CS, indicating the high quality of maternity care and the competence of healthcare professionals. (Kruit et al., 2022) The average age of mothers in Estonia and Finland has increased throughout the entire period and has exceeded 30 years. Estonia has exceeded the target values for the R2 group at times, but since 2013, it has remained below 35%. Finland's R2 rate has mostly been below 35%. The CS proportion in Group R2 in Sweden was 32.3% (Savchenko et al. 2022), and in Norway, it decreased to 26.6% in 2018. (Laine et al., 2023) When combining R1 + R2 (Nulliparous, single cephalic, ≥37 weeks, spontaneous labour, induced or CS before labour), the result may still be within the target value range of 10% to 35%. (World Health Organization., 2020) In Estonia and Finland, R1+R2 has remained within the target values throughout the entire period. Robson groups R1+R2 make up the most significant proportion of births, usually representing 35–42% of the women's population giving birth in most hospitals. (World Health Organization., 2020) Nordic studies have suggested that a decreased CS rate in the R1 and R2 groups leads to a lower total CS rate. (Pyykönen et al., 2017)

The target value of R5 (Previous CS, single, cephalic, ≥37 weeks) should be 50% to 60%. (World Health Organization., 2020) The proportion of multiparous women with a previous CS has significantly increased in Finland and Estonia (Table 3). In Finland, the R5 group has been stable and remained below 45% for a long time, but it has been increasing since 2019 and has exceeded 50% since 2021. In Estonia, the share of CS in the R5 group has been out of the target value, but since 2007, the share of CS has been steadily declining, reaching 55.8% by 2023. This may be because, in the 20th century, it was expected that if a woman had given birth to one child in CS, the following births would also be in CS. (Reif et al., 2016) However, in the new century, the need for a CS began to be increasingly questioned birth after CS has been compiled, which allows vaginal delivery even after an earlier CS. (Reif et al., 2016) The CS proportion in Group R5 in Sweden was 52.8% (Savchenko et al., 2022) and in Norway, 47.2%. (Laine et al., 2023) However, there are many European countries where the CS rate in the R5 group is higher than the target value, such as Slovenia, Germany, Malta, and Belgium, and it exceeds 80% in Latvia, Italy, and Cyprus. (Zeitlin et al., 2021)

Robson Ten-Group Classification System is critical because it provides a standardised, objective, and comparable method for analysing CS rates across different hospitals, countries, and time periods. (Betran et al., 2016) A systematic review and meta-analysis have found that fewer European countries have nationally based surveys for TGCS, and more countries have hospital-based, short-term, and old surveys. Studies from Central and Southern European countries do not reflect nationwide results. (El Radaf et al., 2025) In contrast, Northern Europe is a perfect example with its country-specific studies, and countries like Denmark and Norway routinely collect and calculate statistics based on the TGCS. (Norwegian Institute of Public Health, n.d.; The Danish Health Data Authority, n.d.) The Council of European Board and College of Obstetrics and Gynaecology, along with the Euro-Peristat research group, propose implementing the TGCS and creating a list of data items and making it available nationally and internationally to enable comprehensive monitoring and evaluation of CS practices. (Velebil et al., 2025) In Estonia and Finland, TGCS statistics are not routinely collected and calculated.

Comparable health data are essential for analysing CS rates and understanding the reasons for their variability. A review of European international databases, such as Eurostat, OECD, and WHO, contained minimal data to understand the reasons behind operative births. At the same time, many European countries collect extensive data in their national health information systems, which can be used to investigate variations in CS rates, including information on the timing and indications for the procedure, as well as population and healthcare system characteristics that influence the risk of CS. (Velebil et al., 2025)

Maintaining population-based medical registries is very important because they provide invaluable data in healthcare and research, which helps develop healthcare policies, improve services, and give an overview of the spread of health issues at the national level. These data also offer unique opportunities for healthcare research. (Smith Jervelund & De Montgomery, 2020) Treatment Quality Indicators are essential because they provide hospitals with valuable self-analysis, comparison, and development information. Indicators also highlight systemic shortcomings, such as continuity of care and collaboration. However, they should not be used to make definitive judgments about hospital performance. (Kree, 2017) In Estonia in 2013, an advisory council focused on Treatment Quality Indicators was established in collaboration with the Estonian Health Insurance Fund and the University of Tartu. The council aimed to develop a systematic approach for selecting indicators that accurately reflect the quality of medical treatment. As a result, five key indicators for obstetric care were identified in Estonia, including CS rates in the R1+2 and R5 Robson groups. These indicators are essential for monitoring obstetric care quality and allocating healthcare resources effectively. (Kree, 2017)

International comparisons highlight the need for comparable health indicators to better understand and address the causes of variability. (Velebil et al., 2025)

The CS rate is often used as an indicator for monitoring the quality of maternity care, but it has several limitations. The OECD Health Care Quality Framework and the Nordic perinatal health report highlight that there is no internationally recognised standard for all countries to achieve the optimal CS rate. Additionally, it is difficult to collect reliable data on the medical indications for CS, which complicates meaningful comparisons between countries and healthcare institutions. Therefore, it is recommended that the CS rate be interpreted alongside other quality and safety indicators to gain a more comprehensive understanding of the performance and evidence-based nature of maternity care systems. (Gissler et al., 2015; OECD, 2023)

6.3 Operative vaginal delivery rates and trends

Operative deliveries (OVD and CS) in the second stage of labour are challenging, and decision-making is complex. (Ramphul, 2019) The OVD rate mainly consists of vacuum extractions in Estonia and Finland. In Estonia, only one forceps birth occurred in 2023. Estonia and Finland are moving towards countries where forceps births are rare, and the number of doctors qualified to perform the procedure is decreasing. While vacuum extraction is generally simpler and associated with fewer maternal risks, forceps may be preferable in selected circumstances, including occipito-posterior foetal position, preterm birth, and failed vacuum attempts. (Verma et al., 2021) Other authors have also highlighted this issue in OVD, expressing concern about whether vacuum extraction will be the only option in the future or whether doctors must develop their forceps delivery skills using simulators. (Dildy et al., 2016) The obstetrics societies and universities of Estonia and Finland will also need to decide in the future whether to teach the method of forceps deliveries to doctors as a historical legacy or as a practical delivery method. They must also consider whether and how to provide practical experience.

Operative vaginal delivery is widely used in Ireland and the UK. (Ramphul, 2019) An increase in the proportion of forceps deliveries has been noted in Ireland. This differs significantly from international trends. It may be related to the trend in Irish hospitals to provide training in forceps deliveries for trainees. (Kane et al., 2024) In Ireland, the OVD rate is 17.4%, with 4.4% being forceps deliveries and 13.0% vacuum extractions. (Kane et al., 2024) According to the Euro-Peristat 2019 study, Spain has the highest rate of OVD at 14.4%, and the lowest is in Croatia at 1.4%, Lithuania and Hungary at 1.6%. The European median rate is 6.1%. (Euro-Peristat, 2022) In both Estonia and Finland, the number of OVDs has increased over time. The rate of OVD differs in 2023 between Estonia and Finland, with 5.7% in Estonia and 10.2% in Finland.

In Estonia, the CS rate has remained stable over the past 16 years, while the rate of OVD has shown a mostly upward trend. In Finland, the CS rate remained stable until 2019, after which it began to rise. Meanwhile, the OVD rate in Finland has consistently increased throughout the entire period. This indicates that OVD and CS rates are not directly correlated. Regarding total operative births (CS + OVD), Finland's rate has been higher than Estonia's. As the rates of CS and OVD may vary individually across countries, the overall rate of operative deliveries has to be analysed in addition to CS rates.

OVD rates vary significantly across European countries, and there is no balance between CS and OVD rates. In Poland, with a very high CS rate (55.1%), the OVD rate is only 1.2%. Central European countries such as France, Belgium, Germany and Switzerland have achieved a better balance. (Wladimiroff et al., 2025) Maternity hospitals need to find a balance between operative and vaginal deliveries, including both CS and OVD. Clinical guidelines play a critical role in influencing the use of operative deliveries. They provide healthcare professionals with recommendations and standards for the management of childbirth. Guidelines are intended to inform clinical decision-making and practices related to interventions. They contribute to the appropriate and safe application of such interventions, promote evidence-based practices, and support improvements in maternal and neonatal outcomes. (Murphy et al., 2020) In Estonia, comprehensive national guidelines are available for key aspects of childbirth care, including labour induction, epidural analgesia for pain management, and monitoring normal labour. Finland has fewer detailed national guidelines specifically addressing intrapartum care. (Estonian Gynaecologists Society, n.d.; *Suositukset (Finland Maternity Care Guidelines)*, n.d.)

Hospitals must also consider cost-effectiveness. (Bost et al., 2003) Global inequities in the performance of CS and the associated costs have increased since 2008, leading to a disproportionate allocation of resources. (Wu et al., 2023) Compared to planned CS, vaginal birth after CS is cost-effective, resulting in a cost reduction and gains in higher quality-adjusted life years (QALY) in Belgium, Germany, Ireland, and Italy. (Fobelets et al., 2018) When comparing OVD to CS across two subsequent pregnancies, OVD proved more cost-effective, resulting in higher QALYs and lower costs. Managing a stalled second stage of birth with

OVD leads to fewer CS and improved maternal and neonatal outcomes. (Gallagher et al., 2018)

It is important to note that the rise in CS rates affects doctors' skills and competencies in performing OVD; the fewer such procedures are performed, the less confident specialists become. Since the rate is only 1–2% per year in many European countries, it is crucial to offer training opportunities actively. (Velebil et al., 2025) Although the OVD rate in Estonia and Finland is higher than in many other European countries, training remains essential. To ensure well-rounded obstetric training, greater emphasis should be placed on postgraduate education in vaginal and operative deliveries for junior doctors. Simulation training is essential for developing skills like vacuum and forceps-assisted births and managing rare obstetric emergencies. While simulations help build competence and identify learning gaps, hands-on experience with real patients remains crucial. The rise in CS highlights the need for balanced training in both surgical and non-surgical techniques. Updating curricula may be necessary to maintain comprehensive obstetric care standards. (Wladimiroff et al., 2025) It is essential to maintain and develop the skills required to perform OVD, as there are situations in obstetric care where the benefits of OVD outweigh the risks. Organising simulation training and developing communication skills in the context of OVD is essential to improve maternal and neonatal outcomes. (Euro-Peristat, 2022; Ramphul, 2019) The European Board and College of Obstetrics and Gynaecology and the Project for Achieving Consensus in Training initiative introduced a pan-European training curriculum outlining standardised training outcomes for maternal and newborn care across Europe. Adopting these standards aims to improve clinical quality and reduce unnecessary CS. (Wladimiroff et al., 2025)

7. CONCLUSIONS

This dissertation provides a comprehensive analysis of operative births (CS and OVD) trends in Estonia and Finland, using various methodological approaches and covering the period from 1992 to 2023, during which significant changes occurred. The results showed that the proportion of CS and OVD has increased in Estonia and Finland.

1. The CS rates have increased in both countries over the past 30 years. The CS rate in Estonia was 6.5% in 1992 and rose steadily until 2007, remaining stable over the past 16 years. In Finland, the CS rate has been stable at around 16%, though it has shown an upward trend since 2019. The CS rate in Estonia has been higher than that of Finland since 2004. As of 2023, the CS rates in Estonia and Finland are similar to the global CS rate of 21%, although Finland still has a slightly lower rate than Estonia. However, the CS rate is significantly higher in many other European countries.
2. The CS rates of groups R1, R2, and R5 in Estonia showed an upward trend parallel to the overall increase in CS rates. After the overall CS rate stabilised in Estonia after 2007, the R1 group remained stable, while the rates in groups R2 and R5 began to decline. In contrast, Finland's R1, R2, and R5 remained relatively stable until 2019, after which they increased. A similar trend was observed in the total CS rate in Finland. Estonia and Finland's R1+R2 and R5 results remained the WHO target values in 2023. The study results show that Estonia is similar to the Nordic countries in terms of the TGCS, such as Finland.
3. The rate of OVD (vacuum and forceps) births has shown an upward trend over time. In Estonia, the rate of OVDs rose rapidly until 2007; later, the growth slowed and reached 5.7%. In Finland, the increase continued steadily throughout the study period, reaching 10.2%. Finland's OVD rate has consistently been about twice higher than in Estonia. By the end of the study period, the proportion of all operative births accounted for about a quarter of all births in both countries. Vacuum extraction has become the only method of OVD in both countries, and the same trend has been observed in many European countries. Several risk factors: maternal age, birthweight, and use of epidural/spinal anaesthesia, were significantly associated with OVD and CS, which is also confirmed by other studies.

8. IMPLICATIONS FOR FUTURE RESEARCH AND HEALTH POLICY

8.1 Implications for future research

Conducting cross-country comparative analyses is essential. However, personalised data analysis has become difficult, as obtaining permission is highly complicated, and accessing the data comes with high costs. This negatively impacts the development of healthcare and hinders comparisons between countries and index analyses of healthcare quality. Although often overlooked due to cost and complexity, high-quality health information systems are essential for improving clinical practices and perinatal health. This study focused only on analysing R1, R2, and R5 groups; in the future, it is crucial to study all 10 groups, and not only from the perspective of CS but also from the perspective of OVD, which would allow comparisons of operative deliveries across different countries. In addition, it is important to study the association between OVD and perinatal outcomes. Further research, especially using qualitative methods, is warranted to analyse trends in operative deliveries and the factors (clinical guidelines, the impact of funding, and others) influencing them more granularly. Attention should also be given to women who have given birth operatively. Their quality of life and changes in it after a CS or OVD require further research.

8.2 Implications for health policy

The number of births is sharply declining across Europe, including Estonia and Finland. From the national policy point of view, it is essential to increase the birth rate, which makes it especially important in the future to consider the choice of delivery method and avoid unnecessary CS. A country needs to have a well-functioning Medical Birth Registry with high-quality data. Good-quality registry data is necessary for evidence-based health policy decisions. The TGCS should be implemented nationally in each hospital. All operative deliveries, including CS and OVD, should be regularly analysed using the TGCS. Regional health policy interventions could help address disparities between hospitals and regions, supporting more efficient and safer perinatal care. Feedback should be provided to each hospital, and a comparison with other hospitals should also be created so that each hospital can see which Robson groups need more attention. Data should be collected not only at the national level but also requires resources to be compiled at the international level, using harmonised indicators that enable comparative analysis. When updating or making new national and hospital-level obstetric care guidelines, factors affecting operative deliveries, recommendations based on WHO target values to the TGCS, and national Medical Birth Registry statistical findings will be essential. Health policy decisions, guidelines, registry data collection, and analysis of trends in operative deliveries among different countries improve maternal and neonatal outcomes.

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10. SUMMARY IN ESTONIAN

Operatiivsed sünnitused Eestis ja Soomes 1992–2023

Sissejuhatus

Euroopa Liidus (EL) sündis 2022. aastal ligikaudu 3,88 miljonit last ning EL-i liikmesriikides tehti rohkem kui 1,10 miljonit (~28%) keisrilõiget. Operatiivsed sünnitused saab jaotada kaheks: abdominaalne operatiivne sünnitus ehk keisrilõige ning operatiivne vaginaalne sünnitus ehk vaakum- ja tangisünnitus. Maailmas on keisrilõigete osakaal viimastel aastakümnetel pidevalt tõusnud. WHO rõhutab, et keisrilõige on elupäästev operatsioon emale ja lapsele vaid juhul, kui selleks on selge meditsiiniline näidustus. Mittevajalikud keisrilõiked suurendavad ema- ja vastsündinu võimalike tüsistuste riski ning toovad kaasa märkimisväärsed kulud tervishoiusüsteemile. Samas pakub operatiivne vaginaalne sünnitus teatud juhtudel ohutuma alternatiivi just sünnituse teises faasis.

Riiklik keisrilõigete osakaal soovitatakse hoida vahemikus 15–20%, tagamaks tasakaalu vaginaalsete sünnituste ja elupäästvate sekkumiste vahel. Euroopas esineb keisrilõike osakaaludes piirkondlikke erinevusi, Põhjamaade osakaal viitab meditsiiniliselt põhjendatud lähenemisele, Lõuna- ja Ida-Euroopas on aga osakaalud oluliselt kõrgemad. Paljud Euroopa riigid on ületanud soovituslike piirmäärasid, mis annab alust arvata, et on olemas vajadus tõhusama kliinilise järelevalve järele. Operatiivne vaginaalne sünnitus on meetodina kasutusel enam kõrge sissetulekuga riikides kui madala ja keskmise sissetulekuga riikides. Osakaalud Euroopas erinevad samuti, kõrgemad on need Kesk-Euroopas. Keisrilõigete ja operatiivsete vaginaalsete sünnituste osakaalude vahel puudub tasakaal.

WHO soovitab sünnitusabi järjepidevaks hindamiseks ja arendamiseks ülemaailmse standardina kasutada Robsoni klassifikatsioonisüsteemi. See on Dr Michael Robson poolt välja töötatud süsteem mis jagab kõik sünnitavad naised kümnesse rühma. Robsoni klassifikatsioonisüsteem põhineb sünnitusabi parameetritel: sünnituste arv, antud sünnituse käivitamise viis, varasem keisrilõige, raseduse kestus, loote asend, loodete arv. Antud süsteem võimaldab hinnata objektiivselt keisrilõigete osakaalu, seda jälgida ja võrrelda siseriiklikult erinevates tervishoiuasutustes kui ka ülemaailmselt. Robsoni klassifikatsioonisüsteem on kasutatav ka operatiivse vaginaalse sünnituse osakaalu hindamiseks ja võrdluseks.

Keisrilõigete osakaalu vähendamine Euroopas nõuab piirkonnaspetsiifilisi strateegiaid, kuna tegurid erinevad riigiti. Praktiliste lahenduste väljatöötamiseks on oluline jälgida ja hinnata keisrilõigete ja operatiivsete vaginaalsete sünnituste osakaalusid, kasutades riiklikke registreid ja kvaliteedinäitajaid, nt Robsoni klassifikatsioonisüsteemi. Standardiseeritud andmekogumine ja ühtse klassifikatsioonisüsteemi kasutamine toetavad tõenduspõhist praktikat ning võimaldavad piirkondlikke võrdlusi, mis omakorda aitavad parandada perinataalset tulemit. Kogu maailma emade ja laste tervise seisukohalt on oluline, et operatiivset sünnitusabi osutatakse üksnes kliinilise vajaduse korral, kuna see on seotud lühi- ja pikaajalisete tüsistustega nii emale kui lapsele.

Eesti ja Soome on naaberriigid, kuid perinataalnäitajad on uurimisperioodi alguses olnud väga erinevad. Käesolev uurimus annab võimaluse võrrelda operatiivsete sündide osakaalusid kolme aastakümne jooksul Eestis ja Soomes. Uuringuperioodi jooksul on Eestist saanud üks turvaliseim riik kus sünnitada, seejuures järgides Soome eeskuju.

Eesmärgid

Käesoleva uuringu eesmärk oli analüüsida kõikide operatiivsete sündide ajatrende Eestis ja Soomes aastatel 1992–2023:

1. Analüüsida keisrilõigete ajatrende Eestis ja Soomes.
2. Võrrelda keisrilõigete ajatrende Eestis ja Soomes, kasutades Robsoni klassifikatsioonisüsteemi.
3. Võrrelda operatiivsete vaginaalsete sünnituste ajatrende ja riskitegureid Eestis ja Soomes.

Metoodika

Soome Meditsiiniline Sünniregister loodi 1987. aastal ja Eesti Meditsiiniline Sünniregister 1991. aastal. Eesti Meditsiinilise Sünniregistri loomisel oli eeskujuks Soome. Andmekogumine Eestis algas 1. jaanuaril 1992, eesmärgiga koguda andmeid elus- ja surnultsündide kohta, rasedusaegse ja sünnitusjärgse tervishoiuteenuse ning sündimusstatistika korraldamiseks ja perinataalse haigestumuse ja suremuse epidemioloogiliseks uurimistööks. Andmed Eesti ja Soome meditsiinilistesse sünniregistritesse saadakse sünnikaartidelt. Registrite andmestik on sarnane, mis teeb omavahelised rahvusvahelised võrdlused lihtsaks.

Anonümiseeritud individuaalsed sünniandmed saadi nii Eesti kui ka Soome Meditsiinilisest Sünniregistrist. Hõlmates perioodil 1992–2016 Eesti ja Soome sünde. Lisaks kasutati artikli III ja dissertatsiooni jaoks aastate 2017–2023 Eesti ja Soome Meditsiinilise Sünniregistri agregeeritud andmeid, sealhulgas Robsoni klassifikatsiooni rühmade Robson 1 (R1), Robson 2 (R2) ja Robson 5 (R5) andmeid. Nende põhjal uuendati varasemaid tulemusi antud perioodi võrra ja tehti lisaanalüüse.

Keisrilõigete ajatrendide analüüsiks kasutati logistilisi ja lineaarseid regressioonimudeleid. Eesti ja Soome keisrilõigete osakaalude erinevuste ning Robsoni rühmade R1, R2 ja R5 analüüsimiseks kasutati kohandatud logistilist regressioonimudelit. Üldine keisrilõike osakaal kohandati sünnikaalule, varasemale rasedusele, varasemale keisrilõikele, raseduse kestusele, üksikule lootele, peaseisule, induktsioonile ja ema vanusele. R1, R2 ja R5 osakaalude puhul kohandati see sünnikaalule ja ema vanusele.

Operatiivsete sündide ajatrendide hindamiseks kasutati logistilisi ja lineaarseid regressioonimudeleid. Operatiivsete vaginaalsete sünnituste ajatrendi muutuse hindamiseks kasutati Joinpoint regressioonimudelit ning tulemused esitati aastase protsentuaalse muutusena (APC). Operatiivse vaginaalse sünnitusega seotud tegurite tuvastamiseks koostati eraldi logistiline regressioonimudel Eesti ja Soome andmetele; mudel kohandati aasta, ema vanuse, sünnikaalu, ning epiduraal/spinaalanesteesia kasutamise alusel. Eraldi koostati logistiline regressioonimudel keisrilõikega seotud tegurite tuvastamiseks mõlemas riigis.

Joinpoint regressiooni kasutati R1+R2 ja R5 rühmade keisrilõigete trendide ajas muutumise hindamiseks ning tulemused esitati aastase protsentuaalse muutusena (APC).

Statistiliste analüüside tegemiseks kasutati statistikatarkvarana Stata/IC 14 for Windows. Uuringule andsid loa Tallinna Meditsiiniuuringute Eetikakomitee ja THL Finnish Institute for Health and Welfare.

Peamised tulemused

Keisrilõigete osakaal kasvas mõlemas riigis, kuid ajatrendid olid erinevad. Eestis tõusis keisrilõigete osakaal pärast oma riigi iseseisvuse taastamist kiiresti. Aastal 1992 oli keisrilõigete osakaal Eestis 6.5% ja Soomes 15.1%. Eestis ületas keisrilõigete osakaal Soome oma 2004. aastal, ning kasv stabiliseerus 2007. aastal jäädes edaspidi 19–21% vahele. Soomes püsis keisrilõigete osakaal stabiilsena umbes 16-17% juures kuni 2019. aastani, mil algas kiire tõus ja keisrilõigete osakaal ületas 20% piiri aastaks 2023. Põhjamaades on keisrilõigete osakaal madalam kui mujal Euroopas, Eesti on oma keisrilõigete näitajate poolest Põhjamaade sarnane.

Robsoni klassifikatsioonisüsteemi põhjal analüüsiti rühmade R1, R2 ja R5 ajatrende, mis moodustavad üle poole kõikidest keisrilõigetest. Eestis kasvasid nende rühmade osakaalud paralleelselt kogu keisrilõigete osakaaluga, kuid pärast üldise keisrilõike osakaalu stabiliseerumist jäi stabiilseks ka R1, samas kui R2 ja R5 osakaalud hakkasid langema. Soomes püsisid nende gruppide osakaalud stabiilsena kuni 2019. aastani, mil hakkasid need tõusma koos üldise keisrilõike osakaalu tõusuga. Rühmad R1+2 ja R5 jäävad nii Eestis kui Soomes oma 2023. aastal tulemustega WHO soovitatud vahemikku.

Operatiivsete vaginaalsete sünnituste osakaalud näitasid mõlemas riigis kasvutrendi. Eestis oli selle osakaal 1992. aastal 0,6%, kasvades kiiresti, kuni 2007. aastani, mille järel kasv aeglustus, jõudes 2023. aastaks 5,7%-ni. Soomes on operatiivse vaginaalse sünnituse osakaal kogu ajaperioodi jooksul olnud kõrgem, olles 1992. aastal 5,2% ja pidevalt tõustes, jõudnud 2023. aastaks 10,2%-ni. Enamiku operatiivsetest vaginaalsetest sünnitustest moodustasid vaakumsünnitused, tangide kasutamine oli vähene. Aastaks 2023 on tangide kasutamine Eesti ja Soome sünnitusabis nullilähedane. Epiduraalanesteesia on peamiseks teguriks, mis suurendas operatiivsete vaginaalsete sünnituste osakaalu, olles Soomes selgelt tugevama mõjuga kui Eestis.

Kokkuvõttes näitavad tulemused, et keisrilõiked ja operatiivse vaginaalse sünnituse osakaalud on Eestis ja Soomes oluliselt muutunud, peegeldades nii meditsiinisüsteemi arengut kui ka sünnitusabi praktikate muutusi. Põhjamaades, sh Soomes ja ka Eestis on keisrilõiked lubatud ainult meditsiinilisel näidustusel ja nende osakaal jääb soovituslikule tasemele. Robsoni klassifikatsioonisüsteemi kasutamine võimaldab tuvastada enim tähelepanu vajavad rühmad ning toetab tulevikus sihipärast poliitikakujundamist ja kvaliteedi hindamist perinataalvaldkonnas. Uuringu tulemused rõhutavad lisaks vajadust ühtlustatud andmekogumise ja -analüüsi järele, mis võimaldab rahvusvahelist võrdlust ning tõenduspõhist tervisepoliitikat.

Järeldused

Antud doktoritöö annab põhjaliku ülevaate operatiivsete sündide (keisrilõike ja operatiivne vaginaalse sünnituse) ajatrendidest Eestis ja Soomes, kasutatud on mitmeid metoodilisi lähenemisviise, uuringu ajaperiood on 1992–2023, mil toimusid olulised muutused. Tulemused näitasid, et keisrilõigete ja operatiivsete vaginaalsete sünnituste osakaal on kasvanud nii Eestis kui ka Soomes.

1. Keisrilõigete osakaal on viimase 30 aasta jooksul mõlemas riigis suurenenud. Eestis oli keisrilõigete osakaal 6.5% ja see on ajas kasvanud kuni 2007 aastani, kuid viimased 16 aastat on püsinud stabiilsena. Soomes on keisrilõigete osakaal püsinud ligikaudu 16% juures, kuid alates 2019. aastast on täheldatud kasvutrendi. Alates 2004. aastast on Eesti keisrilõike osakaal olnud kõrgem kui Soomes. Eesti ja Soome keisrilõike osakaal on 2023. aasta seisuga sarnane maailma keskmise tasemega (21%). Samas on Soome keisrilõigete osakaal siiski veidi madalam kui Eestis. Paljudes teistes Euroopa riikides on keisrilõike osakaal aga märgatavalt kõrgem.
2. Robsoni rühmade R1, R2 ja R5 keisrilõigete osakaalud Eestis näitasid kasvutrendi, mis sarnanes keisrilõigete üldise tõusuga. Pärast seda, kui üldine keisrilõigete osakaal Eestis 2007. aastal stabiliseerus, jäi R1 rühma osakaal püsima stabiilsena, samas kui R2 ja R5 rühmade osakaalud hakkasid langema. Vastupidiselt püsisid Soomes R1, R2 ja R5 osakaalud suhteliselt stabiilsed kuni 2019. aastani, millele järgnes kasv. Sarnast trendi täheldati ka üldises keisrilõigete osakaalus. Eesti ja Soome R1+R2 ning R5 tulemused vastasid 2023. aastal WHO soovituslikele väärtustele. Uuringu tulemused näitavad, et Eesti sarnaneb Robsoni klassifikatsiooni süsteemi tulemuste alusel Põhjamaadele, sealhulgas Soomele.
3. Operatiivse vaginaalse sünnituste (vaakum- ja tangisünnitus) osakaal on aja jooksul kasvanud. Eestis tõusis osakaal kiiresti kuni 2007. aastani; hiljem kasv aeglustus ja ulatus 5.7%-ni. Soomes jätkus tõus ühtlaselt kogu uuringuperioodi vältel, ulatudes 10.2%-ni. Soome operatiivse vaginaalse sünnituse osakaal on kogu uuringuperioodi jooksul olnud ligikaudu poole kõrgem kui Eestis. Uuringuperioodi lõpuks moodustasid operatiivsed sünnid umbes veerandi kõigist sündidest mõlemas riigis. Vaakumsünnitusest on saanud ainus

operatiivse vaginaalse sünnituse meetod mõlemas riigis ning paljudes teistes Euroopa riikides täheldatakse sama trendi. Mitmed riskitegurid nagu ema vanus, vastsündinu sünnikaal ja epiduraal/spinaalanesteesia kasutamine, olid märkimisväärselt seotud nii operatiivse vaginaalse sünnituse kui ka keisri-lõikega, seda kinnitavad ka teised uuringud.

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12. APPENDICES

Appendix 1. A birth card since 2020

SÜNNIKAART

Raseduse infosüsteem. Tervise Arengu Instituut, Hiiu 42, 11619 Tallinn
Kaart täidetakse iga elusalt või surnult sündinud lapse kohta

1. TERVISHOIUTEENUSE OSUTAJA
Tervishoiuasutus või litsentsi nr ____ Haigusjuhu number ____

2. EMA ISIKUANDMED
Isikukood ____
Sünniaeg päev kuu aasta ____
Eesnimi ____
Perekonnanimi ____
Rahvus ____
Elukoht Vald/alev/linn ____
Maakond ____
Riik (kui elukoht pole Eesti) ____

Tavategevusala
1 Töötav
2 Töötu
3 Ajateenija
4 Kinnipeetav
5 (Üli)õpilane
6 Pensionär/töövõimetu
7 Kodune
Amet ____

Haridus
1 Algharidus või vähem
2 Põhiharidus
3 Keskharidus
4 Keskeriharidus
5 Rakenduskõrgharidus
6 Ülikooliharidus

Ema perekonnaseis
1 Registreeritud abielus, sõlmimise aeg päev kuu aasta ____
2 Vabaabielus, kooselu algus kuu aasta ____
3 Vallaline
4 Lahutatud
5 Lesk
6 Teadmata

3. ISA ISIKUANDMED
1 Ei avalda
Isikukood ____
Sünniaeg päev kuu aasta ____
Eesnimi ____
Perekonnanimi ____
Rahvus ____
Elukoht Vald/alev/linn ____
Maakond ____
Riik ____

Tavategevusala
1 Töötav
2 Töötu
3 Ajateenija
4 Kinnipeetav
5 (Üli)õpilane
6 Pensionär/töövõimetu
7 Kodune
Amet ____

Haridus
1 Algharidus või vähem
2 Põhiharidus
3 Keskharidus
4 Keskeriharidus
5 Rakenduskõrgharidus
6 Ülikooliharidus

4. VARASEMAD RASEDUSED JA SÜNNITUSED
Sünnituste arv kokku ____ (kui ei tea – 99)
Neist lõppesid: elussünniga ____ surnultsünniga ____
Eelmise sünnituse kuupäev päev kuu aasta ____
Sünnitus lõppes: 1 elussünniga 2 surnultsünniga

Raseduse katkemiste/katkestamiste arv kokku ____ (kui ei tea – 99)
Neist
1 Iseeneslik raseduse katkemine ____
2 Omal soovil katkestamine ____
3 Meditsiinilisel näidustusel katkestamine ____
4 Emakaväline rasedus ____
5 Muu raseduse katkemine/katkestamine ____

5. RASEDUSAEGNE JÄLGIMINE
Rasedusaegsete visiitide arv (kui ei tea – 99) ____
Neist arv
1 Ämmaemand ____
2 Naistearst ____
3 Perearst ____
4 Ei jälgitud

Esimese visiidi aeg päev kuu aasta ____
Raseduskestus 1. visiidil
____ täisnädalat ____ päeva (kui ei tea – 9)
Ema pikkus ____ cm
Ema kaal (enne rasedust) ____ kg

Suitsetamine raseduse ajal
1 Ei suitsetanud
2 Lõpetas suitsetamise I trimestril
3 Suitsetas
4 Andmed puuduvad

6. RASEDUSEGA SEOTUD UURINGUD, TOIMINGUD JA RISKITEGURID (võib märkida mitu valikut)

Kunstlik viljastamine 1 Jah 2 Ei
1 Kehaväline viljastamine (IVF), sh seemneraku süstimine munarakku (ICSI), värske embrüo siirdamine
2 Külmutatud embrüo siirdamine (FET)
3 Emakasisene inseminatsioon (IUI)

Sünnieelne diagnostika
1 I trimestri kombineeritud sõeluuring
2 I trimestri UHD (seerummarkeriteta)
3 Loote DNA ema verest (NIPT)
4 II trimestri UHD sõeluuring
5 Koorionibiopsia
6 Amniotsentees
7 Keeldus sõeluuringutest
8 Ei ole teada/sõeluuringud tegemata

Riskitegurid
1 Varasem keisrilõige
2 Aneemia (Hgb < 100g/L)
3 Raseduseelne insuliinsõltuv diabeet
4 Enne rasedust diagnoositud hüpertensioon

Uuringud ja ravi
1 Tromboosi profülaktika
2 Glükoosi taluvuse test (GTT) norm.
3 GTT patoloogiline
4 Raseduse ajal alustatud insuliinravi

Ema raseduspuhused diagnoosid, sealhulgas kaasnevad haigused (RHK kood)
1 ____ 2 ____ 3 ____ 4 ____ 5 ____ 6 ____

7. SÜNNITUSE ANDMED
Raseduskestus sünnituse hetkel ____ nädalat ____ päeva

Lapse sünnikoht
1 Haiglas
2 Teel haiglasse
3 Assisteeritud kodusünnitus
4 Assisteerimata kodusünnitus
5 Andmed puuduvad

Valutustamine (võib valida mitu)
1 Epiduraalanalgeesia
2 Spinaalanalgeesia
3 Paratservikaalanalgeesia
4 Pudendaalanalgeesia
5 Naerugaas
6 Muu medikamentoosne valutustamine
7 Muu mittemedikamentoosne valutustamine
8 Ei kasutatud valutustamist
9 Ei ole teada

Sünnitusega seotud toimingud

Sünnituse indutseerimine
- 1 Looteveepõie avamine
- 2 Oksütotsiin
- 3 Prostaglandiin
- 4 Ballooni asetamine

Sünnituse stimuleerimine
- 1 Looteveepõie avamine
- 2 Oksütotsiin

Loote elektrooniline jälgimine
- 1 Kardiotokograafia (KTG)
- 2 Loote ST-analüüs (STAN)

Emale antibiootikumide manustamine
- 1 Profülaktiline
- 2 Antibakteriaalne ravi

Peresünnitus ☐ 1 Jah ☐ 2 Ei

Sünnituse viis
- 1 Loomulikul teel
- 2 Vaakumsünnitus
- 3 Tangsünnitus
- 4 Plaaniline keisrilõige
- 5 Erakorraline keisrilõige
- 6 Hädakeisrilõige
- 7 Keisrilõige pärast ebaõnnestunud vaakumsünnitust

Lootevee puhkemise kuupäev ☐ 1 Teadmata

päev kuu aasta tund min

Sünnituse kestus tund min
- 1 Avanemisperioodi kestus
- 2 Väljutusperioodi kestus
- 3 Päramisteperioodi kestus

Verekaotus .... ml

Muud toimingud
- 1 Episiotoomia
- 2 Platsenta manuaalne eemaldamine
- 3 Emakaõõne revisioon/abrasioon
- 4 Ema vereülekanne
- 5 Hüsterektoomia

Sünnituspuhused ja -järgsed diagnoosid
- 1 Platsenta eesasetsus
- 2 Platsenta enneaegne irdumine
- 3 Preeklampsia
- 4 Eklampsia
- 5 Funktsionaalselt kitsas vaagen
- 6 Vaagnaotsseis
- 7 Muu atüüpiline loote seis
- 8 Õlgade düstookia
- 9 Lahkliha III, IV astme rebend
- 10 Emakarebend
- 11 Sepsis

Ema sünnituspuhused ja -järgsed diagnoosid (RHK kood)

1 ___ 2 ___ 3 ___ 4 ___ 5 ___ 6 ___ 7 ___ 8 ___

8. LAPSE ANDMED

Isikukood/sünniaeg

tund min

Sugu
- 1 Poiss
- 2 Tüdruk
- 3 Ebaselge

Laps sündis
- 1 Elusalt
- 2 Surnult, antenataalselt
- 3 Surnult, intranataalselt
- 4 Surnult, aeg täpsustamata

Sündinud laste arv

Mitmike puhul järjekorra täht

☐ A ☐ B ☐ C ☐ D

Platsentatsiooni tüüp mitmikel
- 1 Dikoriaalne
- 2 Monokoriaalne diamniaalne
- 3 Monokoriaalne monoamniaalne
- 4 Teadmata/muu

Sünnikaal (g)

Sünnipikkus (cm)

Pea ümbermõõt (cm)

Apgar (min)

1 ___ **5** ___ **10** ___

	pH	BE	Ebaõnnestunud	Võtmata/teadmata
Nabaarter			1	2
Nabaveen			1	2
Täpsustamata veresoon			1	2

Koheselt sünnijärgselt tehtud toimingud
- 1 Lisahapnik ___ %
- 2 Maskventilatsioon
- 3 Ninakaudne CPAP-ravi
- 4 Intubatsioon
- 5 Kaudne südamemassaaž
- 6 Adrenaliini manustamine
- 7 Voluumeni täitmine
- 8 Aktiivravi ei alustatud (*prognosis pessima*)

RHK kood ___ ___

9. LAPSE ANDMED HAIGLAST LAHKUMISEL VÕI KUNI 7 PÄEVA VANUSELT

Toimingud (alla 72 t / üle 72 t)
- 1 Mitte-invasiivne hingamistoetus
- 2 Invasiivne hingamistoetus
- 3 Antibakteriaalne ravi
- 4 Intensiivravi
- 5 Lisahapnik ___ %
- 6 Verevahetusülekanne
- 7 Vereülekanne (kõik komponendid)
- 8 Fototeraapia
- 9 Terapeutiline jahutamine

Väärarendid (RHK kood)

1 ___ 2 ___ 3 ___

- 1 Kombineeritud väärarend
- 2 Väärarend avastati antenataalselt

	Jah	Ei	Vanemad keeldusid
K-vitamiin	1	2	3
Sõeluuringud			
Kaasasündinud haigused	1	2	3
Kuulmissõeluuring (OAE)	1	2	3
Saturatsioon (SpO2)	1	2	3
Silma punase refleksi kontroll	1	2	3
Immuniseerimine			
Tuberkuloos (BCG)	1	2	3
B-hepatiidi immunoglobuliin	1	2	3
B-hepatiidi vaktsiin	1	2	3
Tuulerõugete immunoglobuliin	1	2	3
Muu, täpsustada	1	2	3

Toitmine

☐ 1 Täielik rinnapiim ☐ 2 Osaline rinnapiim ☐ 3 Vastsündinute piimasegu

☐ 4 0 dieet ☐ 5 Teadmata

Lapse muud diagnoosid (RHK kood)

1 ___ 2 ___ 3 ___ 4 ___ 5 ___ 6 ___

Lapse seisund 7 päeva vanusena või haiglast lahkumisel
- 1 Koju kirjutatud (päev kuu aasta, tund min)
- 2 Endiselt samas raviasutuses
- 3 Ravil teises raviasutuses .... (asutuse nimi) Üle viidud (päev kuu aasta)
- 4 Surnud (päev kuu aasta, tund min)

Ema ravi kestus haiglas (päevade arv)

Saabus (päev kuu aasta)

Lahkus (päev kuu aasta)

10. TERVISHOIUTÖÖTAJA

Nimi .... Kood ___ Allkiri ....

Märkused ....

TÜHJENDA VÄLJAD

13. PUBLICATIONS

14. CURRICULUM VITAE

Name: Kaire Sildver
Date of birth: March 19, 1985
Citizenship: Estonia
E-mail: kaire.sildver@gmail.com

Education

2018–2025	University of Tartu, Faculty of Medicine, Doctoral studies in Medicine
2012–2014	University of Tartu, Master of Science in Health Sciences
2005–2010	Tallinn Health Care College, midwifery
1992–2004	Tartu Mart Reinik Gymnasium

Professional employment:

2017–...	Tallinn Health University of Applied Sciences, Health Education Centre, Midwife Curriculum, Midwife Curriculum Senior Lecturer (1,00)
2023–2024	University of Tartu, Faculty of Medicine, Institute of Family Medicine and Public Health, Junior Research Fellow in Epidemiology (0,50)
2015–2017	Tallinn Health Care College, Teacher (1,00)
2014–2015	Tallinn Health Care College, Teacher (1,00)

Membership in professional societies

Estonian Midwives Association, member
Estonian Perinatal Society, member

Main fields of research: Public health, epidemiology

Publications related to the thesis:

Sildver, Kaire; Veerus, Piret; Lang, Katrin; Pisarev, Heti; Gissler, Mika (2023). Cesarean section trends from 1992 to 2016 in Estonia and Finland: A registry-based study. Acta Obstetricia Et Gynecologica Scandinavica, Aug;102(8): 1007–1013. doi: 10.1111/aogs.14609

Sildver, Kaire; Veerus, Piret; Gissler, Mika; Lang, Katrin; Pisarev, Heti. (2024). Caesarean section and operative vaginal delivery in Estonia and Finland from 1992 to 2016: registry-based study. European Journal of Public Health, Dec 1;34(6):1205–1209. doi: 10.1093/eurpub/ckae162

Sildver, Kaire; Veerus, Piret; Gissler, Mika, Lang, Katrin, Pisarev, Heti. (2025). Cesarean section trends from 1992 to 2023 in Estonia among singleton term pregnancies: A registry-based study. European Journal of Midwifery. April; 9:1–8. doi:org/10.18332/ejm/201342

15. ELULOOKIRJELDUS

Nimi: Kaire Sildver
Sünniaeg: 19. märts 1985
Kodakondsus: Eesti
E-post: kaire.sildver@gmail.com

Haridustee

2018–2025	Tartu Ülikool, Meditsiiniteaduste valdkond, arstiteaduse doktoriõpe
2012–2014	Tartu Ülikool, terviseteaduse magister (rahvatervishoid)
2005–2010	Tallinna Tervishoiu Kõrgkool, ämmaemandus
1992–2004	Tartu Mart Reiniku Gümnaasium

Töökogemus

2017–...	Tallinna Tervishoiu Kõrgkool, Tervishariduse keskus, Ämmaemanda õppekava, õppejõud-vanemlektor (1,00)
2023– 2024	Tartu Ülikool, Meditsiiniteaduste valdkond, peremeditsiini ja rahvatervishoiu instituut, epidemioloogia nooremteadur (0,50)
2015–2017	Tallinna Tervishoiu Kõrgkool, Ämmaemanduse õppetool, õppejõud-assistent (1,00)
2014–2015	Tallinna Tervishoiu Kõrgkool, Õpetaja (1,00)

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Eesti Perinatoloogia Selts, liige

Teadustöö põhisuunad: Rahvatervishoid, epidemioloogia

Väitekirjaga seotud publikatsioonid:

Sildver, Kaire; Veerus, Piret; Lang, Katrin; Pisarev, Heti; Gissler, Mika (2023). Cesarean section trends from 1992 to 2016 in Estonia and Finland: A registry-based study. Acta Obstetricia Et Gynecologica Scandinavica, Aug;102(8): 1007–1013. doi: 10.1111/aogs.14609

Sildver, Kaire; Veerus, Piret; Gissler, Mika; Lang, Katrin; Pisarev, Heti. (2024). Caesarean section and operative vaginal delivery in Estonia and Finland from 1992 to 2016: registry-based study. European Journal of Public Health, Dec 1;34(6):1205–1209. doi: 10.1093/eurpub/ckae162

Sildver, Kaire; Veerus, Piret; Gissler, Mika, Lang, Katrin, Pisarev, Heti. (2025). Cesarean section trends from 1992 to 2023 in Estonia among singleton term pregnancies: A registry-based study. European Journal of Midwifery. April; 9:1–8. doi:org/10.18332/ejm/201342

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