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Post-Hysterectomy Pelvic Organ Prolapse, Recurrence, Complications and Patient-Reported Outcomes

TEA KUITTINEN

ACADEMIC DISSERTATION

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Reviewed by

Associate Professor Kaisa Raatikainen, MD, PhD

Department of Obstetrics and Gynaecology, University of Eastern Finland, Kuopio University Hospital, Kuopio, Finland

Associate Professor Kari Nieminen MD, PhD, Department of Obstetrics and Gynaecology, Tampere University, Tampere University Hospital, Finland

Custos

Professor Tomi Mikkola, MD, PhD

Department of Obstetrics and Gynaecology, University of Helsinki, Helsinki University Hospital, Helsinki, Finland

Supervised by

Associate Professor Maarit Mentula, MD, PhD

Department of Obstetrics and Gynaecology, University of Helsinki, Helsinki University Hospital, Helsinki, Finland

Associate Professor Päivi Rahkola-Soisalo, MD, PhD

Department of Obstetrics and Gynaecology, University of Helsinki, Helsinki University Hospital, Helsinki, Finland

Associate Professor Päivi Härkki, MD, PhD

Department of Obstetrics and Gynaecology, University of Helsinki, Helsinki University Hospital, Helsinki, Finland

Official opponent

Associate Professor Pauliina Aukee, MD, PhD

Department of Obstetrics and Gynaecology, Central Hospital Nova, Jyväskylä, University of Eastern Finland, Kuopio, Finland

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To all women living with pelvic floor disorders

Abstract

Hysterectomy and pelvic organ prolapse (POP) repair are the most common benign gynaecological procedures. POP involves the downward displacement of pelvic organs — bladder, uterus, rectum, or vaginal apex with or without cervix — into or beyond the vagina, resulting from weakened pelvic supporting structures of which hysterectomy may also influence. In Finland, the lifetime risk of undergoing POP surgery is 13%. Symptoms can range from none to pelvic heaviness, bulging, incontinence, or sexual difficulties. Treatment is tailored according to symptoms, affected compartments, and patient preferences, with options ranging from conservative treatments to surgical repair.

This thesis utilized data from the prospective FINHYST cohort of 5,279 benign hysterectomies, representing 79% of all such procedures in Finland in 2006. This data was combined with the Finnish Care Register allowing a follow-up from 1996 until the year 2016. The FINHYST cohort was divided into women who underwent hysterectomy for POP with or without urinary incontinence (UI) (POPUI group) and for non-prolapse indications (Non-POPUI group).

We studied primary and recurrent POP related operations and visits after hysterectomy with different approaches AH (abdominal hysterectomy), LH (laparoscopic), LAVH (laparoscopic-assisted vaginal), and VH (vaginal). In addition, we evaluated surgical and patient-related risk factors for primary and recurrent POP, and short- (two months) and long-term (ten years) patient satisfaction, complications, de novo pelvic floor symptoms, and factors associated with satisfaction.

Of women who underwent hysterectomy for non-prolapse indication (n=3582), 1.6% underwent primary POP surgery and 2.6% had a POP-related clinic visit during ten years follow-up time. Most prolapse repairs, of which posterior compartment was the most common (1.6%), occurred within six years after hysterectomy. LAVH carried a higher risk of post-hysterectomy POP operations and outpatient visits compared to AH (HR 3.0 and 2.2, respectively); 9 women with LAVH (3.6%) and 12 women with AH (0.9%) underwent a POP operation.

Of women who underwent hysterectomy for POP as a primary or a secondary indication (n=1697), 16.5% underwent POP reoperation and 21.2% had an outpatient visit during the follow-up time. Vaginal vault repairs were the most frequent POP reoperations (10.7% of patients, 65% of reoperations), followed by the anterior repairs (7.1% of patients, 43% of reoperations). Hysterectomy approach had no significant impact on POP recurrence (reoperations or POP-

related visits), although the crude recurrence rate was numerically highest after LH. Concomitant prolapse repair reduced same-compartment recurrence (anterior 30%, posterior 60%). Nevertheless, 68% of POP reoperations involved the same compartment repaired during hysterectomy.

Both short and long-term satisfaction for primary hysterectomy was high (VAS 89.5 and 91.7) and most women (94%) would choose hysterectomy again.

At two months women in the POPUI group reported significantly less (9.0%) dissatisfaction (VAS <70) than women in the non-POPUI group (11.0%, $p=0.02$). Additionally, women in the POPUI group experienced less complications. Among all women complications (surgical site infection, reoperation for a complication) and inadequate pain management diminished short-term satisfaction.

Ten years after hysterectomy women in the POPUI group reported significantly lower mean VAS scores for a satisfaction (89.2 vs. 92.5), more dissatisfaction (11.7% vs. 7.0%) and more pelvic floor symptoms (86.7 vs. 64.0%) than women in the non-POPUI group. Additionally, women in the POPUI group underwent more POP reoperations and had more visits than the women in the non-POPUI group. Bulging symptoms, older age, and complications associated with dissatisfaction.

This dissertation states that rates of post-hysterectomy POP symptoms and operations are low among women without pre-existing pelvic floor dysfunction. In contrast, among women with hysterectomy preceding POP symptoms, the risk of POP recurrence (same or different site) after hysterectomy is ten folded. However, satisfaction for hysterectomy remain high among all women even if pelvic floor dysfunction associates with decreased long-term satisfaction. These data can be utilized in patient counselling and decision making for benign hysterectomy, especially in women with prior vaginal births or prolapse symptoms.

Tiivistelmä

Kohdunpoisto ja laskeumaleikkaukset ovat yleisimpiä gynekologisia leikkauksia, jotka tehdään muusta kuin pahanlaatuisen tautiin liittyvästä syystä. Laskeuma tarkoittaa lantionpohjan elinten – virtsarakon, kohdun, peräsuolen, emättimen pohjan tai kohdunkaulan – laskeutumista emättimeen tai sen ulkopuolelle, kun tukikudokset heikentyvät. Kohdunpoiston voi vaikuttaa laskeuman (POP) tai uusintalaskeuman ilmaantumiseen. Suomessa elinaikainen riski joutua laskeumaleikkaukseen on 13%. Oirekuva vaihtelee oireettomuudesta lantionpohjan painontunteeseen, pullistuman tunteeseen, pidätysvaikeuksiin tai seksuaalitoimintojen häiriöihin. Hoidon valinnassa otetaan huomioon potilaan toiveet, oireiden laatu sekä laskeuman tyyppi. Hoitovaihtoehtoina ovat konservatiiviset hoitomuodot sekä leikkaushoito.

Tämä väitöskirja pohjautuu FINHYST-aineiston 5 279 kohdunpoistoon, jotka tehtiin hyvänlaatuisen syyn vuoksi. Nämä muodostivat 79% kaikista vuonna 2006 Suomessa tehdyistä toimenpiteistä. FINHYST-aineisto yhdistettiin Hoitoilmoitusrekisteriin (HILMO) vuodesta 1996 vuoteen 2016 saakka ja jaettiin potilaisiin, joilla oli laskeuma tai laskeuma ja virtsankarkailu ennen kohdunpoistoa (POPUI-ryhmä) ja niihin, joilla ei ollut laskeumaa eikä virtsankarkailua ennen kohdunpoistoa (Non-POPUI-ryhmä).

Selvitimme kohdunpoiston jälkeen ilmaantuvat primaari- ja uusintalaskeumaleikkaukset sekä niiden yhteyden eri kohdunpoistomenetelmiin (AH=avoleikkaus, LH=tähystysleikkaus, LAVH=tähystysleikkaus emättimen kautta avustaen, VH=kohdunpoisto emättimen kautta). Seurannan aikana katsottiin myös laskeumadiagnoosilla toteutuneet poliklinikkakäynnit. Lisäksi arvioimme primaari- ja uusintaleikkaukseen sekä potilaaseen liittyviä riskitekijöitä, lyhyen (2 kk) ja pitkän (10 v) aikavälin potilastyytyväisyyttä, komplikaatioita, uusia lantionpohjaoireita ja niiden vaikutusta potilastyytyväisyyteen.

Kymmenen vuoden seurannassa vain 1,6% naisista, joilla ei ollut laskeumaa ennen kohdunpoistoa (n=3582), joutui laskeumaleikkaukseen ja vastaanottokäynnin syynä 2,6%:lla oli jokin laskeuma. Suurin osa laskeumaleikkauksista, joista yleisin oli takaseinäman laskeuman korjaus (1,6%), tehtiin kuuden vuoden sisällä kohdunpoistoleikkauksesta. Kohdunpoistomenetelmistä LAVH lisäsi laskeumaleikkauksen tai laskeuman vuoksi tehdyn poliklinikkakäynnin riskiä kohdunpoiston jälkeen (HR 3.0 ja 2.2)

avoleikkaukseen verrattaessa; 9 naista LAVH-ryhmästä (3.6%) ja 12 naista AH-ryhmästä (0.9%) joutui laskeumaleikkaukseen.

Naisista, joilla oli laskeuma jo ennen kohdunpoistoa (n=1697), 16,5% joutui uusiutuneen laskeuman vuoksi leikkaukseen ja 21,2%:lla oli vastaanottokäynnin syynä uusiutunut laskeuma seuranta-aikana. Emättimen pohjan korjausleikkaukset (10.7% potilaista, 65% kaikista uusintaleikkauksista) olivat yleisimpiä uusintaleikkauksia, ja toiseksi yleisimmin tehtiin emättimen etuseinämän korjauksia (7.1% potilaista, 43% uusintaleikkauksista). Kohdunpoistotapa ei vaikuttanut merkittävästi laskeuman uusiutumisriskiin (uusintaleikkauksiin tai poliklinikkakäynteihin), vaikkakin raakadatassa uusiutumisriski oli korkein LH:n jälkeen. Kohdunpoiston yhteydessä tehty laskeuman korjaus vähensi saman laskeumatyyppin uusiutumista (etuseinä 30%, takaseinä 60%), mutta silti 68% uusintaleikkauksista tehtiin samaan paikkaan.

Potilastyytyväisyys kohdunpoiston jälkeen oli korkea ja säilyi vakaana kahdesta kuukaudesta kymmeneen vuoteen (VAS 89,5 ja 91,7). Suurin osa naisista (94 %) valitsisi kohdunpoiston uudelleen.

Kaksi kuukautta kohdunpoiston jälkeen POPUI-ryhmän naiset raportoivat merkittävästi vähemmän tyytymättömyyttä (9,0%, VAS <70) kuin Non-POPUI-ryhmän naiset (11,0%, $p=0.02$). POPUI-ryhmässä oli myös vähemmän komplikaatioita. Kaikilla naisilla komplikaatiot (infektio, uusintaleikkaus komplikaation vuoksi) ja riittämätön kivunlievitys heikensivät tyytyväisyyttä.

Kymmenen vuotta kohdunpoiston jälkeen POPUI-ryhmän naisilla oli merkittävästi matalammat VAS-pisteet (89,2 vs. 92,5), enemmän tyytymättömyyttä (11,7% vs. 7,0%) ja enemmän lantionpohjan oireita (86,7% vs. 64,0%) kuin Non-POPUI-ryhmän naisilla. Lisäksi POPUI-ryhmän naisilla oli enemmän uusintaleikkauksia laskeuman vuoksi ja enemmän poliklinikkakäyntejä kuin Non-POPUI-ryhmässä. Pullistuman tunne, korkeampi ikä ja komplikaatiot kohdunpoiston yhteydessä lisäsivät merkittävästi tyytymättömyyttä POPUI-ryhmässä.

Tässä väitöskirjassa toteamme, että kohdunpoiston jälkeinen laskeumariski on matala naisilla, joilla ei ole todettu laskeumaa ennen kohdunpoistoa. Sen sijaan naisilla, joilla on jo laskeumaa ennen kohdunpoistoa, riski uusintalaskeumaan (joko saman tai eri paikan) on 10-kertainen. Tästä huolimatta kaikki naiset ovat erittäin tyytyväisiä kohdunpoiston jälkeen sekä lyhyen, että pitkän aikavälin seurannassa, vaikkakin uusiutuneet lantionpohjaoireet heikentävät pitkän aikavälin tyytyväisyyttä. Tätä tietoa voidaan hyödyntää kliinisessä työssä hyvänlaatuisen syyn vuoksi kohdunpoistoa pohtivien naisten potilasohjauksessa ja hoitopäätöksiä tehtäessä; etenkin aiemmin synnyttäneillä sekä naisilla, joilla on jo laskeuma ennen kohdunpoistoa.

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List of original publications

This thesis is based on the following publications:

- I Kuittinen T, Tulokas S, Rahkola-Soisalo P, Brummer T, Jalkanen J, Tomas E, Mäkinen J, Sjöberg J, Härkki P, Mentula M. Pelvic organ prolapse after hysterectomy: A 10-year national follow-up study. *Acta Obstet Gynecol Scand.* 2023; 102: 556-566. doi:10.1111/aogs.14542.
- II Kuittinen T, Mentula M, Tulokas S, Brummer T, Jalkanen J, Tomas E, Mäkinen J, Sjöberg J, Härkki P, Rahkola-Soisalo P. Recurrent pelvic organ prolapse after hysterectomy; a 10-year national follow-up study. *Arch Gynecol Obstet.* 2024; 310: 2705–2715. <https://doi.org/10.1007/s00404-024-07615-x>.
- III Kuittinen T, Tulokas S, Rahkola-Soisalo P, Brummer T, Härkki P, Mentula M. Patient-Reported Outcomes after Hysterectomy due to Pelvic Organ Prolapse versus Other Indications – a 10-year National Follow-up Study. *BMC Women's Health.* 2026; 26: 151. <https://doi.org/10.1186/s12905-026-04304-6>.

The publications are referred to in the text by their roman numerals.

Abbreviations

AH abdominal hysterectomy
BMI body mass index
HRQoL health-related quality of life
HUH Helsinki University Hospital
ICS International Continence Society
IUC The International Urogynecological Consultation
IPTW Inverse Probability of Treatment Weighting
IUGA The International Urogynecological Association
LAM Levator Ani Muscle
LAVH laparoscopic assisted vaginal hysterectomy
LH laparoscopic hysterectomy
LSCP laparoscopic sacrocolpopexy
LUTS lower urinary tract symptoms
MUI mixed urinary incontinence
OAB overactive bladder
PFMT pelvic floor muscle therapy
POP pelvic organ prolapse
POP-Q The Pelvic Organ Prolapse Quantification
PRO patient reported outcomes
PROM patient reported outcome measures
QoL quality of life
S-POP The simplified POP-Q system
SSLF sacrospinous ligament fixation
SUI stress urinary incontinence
UI urinary incontinence
USLS uterosacral ligament suspension
UTI urinary tract infections
UUI urgency urinary incontinence
VH vaginal hysterectomy
vNOTES vaginal natural orifice transluminal endoscopic surgery

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1 Introduction

Hysterectomy is one of the most frequently performed gynaecological procedures, although the number of hysterectomies in Finland has decreased by half over the last two decades due to less invasive treatment alternatives ^{1,2}. It is estimated that by the age of 75, one in five women in Finland undergo a hysterectomy for benign indications such as abnormal uterine bleeding, pelvic organ prolapse (POP), fibroids, and endometriosis ², while the corresponding numbers in USA are one in three women ^{3,4}. These main indications as well as hysterectomy approaches have changed over the past decades ⁵⁻⁷, vaginal (VH) and laparoscopic (LH) approaches have surpassed the abdominal (AH) one ^{1,6}.

Hysterectomy has been suggested to weaken the pelvic floor supporting structures, thereby increasing the risk of subsequent prolapse ⁸⁻¹³, especially if prolapse was the reason for the procedure ^{9,10,14,15}. However, there are also conflicting research findings indicating that a prolapse repair performed at the time of hysterectomy protects against future POP ^{16,17}.

POP is common, the lifetime risk of undergoing POP surgery in Finland is 13% ¹⁸, while the rate of reoperations is 13% during a seven-year follow-up ¹⁹. The aetiology of POP is multifactorial. According to recent systematic review ²⁰ the confirmed risk factors for primary prolapse are vaginal deliveries, parity, high birth weight of the child, age, body mass index (BMI), levator ani muscle (LAM) defect and enlarged levator hiatal area. The risk factors for POP recurrence after native tissue repair are preoperative advanced prolapse stage and younger age ^{20,21}. Less is known about the role of hysterectomy approach, intra- or perioperative factors, complications, experience and status of the surgeon, or preceding and concomitant surgical procedures such as POP repairs and/ or stress urinary incontinence (SUI) operations.

Anterior compartment prolapse is the most common form of POP ^{22,23}, found in 34% of women examined ²⁴. However, findings regarding the risk of the type of the primary prolapse following hysterectomy remain inconsistent ^{9,10,13,15}, as do reports concerning recurrence ^{25,26}. Moreover, the surgical approach of hysterectomy may influence the incidence of subsequent prolapse or recurrence, although existing evidence is conflicting ^{8-11,15}.

POP may have a significant impact on the health-related quality of life (HRQoL) ^{27,28} and even if the literature often emphasizes the overall symptoms

improvement and better HRQoL post-surgery, factors like de novo symptoms, reoperations and pre-existing conditions ²⁷⁻²⁹ can negatively affect outcomes. Given this, rather than focusing solely on anatomical outcomes, it is crucial to assess subjective long-term outcomes, including symptom improvement and patient satisfaction.

2 Review of Literature

2.1 Hysterectomy

Hysterectomy for benign indications aims to relieve symptoms and improve QoL. It may also form part of a POP procedure in women with apical compartment prolapse, although hysterectomy itself may adversely affect the supporting structures and functional integrity of the pelvic floor.

2.1.1 Indications and Prevalence

The United States has long been characterized by a high rate of hysterectomy compared to most other developed nations. It is the second most frequently performed major surgery for women with approximately 500,000 procedures conducted annually ³⁰. In the Nordic countries (Denmark, Sweden, and Norway), hysterectomy rates have been broadly comparable, at approximately 200 per 100,000 women per year ³¹.

In Finland, hysterectomy has historically been prevalent: by 1989, approximately 20% of women aged 45–64 had undergone the procedure ³². Rates continued to increase throughout the 1990s, reaching a peak of 12,400 procedures in 1998 ³². Over the past two decades, hysterectomy incidence has steadily declined, excluding hysterectomies for prolapse, the number was 4081 in 2024 (approximately 250/100,000) ^{2,31,33,34}. This trend reflects the broader adoption of uterus-sparing treatments for benign gynaecological conditions, such as medication, the levonorgestrel intrauterine device, endometrial ablation, high-intensity focused ultrasound (HIFU) treatment, uterine artery embolization and hysteroscopic procedures, alongside Finnish guidelines and clinical practise that increasingly prioritize these alternatives over hysterectomy.

The most common indications for benign hysterectomies are uterine fibroids, menorrhagia, uterine prolapse and endometriosis ^{6,35}. Uterine fibroids were the leading indication for hysterectomy before 2000, and in 2006 accounted for 32.9% of procedures, followed by uterine prolapse (28%), menorrhagia (20.9%), adnexal mass ($\approx$ 5%), and dysmenorrhea and endometriosis (each $\approx$ 2.5%) ⁶. Over recent decades, the lifetime risk of hysterectomy for fibroids has fallen from 12.8% to 4.8%, while rates for other indications have remained largely stable (Figure 1.) ³³.

Consequently, uterine prolapse has emerged as the most common primary benign indication ^{2,33} probably due to increasing aging of the Finnish population.

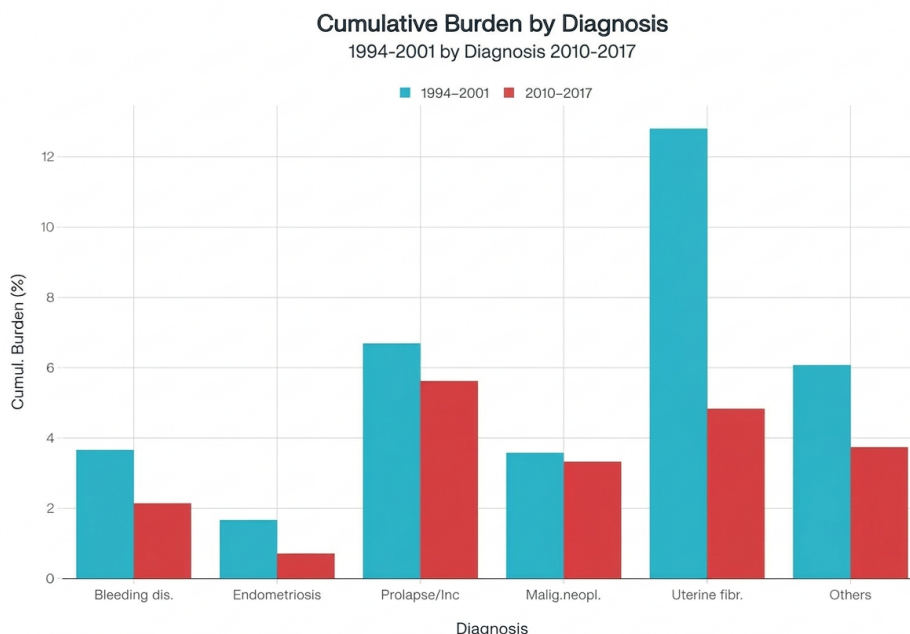


Figure 1. Trends in cumulative burden (%) of hysterectomy indications, 1994–2001 vs. 2010–2017 ³³. Dis disorder, Malign. neopl malignant neoplasm, fibr fibroma, Inc incontinence.

2.1.2 Trends and Methods

Hysterectomy is performed using several distinct approaches ³⁶. A traditional AH requires an incision in the lower abdomen, while a VH is performed entirely through the vagina, leaving no external scars. Minimally invasive options include LH. In this technique, the uterus is removed either vaginally or in pieces through a small abdominal incision (morcellation). LH subtypes are defined by the division between the laparoscopic and vaginal stages. Laparoscopic-assisted vaginal hysterectomy (LAVH) does not involve division of the uterine arteries laparoscopically. Laparoscopic surgery can also be robotically assisted (RH), where a surgeon operates a robotic system for enhanced precision.

Since surgeons are doing fewer traditional VH, proficiency may be declining ²⁹. A new technique called Vaginal Natural Orifice Transluminal Endoscopic Surgery (vNOTES) is becoming an alternative because it combines the scar-free benefit of vaginal surgery with the superior visualization of endoscopy. vNOTES

has the potential to revive the vaginal approach by overcoming its traditional limitations, such as a large uterus, the absence of prolapse, or prior abdominal surgery. However, RH and vNOTES require further evaluation since there is a lack of evidence of any patient benefit over conventional LH or VH ³⁶.

In Finland in the early 1990s, over 90% of hysterectomies were performed via the abdominal route. From 2002, the VH became predominant, until roughly 2013, when LH techniques overtook it ^{6,31}. By 2024, of 5,035 benign hysterectomies, 2,447 were laparoscopic (48.6%), 954 vaginal for prolapse (18.9%), 699 abdominal (13.9%), 474 laparoscopic-assisted vaginal (9.4%), and 259 vaginal for non-prolapse indications (5.1%) (Figure 2) ³⁴.

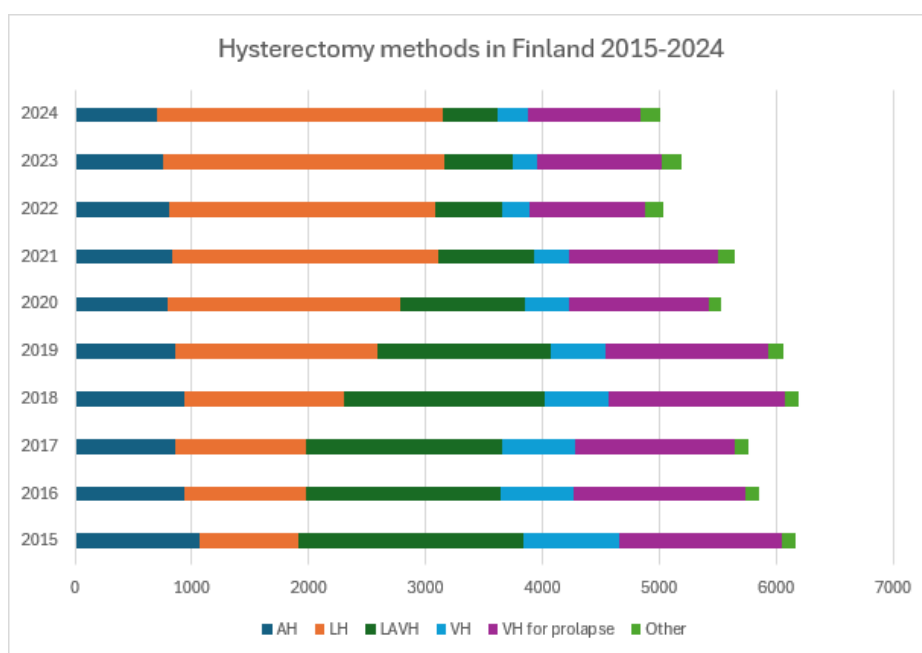


Figure 2. Trends in hysterectomy methods in Finland, 2015-2024. AH abdominal hysterectomy, LH, laparoscopic hysterectomy, LAVH laparoscopic assisted vaginal hysterectomy, VH vaginal hysterectomy.

While LH is common in Finland, its prevalence varies significantly across the Nordic region ³¹. In Finland, LH represent 60% (2,447/4,081) of hysterectomies, though this figure drops to 50% (2,447/5,035) when vaginal prolapse cases are included in the total number of hysterectomies (the Finnish Institute for Health and Welfare, statistics 2024). Current rates of LH in Norway and Denmark are similar at approximately 60% ³⁷, whereas Sweden's rate was notably lower at 11% in 2015 ³⁸. The proportion of LH has been steadily

increasing in many countries ³⁹⁻⁴¹. This trend is driven by the significant advantages of minimally invasive techniques, which offer lower complication rates, shorter hospital stays, faster recovery, and superior cosmetic outcomes compared to conventional AH ⁴.

As hysterectomy rates have declined, residents now have fewer opportunities for hands-on training, particularly in open and vaginal techniques ⁴². Trainees typically require longer operative times, which may contribute to greater blood loss ³¹. though major complication rates do not differ significantly between trainees and specialists. These trends underscore the importance of simulation-based training and innovative educational strategies to maintain surgical proficiency despite reduced clinical case exposure ²⁹.

2.1.3 Complications

Major complication rates after hysterectomy vary from 1% to 7% and include organ injuries (to the bladder, ureter, bowel, and vessels), venous thromboembolism (VTE), fistula formation, neuropathies, complex regional pain syndrome, vaginal cuff dehiscence, and haemorrhage (Table 1) ⁴³⁻⁴⁶. Infections (wound infections, pelvic cellulitis, infected hematomas, febrile events, urinary tract infections=UTIs) are the most common minor complications (Table 1) ^{1,43,44,46}. The rates of minor and major complications according to the different hysterectomy approach are shown in table 1.

Table 1. The rates of complications after hysterectomy. AH abdominal hysterectomy, LH, laparoscopic hysterectomy VH vaginal hysterectomy.

Complication Type	Rate %	AH %	LH %	VH %	Study setting (n)
Major complications (includes bladder, ureter, bowel, and vessel injuries)	1.0–10.3	4.0–10.3	4.1–7.8	2.6–7.2	Prospective cohort (n=51,141) ⁴⁶ Prospective cohort (n=37,512) ⁴⁵ Prospective cohort (n=5,279) ⁴⁷ , Review (n=n/a) ⁴⁴
Genitourinary tract injury	1.0–2.0	1.2 *	1.3 *	0.64 *	* Prospective cohort (n=5,279) ⁴⁷ , Retrospective cohort (n=78,577) ⁴⁸ , Review (n=n/a) ⁴⁴
Ureteric injury	0.3	0.2–0.3	0.3–0.5	0.04 *	Systematic review (n=1,741,894) ⁴⁹ , * Prospective cohort (n=5,279) ⁴⁷
Gastrointestinal injury	0.1–1.0	0.2–0.8	0.4–0.5	0.1–0.5	Prospective cohort (n=5,279) ⁴⁷ , Retrospective cohort (n=78,577) ⁴⁸ , Review (n=n/a) ⁴⁴
Vaginal cuff dehiscence	0.2–0.4	0.02–0.4	1.2–1.3	0.05–0.1	Retrospective cohort (n=78,577) ⁴⁸ , Retrospective cohort (n=13,645) ⁵⁰ , Retrospective cohort (n=12,472) ⁵¹
Post-operative haemorrhage or haematoma	2.7	2.6	2.7	2.8	Prospective cohort (n=5,279) ⁴⁷
Infections (wound, pelvic cellulitis, infected hematomas, febrile events, UTIs)	6.3–11.7	7.7–10.5	6.7–12.1	5.2–13	Prospective cohort (n=51,141) ⁴⁶ , Prospective cohort (n=10,110) ¹ , Prospective cohort (n=5,279), ⁴⁷ Review (n=n/a) ⁴⁴

According to the Cochrane review and meta-analysis ^{4,52} VH stands as the benchmark procedure in terms of complications. When technically feasible, it offers the lowest overall morbidity profile, characterized by the fastest recovery and fewer postoperative complications like fever and wound infections.

LH reduces morbidity from an abdominal incision, resulting in faster recovery and fewer superficial infections (OR 0.29 LH vs AH). However, this benefit is

balanced by longer operative time and a higher risk of serious internal injury, particularly to the urinary tract (OR 2.4 LH vs AH). LH should be viewed as a minimally invasive alternative to AH rather than a replacement for VH, where its safety and recovery benefits are situation-dependent ⁴⁶.

Finnish nationwide study ¹ demonstrates that greater surgical experience and targeted training have led to significant declines in major complications, such as urinary tract and bowel injuries, particularly as rates of vaginal and laparoscopic hysterectomy rose. Nonetheless, perioperative risk remains elevated in patients with obesity, previous pelvic surgery, or cesarean section ⁵³.

2.1.4 Impact on Pelvic Floor

The uterus is suspended by the cardinal and uterosacral ligament complex, which constitutes the highest level of pelvic support (Level 1 support according to DeLancey 1992 ⁵⁴, Figure 3).

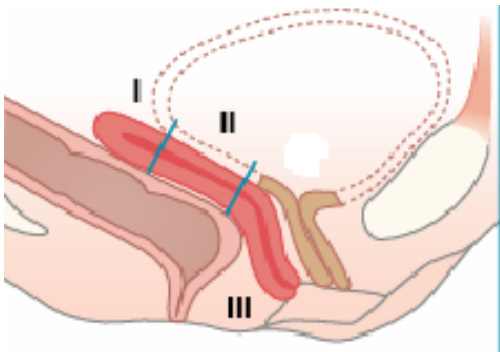


Figure 3. Three levels of support of the vagina and uterus according to DeLancey ⁵⁴. Level I uterosacral and cardinal ligament complex, level II endopelvic fascia, arcus tendineus fascia pelvis and levator ani muscles, III lower third of vagina, anteriorly blending with the pubourethral ligaments, laterally with levator ani muscles and posteriorly with perineal membrane and perineal body.

The removal of the uterus necessitates the division of this complex, compromising the structural integrity of the vaginal apex. While surgeons attempt to resuspend the vaginal cuff after hysterectomy, this surgical reattachment may not fully replicate the strength and dynamic function of the native ligamentous system raising the risk of later POP development ^{8,9,11–13,55}, especially when hysterectomy is part of a POP procedure ^{9,10,14,56}. However, evidence also indicates that concomitant prolapse repair with hysterectomy may lower the chance of future POP ^{16,17}.

In a recent review hysterectomy was associated with SUI, overactive bladder (OAB) and mixed urinary incontinence (MUI) within ten years after hysterectomy while association with POP remained insignificant ⁵⁷ (Table 2). However, beyond ten years after hysterectomy the association with POP was found statistically significant, as well as the association with SUI. Hysterectomy associated also with greater odds of fecal incontinence and defecatory dysfunctions within ten years after surgery. Recent studies found no significant changes in sexual function after hysterectomy ^{58,59}.

The surgical approach ^{8,9,11,56} and pre-existing health factors, such as pelvic floor dysfunction ^{14,20}, may expose for further POP. Some studies link VH to a higher risk of POP an UI ^{8,9}, while women with vaginal deliveries ^{13,20,21} or obesity ^{20,21} may be more susceptible to post-hysterectomy POP.

Table 2. Summary of the risk of the post-hysterectomy POP and UI symptoms associated with hysterectomy according to the systematic review of Chang et al. 2025 ⁵⁷. POP pelvic organ prolapse, SUI stress urinary incontinence, OAB overactive bladder, MUI mixed urinary incontinence, OR odds ratio, CI confidence interval, No number.

Outcome	POP OR (95% CI)	SUI OR (95% CI)	OAB OR (95% CI)	MUI OR (95% CI)
Within 10 years	1.31 (0.81–1.80)	1.31 (1.06–1.56)	1.41 (1.25–1.58)	1.62 (1.40–1.85)
Beyond 10 years	1.56 (1.35–1.78)	2.40 (2.17–2.63)	—	—
No. of studies	11	19	16	3

2.1.5 Impact on Quality of Life

The physical effects of hysterectomy on QoL occur in two stages: the immediate post-operative period and a longer-term phase involving ongoing physiological changes that may influence HRQoL. Both short- and long-term outcomes are related to preoperative psychosocial and clinical status, pain and discomfort during recovery, indications for surgery, complications, de-novo pelvic floor and other symptoms and the surgical approach ⁶⁰.

Hysterectomy for benign conditions generally results in significant improvements in QoL and pelvic floor symptoms, particularly among women with prolapse, fibroids, abnormal bleeding, or endometriosis ^{61–64}. A meta-analysis of over 3,000 patients found that minimally invasive hysterectomy (VH, LH) offers superior short-term QoL compared to AH, though long-term outcomes are similar ⁶⁵. However, a recent prospective cohort study of 260 woman found no difference in quality of life after different hysterectomy approaches ⁶³.

2.2 Pelvic Organ Prolapse

2.2.1 Definition and Evaluation

The International Urogynecological Association (IUGA) and the International Continence Society (ICS) define POP as the descent of one or more of the anterior vaginal wall (cystocele), posterior vaginal wall (rectocele), the uterus (cervix), or the apex of the vagina (vaginal vault or cuff scar post-hysterectomy) towards or beyond the vaginal opening (hymen) ⁶⁶. Clinically, POP is considered present when the leading edge of the prolapsed organ is at or beyond the hymen, often accompanied by bothersome symptoms such as a vaginal bulge, pelvic pressure, or associated functional disturbances ^{67,68}. Those who fulfil the anatomical criteria but have no clinical symptoms are categorized as having anatomical POP without clinical significance ^{67,68}.

A cystocele with or without urethrocele, is anterior vaginal wall prolapse and the most frequent form of POP resulting to bladder descent into the vagina ⁶⁹. A rectocele involves the rectal wall herniating through the rectovaginal septum, causing a bulge in the posterior vaginal wall and may include an enterocele, which is herniation of the peritoneal sac between the vagina and rectum. Rectocele can also be associated with rectal prolapse or internal intussusception ⁷⁰. Vaginal vault prolapse occurs when the vaginal cuff descends below a threshold point after hysterectomy and can coexist with cystocele, rectocele, or enterocele, leading to urinary, bowel, and sexual dysfunction.

A perineocele is a posterior pelvic floor defect. Level III vaginal support ⁵⁴ (Figure 3.), relies on the levator ani and perineal body. Disruption of this perineal body and muscles leave the rectum unsupported, leading to distal posterior prolapse and bulging of the anal canal during defecation ^{71,72}. Perineal damage is thus a common cause of distal rectocele ⁷³.

The severity of prolapse is systematically staged using the POP-Q (Pelvic Organ Prolapse Quantification) system (Figure 4), which standardizes the measurement of the descent relative to the hymen using six vaginal points and three landmarks ⁶⁶. Positive numbers indicate points (in centimeters) distal to the hymen, while negative numbers represent points proximal to the hymen. POP-Q stages range from 0 (no prolapse) to IV (complete vaginal eversion) (Table 3). POP-Q has surpassed Baden-Walker halfway system due to more detailed measurement and higher reproducibility ⁶⁷. The simplified POP-Q system (S-POP) was developed and validated as a more user-friendly alternative, measuring only four points relative to the hymen, Ba (anterior wall), Bp (posterior wall), C (cervix or cuff) and D (posterior fornix) (Figure 4) ^{74,75}. Additionally, the total vaginal length and genital hiatus should be assessed.

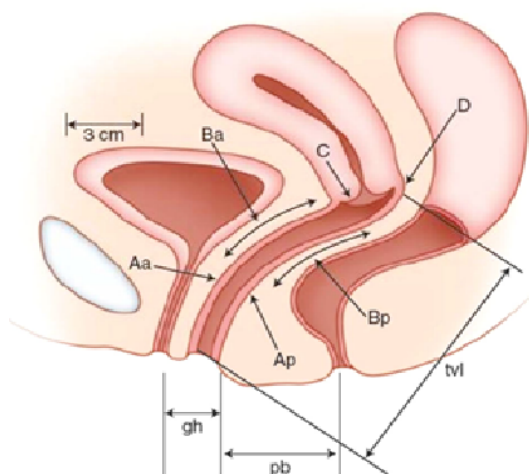


Figure 4. The Pelvic Organ Prolapse Quantification (POP-Q) system ⁶⁶. Aa 3 cm proximal to the hymen, Ba representing the most distal position of the anterior vaginal wall. Points Ap and Bp: correspond to analogous locations on the posterior vaginal wall. Point C: the lowest edge of the cervix or vaginal cuff. Point D: the uppermost point of the posterior vaginal wall, if the uterus is present. tvl total vaginal length, pb perineal body, gh genital hiatus. Republished with permission from Springer Nature.

Table 3. POP Q stages from 0 to IV.

Stage	Description
0	No prolapse is demonstrated
I	Most distal prolapse >1 cm above hymen
II	Most distal prolapse from 1 cm above to 1 cm below hymen
III	Most distal prolapse >1 cm below hymen, not complete eversion
IV	Complete eversion of the vagina

2.2.2 Epidemiology

Reported prevalence rates for POP (1-65%) differ widely due to variations in definitions, diagnostic methods, and studied populations ⁷⁶. Worldwide, about 40-50% of parous women have some degree of prolapse upon vaginal examination ^{76,77} and this proportion is expected to increase with the aging of the population ⁷⁸.

However, most women remain asymptomatic, with only around 10 to 31 % experiencing bothersome symptoms of pelvic organ prolapse ^{76,79,80} and of these women, 30-45% are seeking treatment ⁸¹.

In Finland, about 5,500 POP operations are performed annually, making it one of the most common gynaecological surgeries ³⁴. The lifetime risk for a woman undergoing at least one POP surgery is 12.8% and recurrent surgery 11% ¹⁸. The incidence peaks among women approximately 70 years ^{18,77}. In the U.S. prevalence estimates for POP in population-based studies range from 2.9% to 64.8% ⁷⁶, depending on study design and definition. The risk of undergoing POP surgery during a woman's lifetime in the U.S. is about 12.6% ⁷⁸.

At 2015, according to the Finnish national prospective cohort study (FINPOP) 80% of POP surgeries were native tissue repairs ²⁷. Currently, anterior and posterior repairs are the most frequently performed POP procedures, each accounting for around 1,400 operations annually (Figure 5). Over the past decade, there has been a marked decline in VH procedures and a corresponding increase in Manchester operations for POP in Finland. Mesh surgeries have also decreased, largely due to concerns about long-term mesh-related complications ⁸² and official advisories restricting vaginal mesh use in several countries ⁸³.

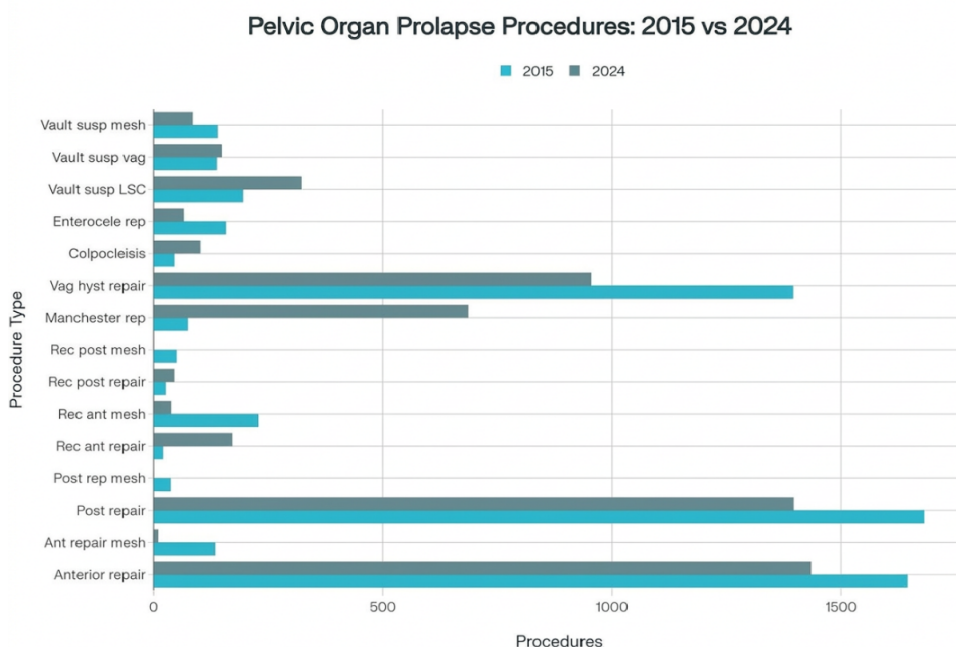


Figure 5. POP procedure volumes by type in Finland in 2015 and 2024. Susp suspension, LSC laparoscopic, Rep repair, Vag hyst repair vaginal hysterectomy with concurrent POP repairs, Rec recurrent, Post posterior, Ant anterior.

2.2.3 Risk Factors and Pathophysiology

The risk factors can be classified into three categories: acute trauma (obstetric and surgical), chronic structural compromise (mechanical and degenerative), and factors that reflect an underlying predisposition (genetic and connective tissue disorders). These factors contribute to both the development of de novo POP and the risk of recurrence, with recurrence risk often emphasizing prior treatment and tissue weakness.

Most primary POP cases are attributed to a combination of pregnancy, vaginal childbirth, genetic factors, and the age-related weakening of pelvic floor tissues ⁸⁴. High parity significantly increases POP risk, which is reported to be over ten times higher (RR 10.85) in women with high parity (n=17,032) compared to nulliparous women ⁸⁵. Forceps delivery and the first vaginal birth have been identified as specific risk factors for both anatomic and symptomatic POP, while nulliparity and delivery by cesarean section only are strongly protective ^{84,86}. Vaginal delivery contributes to POP pathology through potential mechanisms including LAM injury, nerve and perineal trauma, progressive decrease in pelvic floor muscle strength, and damage to connective tissue ^{20,84,87–89}.

Advanced age is a critical factor, with each additional year contributing to a 10% increase in POP risk ⁸⁴. This is reflected in the prevalence of bothersome symptoms, which are highest in the oldest age groups. While postmenopausal status is also associated with POP risk, its effect is difficult to isolate from the concomitant factor of age ⁸⁴.

Factors that chronically increase intra-abdominal pressure, such as obesity, chronic constipation, strenuous physical labor, and persistent cough, are associated with elevated POP risk ^{90–92}. Women with a BMI over 30 experience more than a 50% higher initial POP risk compared to those of normal weight ⁹³. However, obesity does not appear to significantly increase the risk of recurrence after surgical repair ^{26,94}.

A strong family history of POP (first-degree relative) increases the risk of de novo POP (OR2.3-2.7) and recurrence (OR1.4) ⁹⁵, which may be linked to genetic variations affecting in connective tissue and sex hormone activity ⁹⁶. Connective tissue disorders like joint hypermobility, Ehlers-Danlos or Marfan syndrome indicate inherently weaker tissues, predisposing even young, nulliparous women to POP ^{12,90,97}.

Hysterectomy treats POP surgically but also raises the risk of subsequent POP ^{8,9,12,13,85}, especially in the posterior compartment ^{13,55}. This paradoxical relationship complicates its use in POP management. Previous studies indicate that vaginal vault prolapse occurred 9–13 years post-hysterectomy in 11.6% of women operated for POP, compared with 1.8% of those hysterectomized for other benign indications ⁹⁸. However, more recent evidence complicates this view, suggesting that concomitant hysterectomy during prolapse repair may be

associated with a lower rate of POP recurrence (HR 0.51)¹⁷. Cuff suspension during hysterectomy (e.g., McCall culdoplasty, uterosacral ligament suspension) may slightly reduce the risk of apical vault prolapse after hysterectomy, but evidence for overall POP prevention is mixed and not consistently significant^{56,99}. Additionally, hysterectomy technique shows no major difference in subsequent POP risk after adjustment for confounders.^{13,100}

Risk factors specifically linked to POP recurrence include systemic comorbidities (such as obesity, diabetes, and chronic cardiac or respiratory disease), younger age, levator ani muscle defects, larger levator hiatal area, advanced preoperative prolapse stage (Stage 3 or 4), family history of prolapse, and previous POP surgery^{17,20,101,102}.

2.2.4 Pelvic Floor Symptoms

Women with POP experience a range of symptoms including protrusion symptoms (vaginal bulging, pelvic heaviness, and backache), lower urinary tract symptoms (LUTS), bowel symptoms, and sexual difficulties that vary by prolapse type and severity (Table 4)^{103–106}. Apart from vaginal bulging, most prolapse symptoms are nonspecific and can occur even in women without anatomical prolapse^{106,107}. However, 6-35% of women without anatomical prolapse report bothersome bulge symptoms^{79,108,109}.

The sensation of vaginal bulging is the most specific symptom of prolapse, with up to 99% specificity, and becomes more pronounced as prolapse extends beyond the vaginal opening (Table 4)^{68,76}. A reported bulge accurately predicts anatomical prolapse in 81% of cases, making patient-reported symptoms a reliable indicator of significant prolapse, though other symptoms correlate poorly with examination findings^{67,110}. The presence of prolapse beyond the hymen is the strongest predictor of symptom improvement after surgery²⁷.

Table 4. POP associated symptoms and prevalence in POP. SUI stress urinary incontinence, MUI mixed urinary incontinence, UUI urgency urinary incontinence, OAB overactive bladder, IUC international urogynecological consultation.

Study Setting (n)	Symptom Category	Specific Symptom	Rate in POP %	Clinical Notes
IUC review of 29 studies (n=71,000) ⁷⁶ , Review ⁶⁸ , Prospective cohort (n=3,515) ²⁷	Protrusion Symptoms	Vaginal bulge	25–65	99% specificity; strongest predictor
Systematic review of 41 studies (n=11,141) ¹⁰⁶ , Retrospective cohort study (n=3,515) ¹¹¹	Bowel Symptoms	Obstructed defecation	23–41	Most characteristic of posterior prolapse
Systematic review of 41 studies (n=11,141) ¹⁰⁶ , Prospective cohort n=237 ¹¹² , Retrospective cohort (n=3,515) ¹¹¹	Bowel Symptoms	Straining to pass stool	17–51	Common with rectocele
Systematic review of 41 studies (n=11,141) ¹⁰⁶ , Prospective cohort n=237 ¹¹² , Retrospective cohort (n=3,515) ¹¹¹	Bowel Symptoms	Incomplete evacuation	33–57	Correlates with posterior wall prolapse
Systematic review of 41 studies (n=11,141) ¹⁰⁶ , Prospective cohort n=237 ¹¹² , Retrospective cohort (n=3,515) ¹¹¹	Bowel Symptoms	Vaginal splinting for defecation	8–49	Highly specific for posterior compartment
Systematic review of 41 studies (n=11,141) ¹⁰⁶ , Prospective cohort (n=237) ¹¹² , Prospective cohort (n=223) ¹¹³	Bowel Symptoms	Constipation requiring laxatives	12–31	May be cause or consequence
Systematic review of 43 studies (n=11,262) ¹⁰⁶ , Systematic review of 25 studies n=1,855, ¹¹⁴ Prospective cohort (n=237) ¹¹² , Prospective cohort (n=223) ¹¹³	Urinary Storage	SUI	13–53	May be masked by severe prolapse, cured 48–61%, de novo SUI after POP surgery 1–43%
Systematic review of 43 studies (n=11,262) ¹⁰⁶ , Prospective cohort n=237 ¹¹²	Urinary Storage	UUI	5–47	Common with anterior/apical prolapse
Systematic review of 43 studies (n=11,262) ¹⁰⁶ , Systematic review of 9 studies (n=13,540) ¹¹⁵ , Prospective cohort (n=237) ¹¹² , Prospective cohort (n=6,000) ¹¹⁶ ,	Urinary Storage	MUI	18–73	Combination of SUI and UUI

Study Setting (n)	Symptom Category	Specific Symptom	Rate in POP %	Clinical Notes
Prospective cohort (n=2,933) ¹¹⁷				
Systematic review of 43 studies (n=11,262) ¹⁰⁶ , Systematic review of 63 studies (n=n/a) ¹¹⁸ , Systematic review 25 studies (n=1,855) ¹¹⁴ , Prospective cohort (n=237) ¹¹²	Urinary Storage	OAB (frequency, urgency, nocturia)	31–86	After POP surgery symptom reduction 8–69%, de novo symptoms 5–22%
Systematic review of 43 studies (n=11,262) ¹⁰⁶	Urinary Voiding	Voiding difficulties	6–60	Correlates with advanced prolapse; majority improve after surgery
Systematic review of 8 studies (n=1,677) ¹¹⁹	Urinary Voiding	Recurrent UTI	21	Associated with incomplete emptying
Systematic review of 8 studies (n=1,677) ¹¹⁹	Urinary Voiding	Hydronephrosis	10–16	Seen in advanced prolapse stages
Systematic review of 67 studies n=11,076 ¹⁰⁶	Sexual dysfunction	Dyspareunia, obstructive symptoms	30–73	Obstructive symptoms being the most prevalent

Posterior prolapse associate with bowel-related symptoms, particularly obstructed defecation including straining, incomplete evacuation, and vaginal splinting to facilitate bowel movements (Table 4) ^{106,111}. Posterior prolapse related constipation requiring laxatives affects one in ten of patients, while fecal incontinence and urgency are less common ¹⁰⁶. Although obstructed defecation correlates most strongly with posterior prolapse, the association between prolapse severity and all defecatory symptoms remains inconsistent ^{111,112}. Internal rectal intussusception and posterior vaginal prolapse are frequently concomitant findings (nearly 50% of patients), often confusing the diagnosis because their symptoms (incomplete evacuation, urge to defecate, pelvic pressure, digitation and mucous discharge) overlap significantly. ¹²⁰

LUTS are common in women with prolapse and include storage symptoms (stress incontinence, urgency, frequency) and voiding symptoms (weak stream, hesitancy, incomplete emptying, splinting) (Table 4) ¹⁰⁶.

Advanced anterior/apical compartments prolapse correlates most consistently with voiding difficulties while paradoxically, severe prolapse may mask stress

incontinence by kinking the urethra ^{106,112,113}. Voiding difficulties may result in elevated postvoid residuals, recurrent UTIs and urinary retention (Barber et al 2005). Meta-analysis shows 54% of women with prolapse have storage symptoms, with hydronephrosis affecting 10-16% of advanced cases (Table 4) ^{106,119}.

POP impairs sexual function through both physical (dyspareunia, vaginal looseness, mechanical obstruction) and psychological factors (embarrassment, poor body image, low desire) ¹²¹⁻¹²³. Obstruction caused by POP is the most reported symptom of sexual dysfunction (37-100%) and 32% of women with POP avoid intercourse due to vaginal bulging, compared with 5% of women without POP ¹⁰⁶. Women with POP also report reduced arousal, less frequent orgasm, and more dyspareunia, though anatomical severity does not always correlate with sexual dysfunction ¹²⁴. Beyond sex, POP has a major negative impact on general wellbeing limiting daily activities and exercise ^{125,126}.

2.2.5 Non-Surgical Treatment

Treatment options include information, observation, lifestyle modifications (such as weight loss and minimizing constipation and straining), pelvic floor muscle therapy (PFMT), pessary use, and surgical intervention. Treatment choice depends on age, fertility plans, sexual function, symptom severity, comorbidities, and the affected compartment. The main goals are symptom relief, preservation of sexual function, prevention of new support or continence issues, and restoration of pelvic support.

Observation is appropriate for mild or asymptomatic cases, as most symptoms do not occur until prolapse extends beyond the vaginal opening ¹²⁷. Based on established medical literature ^{22,128}, the natural history of POP is highly variable and not always a straightforward progression. While many women with advanced age and stage of POP experience a worsening of the condition over time ²³, it can also remain stable for long periods or even improve spontaneously in women with mild prolapse ²² or in the postpartum period ¹²⁹.

Vaginal pessaries function as internal supports for the vaginal walls and apex. Observational studies have shown that pessaries may improve symptoms ¹³⁰. Pessaries are classified into two main categories: support types, such as the ring or ring with support, and space-filling types, like the Gellhorn or cube ^{131,132}. Pessaries are suitable for all prolapse stages, restore anatomy, prevent progression, and postpone surgery; 85% of women are successfully fitted ¹³³. However, there may be an increased risk of adverse events with pessaries, such as increased vaginal discharge and bleeding (10-30%), urinary symptoms (17-61%) and erosion or irritation (7-45%) of the vaginal walls compared to PFMT or no treatment ^{130,133-135}.

PFMT is an effective conservative therapy for improving symptoms and quality of life in women with POP, especially those with mild to moderate prolapse^{133,136,137}. Evidence for anatomical improvement and benefits as a supplement to surgical management is less conclusive. Eleven RCTs show that PFMT helps reduce prolapse symptoms and improve POP stage in women with stage I–III POP. However, nine out of ten RCTs found no benefit from adding PFMT before or after prolapse surgery¹³⁸ corresponding with prior studies^{139,140}. Long-term results are limited and mixed likely due to the challenge of maintaining motivation after direct supervision ends¹³⁸.

2.2.6 Surgical Treatment and Outcome Assessment

Surgical management is a primary option for women with symptomatic POP who have failed or declined conservative treatments. Procedures are broadly categorized into reconstructive surgery, which aims to restore normal anatomy, and obliterative surgery, which closes off the vaginal canal. The restoration of normal anatomy can be made with native tissue repair or with abdominal or vaginal mesh augmentations.

Outcome assessment

While anatomical correction (POP-Q Stage 0-2) has traditionally defined surgical success, there is growing consensus that patient-reported outcomes are equally or more valid endpoints for assessing efficacy. The International Urogynecological Consultation (IUC) Group 4.1 now recommends defining success primarily by the absence of bothersome bulge symptoms or need for retreatment, while anatomical outcomes should always be reported but never used as the sole measure of success¹⁴¹. Composite outcomes should be avoided, as they overestimate failure rates and are difficult to interpret^{68,142,143}. Current best practice emphasizes comparing treatments using continuous patient-reported outcome measures (PROMs) for symptom severity and quality of life, alongside reoperation and complication rates, rather than dichotomizing results into success or failure (Table 5)^{68,144}. This approach, which includes measuring maximum vaginal descent in centimetres (SLmax)¹⁴⁵, provides a more nuanced and clinically meaningful assessment of surgical outcomes.

Table 5. Recommendations how to evaluate and report the success of surgical repair for pelvic organ prolapse.

Category	Recommendation Details
Anatomical Outcomes	Report POP-Q points and staging; assessments should be prospective and blinded.
Prolapse Surgery	a) primary surgery
	b) repeat surgery with site-specific classification
	c) complications
	d) other surgeries
Functional Outcomes	Use validated symptom questionnaires and condition-specific HRQOL instruments.
Sexual Function	a) validated condition-specific HRQL instruments
	b) validated sexual function questionnaires (PISQ/SF)
	c) pre- and postoperative sexual activity status (sexually active without pain, sexually active with pain, or not sexually active)

2.2.6.1 Approaches

Anterior repair

Anterior compartment prolapse is the most common type of POP, occurring in 54–79% of women undergoing POP surgery ^{146,147}. A native tissue repair is considered as a first-line treatment for primary anterior compartment prolapse ^{66,148}. It is mostly performed by placing sutures that plicate the vesicovaginal fascia in the midline ⁶⁶ although extensive variability in the literature and in practice exists ¹⁴⁸. Transvaginal mesh was developed to maintain the advantage of a vaginal procedure, while reducing the risk of recurrent prolapse compared with native tissue repair. Synthetic non-absorbable mesh for a recurrent anterior prolapse may be considered as a treatment option while biological graft repair or absorbable mesh provides minimal advantage compared with native tissue repair ¹⁴⁹.

Native tissue repair, although associated with lower success rates when using composite definition of success (awareness of prolapse, repeat surgery for prolapse and prolapse on examination) and compared with mesh-augmented repair, is effective for relieving vaginal bulge symptoms and reducing prolapse within the vagina ^{149–151}. Additionally, it is associated with reduced risk of de-novo SUI, bladder injury and repeat surgery for POP, SUI and mesh exposure (as a composite outcome ¹⁴⁹.

According to the Cochrane review ¹⁴⁹ permanent mesh reduces prolapse awareness from 19% to 10–15% and recurrent prolapse on examination from 38%

to 11-20% compared to native tissue repair. However, mesh increases reoperation risks from 5% to 7-18%, with 8% of mesh patients requiring surgery specifically for mesh complications. Most studies have evaluated mesh types that are no longer available on the market because of the FDA safety alerts concerning pain and dyspareunia⁸³. They have been replaced by new lighter mesh which lack evidence of safety, although few studies exist with promising data¹⁵²⁻¹⁵⁵.

Posterior repair

Surgical management of posterior wall prolapse can be made transvaginally and transanally. Prior literature favour transvaginal repair with better outcomes^{144,156-159}. The repair techniques for posterior compartment prolapse are midline fascial plication (posterior colporrhaphy), site-specific repair, and in combined apical and posterior prolapses sacrocolpopexy with concomitant ventral rectopexy¹⁴⁴. Perineorrhaphy may be performed concurrently^{73,160} and its importance may have been underestimated over time^{66,73,161-163}, since the distal support of the posterior vaginal wall (level III) is primarily provided by the perineum¹⁶⁴.

Evidence does not support using vaginal mesh or biological grafts at the time of posterior vaginal repair^{144,158}. In the Cochrane review recurrent posterior prolapse was found in 13% of women on examination after native tissue repair while 4%-13% are likely to have recurrent prolapse after biological graft¹⁵⁸. In the synthetic graft group 7% of women had a mesh exposure but no difference was found between adverse events nor objective or subjective cure rates.

Enterocoele may be concomitant with uterovaginal prolapse or, more frequently, associated with vaginal cuff descensus¹⁶⁵. There is a lack of consensus regarding the optimal surgical management. However, surgical principles include removal of the hernial sac and support of the vaginal cuff by reapproximating pubocervical and rectovaginal fascias and reattaching them to the suspensory cardinal uterosacral complex to close the hernial port¹⁶⁶.

Ventral rectopexy combined with sacral colpopexy, utilizing mesh extended to the posterior vaginal wall or perineum, effectively treats multicompartment prolapse^{144,167,168}. Although the abdominal route was traditional, minimally invasive techniques now offer improved outcomes with a comparable safety profile¹⁶⁸⁻¹⁷¹. High-quality comparative data are limited, but two studies indicate that vaginal or perineal approaches do not elevate the risk of age-adjusted postoperative complications compared to abdominal surgery^{172,173}.

Apical repair

Evidence from systematic reviews suggests that apical support status is a significant factor in determining overall surgical outcomes following pelvic reconstructive surgery, not only for the apex but also for the anterior and posterior compartments ^{127,174}. The primary options can be broadly categorized into vaginal native tissue repairs, abdominal or mesh-augmented procedures, and obliterative surgeries (colpocleisis).

Abdominal or laparoscopic sacrocolpopexy (LSCP), which suspends the vaginal apex to the sacrum with mesh, has traditionally been the standard for apical support, though alternative techniques such as uterosacral ligament suspension (USLS), sacrospinous ligament fixation (SSLF) and laparoscopic pectopexy have also demonstrated efficacy ^{175–178}. SSLF uses an extraperitoneal approach to suspend the vaginal apex to the sacrospinous ligament, while pectopexy and USLS employ an intraperitoneal approach to bilaterally attach the apex to the iliopectineal ligaments or the proximal uterosacral ligaments. Laparoscopic USLS (L-USLS) is increasingly favoured due to improved visualization, higher ligament attachment points, and reduced ureteral injury risk compared to vaginal USLS, with no difference in recurrence rates ^{179–181}. Randomized trials show comparable outcomes between transvaginal USLS and SSLF ^{182,183} as well as between pectopexy and LSCP ¹⁸⁴, while a recent cohort study of 4,098 women found colpocleisis had the lowest reoperation rate among apical prolapse procedures ¹⁸⁵ (Figure 6).

Comparing Surgical Procedures: 7-Year Reoperation Risk

Not all surgeries are equal. Long-term data from older women reveal distinct risk profiles for the most common apical suspension procedures, guiding the choice between native tissue and other repairs.

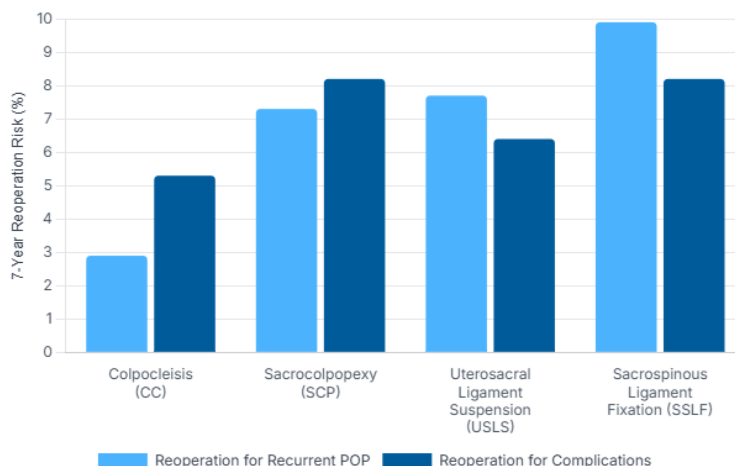


Figure 6. Reoperation risk after apical prolapse procedures in women aged 65 years and older. (Berger et al. 2024).

A recent Cochrane review ¹⁷⁶ reported an increased risk of both subjective failure (18% vs. 8%) and objective failure (23-47% vs. 18%) for vaginal suspension compared to LSCP. The review also noted a higher reoperation risk (14% vs. 6%) with the vaginal approach. In contrast, another recent review ¹⁸⁶ found no significant difference in subjective outcomes or reoperation rates at 1-5 years of follow-up. However, they did find that the vaginal approach was associated with a higher risk of subsequent anterior and apical recurrence.

In Finland, the Manchester procedure became the leading surgical treatment for uterine prolapse in 2024, replacing vaginal hysterectomy, which had been most common in 2015 ³⁴. Uterus-preserving options, including vaginal and laparoscopic hysteropexy as well as the Manchester procedure, have also gained international acceptance ¹⁸⁷⁻¹⁹⁰. Studies show comparable one-year cure rates and high patient satisfaction for laparoscopic sacral and vaginal mesh hysteropexy ¹⁹¹. Evidence from randomized, cohort, and registry studies suggests sacrospinous hysteropexy is less effective than the Manchester procedure ^{187,190,192,193}. However, limited randomized trial data comparing hysteropexy with hysterectomy indicate no meaningful differences in clinical outcomes ^{144,176,194}.

2.2.6.2 Risk of Recurrence

There is no agreed definition for recurrent POP ¹⁹⁵. Recurrence may involve the originally treated compartment (direct) or a different site (indirect) and often co-occurs with pelvic floor disorders such as SUI. Notably, recurrent symptoms are best correlated with a leading edge extending at least 1 cm beyond hymen ¹⁹⁶. Thus, recurrent POP may be defined objectively as prolapse below the hymenal level (POP-Q stage $\geq 2b$), and subjectively as the presence of POP related symptoms ¹⁹⁵.

The estimated recurrence rates following surgery for POP vary by compartment (Table 6). Anterior compartment repairs are the most frequent reoperations, followed by procedures for vaginal vault and posterior compartment prolapse ^{182,197,198}. Additionally, follow-up time impacts reoperation rates for POP: risk accumulates over time, yet most events (50–70%) occur within the first 1–2 years, after which it plateaus ¹⁹⁹. Short-term follow-up (under 1–2 years) may underestimate total risk compared to long-term.

Table 6. Recurrence and reoperation rates for POP surgery.

Study Type	Rate	Details
Cochrane review of RCT's (n=3,332) ¹⁴⁹ , Prospective follow-up (n=121) ²⁵ , Prospective follow-up (n=82) ²⁰⁰ , Retrospective cohort (n=18,382) ¹⁹⁷ , Retrospective cohort (n=207) ²⁰¹	2–45 %	Anterior compartment: Highest recurrence rate, reoperations 2–12%, recurrences 27–45%
Cochrane review of RCT's (n=1,099) ¹⁵⁸	4–13 %	Posterior compartment: Reoperation and recurrence rate
Cochrane review of RCT's (n=6,705) ¹⁷⁶	1–63 %	Apical compartment: Reoperation rate after vaginal surgery 8–25%, after sacrocolpopexy 6%, Recurrence rate 23–63 %
Prospective FINPOP cohort (n=3,535) ²⁷	25 %	Overall reoperation rate: 17 % same compartment, 8 % different
Prospective cohort (n=374) ¹⁰¹	17 %	Overall POP and UI reoperation rate
Retrospective cohort (n=149,554) ¹²⁸	29 %	Overall POP and UI reoperation rate
Finnish retrospective cohort (n=77,906) ¹⁸	10 %	National lifetime risk for reoperation
Retrospective cohort (n=11,805) ¹⁹⁷	11.5 %	Overall POP reoperation rate in the same compartment

Failure to identify and correct all pelvic floor defects in primary surgery is associated with a higher incidence of recurrent POP^{187,198}. Vaginal vault recurrence implicates a failure to adequately secure the vaginal apex (Level I support) at the time of the initial surgery⁸⁹. Additionally, loss of apical support is a direct and frequent cause of subsequent anterior and posterior vaginal wall prolapse^{202,203}.

In clinical studies manual elevating the vaginal apex during a pelvic examination correct a significant percentage of anterior (55%) and posterior compartment defects (30%)²⁰². This emphasizes the critical importance of re-establishing apical support at the time of hysterectomy for prolapse²⁰⁴. However, despite this knowledge data from US show that between 2002-2012 approximately 60% of all uterovaginal POP procedures were performed without apical suspension²⁰⁵. The reason for this is likely multifactorial and may be due to surgeon's training (general gynaecologist vs. urogynaecologist), primary indication for hysterectomy (POP vs. non-POP), and time pressure. Finnish data on apical suspension procedures are unavailable, despite the likelihood that these procedures are commonly performed during hysterectomy.

2.2.6.3 Impact of POP Surgery on QoL and Patient Satisfaction

The development of POP and POP symptoms disrupts the QoL²⁰⁶. Among women with POP QoL was worse than that of the age-standardized population^{27,207}. Additionally, worsening body image correlated with lower QoL on both the physical and mental scales of the SF-12 (12-item Short Form health survey)²⁰⁷. Surgical correction of prolapse restores anatomical support and relieves POP symptoms leading to clear, statistically and clinically significant improvements in short-term patient-reported QoL and very high satisfaction rates (over 90%)^{27,208}. Most patients (over 70%) report their condition to be improved after surgical POP treatment in dimensions of sexual activity, excretion and discomfort, symptoms and in general HRQoL^{27,207-209}. Dissatisfaction and remaining symptoms are associated with recurrent prolapse or pre-existing co-morbid symptoms.

Roos et al.¹²² found that only 17% of women with POP and UI were completely satisfied about their sex life. Both POP and UI had a negative effect on body image. Women with POP had a negative image of their vagina, which caused them to be insecure about their partner's sexual experience, while women with UI were embarrassed about their incontinence and pad use and feared smelling of urine. These factors contribute to the higher sexual dysfunction rates among women with pelvic floor disorders (50-83%) compared to the general population (30-50%)²¹⁰. Improvement in sexual function is a primary goal for women undergoing pelvic organ prolapse surgery, with nearly 60% identifying it as the

most important functional outcome preoperatively. However, fewer than 40% achieve this goal after surgery.²¹¹

2.2.6.4 Patient-Reported Outcomes and Outcome Measures (PROM)

A patient-reported outcomes (PRO) is defined as “any report of the status of a patient’s health condition that comes directly from the patient, without interpretation of the patient’s response by a clinician or anyone else”²¹². A PROM is the tool or standardized questionnaire used to collect the data on symptoms, HRQoL and functional status. PROMs can be generic or disease-specific and both should be used to assess treatment efficacy, quality of care and inform health policies²¹³. To function effectively as a quality-of-care instrument, the PRO must capture patient-reported symptoms, such as fecal incontinence, urinary incontinence, constipation, lower urinary tract symptoms, and sexual dysfunction.

There has been the lack of consensus among clinicians and researchers regarding which instruments should be used and reported in research publications. Recent systematic review¹⁷⁵ identified a wide variation in outcomes and outcome measures for apical prolapse in the selected trials. Efficacy of the procedure was evaluated by recurrence of prolapse (14 studies; 45%) and the need for reoperation for prolapse (17 studies; 55%). Patient satisfaction was evaluated only in eight (26%) studies. The most common disease-specific questionnaire for QoL was the Pelvic Floor Distress Inventory (PFDI) (8 studies; 26%), followed by the Urinary Distress Inventory (UDI) (6 studies; 19%). Finnish versions of these questionnaires have been validated, and for the PFDI-20 and POPDI-6 (Pelvic Organ Prolapse Distress Inventory 6) clinically meaningful threshold values have been established²¹⁴.

Lukacz et al.²¹⁵ assessed the validity of Visual Analog Scales (VAS) in urogynecologic research and its ability to measure patient satisfaction. A questionnaire included the short forms of the Urogenital Distress Inventory (UDI-6), Incontinence Impact Questionnaire (IIQ-7)¹ and Beck depression inventory–fast screen (BDI-FS). The latter was included to evaluate the generalizability of the VAS format because it is a well-validated 4-point Likert-type scale that assesses a different condition than the UDI-6 and the IIQ-7. They demonstrated that the VAS method shows similar reliability to Likert-type responses in both the UDI-6 and IIQ-7 questionnaires.

3 Aims of the Study

This dissertation evaluated the risk and recurrence of POP after hysterectomy and identified key risk factors including surgical approach. It also assessed patient satisfaction and complication rates, analyzing their impact on long-term outcomes. The specific aims of the individual studies were:

- I To estimate the long-term risk of POP operations and visits after hysterectomy for non-prolapse indications and to identify associated risk factors and the type of the POP
- II To estimate the long-term risk of POP reoperations and re-visits after hysterectomy for POP and to identify associated risk factors and the type of the recurrence
- III To assess the short- and long-term patient satisfaction after hysterectomy due to POP and non-POP indications, to identify complications, de novo pelvic floor symptoms and patient-satisfaction associated risk factors

4 Materials and Methods

4.1 Study Design and Setting

This thesis used data from the prospective FINHYST cohort of 5,279 women with hysterectomy for benign indications, representing 79% of all such procedures in Finland in 2006 ⁶. The cohort was subsequently linked to the Finnish Care Register maintained by the Finnish Institute for Health and Welfare. Women included in the studies were followed through the registers (Studies I, II and III), and with the follow-up questionnaires at two months and at ten years (Study III). Flowchart of the studies I-III is presented in Figure 7.

The FINHYST study evaluated the trends in hysterectomy in Finland, incidences and risk factors for complications. The study comprised all 46 public hospitals (five university clinics, 16 central hospitals, 23 local hospitals) and 7 private clinics. The latter covered only 1.3% of all hysterectomies. The FINHYST cohort was included in the ClinicalTrials.gov protocol and written informed consent was obtained from each patient.

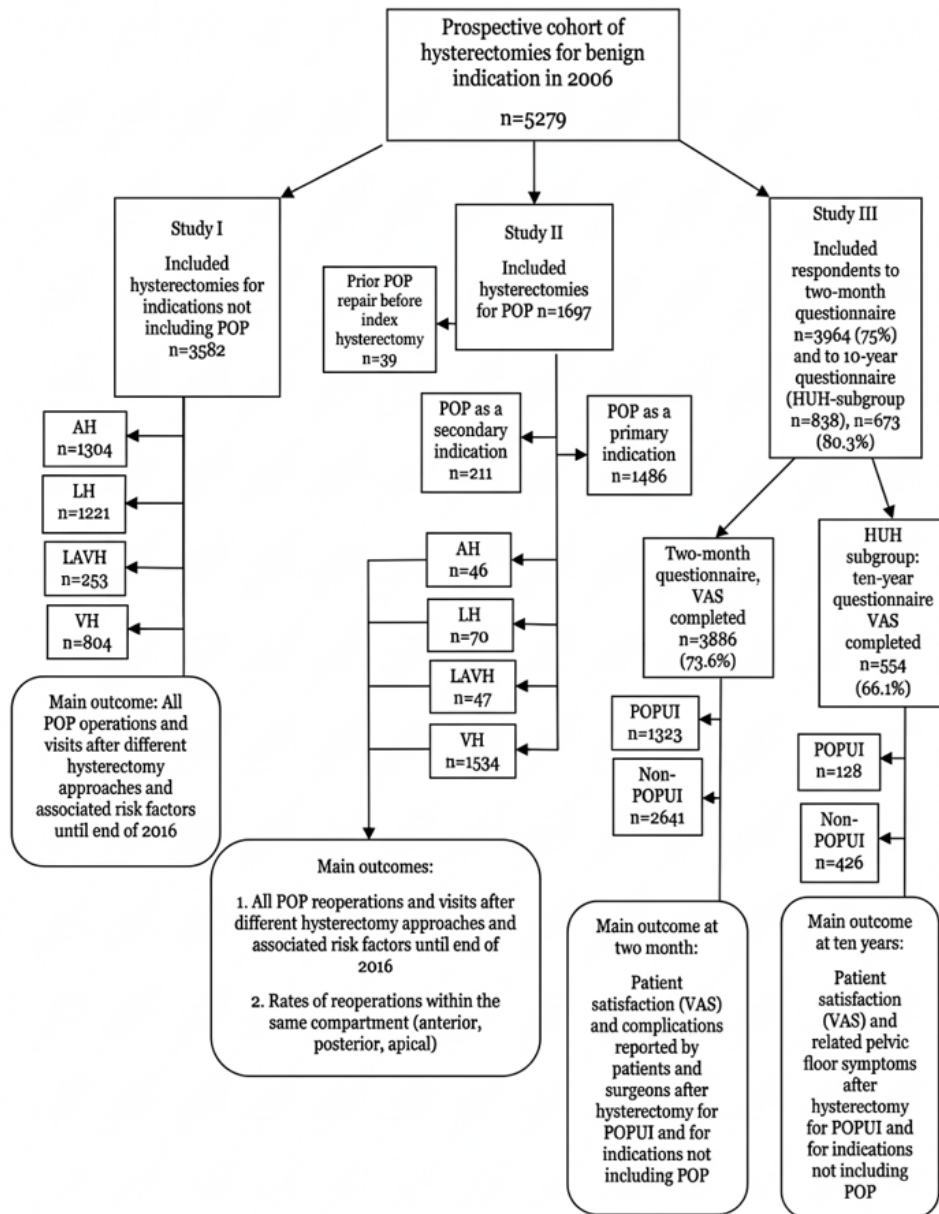


Figure 7. Flowchart of the studies I-III. AH abdominal hysterectomy, LH, laparoscopic hysterectomy, LAVH laparoscopic assisted vaginal hysterectomy, VH vaginal hysterectomy, POP pelvic organ prolapse, VAS visual analog scale, HUH Helsinki University Hospital, UI urinary incontinence.

4.2 Data Sources and Collection

We used register data and questionnaires. All surgeons completed paper questionnaires which covered patient characteristics, surgical details, complications and main indication (fibroids, menorrhagia, dysmenorrhea, endometriosis, uterine prolapse, adnexal mass and other) immediately after surgery and after discharge at follow-up outpatient visits ⁶. Surgeons provided diagnosis but not the stage of the prolapse nor the method of vaginal vault suspension ⁶. The approach of hysterectomy—AH (including both total and subtotal hysterectomies and conversions), LH, LAVH, VH—was chosen by the surgeon based on patient factors and local practice.

The study I included 3,582 (68%) out of 5,279 women who underwent hysterectomy for benign, non-prolapse indications. Women with previous POP diagnoses or surgeries were excluded (n=1697). Post-hysterectomy operations and outpatient clinical visits for POP were followed up until the end of year 2016.

The study II included 1,697 (32%) women with prior diagnosis and/or operation of POP or POP as the indication for hysterectomy and excluded those without POP (n=3582). Post-hysterectomy reoperations and outpatient clinical visits for recurrent POP were followed up until the end of year 2016.

In study III, all patients (n=5,279) were sent a postoperative questionnaire two months after surgery, inquiring about satisfaction (measured by a 100mm visual analogue scale, VAS), readmissions, complications, healthcare utilization, and sick leave. For dissatisfaction a cut-off of VAS under 70 was used based on earlier literature estimating that patient satisfaction with the treatment result of ≥ 60 or 80 on VAS from 0–100 was a good outcome ^{216,217}. Surgeons also completed a structured form documenting peri- and postoperative details and complications.

A subgroup of patients from the Helsinki University Hospital district (HUH-subgroup, n=838) received the same two-month questionnaire and in addition, a separate, non-validated postal ten-year questionnaire. This survey addressed long-term urinary and defecation symptoms, prolapse-related symptoms and treatments, pain, sexual activity, additional surgeries, and satisfaction using VAS. Women were asked whether, in retrospect, they would choose hysterectomy again.

For analysis, women who responded to the two-month (n=3,964) and ten-year (n=554, HUH-subgroup) questionnaire were divided into two groups: those with hysterectomy for POP with or without UI surgery (POPUI) and those for other benign indications (Non-POPUI). UI surgery comprises all operations with Tension-free Vaginal Tape (TVT), TVT-obturator (TVT-O) and Trans-Obturator Tape (TOT), Burch procedures were none.

Clinical outcome data of all three studies and data of the FINHYST cohort was linked to the Finnish Care Register. Completeness and accuracy of the register varies from satisfactory to very good with high positive predictive values for common diagnosis ²¹⁸. This register contains information on hospital admission

and discharge dates, diagnoses coded according to the International Classification of diseases (ICD) and operation codes based on the Nordic Classification of Surgical Procedures (NSCP) for all clinical in- and outpatient visits in specialized healthcare facilities throughout Finland. The included POP and UI diagnoses and operation codes were ICD10 N81.*, N39.3, N39.4. and NSCP LEF*codes. This enabled comprehensive assessment of all relevant gynaecological readmissions, outpatient visits, and surgeries from 1996 until the end of 2016. (Table 7).

Table 7. Diagnosis codes (ICD-10) and operation codes (NSCP) found in the cohort and used to identify readmissions, outpatient visits and surgeries from 1996 until the end of 2016.

ICD10		NSCP Code	
N81 *	Female genital prolapse	LEF*	Prolapse repair procedures
N81.0	Urethrocele		
N81.1	Cystocele	LEF00	Anterior repair without mesh
N81.2	Incomplete uterovaginal prolapse	LEF03	Posterior repair without mesh
N81.3	Complete uterovaginal prolapse	LEF04	Combined repair without mesh
N81.4	Uterovaginal prolapse, unspecified	LEF05	Anterior re-repair without mesh
N81.5	Enterocoele	LEF06	Anterior re-repair with mesh
N81.6	Posterior vaginal wall prolapse	LEF08	Repair of enterocoele
N81.8	Other/unspecified POP	LEF09	Posterior re-repair with mesh
N81.9	Other/unspecified POP	LEF96	Other or unspecified vaginal operation for POP
N99.3	Vaginal vault prolapse	LEF51	Laparoscopic vault suspension with mesh
N39 *	Urinary incontinence	LEG*	Procedures for urinary incontinence
N39.3	Stress urinary incontinence	LEG10	Retropubic mid-urethral sling (TVT)
N39.4	Mixed urinary incontinence	LEG12	Transobturator mid-urethral sling (TOT)
N39.8	Other incontinence	LEG13	Transobturator mid-urethral sling (TVT-O)
N39.9	Unspecified incontinence	LEG96	Other or unspecified operation for incontinence

4.3 Outcome Measures and Statistical Analysis

4.3.1 Study I

As the primary outcome the incidence of post-hysterectomy POP surgeries and clinical visits for POP symptoms were recorded at least 60 days after the index hysterectomy, with follow-up ending at the first POP-related event or at the end of 2016.

We also evaluated if POP was associated with hysterectomy approach and patient related factors, such as preceding and concomitant operations, age, BMI, parity, vaginal deliveries, indication, uterus size, some autoimmune disease, chronic obstructive pulmonary disease/asthma, difficulty of the hysterectomy, intra- and perioperative complications, experience of the surgeon and hospital

type. The frequency of pre- and post-hysterectomy UI diagnoses were also assessed.

4.3.2 Study II

To assess the incidence of post-hysterectomy POP reoperations and clinical re-visits for POP symptoms, all women who underwent a hysterectomy in 2006 for POP indication or had some form of POP diagnosis or a concomitant operation code for POP within 10 years before or at time of the hysterectomy, were included from the FINHYST cohort (n=1697).

The primary outcomes were repeat POP surgery and/or clinically diagnosed prolapse at an outpatient visit, occurring at least 60 days after the original hysterectomy. We evaluated both the overall reoperation rate and the rate of reoperations within the same compartment. POP reoperations and diagnoses were categorized into three groups based on the affected compartment (anterior, apical, and posterior). Prolapse cases were classified as apical if the primary surgery addressed uterine prolapse, not solely when sacrospinous fixation procedures were performed. We also calculated the number of second and third reoperations according to different compartments.

The secondary outcomes included the association of subsequent POP with the hysterectomy approach (AH, LH, LAVH and VH) and other surgical (indication, uterus size, complications, experience of the surgeon, operator status, hospital type, prior and concomitant surgeries) and patient-related risk factors (age, BMI, parity, vaginal deliveries, some autoimmune disease, chronic pulmonary disease (COPD) and asthma).

4.3.3 Study III

All women underwent total hysterectomy; those in the POPUI group also had concurrent prolapse repair (anterior/posterior repair, sacrospinous fixation, and/or mesh as appropriate).

Outcomes compared between groups included postoperative (two months) and long-term (ten years) patient satisfaction, complications, new symptoms, and health service utilization (outpatient visits and reoperations for POP from the care register until the end of 2016). In the HUH-subgroup, patient-reported new symptoms and treatments at ten years were compared with registry-based procedures and visits. Factors (age, BMI, parity, hysterectomy approach, infections, complications, inadequate pain relief, working status, pelvic floor symptoms, POP visits and POP reoperations) associated with dissatisfaction were specifically examined.

Statistical analysis

Categorical variables were compared by the Chi-Square or Fisher exact tests, as appropriate. Continuous variables were compared using either the Student's t-test or the Mann–Whitney U test. When comparing more than two groups, the one-way ANOVA was employed and when comparing one continuous and two categorical variables, the two-way ANOVA was used. All patient- and operation-related factors were assessed as potential risk factors using univariate and multivariate Cox regression analyses. The variables found to be significant in univariate models were tested in a multivariate Cox regression model and adjusted with each other. Results were expressed using hazard ratios with 95% confidence intervals. Binary logistic regression model was used to identify independent predictors of visual analogue scale scores under 70. This analysis was performed on factors with a p-value < 0.10 in univariate analysis.

In study III propensity score matching yielded excessive sample reduction and residual imbalance, so we applied inverse probability of treatment weighting (IPTW) for causal estimation. Sensitivity analyses excluded early complications and stratified by hysterectomy route (AH, LH, VH), using generalized linear models adjusted for age, BMI, parity, and occupational status. Multiple imputation was unstable due to high missingness (FMI > 0.78); thus, 10-year HUH-subgroup results report complete-case analysis (n=554).

A significance level of $p < 0.05$ was used for all analyses. Data were analyzed using the SPSS for Windows statistical software versions 26.0- 29.0 (SPSS, Inc., Chicago, IL).

4.4 Ethical Considerations

The FINHYST study protocol was approved by the relevant Finnish ethics committees (the Ethical Committee of the Helsinki and Uusimaa Hospital District Dnro 457/E8/04 and 343/13/03/03/2015) and was registered in the ClinicalTrials (NCT00744172). All women gave written informed consent. The Declaration of Helsinki was followed in all the studies. The use of data from the Care Register in studies I-III was authorized by the national health authorities (Finnish Institute for Health and Welfare), and all data were used in accordance with national and institutional regulations. Institutional approval was obtained from each participating hospital.

5 Results

5.1 Clinical Characteristics

The FINHYST cohort baseline characteristics have been previously documented ⁶. The average age of participants ranged from 52 to 60 years, depending on the subgroup and indication. Two thirds of women were multiparous (majority had one or more vaginal deliveries), and the mean BMI was in the overweight range (around 27–28 kg/m²). The indication rates for hysterectomy were uterine fibroids (33%), POP (28%), abnormal uterine bleeding (21%), adnexal masses (6%) and endometriosis (2%) ⁶. The baseline characteristics for the studies I, II and III are presented in Table 8.

A significant proportion of participants completed the two-month questionnaire in the study III: 75.1% (3964/5279) of all women and 78.0% (1323/1697) of women in the POPUI group and 73.7% (2641/3582) of women in the Non-POPUI group (Figure 7). A proportion of women completing VAS question was 73.6% (3886/5279). In the HUH-subgroup 80.3% (673/838) of the women answered to the two-months questionnaire and 66.1% (554/838) to the ten-year questionnaire (57.7% of women in the POPUI group and 69.2% of women in the Non-POPUI group). Demographically, the POPUI and Non-POPUI women differed significantly in age, parity, hysterectomy method, occupational status, and postoperative complications.

Table 8. Demographics of the study population (studies I-III). AH, abdominal hysterectomy, LH laparoscopic hysterectomy, LAVH laparoscopic assisted vaginal hysterectomy, SUI Stress urinary incontinence, POP pelvic organ prolapse, UI urinary incontinence, BMI body mass index.

	Study I					Study II					Study III		
	All	AH	LH	LAVH	VH	All	AH	LH	LAVH	VH	All	POPUI	Non-POPUI
n (%)	3582 (100)	1304 (36.4)	1221 (34.1)	253 (7.1)	804 (22.4)	1697 (100)	46 (2.7)	70 (4.1)	47 (2.8)	1533 (90.3)	3964 (100)	1323 (33.4)	2641 (66.6)
Age mean (Std)	48.8 (8.1)	49.8 (8.5)	48.6 (8.0)	49.3 ()	46.7 (6.6)	59.2 (11.6)	57.8 (13.0)	55.6 (11.6)	56.8	59.4 (11.6)	52.0 (10.5)	59.1 (11.4)	48.9 (7.9)
BMI mean (Std)	26.5 (5.9)	27.2 (5.3)	25.9 (4.6)	26.2 (4.6)	26.2 (5.0)	26.5 (4.1)	27.1 (5.1)	26.7 (4.9)	26.2 (3.3)	26.5 (4.1)	26.5 (4.7)	26.5 (4.1)	26.5 (4.9)
Parity													
No deliveries n (%)	785 (21.9)	378 (29.0)	303 (24.8)	37 (14.6)	67 (8.3)	102 (6.0)	5 (10.9)	6 (8.6)	2 (4.3)	89 (5.8)	671 (16.9)	79 (6.0)	592 (22.4)
One to two n (%)	1701 (47.5)	552 (42.3)	578 (47.3)	130 (51.4)	441 (54.9)	872 (51.4)	23 (50.0)	35 (50.0)	22 (46.8)	792 (51.6)	2058 (51.9)	681 (51.5)	1377 (52.1)
Three or more n (%)	787 (22.0)	227 (17.4)	238 (19.5)	68 (26.9)	254 (31.6)	708 (41.7)	16 (34.8)	27 (38.6)	22 (46.8)	643 (41.9)	1235 (31.2)	563 (42.6)	672 (25.4)
Hysterectomy Approach													
AH											947 (23.9)	30 (2.3)	917 (34.7)
LH											1234 (31.1)	95 (7.2)	1139 (43.1)
VH											1783 (45.0)	1198 (90.6)	585 (22.2)
Any Complication	420 (11.7)	230 (17.6)	87 (7.1)	28 (11.1)	75 (9.3)	157 (9.3)	14 (30.4)	7 (10.0)	3 (6.4)	133 (8.7)	577 (14.6)	155 (11.7)	422 (16.0)
Employed											152 (3.8)	26 (2.0)	126 (4.8)
Main indication													
Fibroids	1662 (46.4)	768 (58.9)	489 (40.0)	92 (36.4)	313 (38.9)	85 (5.0)	24 (52.2)	17 (24.3)	3 (6.4)	41 (2.7)			
Dysfunctional Uterine Bleeding	1032 (28.8)	192 (14.7)	386 (31.6)	81 (32.0)	373 (46.4)	62 (3.7)	5 (10.9)	10 (14.3)	4 (8.5)	43 (2.8)			
Dysmenorrhea	131 (3.7)	27 (2.1)	51 (4.2)	14 (5.5)	39 (4.9)	11 (0.6)	1 (2.2)	2 (2.9)	2 (4.3)	6 (0.4)			
Endometriosis	125 (3.5)	82 (6.3)	37 (3.0)	5 (2.0)	1 (0.1)	5 (0.3)	2 (4.3)	0 (0.0)	0 (0.0)	3 (0.2)			
Adnexal mass or other	632 (17.6)	235 (18.0)	258 (21.1)	61 (24.1)	78 (9.7)	51 (3.0)	12 (26.1)	19 (27.1)	9 (19.1)	11 (0.7)			
POP						1483 (87.4)	2 (4.3)	22 (31.4)	29 (61.7)	1430 (93.2)			
Uterus size, mean in grams (Std)	286 (295)	427 (419)	209 (143)	215 (138)	200 (131)	103 (94)	296 (280)	171 (106)	136 (84)	94 (73)			
Concomitant operations													
SUI operation	22 (0.6)	1 (0.1)	6 (0.5)	2 (0.8)	13 (1.6)	65 (3.8)	3 (6.5)	3 (4.3)	2 (4.3)	57 (3.7)			
Colporrhaphy anterior						1138 (67.1)	5 (10.9)	24 (34.3)	28 (59.6)	1081 (70.5)			
Colporrhaphy posterior						846 (49.9)	12 (26.1)	28 (40.0)	21 (44.7)	785 (51.2)			
Transvaginal mesh						31 (1.8)	0 (0.0)	0 (0.0)	0 (0.0)	31 (1.8)			
Sacrospinous fixation						37 (2.2)	0 (0.0)	1 (1.4)	1 (2.1)	35 (2.3)			

5.1.1 De Novo and Recurrent POP after Hysterectomy (Study I and II)

During the median 10.6-year follow-up, 1.6% (n=58) of women without pre-existing POP underwent a POP operation, most commonly a posterior repair (1.1%, n=39; Table 9). POP reoperations were markedly more frequent among women with POP at or before index hysterectomy, with 16.5% (n=280) requiring additional surgery. Vaginal vault repair was the predominant reoperation for recurrent prolapse (10.7%, n=181) when primary uterine prolapse was classified as apical.

Outpatient visits for POP symptoms occurred in 2.6% (n=92) of women without prior POP (Study I), compared to 21.2% (n=359) of those with antecedent POP in Study II. In Study I, posterior wall prolapse was the most common diagnosis among women who underwent surgery or had an outpatient visit (1.6%, n=58) for prolapse whereas anterior wall prolapse predominated among re-visits in Study II (12%, n=204). The median time to first POP surgery or visit (Study I), and to POP reoperation or re-visit (Study II), was six years and three to four years after hysterectomy, respectively.

Table 9. Incidence of prolapse repair, reoperations and visits after hysterectomy (Studies I and II). POP pelvic organ prolapse.

Operation type/ Compartment	POP Operation n (%)	POP Visit n (%)	POP Reoperation n (%)	POP Visit n (%)
	n=3582 (%) Study I	n=3582 (%) Study I	n=1697 (%) Study II	n=1697 (%) Study II
Any (overall)	58 (1.6)	92 (2.6)	280 (16.5)	359 (21.2)
Anterior	24 (0.7)	35 (1.0)	120 (7.1)	204 (12.0)
Posterior	39 (1.1)	58 (1.6)	76 (4.5)	112 (6.6)
Vaginal vault	11 (0.3)	20 (0.6)	181 (10.7)	186 (11.0)

In the Study I, the women with LAVH underwent post-hysterectomy POP operation (n=9, 3.6%) more often than those with AH and experienced post-hysterectomy vaginal vault prolapse (n=5, 2.0%) more often than those

undergoing any other hysterectomy approach (Table 10). In contrast, hysterectomy approach did not significantly affect reoperation or visit rates in Study II, although LH showed the highest (non-significant) rates (Table 10).

Table 10. Rates of de novo and recurrent prolapse repairs according to prolapse compartments and hysterectomy approach (Studies I and II). AH abdominal hysterectomy, LH laparoscopic hysterectomy, LAVH laparoscopic assisted vaginal hysterectomy, VH vaginal hysterectomy.

Repair Type	AH	LH	LAVH	VH	P value
Study I n=3582 (%)					
Any prolapse repair	12 (0.9)	19 (1.6)	9 (3.6)	18 (2.2)	0.01
Anterior repair	6 (0.5)	9 (0.7)	2 (0.8)	7 (0.9)	0.69
Posterior repair	7 (0.5)	14 (1.1)	5 (2.0)	13 (1.6)	0.05
Vaginal vault repair	1 (0.1)	1 (0.1)	5 (2.0)	4 (0.5)	<0.01
Study II n=1697 (%)					
Any prolapse re-repair	6 (13.0)	15 (21.4)	6 (12.8)	253 (16.5)	0.55
Anterior re-repair	3 (6.5)	8 (11.4)	3 (6.4)	106 (6.9)	0.55
Posterior re-repair	2 (4.3)	6 (8.6)	1 (2.1)	67 (4.4)	0.34
Vaginal vault re-repair	3 (6.5)	9 (12.9)	3 (6.4)	166 (10.8)	0.55

Of women who underwent de novo POP surgery, 29.1% required more than one procedure. Of women with recurrent POP surgery, 8.2% (n=23) required a second reoperation, primarily for vaginal vault repair, and 1.1% of these women (n=3) had a third reoperation.

Reoperations associated mostly 68% with the same compartment that had been repaired concurrently with the hysterectomy. Multicompartment reoperations were most common (11.2%), while among isolated compartments, apical prolapse (prior uterine prolapse or enteroceles) had the highest reoperation rate (8.8%) (Figure 8).

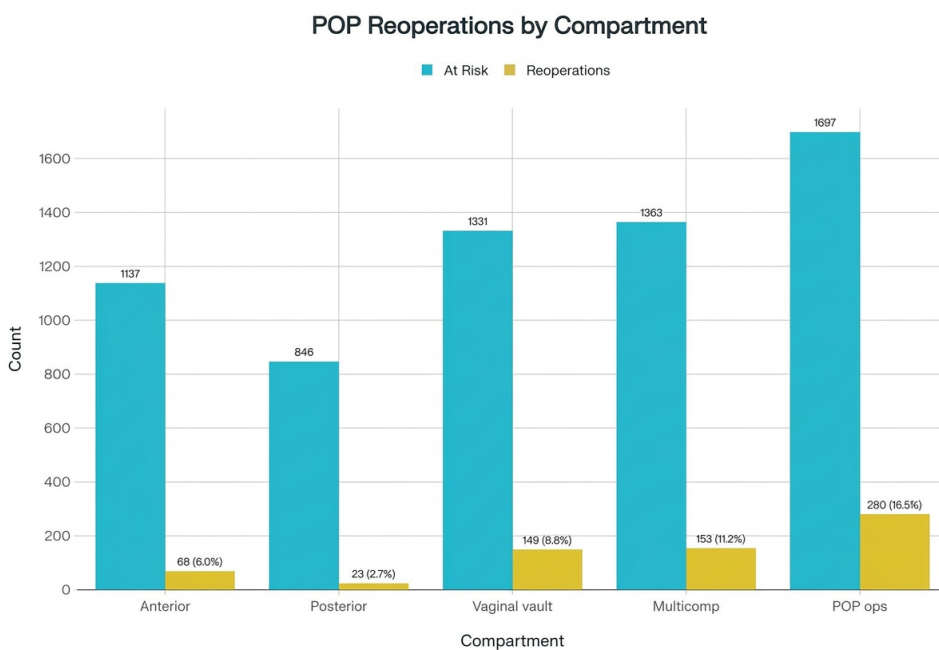


Figure 8. POP reoperations in the same compartment after hysterectomy for POP. At risk=number of POP repairs concomitant with hysterectomy. POP pelvic organ prolapse, Multicomp multicompartiment prolapses, Ops operations total.

In the study I, the time from hysterectomy to the first POP visit was shorter for women who had an AH (4.0 years) compared to those who had a LH (6.8 years) or VH (7.1 years) ($p < 0.01$). Rate of UI diagnoses increased from pre-hysterectomy 2.6% to that of 4% post-hysterectomy. This increase was most notable in women who underwent LAVH ($p = 0.03$ AH vs. LAVH).

In risk factor analysis LAVH, concomitant SUI operation and vaginal deliveries increase the risk for de novo POP operation while residential operator status and concomitant sacrospinous fixation associated with risk for re-operation (Table 11).

Table 11. Factors associated with de novo and recurrent POP operations after hysterectomy. Multivariate logistic regression: operation type adjusted with all mentioned variables and with continuous age and continuous BMI. Only statistically significant variables are shown. AH abdominal hysterectomy, LAVH laparoscopic assisted vaginal hysterectomy, SUI Stress urinary incontinence, HR Hazard Ratio, CI Confidence Interval.

Adjusted variable	Vaginal vault/anterior repair HR (95% CI)	Posterior repair HR (95% CI)	Any POP repair HR (95% CI)
Vaginal deliveries 1–2 (vs. none) (Study I)	4.7 (1.1–20.5)		3.6 (1.2–10.4)
Vaginal deliveries ≥3 (vs. none) (Study I)		6.2 (1.8–22.1)	5.1 (1.7–15.3)
LAVH vs. AH (Study I)	4.3 (1.4–13.9)		3.0 (1.2–7.7)
Concomitant SUI operation (Study I)		7.9 (1.8–34.2)	5.5 (1.3–23.6)
Previous Cesarean section (Study II)	0.6 (0.3–1.0)		
Main indication uterus prolapse (Study II)	1.3 (1.0–1.7)		
Concomitant anterior repair (Study II)	0.7 (0.5–0.9)		
Concomitant posterior repair (Study II)		0.4 (0.3–0.8)	
Concomitant sacrospinous fixation (Study II)	2.2 (1.2–4.1)		2.2 (1.2–3.9)
Operator status: Resident vs. Specialist (Study II)			2.3 (1.1–5.0)

In contrast, caesarean section and concomitant POP repairs were protective factors, reducing the risk for reoperation (Table 11). Visits for de novo and recurrent POP symptoms showed almost identical risk profile as risk for operations (Table 12).

A uterus weight of over 500g was associated with a fivefold increased risk for rectocele visits while a resident surgeon status presented an elevated risk for any POP reoperations and visits (Table 11 and 12).

Table 12. Factors associated with POP visits and re-visits after hysterectomy. Multivariate logistic regression: visit type adjusted with each mentioned variable and with continuous age and continuous BMI. Only statistically significant variables are shown. AH abdominal hysterectomy, LH laparoscopic hysterectomy, LAVH laparoscopic assisted vaginal hysterectomy, SUI Stress urinary incontinence, HR Hazard Ratio, CI Confidence Interval.

Adjusted variable	Vaginal vault/cystocele visit HR (95% CI)	Rectocele visit HR (95% CI)	Any prolapse visit HR (95% CI)
Vaginal deliveries 1–2 (vs. none) (Study I)	5.2 (1.6–17.5)	4.7 (1.6–12.8)	4.0 (1.8–9.0)
Vaginal deliveries ≥3 (vs. none) (Study I)	4.4 (1.2–15.8)	4.9 (1.6–14.8)	3.9 (1.6–9.1)
LAVH vs. AH (Study I)	3.1 (1.1–9.2)		2.2 (1.0–4.9)
Concomitant SUI oper. (Study I)		5.4 (1.3–22.7)	
Uterus size >500g (Study II)		5.5 (1.5–19.8)	
Previous cesarean section (Study II)	0.5 (0.3–1.0)		0.6 (0.4–1.0)
Concomitant anterior repair (Study II)	0.8 (0.6–1.0)		0.8 (0.7–1.0)
Concomitant posterior repair (Study II)		0.4 (0.3–0.6)	
Concomitant sacrospinous fixation (Study II)			1.7 (1.0–3.1)
Operator status: Specialist (Study II)	2.4 (1.1–5.1)		2.4 (1.2–4.9)
Operator status: Resident (Study II)	2.8 (1.3–6.1)	7.8 (1.1–57.6)	2.7 (1.3–5.6)

5.1.2 Patient Satisfaction (Study III)

Two months after hysterectomy, the mean patient satisfaction score (VAS) was 89.5 (Std 16.7) across all women (Table 13). There was no significant difference in mean satisfaction scores between the POPUI (88.1) and Non-POPUI groups (89.8), neither in the full cohort nor in the HUH-subgroups. However, the POPUI group had a significantly ($p=0.02$) smaller percentage of crude and IPTW adjusted VAS scores under 70 compared to the Non-POPUI group (Table 13). After adjusting for baseline imbalances, the difference between the groups was nonsignificant, while a separate model demonstrated that women undergoing hysterectomy for POP as the primary indication had 1.18 (adjusted OR) times

higher probability of short-term postoperative dissatisfaction compared to those with other benign indications (95% CI 1.03-1.36, p=0.02).

Table 13. Patient-reported satisfaction two months after hysterectomy and POP repair by VAS-scores from 0 (very unsatisfied) to 100 (very satisfied). A subgroup of Helsinki University Hospital district (HUH) participants are shown separately. * Statistically significant. POP pelvic organ prolapse, UI urinary incontinence, VAS visual analogue scale, Std standard deviation.

	All	POPUI	Non-POPUI
Whole cohort, n	3964	1323	2641
VAS (mean, Std)	89.5 (16.7)	88.1 (19.9)	89.8 (16.3)
VAS <70 (crude), n (%)	415 (10.7)	116 (9.0) *	299 (11.5) *
VAS <70 (IPTW adjusted), n (%)	2185	420 (11.8) *	(1765 (21.0) *
HUH-subgroup, n	838	222	616
VAS (mean, Std)	90.2 (16.0)	88.3 (18.7)	90.8 (15.0)
VAS <70 (crude), n (%)	74 (11.0)	22 (12.3)	52 (10.5)

Ten years after hysterectomy satisfaction remained high among all HUH-subgroup women (VAS 91.7), but women with POPUI reported significantly lower mean VAS scores and were more likely to report VAS scores under 70 than women without POPUI (Table 14). Despite these differences, a large majority of women (91-94%) would still choose to undergo the procedure.

Table 14. Patient satisfaction by VAS-scores (0-100) ten years after hysterectomy. The Helsinki University Hospital District (HUU) subgroup participated in the 10-year questionnaire. POP pelvic organ prolapse, UI urinary incontinence, VAS visual analogue scale, Std standard deviation.

	All (n=838)	POPUI (n=222)	Non-POPUI (n=616)	p
n (%) answered	554 (66.1)	128 (57.6)	426 (69.2)	
VAS (mean, Std)	91.7 (1.4)	89.2 (1.5)	92.5 (1.3)	<0.01
VAS score under 70, n (%)	45 (8.1)	15 (11.7)	30 (7.0)	
Would choose hysterectomy again?				
Yes, n (%)	521 (94.0)	117 (91.4)	404 (94.8)	<0.01
No	24 (4.3)	9 (7.0)	15 (3.5)	

5.1.3 Complications

At the two-month follow-up the total number of women reporting any complication was 29.3% in the POPUI group and 34.3% in the Non-POPUI group ($p<0.01$). Urinary tract infections (UTI) were the most common complication, affecting 6.1% of all women. Women with POPUI experienced more UTIs (7.9% vs 5.1%) but fewer postoperative pelvic hematomas and infections (2.9 vs 5.0%), reoperations (1.5 vs 2.8%), and major complications (2.3 vs 4.0%) (all $p<0.01$).

A comparison between patient- and surgeon-reported complications showed that patients reported more complications (29-34% vs. 12-16%). Wound opening (1.6% vs 0.1%) and infection (4.4% vs. 1.4%) were the most common complications not reported by surgeons, while pelvic haematoma/infection showed the best agreement (31%).

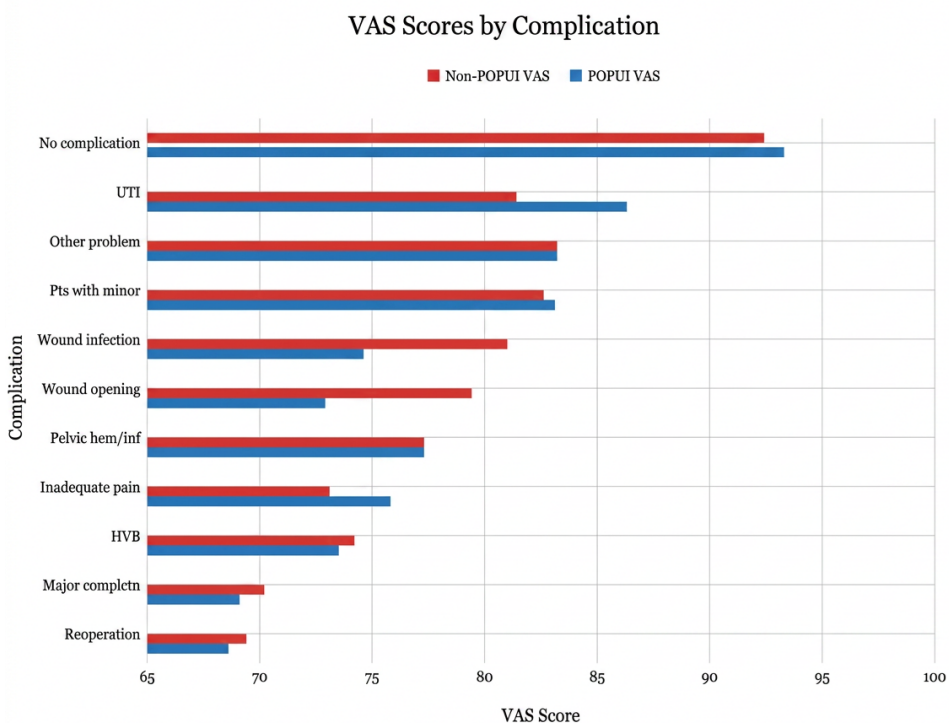


Figure 9. VAS scores according to complication reported by patients two months after hysterectomy. VAS visual analogue scale, HVB heavy vaginal bleeding, UTI urinary infection, hem hematoma, inf infection, Inadequate pain Inadequate pain relief, Major complctn major complication, Pts patients, POP pelvic organ prolapse, UI urinary incontinence.

At the two-month follow-up, the lowest satisfaction scores were observed among women experiencing inadequate pain relief (VAS 73.7), undergoing reoperation (VAS 69.1), or encountering major complications (VAS 69.6) (Figure 9). Furthermore, multivariable logistic regression analysis revealed that reoperations, minor complications, and insufficient pain relief were each independently associated with an increased risk of patient dissatisfaction. (Table 16).

Table 16. Risk factors associated with VAS<70 at two months after hysterectomy in the POPUI and Non-POPUI groups, analyzed with multivariable logistic regression. Each minor complication was adjusted with classified age and BMI, approach, parity, reoperation and postoperative infection. Bolded are statistically significant. BMI body mass index, POP pelvic organ prolapse, UI urinary incontinence, UTI urinary tract infection, inf infection, OR odds ratio, CI confidence interval.

Variable	POPUI OR (95% CI)	Non-POPUI OR (95% CI)
Age over 50	0.9 (0.6–1.5)	1.3 (1.0–1.7)
BMI over 30	0.6 (0.3–1.0)	0.7 (0.5–0.9)
Parity (1–2)	0.6 (0.3–1.2)	0.7 (0.5–1.0)
Parity (> 3)	0.7 (0.3–1.4)	0.7 (0.5–1.0)
Reoperation for a complication	7.0 (2.5–19.2)	5.1 (3.0–8.6)
UTI	1.4 (0.7–2.7)	1.9 (1.2–3.0)
Wound infection	4.1 (2.0–8.4)	2.4 (1.5–3.8)
Pelvic haematoma/inf	1.5 (0.6–3.8)	2.9 (1.8–4.6)
Nonadequate pain relief	3.9 (1.4–11.0)	4.1 (2.3–7.2)

5.1.4 Patient-Reported Outcomes after Ten Years (Study III)

After ten years pelvic floor symptoms were common in all studied women, even if all assessed symptoms, and POP or SUI operations were more common in the POPUI group (Table 17). Symptomatic POPUI women experienced significantly lower VAS scores than women without POPUI (Figure 10).

Table 17. Pelvic floor symptoms, conservative treatments and reoperation rates reported by the Helsinki and Uusimaa Hospital District (HUUH) subgroup ten years after hysterectomy. All listed variables had p-values less than 0.05, indicating statistically significant differences between the POPUI and Non-POPUI groups. POP pelvic organ prolapse, UI urinary incontinence, UUI urge urinary incontinence, SUI stress urinary incontinence.

Variable	POPUI n=222 (%)	Non-POPUI n=616 (%)
Answered	128 (57.7)	426 (69.2)
Any urinary symptoms	77 (60.2)	187 (43.9)
UI	42 (32.8)	102 (23.9)
UUI	34 (26.5)	80 (18.7)
UI medication	20 (15.6)	32 (7.5)
SUI operation	18 (14.0)	9 (2.1)
Any defecatory symptoms	53 (41.4)	116 (27.2)
Constipation	41 (32.0)	90 (21.1)
Fecal Incontinence	18 (14.0)	23 (5.4)
Medication for constipation or incontinence	24 (18.8)	31 (7.3)
Operation for defecatory symptom	9 (7.0)	10 (2.3)
Bulging	48 (37.5)	37 (8.8)
Pessary treatment	8 (6.3)	2 (0.5)
Prolapse operation (pt reported)	27 (21.0)	8 (1.9)
Other gynecological operation	26 (20.3)	19 (4.5)
Any pelvic floor symptom	111 (86.7)	273 (64.0)
Prolapse/UI visit registry	69 (31.1)	38 (6.2)
Prolapse/UI operation registry	46 (20.7)	14 (2.3)

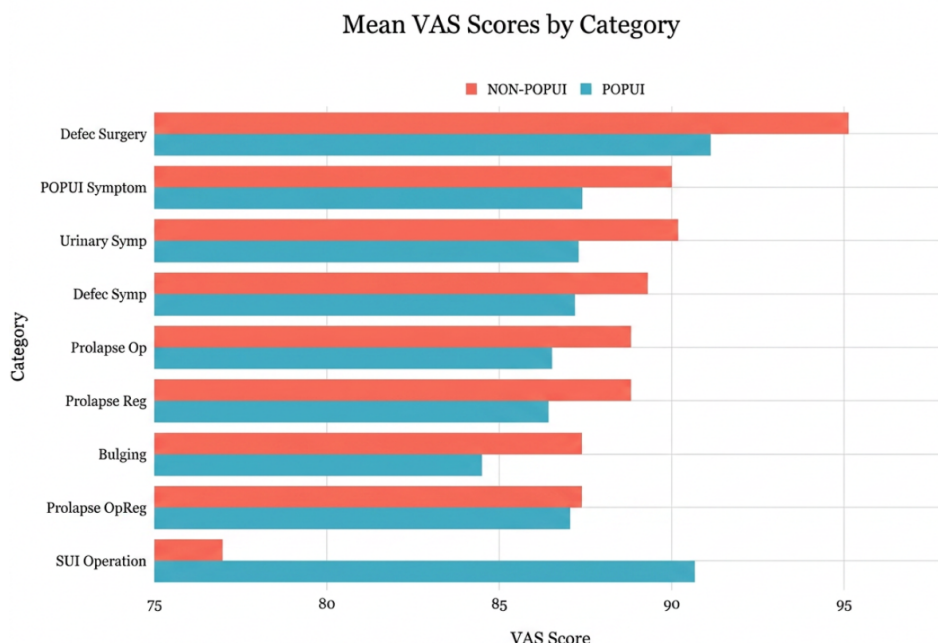


Figure 10. Bar chart of the VAS scores according to symptom reported by HUH-subgroup ten years after hysterectomy. Defec defecation, POP pelvic organ prolapse, UI urinary incontinence, Symp symptom, Op operation, Reg registry, SUI stress urinary incontinence, HUH Helsinki University Hospital.

After ten years pelvic floor symptoms, especially bulging (OR 3.4) associated with an increased risk of dissatisfaction among all women (Table 18). Risk profiles according to the groups are shown in detail in Table 18.

Table 18. Risk factors for VAS scores <70 ten years after hysterectomy in the HUH (Helsinki University Hospital) subgroup, analyzed with binary logistic regression. VAS score <70 adjusted with each mentioned variable and with continuous age and continuous BMI. BMI body mass index, POP pelvic organ prolapse, UI urinary incontinence, OR odds ratio. CI confidence interval. Only statistically significant variables are shown (p<0.05).

Variable	All OR (95%CI)	POPUI OR (95%CI)	Non-POPUI OR (95%CI)
Age (continuous)	1.1 (1.0–1.1)	1.2 (1.0–1.5)	
BMI (continuous)	0.9 (0.8–1.0)	0.5 (0.3–0.9)	
Parity (3 or more)		0.1 (0.1–0.3)	
Complications		5.1 (1.4–18.9)	
Bulging	3.4 (1.7–7.1)	4.1 (1.1–15.9)	2.8 (1.0–7.7)
Any urinary symptom			2.3 (1.1–5.1)
Any pelvic floor symptom	4.0 (1.5–10.5)		4.0 (1.4–11.9)
Any defecatory symptom	2.1 (1.1–3.9)		
POP/UI visit registry	2.4 (1.1–5.4)		

6 Discussion

This thesis underscores that de novo POP operations and visits following benign hysterectomy are rare (1.6% and 2.6%), whereas the risk is approximately tenfold higher in women who have undergone hysterectomy for pelvic floor dysfunction. Moreover, the most frequently prolapsing compartments differed between women with hysterectomy for non-POP indications and those with hysterectomy for POP. Posterior vaginal wall prolapse was the most common form of de novo POP, whereas vaginal vault and anterior wall prolapse were more prevalent among women with recurrent prolapse.

These results are likely related to different aetiologies. Hysterectomy may damage the pelvic floor supporting structures leading to de novo posterior prolapse, whereas defects in the vault and anterior compartments may indicate more extensive injury. Consequently, such defects may be more difficult to reconstruct with long-term durability.

Patient-reported satisfaction following hysterectomy remained high throughout the ten-year follow-up period (VAS 89.5-91.7), even though up to 62% of the women experienced some pelvic floor symptom reducing their long-term satisfaction.

6.1 Risk of POP Surgery after Hysterectomy

Of women with hysterectomy for non-POP indications only 1.6% required a POP operation and only 2.6% had a POP visit during ten years' time, indicating that one third of symptomatic women were managed conservatively. These findings align with previous natural history studies in which the key symptom, "feeling of vaginal bulge," and POP-Q stage remained unchanged in one-third of women and only 38% pursued active treatment within five years ^{219,220}.

In contrast, pre-existing POP predisposed women for more reoperations (16.5%) and re-visits (21.2%) indicating that conservative treatments were sufficient only one fourth of these women likely due to more extensive injury in pelvic supporting structures. Our data support the previous studies, in which de novo POP operation incidence after hysterectomy vary between 0.3% to 12.0% ^{9,12-14,55,62,221}, and reoperation rates between 9 to 29% with follow-up periods of 5 – 32 years ^{25,26,101,221-223}.

Variation in follow-up duration likely influences reoperation rates, as POP incidence peaks at ages 60–79 years and may be missed in shorter follow-up periods ^{18,78,127}. Premenopausal status is a recognized risk factor for recurrence, attributed to genetic and individual predispositions ²²³. In our cohort, de novo POPs and recurrences typically occurred at six- and three-years post-hysterectomy, respectively, consistent with previous studies reporting most de novo POPs within seven years ⁵⁵ and recurrences within five years ^{8,197,222}. Our follow-up period was likely sufficient to capture most recurrences. However, additional de novo POPs may still develop in women undergoing hysterectomy for non-POP indications, as 53% were younger than 54 years. Furthermore, de novo POP is corrected at a median of 16 years post-hysterectomy ²²⁴.

6.2 POP Types after Hysterectomy

The prolapsed compartments after hysterectomy differed between women with hysterectomy for non-POP indication and hysterectomy for POP. In women with de novo POP, the prolapse occurred mostly in the posterior compartment, whereas recurrent prolapses were primarily associated with the vaginal vault and anterior compartment. The higher incidence of apical and anterior recurrences is likely attributable to damage to supporting structures, such as the uterosacral ligaments and paracervical ring, as well as the possibility of missing an occult prolapse and leaving it untreated during the primary surgery.

Our results are supported by the previous studies ^{13,55}. It is likely that the supporting structures of the posterior wall are damaged during the hysterectomy, predisposing women to further prolapse. This explanation is supported by the fact that most isolated prolapses after vaginal delivery occur in the posterior compartment ^{13,21,225,226}, likely due to similar fascial damage mechanisms. This aligns with our finding that vaginal delivery most increased risk. However, posterior injuries and perineal tears often scar and stabilize via fibrosis. In contrast, LAM avulsion, puborectalis detachment from the pubic bone, is permanent and destabilizes anterior and apical compartments, leading to long-term cystocele and uterine prolapse predominance. ²²⁷ It is important to focus on posterior compartment techniques such as midline plication or site-specific repair with or without levatorplasty combined with perineorrhaphy and with chosen type of prophylactic uterosacral ligament suspension during hysterectomy, which have been the focus of recent research ^{99,204,228,229}.

Vaginal vault prolapses are challenging to repair, at least when they re-occur. It is known that insufficient apical support doubles the risk for POP recurrence ²⁰⁴. Therefore, it was not surprising that vaginal vault and anterior compartments were reoperated most often in women with preceding POP. In these women apical support was likely weak already before hysterectomy, and thus, even

if hysterectomy was a part of POP operation damaged sacrouterine ligaments could not be reconstructed to prevent further POP. Our findings align with previous studies reporting 6–10% rates ^{25,101,230}, all conducted (including ours) before vaginal cuff suspension became routine—unlikely likely today. However, data on this surgical practice remain unavailable in Finland.

Further studies are needed to determine whether focusing on apical support can reduce recurrence rates. However, some data suggest that recurrence rates are not decreased ¹⁵, likely because the underlying tissue damage is too extensive and cannot be repaired by the native tissue. Additionally, the use of cuff suspension was not systematically included in the procedures or documentation for this cohort and may underestimate the benefit. However, this theory gets further support from our data that most of the POP reoperations (68%) involved the same compartment repaired at the time of hysterectomy, which is also in line with others ^{25,26,197}. To achieve maximum support, all prolapses should be repaired simultaneously ^{16,26,223}, restoring the vaginal axis ²³¹ and repairing the enlarged genital hiatus and perineal body ²³².

6.3 Risk Factors for De Novo and Recurrent POP after Hysterectomy

Hysterectomy approach is mostly dependent on patient related factors, such as size of the uterus, need for concomitant procedures and presence of possible POP. Surgeon related factors may also play a role, but likely less. Approaches may differ in their possible risk for further POP. Therefore, we wanted to study these in detail. We found that LAVH carried the highest risk for de novo POP operations and visits, even after adjustment for multiple confounders. This aligns with Taiwanese retrospective cohort study of 7298 women¹¹ but contrasts with other cohort studies ^{8,9,56,233} which linked vaginal hysterectomy to greater POP risk, but adjusted analyses showed quite similar long-term risks across approaches ^{15,100,221}.

Mechanism underlying the increased risk for de novo POP associated with LAVH is unclear. It may involve greater tissue stretching, potential compromise of cuff suspension, and anatomical factors related to more advanced uterine descent and occult prolapse or vaginal laxity preoperatively depending on their higher parity. AH and LH were typically chosen for patients with a narrow vaginal segment, absence of occult prolapses, and larger uterine size. It is also possible that this technique was quite new at a time of the study and the risk increase was dependent more on technical skills, such as inadequate cuff suspension. This could be supported by the finding LAVH carried a higher risk of vaginal vault repair, in contrast to other studies in which risk associates with anterior wall repair across all hysterectomy approaches ^{9,14,15}. Currently, LAVH represents only 11% of benign

hysterectomies in Finland ³⁴, so these data cannot be directly used to guide patient counselling.

Of other studied risk factor vaginal deliveries independently increased the risk for de novo POP (HR 4.4). Recent reviews confirm parity and vaginal deliveries as core risk factors for de novo POP due to exposing the pelvic connective tissue, LAMs, and pudendal nerves to mechanical stretching and trauma ^{20,21}. It is unclear why combining a hysterectomy with a concomitant SUI surgery carried a higher risk for future POP surgery (Study I). This may reflect an occult POP and pelvic floor dysfunction.

Traditional risk factors for primary POP have also been investigated as risk factors for POP recurrence. However, since 2004 only preoperative stage has consistently been reported to be a risk factor for POP recurrence ^{20,21,234}. Cesarean section appears to protect not only against de novo POP ^{20,108}, but also against recurrent POP. This can be attributed to the fact that the women with cesarean deliveries experience less or no vaginal deliveries, thus avoiding the stretching and damage to pelvic floor structures associated with vaginal childbirth ^{235,236}.

Uterine weight over 500 g and surgery performed by residents were linked to higher recurrence risk. The pathophysiological mechanisms underlying this relationship remain unclear. Possibly, a large uterus stretches and weakens pelvic floor supporting structures. However, prior studies associate increased preoperative uterine volumes with greater postoperative POP symptoms ²³⁷ and low reoperation rates with surgeons of high expertise and advanced technical skills ^{187,197}.

Despite the benefits of vaginal vault suspension, women undergoing concurrent SSLF showed a higher reoperation risk, likely due to advanced prolapse - known risk factor of POP recurrence ^{20,223} - and weak supporting tissues. Additionally, although we lack data on sacrospinous fixation method, unilateral SSLF is known to have high long-term failure rates (40–70%) ^{182,238} likely due to suture and anchorage problems (insufficient depth, cut-through or loss before fibrosis) ^{239,240}, limited asymmetric apical support ²⁴¹ and underlying connective tissue and levator defects ^{89, 242}.

6.4 Patient Satisfaction after Hysterectomy and Prolapse Surgery

Patient satisfaction after hysterectomy for benign indications was evaluated at both two months and ten years, focusing on effect of complications and de novo and recurrent pelvic floor symptoms on patient-reported outcomes. Despite of rather high numbers of POP symptoms, satisfaction, measured by VAS, remained high at ten years (88–91), aligning with previous findings with one to five-year

follow-up ^{27,61,62}. Most women (94%) would choose hysterectomy again, with this preference being significantly more common among women in the Non-POPUI group.

Women in the POPUI group reported higher short-term satisfaction (more VAS scores >70) than those in the Non-POPUI group, although the difference was not seen at ten-year follow-up in the HUH subgroup. This finding may be related to both bothersome symptoms related to POP and UI, which were more effectively relieved following surgery in the POPUI-group. This was supported by the finding that long-term satisfaction decreased by additional pelvic floor symptoms (VAS <70). Therefore, pelvic floor dysfunction and related symptoms POP and / or UI independently contribute to reduced long-term satisfaction. Although not directly assessed in this study, previous research indicates that persistent symptoms are a major reason for dissatisfaction ^{243,244}. Notably, Wolters et al. ²⁴⁴ found that even among women with complete cure of POP and SUI, 5% were dissatisfied at one year, underscoring the complexity of patient satisfaction. This might also explain why women undergoing hysterectomy for POP as the primary indication reported more short-term dissatisfaction than women with other indications (20% vs. 17%).

Despite the high prevalence of pelvic floor symptoms in both groups, most women required no treatment. These findings align with previous reports that, although women with prolapse experience more pelvic floor symptoms and reoperations, most ultimately manage without treatment ²²⁹. The explanation for this is unclear but is likely related to the natural history of POP ^{219,245,246}.

The relapse rates of POP symptoms in previous studies have ranged from 12.5-36.7% ^{61,62,80,245} corresponding with our observed rate (15.3%) of bulging symptoms. Women with bulging symptoms in the POPUI group had the lowest satisfaction scores, and bulging was a strong predictor of dissatisfaction in all patients. This supports previous findings that absence of postoperative vaginal bulge is a key indicator of improved outcomes ^{27,80}.

The effect of the complications on the patient satisfaction

Number of reported complications differed between the studied women and doctors, since doctors reported only one fourth of those reported by the women. This discrepancy emerged likely because milder events were not treated in hospital and because healthcare professionals may underestimate adverse events ^{29,247,248}. Moreover, patients often view functional issues like incontinence, sexual dysfunction, and symptom recurrence as serious complications ²⁹.

However, complications were the main factor reducing both short- and long-term satisfaction, the major complications, especially re-operations for a complication decreasing it even more than the milder ones. Inadequate pain relief was also a significant determinant in reducing satisfaction, aligning with previous

findings that effective post-operative pain control improves outcomes ²⁴⁹. In addition, it is notable that inadequate pain exposes to chronic pain ^{250,251} which may affect up to half of patients after common surgeries ²⁵² and likely impacts gynaecological patients as well, yet no pain-specific tool exists for women with POP or SUI ^{253,254}.

Risk factors for patient dissatisfaction following hysterectomy

In contrast to some earlier studies ^{243,244,255}, we observed that younger age, higher BMI, and greater parity were associated with long-term patient satisfaction. Age over 60 is a known predictor of POP progression ²⁵⁶, which may explain reduced long-term satisfaction among older women. Alternatively, age itself may negatively influence quality of life, affecting satisfaction scores. Conversely, higher BMI and having three or more deliveries were linked to greater satisfaction at ten years, possibly reflecting increased relief of symptoms after repair of more advanced prolapse or general contentment with family life. While previous research has associated obesity with a higher risk of prolapse ^{20,93} and lower satisfaction after surgery ²⁵⁷ these relationships are likely multifaceted, as conflicting findings have also been reported ^{94,258}.

6.5 Strength and Limitations

This nationwide, prospective cohort study evaluated long-term outcomes of hysterectomy in women with and without POP, drawing on over ten years of follow-up, registry linkage, and patient-reported data. Strengths include the large sample size, comprehensive recording of potential confounders, and capacity to analyze different surgical approaches. The relatively high questionnaire response rate enhanced the reliability of subjective outcome measures. To our knowledge, this is the first study to compare patient and surgeon perceptions regarding hysterectomy related complications. The design enriched the FINHYST 2006 cohort through supplementary surveys at two months and ten years postoperatively, enabling assessment both objective (outpatient visits and reoperations) and subjective endpoints (patient-reported outcomes). Additionally, used Health Care Register (HILMO) is validated, quality register with good national coverage and high positive predictive value ²¹⁸.

Limitations include the inability to identify women with POP who neither sought treatment nor were referred to specialist care, likely underrepresenting those with mild or moderate symptoms. Nevertheless, we believe that the operations and visits represent well symptomatic POP, due to good access to public healthcare in Finland. Additionally, gynaecological examination data and prolapse

staging were unavailable, possibly underestimating associations for advanced disease. However, we postulate that operated patients represent well symptomatic, advanced prolapses, since up 73% of advanced prolapses are concomitant vaginal vault and anterior prolapses¹⁹³. Additional limitations include surgeon-dependent selection of surgical technique and the lack of information on whether, and by which method, vaginal vault suspension was performed. Finally, the Clavien-Dindo classification was not applied to grade surgical complications, as it had not yet been widely adopted in clinical practice during the study period.²⁵⁹

A predominance of vaginal hysterectomy (90%) may have reduced power to detect differences between approaches in study II, and the non-randomized selection of surgical technique introduces potential selection bias despite adjustment for confounders. Use of non-validated questionnaires may have introduced recall and reporting bias, explaining discrepancies between patient- and surgeon-reported complications. Additionally, minor complications treated outside specialist care were not systematically captured.

VAS scoring, instead of Likert scales, was applied for satisfaction assessment, offering continuous values, potentially greater statistical sensitivity, and more accurate reflection of patient experience. VAS is a reliable, reproducible and well-established method in urogynaecologic research^{215,260}.

6.6 Future Perspectives

There remain several key challenges related to de novo and recurrent POP, and patient satisfaction. Notably, surgical correction of POP is common, yet recurrence occurs in approximately one out of every ten cases. Additionally, limited data exist regarding patient expectations and preferences prior to surgery. Even our understanding of symptom relief for specific prolapse compartments and the likelihood of improvement following intervention is inadequate.

Ideally, POP prevention should begin with early postpartum pelvic floor repair within the first year^{73,261}. Surgical technique must be tailored to the individual patient to minimize recurrence risk. Accumulating evidence suggests that uterus-sparing procedures may offer superior outcomes over hysterectomy,^{194,262,263}, questioning the role of routine uterine removal in prolapse surgery. Comparative outcomes — including Manchester repair versus hysterectomy^{264,265}, are needed to clarify which procedures reliably address specific symptoms and align with patient goals, ultimately supporting informed shared decision-making.

Additionally, future research should focus on the role and type of cuff suspension in different hysterectomy approaches and enlighten its possible effect on prevention of de novo and recurrent POP.

Finally, research is needed to identify women who cope without treatment, to clarify the natural history of POP, and to understand what patients consider treatment success or failure. According to Barber ⁶⁸ vaginal bulge is the most reliable and specific symptom for POP and the hymen is an important threshold for symptom development. Additionally, women with advanced POP often have reduced body image and QoL ¹⁰³, and treatment failure can cause shame and be perceived as a personal defeat ²⁹, further diminishing postoperative well-being. Thus, it is crucial to consider both physician and patient perspectives when defining success, with particular emphasis on outcomes important to the patient, since treatment choices depend on numerous factors beyond effectiveness.

6.7 Implications of Findings

Clinical implication of this thesis for women considering hysterectomy is that women without pre-existing POP rarely develop prolapse after hysterectomy (1.6%), with the risk being about ten times lower than in women who had pre-existing POP and concurrent POP surgery at the time of hysterectomy (16.5%). For counselling, this means women without prior POP can be reassured about the low long-term risk, though the posterior compartment may be most at risk, whereas those with pre-existing POP face a much higher recurrence risk, particularly in the apical or anterior compartments.

Long-term satisfaction is generally good, but women with hysterectomy for POP tend to report more subsequent pelvic floor symptoms and need for additional interventions, especially if complications like infection or poor pain control occur in the early postoperative period. It is important to explain that women with pre-existing POP are more likely to have ongoing pelvic floor symptoms and need further interventions, which may reduce satisfaction over time. Proactive management of postoperative pain, infection, and complications can enhance both short- and long-term satisfaction with the procedure.

This thesis enhances our understanding of the patient perspective on the benefits and challenges associated with hysterectomy and POP repair. For benign hysterectomy, patients—especially those with prior vaginal births or prolapse—should be counselled on POP risk, and both short- and long-term consequences to ensure shared-decision, the most appropriate treatment and patient satisfaction. Moreover, because of predominance of posterior repairs and apical prolapse reoperations, vault suspension should be a standard part of hysterectomy, and surgeons need better awareness and more standardized technique for performing it.

7 Conclusions

To summarize, the studies on the effect of hysterectomy on the patient satisfaction and the risk for having de novo or recurrent POP surgery found that:

I After hysterectomy, 1.6% of women without pre-existing POP undergo a POP surgery within ten years. The most common POP operation type is a posterior repair occurring in 1.1% of women. The risk of a POP operation after hysterectomy is associated with LAVH, vaginal deliveries and concomitant SUI operations.

II After hysterectomy, 16.5% of women with pre-existing POP undergo a POP surgery within ten years. The most frequent reoperation is vaginal vault prolapse repair, performed on 10.7% of women. 68% of POP reoperations involved the same compartment repaired during hysterectomy. The hysterectomy approach has no effect on the risk of a POP reoperation.

III Satisfaction remains high in all women at two months (mean VAS 89.5) and at ten years (mean VAS 91.7) after hysterectomy. Women without preoperatively present POP report greater satisfaction at ten years. Hysterectomy due to POP is associated with higher risk of complications, recurrent symptoms and reoperations, reducing long-term satisfaction.

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Appendices

Appendix 1: FINHYST 10-year follow-up questionnaire

FINHYST-Kohdunpoistotutkimuksen 10-vuotiskysely

Kysely terveydentilastanne 10 vuoden kuluttua
kohdunpoistoleikkauksesta

Nimi

Sotu

Osoite

Puhelinnumero

Oliko teillä jotain sairauksia ennen kohdunpoistoleikkausta (esim verenvainetauti, sydämen vajaatoiminta, korkea kolesteroli, sokeritauti, kilpirauhasen vajaatoiminta, kilpirauhasen ylitoiminta, astma, masennus, psyykkinen sairaus, syöpä)?

Kyllä _____ ei _____

Mitä? _____

Onko teille ilmaantunut uusia sairauksia kohdunpoistoleikkauksen jälkeen?

Kyllä _____ ei _____

Mitä? _____

Onko teille aloitettu uusia lääkkeitä kohdunpoistoleikkauksen jälkeen?

Kyllä _____ ei _____

Mitä? _____

Onko teille aloitettu hormonihoitoa vaihdevuosisoireiden hoitoon
kohdunpoistoleikkauksen jälkeen: estrogeenia +/- keltarashormonia suun
kautta/laastarina/geelinä? Kyllä _____ ei _____

Mitä?

Kuinka kauan olette käyttänyt edellä mainittua/mainittuja lääkkeitä?

Onko lääkitys teillä käytössä edelleen?

Kyllä _____ ei _____

Koska lääkitys on mahdollisesti lopetettu?

Onko teille aloitettu paikallinen, emättimeen annosteltava estrogeenivalmiste
kohdunpoistoleikkauksen jälkeen?

Kyllä _____ ei _____

Onko lääkitys teillä käytössä edelleen? Kyllä _____ ei _____

Koska lääkitys on mahdollisesti lopetettu?

Onko teille tullut virtsaamiseen liittyviä ongelmia kohdunpoiston jälkeen?

1. Ponnistamiseen tai nostamiseen liittyvää virtsan karkailua: kyllä _____
ei _____
2. Voimakasta virtsapakkoa (tunne, että on pakko päästä virtsaamaan): kyllä
_____ ei _____
3. Voimakasta virtsapakkoa ja siihen liittyvää virtsan karkailua: kyllä
_____ ei _____
4. Tihentynyttä virtsaamistarvetta: kyllä _____ ei _____
5. Kuinka monta kertaa käynte virtsaamassa päiväsaikaan? _____ kertaa

6. Kuinka monta kertaa käynte virtsaamassa yöllä? _____ kertaa

Onko virtsaamisvaivoja tutkittu?

Kyllä _____ ei _____

Missä?

Onko virtsaamisvaivoja hoidettu?

Kyllä _____ ei _____

Miten virtsaavaivoja on hoidettu? Lääkkeillä? Millä?

Leikkaamalla?

Kyllä _____ ei _____

Missä?

Onko teille tullut ulostamiseen liittyviä ongelmia kohdunpoiston jälkeen?

1. Hidastunut suolen toiminta? Kyllä _____ ei _____
2. Tihentynyt suolen toiminta? Kyllä _____ ei _____
3. Kuinka monta kertaa päivässä suolenne toimii? _____
4. Ummetusta? Kyllä _____ ei _____
5. Ulosteen karkailua? Kyllä _____ ei _____

Onko ulostamisvaivoja tutkittu?

Kyllä _____ ei _____

Missä?

Onko ulostamisvaivoja hoidettu?

Kyllä _____ ei _____

Miten ulostamisvaivoja on hoidettu? Lääkkeillä, millä?

Leikkaamalla?

Kyllä _____ ei _____

Missä?

Onko teille tullut gynekologiseen laskeumaan liittyvää pullistuman tai paineen tunnetta emättimeen kohdunpoistoleikkauksen jälkeen?

Kyllä _____ ei _____

Onko laskeumavaivoja tutkittu?

Kyllä _____ ei _____

Missä?

Onko laskeumavaivoja hoidettu?

Kyllä _____ ei _____

Miten laskeumavaivoja on hoidettu?

Apuvälineillä (esim laskeumarengas/kuutio)?

Kyllä _____ ei _____

Millä muulla?

Leikkaamalla?

Kyllä _____ ei _____

Missä?

Oliko teillä lantion alueen kipuja ennen kohdunpoistoleikkausta?

Kyllä _____ ei _____

Ovatko kivut loppuneet kohdunpoistoleikkauksen jälkeen?

Kyllä _____ ei _____

Onko teille ilmaantunut lantion alueen kipuja vasta kohdunpoistoleikkauksen jälkeen, vaikka niitä ei ollut ennen leikkausta?

Kyllä _____ ei _____

Ovatko nämä myöhemmin alkaneet kivut jo loppuneet?

Kyllä _____ Koska? _____ Ei _____

Onko kohdunpoisto vaikuttanut seksuaalisuuteen? Kyllä _____ ei _____

Kohdunpoisto on parantanut seksuaalisuuttanne? Kyllä _____ ei _____

Kohdunpoisto on huonontanut seksuaalisuuttanne? Kyllä _____ ei _____

Onko teille tehty uusi gynekologinen leikkaus kohdunpoistoleikkauksen jälkeen?

Kyllä _____ ei _____

Mikä leikkaus?

Missä ja koska teidät on leikattu?

Onko teille tehty muu kuin gynekologinen leikkaus kohdunpoiston jälkeen?

Kyllä _____ ei _____

Mikä leikkaus?

Missä ja koska teidät on leikattu?

Minkä arvosanan annatte tällä hetkellä kohdunpoistoleikkauksen vaikutuksesta elämänlaatuunne VAS- asteikolla

1-10? (1=huonoin mahdollinen vaikutus, 10= paras mahdollinen vaikutus)

Vieläkö menisitte kohdunpoistoleikkaukseen tietäen sen vaikutukset elämäänne?

Kyllä _____ ei _____

Lämmin kiitos vastauksestanne!

Original Publications

Pelvic organ prolapse after hysterectomy: A 10-year national follow-up study

Tea Kuittinen¹ | Sari Tulokas¹ | Päivi Rahkola-Soisalo¹ | Tea Brummer² | Jyrki Jalkanen³ | Eija Tomas⁴ | Juha Mäkinen⁵ | Jari Sjöberg¹ | Päivi Härkki¹ | Maarit Mentula¹

¹Department of Obstetrics and Gynecology, University of Helsinki, Helsinki University Hospital, Helsinki, Finland

²Central Hospital Østfold, Østfold, Norway

³Department of Obstetrics and Gynecology, Central Finland Hospital District, Jyväskylä, Finland

⁴Department of Obstetrics and Gynecology, Tampere University Hospital, Tampere, Finland

⁵Department of Obstetrics and Gynecology, University of Turku, Turku, Finland

Correspondence

Tea Kuittinen, Helsinki University Hospital, Women's Clinic, Haartmaninkatu 2, 00290 Helsinki, Finland.
Email: tea.kuittinen@finnet.fi

Funding information

Women's Clinic of Helsinki University Hospital

Abstract

Introduction: Hysterectomy may have an effect on the pelvic floor. Here, we evaluated the rates and risks for pelvic organ prolapse (POP) surgeries and visits among women with a history of hysterectomy for benign indication excluding POP.

Material and methods: In this retrospective cohort study 3582 women who underwent hysterectomy in 2006 were followed until the end of 2016. The cohort was linked to the Finnish Care Register to catch any prolapse-related diagnoses and operation codes following the hysterectomy. Different hysterectomy approaches were compared according to the risk for a prolapse, including abdominal, laparoscopic, laparoscopic-assisted vaginal and vaginal. The main outcomes were POP surgery and outpatient visit for POP, and Cox regression was used to identify risk factors (hazard ratios [HR]).

Results: During the follow-up, 58 women (1.6%) underwent a POP operation, of which a posterior repair was the most common ($n = 39$, 1.1%). Outpatient visits for POP symptoms occurred in 92 (2.6%) women of which posterior wall prolapses ($n = 58$, 1.6%) were the most common. History of laparoscopic-assisted vaginal hysterectomy were associated with risk for POP operation (HR 3.0, $p = 0.02$), vaginal vault prolapse operation (HR 4.3, $p = 0.01$) and POP visits (HR 2.2, $p < 0.01$) as compared to the approach of abdominal hysterectomy. History of vaginal deliveries and concomitant stress urinary continence operation were associated with the risk for a POP operation (HR 4.4 and 11.9) and POP visits (HR 3.9 and 7.2).

Conclusions: Risk for POP operations and outpatient visits for POP symptoms in hysterectomized women without a preceding POP seems to be small at least 10 years after hysterectomy. History of LAVH, vaginal deliveries and concomitant stress urinary incontinence operations increased the risk for POP operations after hysterectomy.

Abbreviations: AH, abdominal hysterectomy; BMI, body mass index; CI, confidence interval; HR, hazard ratio; LAVH, laparoscopic-assisted vaginal hysterectomy; LH, laparoscopic hysterectomy; POP, pelvic organ prolapse; SUI, stress urinary incontinence; UI, urinary incontinence; VH, vaginal hysterectomy.

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These data can be utilized in counseling women considering hysterectomy for benign indication.

KEY WORDS

different approaches, hysterectomy, pelvic organ prolapse, POP operation, POP visit

1 | INTRODUCTION

Hysterectomy remains a common gynecological operation, even if the number of hysterectomies has reduced by half in Finland during the last two decades.¹ It is estimated that by the age of 60, more than a third of all women receive a hysterectomy, largely for benign conditions, such as fibroids, abnormal uterine bleeding, endometriosis and uterine prolapse.² These main indications as well as hysterectomy approaches have changed over the past decades,²⁻⁵ vaginal and laparoscopic approaches have surpassed the abdominal one.^{1,3}

Hysterectomy may contribute to pelvic floor weakness by changing anatomy and nerve supply. It seems to increase the risk for pelvic organ prolapse (POP),⁶⁻⁸ even if hysterectomy has been generally considered as a treatment for apical prolapse. Suspension of the vaginal vault is crucial in preventing POP, since the lack of the apical support doubles the POP recurrence risk.⁹ In addition, several other factors, such as age, obesity, vaginal deliveries, parity, and hysterectomy indication seem to affect the POP risk after hysterectomy.⁶⁻⁸

Less is known about the role of hysterectomy approach, intra- or perioperative factors, complications, body mass index (BMI), experience and status of the surgeon, or preceding and concomitant procedures such as ovariectomy and stress urinary incontinence (SUI) operations. In this retrospective cohort study, we report the rates of post-hysterectomy POP operations and outpatient visits over more than 10 years among 3582 women who underwent hysterectomy for benign indication other than prolapse during the year 2006. We also assessed patient and operation related factors for long-term POP risk.

2 | MATERIAL AND METHODS

The present data is a sub-analysis of the prospective, large nationwide Finhyst-study of 5279 women who underwent hysterectomy for benign indications and was conducted in 53 Finnish hospitals in 2006. It included 79% of all benign hysterectomies in Finland that year. The study comprised all 46 public hospitals (5 university, 16 central and 23 local) and 7 private clinics. The latter covered only 1.3% of all hysterectomies. Due to the prospective, national study design and volunteer participation also for the surgeons, 21% ($n = 1109$) of the benign hysterectomies performed in the first study year (2006) was missed. The study was included in the [ClinicalTrials.gov](https://clinicaltrials.gov) protocol and written consent was obtained from each patient. Paper questionnaires covered patient characteristics and

Key message

After benign hysterectomy, the risk of POP operation was reported in only 1.6% patients without prior POP. The risk for POP was associated with the approach of laparoscopic-assisted vaginal hysterectomy, vaginal deliveries and concomitant stress urinary incontinence operations.

surgical data and were completed by the surgeons.⁴ The main indications for hysterectomy determined by a gynecological surgeon were: fibroids, menorrhagia, dysmenorrhea, endometriosis, uterine prolapse, adnexal mass or other. Other indications included endometrial hyperplasia (3.1%), cervical malignancy (1.8%), abdominal pain, familial history of cancer, adenomyosis, benign pelvic tumor, endometrial polypoidosis, pelvic inflammatory disease, transsexualism, prior breast cancer, hematometra, urinary symptoms, dyspareunia and migraine (each only <0.5%).⁴ Other patient and operation characteristics were defined as described previously.⁴

The hysterectomy approaches were classified as abdominal (AH), including both total and subtotal hysterectomies and conversions), laparoscopic (LH), laparoscopic-assisted vaginal (LAVH) and vaginal (VH). The hysterectomy approach was chosen by a surgeon according to anatomical findings and an indication. The surgeon provided the diagnosis but not the stage of the prolapse nor the method of the vaginal cuff suture. The difficulty of the operation was classified by a surgeon from one to five (1 = easy, 5 = very difficult) and the operation time was also reported. The experience of the surgeon was classified under 10, 10–30 and over 30 operations.

From this data we identified 3582 (68%) women who underwent hysterectomy for any other benign indication than POP. Women with an operation or diagnosis of POP before the hysterectomy were excluded ($n = 1697$). Post-hysterectomy operations and outpatient clinical visits for POP were followed up until the end of year 2016. A flow chart of sample collection is shown in [Figure 1](#).

The cohort was subsequently linked to the Finnish Care Register maintained by the Finnish Institute for Health and Welfare. The Care Register contains information on dates of hospital admission and discharge, diagnoses coded according to the International Classification of diseases (ICD) and operation codes based on the Nordic Classification of Surgical Procedures (NSCP) for all clinical in- and outpatient visits in every specialized health care providing institute in Finland. From the Care Register, we identified all POP

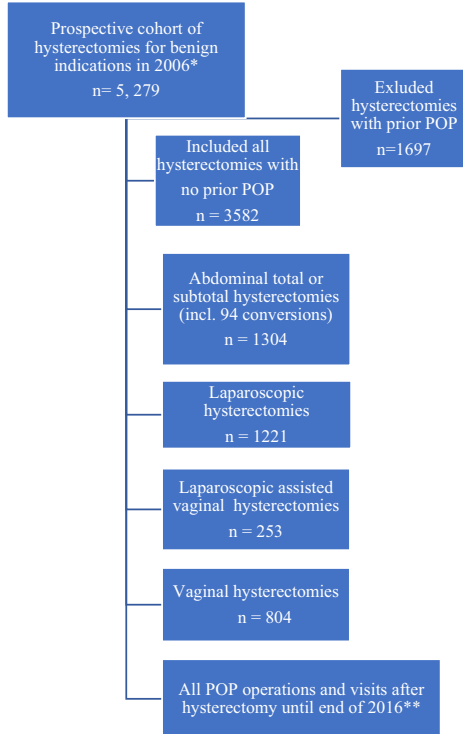


FIGURE 1 Flow of the sample collection. POP, pelvic organ prolapse. *By data collected in the prospective cohort. **By Data from the Care Register for Health Care.

diagnoses (ICD-10 N81*) and/or POP operations (NSCP codes LEF*) from 1996 up to end of 2016. From the Care Register we could identify a prolapse compartment but not prolapse stage.

The primary outcome was the rate of post-hysterectomy POP surgery and/or POP diagnosed at an outpatient clinical visit 60 days or more after the index hysterectomy. Follow-up ended at the first operation or visit for POP. We also evaluated if the presence of POP was associated with the specific surgical procedures and patient related factors, such as the hysterectomy approach, preceding and concomitant operations, age, BMI, parity, vaginal deliveries, indication, uterus size, some autoimmune disease, chronic obstructive pulmonary disease/asthma, difficulty of the hysterectomy, intra- and perioperative complications, experience of the surgeon and hospital type. The frequency of pre- and post-hysterectomy UI (urinary incontinence) diagnoses were also assessed.

The risk factor analysis was conducted for all of the above-mentioned variables by univariate and multivariate analysis. The variables were found to be significant in a univariate model (hysterectomy approach, vaginal deliveries and concomitant SUI operation) were tested in a multivariate Cox regression analysis and adjusted with each other, age, BMI, previous cesarean section and uterus size. For visualization, we created Kaplan–Meier curves for cumulative survival without a POP operation according to the hysterectomy approach.

For continuous variables, results were expressed as mean and standard deviation or as median and interquartile range, and significance calculated using the independent t test. In the case of ordinal variable, proportions were calculated by the Chi-squared or Fisher's exact test as appropriate. When comparing more than two groups, the one-way ANOVA was used. A significance level of $p < 0.05$ was used. Data analysis was performed using IBM SPSS Statistics 26.0.

2.1 | Ethics statement

The study protocol was approved by the Ethical Committee of the Helsinki and Uusimaa Hospital District (Dnro 457/E8/04 on December 16, 2004 and 343/13/03/03/2015 on March 3, 2015) and was registered in the Clinical Trials (NCT00744172). The Finnish Institute for Health and Welfare of Finland authorized the use of the data from the Care Register (THL/986/5.05.00/2018). The research was conducted in accordance with the principles embodied in the Declaration of Helsinki and in accordance with local statutory requirements and all participants gave written informed consent to participate in the study.

3 | RESULTS

Abdominal hysterectomy was the most common approach ($n = 1304$), followed by laparoscopic ($n = 1221$), vaginal ($n = 804$) and laparoscopic-assisted vaginal hysterectomy ($n = 253$). Indications varied between the operation approaches; fibroids were the most common in women with AH, LH and LAVH and dysfunctional bleeding in VH, as prolapse indication was excluded in this study. The women with VH were the youngest, more often multiparous and had the least cesarean sections as compared to the women with other approaches. A BMI of over 30 (25.4%), uterus >500 g (37.6%) and minor complications (16.3%) were over-represented in the women with AH. Concomitant SUI operations were performed more often in women with VH (1.6%) as compared to the women with any other approach (all $<0.8\%$, $p < 0.01$ VH vs LH and AH). The number of post-hysterectomy UI diagnoses ($n = 143$, 4.0%), exceeded that of pre-hysterectomy ($n = 93$, 2.6%) in all women. This increase was greatest (3.9%) among those with a history of LAVH ($p = 0.03$ LAVH vs AH). Baseline characteristics are presented in Table 1.

The women were followed for a median of 10.6 years. Outpatient visits for any POP symptom occurred in 92 (2.6%) of women and most of the diagnoses were posterior wall prolapses (58, 1.6%). Women with LAVH had more visits for any prolapse ($n = 12$, 4.7%) and for vaginal vault prolapse ($n = 4$, 1.6%) than those women with AH ($n = 21$, 1.6%, $p = 0.01$) ($n = 2$, 0.2%, $p = 0.02$, respectively). Time from hysterectomy to any POP visit was shorter in women with AH (4.0 years) as compared to those women with LH (6.8 years) and VH (7.1 years) ($p < 0.01$ for both, Table 2).

During the follow-up time, 58 women (1.6%) underwent some kind of POP operation, of which rectocele was the most common

TABLE 1 Sample demographics.

	All hyst. ^a	AH ^b	LH	LAVH	VH
n (%)	3582 (100)	1304 (36.4)	1221 (34.1)	253 (7.1)	804 (22.4)
Age, mean (SD)	48.8 (8.1)	49.8 (8.5)	48.6 (8.0)	49.3	46.7 (6.6)
Age, n (%)					
Under 45	1045 (29.1)	311 (23.8)	357 (29.2)	72 (28.5)	305 (37.9)
45–54	1897 (53.0)	712 (54.6)	643 (52.7)	120 (47.4)	422 (52.5)
55 and over	640 (17.9)	281 (21.5)	221 (18.1)	61 (24.1)	77 (9.6)
BMI, mean (SD)	26.5 (5.9)	27.2 (5.3)	25.9 (4.6)	26.2 (4.6)	26.2 (5.0)
BMI > 30	736 (20.5)	331 (25.4)	213 (17.4)	47 (18.6)	145 (18.0)
Deliveries					
Cesarean sections one or more	579 (16.2)	1076 (17.5)	1025 (16.1)	50 (19.8)	105 (13.1)
Vaginal deliveries	2488 (69.5)	525 (59.7)	405 (66.8)	55 (78.3)	695 (86.4)
Nulliparous or status unknown	785 (21.9)	378 (29.0)	303 (24.8)	37 (14.6)	67 (8.3)
1–2 vaginal deliveries	1701 (47.5)	552 (42.3)	578 (47.3)	130 (51.4)	441 (54.9)
3 or more vaginal deliveries	787 (22.0)	227 (17.4)	238 (19.5)	68 (26.9)	254 (31.6)
Preceding operations					
Any preceding operation [*]	1859 (51.9)	659 (50.5)	652 (53.4)	145 (57.3)	403 (50.1)
Preceding laparotomy	866 (24.2)	375 (28.8)	283 (23.2)	70 (27.7)	138 (17.2)
Preceding laparoscopy	944 (26.4)	234 (17.9)	370 (30.3)	83 (32.8)	257 (32.0)
Main indication					
Fibroids	1662 (46.4)	768 (58.9)	489 (40.0)	92 (36.4)	313 (38.9)
Dysfunctional uterine bleeding	1032 (28.8)	192 (14.7)	386 (31.6)	81 (32.0)	373 (46.4)
Dysmenorrhea	131 (3.7)	27 (2.1)	51 (4.2)	14 (5.5)	39 (4.9)
Endometriosis	125 (3.5)	82 (6.3)	37 (3.0)	5 (2.0)	1 (0.1)
Adnexal mass or other	632 (17.6)	235 (18.0)	258 (21.1)	61 (24.1)	78 (9.7)
Uterus size, mean (g) (SD)	286 (295)	427 (419)	209 (143)	215 (138)	200 (131)
Uterus >500 g	679 (19.0)	490 (37.6)	110 (9.0)	20 (7.9)	59 (7.3)
Operations					
Any concomitant operation	1510 (42.2)	731 (56.1)	553 (45.3)	134 (53.0)	92 (11.4)
Bilateral salpingectomy	944 (26.4)	464 (35.6)	359 (29.4)	92 (36.4)	29 (3.6)
SUI operation (TOT, TVT, Burch)	22 (0.6)	1 (0.1)	6 (0.5)	2 (0.8)	13 (1.6)
Operator experience					
<30 hysterectomies	762 (21.3)	286 (21.9)	275 (22.5)	57 (22.5)	144 (17.9)
>30 hysterectomies	2695 (75.2)	974 (74.7)	905 (74.1)	180 (71.1)	636 (79.1)
Operator status					
Specialist	2686 (75.0)	954 (73.2)	945 (77.4)	191 (75.5)	596 (74.1)
Resident	695 (19.4)	281 (21.5)	207 (17.0)	43 (17.0)	164 (20.4)
Complications					
Any	420 (11.7)	230 (17.6)	87 (7.1)	28 (11.1)	75 (9.3)
Minor	455 (12.7)	213 (16.3)	130 (10.6)	29 (11.5)	83 (10.3)
Major	147 (4.1)	66 (5.1)	45 (3.7)	7 (2.8)	29 (3.6)
Operating hospital					
University	1409 (39.3)	388 (29.8)	667 (54.6)	94 (37.2)	260 (32.3)
Central	1318 (36.8)	618 (47.4)	327 (26.8)	98 (38.7)	275 (34.2)
Local	814 (22.7)	292 (22.4)	203 (16.6)	59 (23.3)	260 (32.3)
Private	41 (1.1)	6 (0.5)	24 (2.0)	2 (0.8)	9 (1.1)

(Continues)

TABLE 1 (Continued)

	All hyst. ^a	AH ^b	LH	LAVH	VH
UI diagnosis or operation <i>n</i> (%)					
Concomitant SUI operation	22 (0.6)	1 (0.1)	6 (0.5)	2 (0.8)	13 (1.6)
UI diagnosis pre-hysterectomy	93 (2.6)	29 (2.2)	25 (2.0)	8 (3.2)	31 (3.9)
UI diagnosis post-hysterectomy	143 (4.0)	43 (3.3)	45 (3.7)	18 (7.1)	37 (4.6)

Abbreviations: AH, abdominal hysterectomy; BMI, body mass index; LAVH, laparoscopic-assisted vaginal hysterectomy; LH, laparoscopic hysterectomy; SAH, subtotal abdominal hysterectomy; SD, standard deviation; SUI, stress urinary incontinence; TOT, transobturator tape; TVT, tension-free vaginal tape; VH, vaginal hysterectomy.

^aIncluding cesarean sections, laparoscopies, laparotomies.

^aAll hysterectomies.

^bincluding SAH and conversions.

TABLE 2 Incidence of prolapse repair and visits after different hysterectomy approaches by type.

	All hyst. <i>n</i> = 3582	AH <i>n</i> = 1304	LH <i>n</i> = 1221	LAVH <i>n</i> = 253	VH <i>n</i> = 804	<i>p</i> -value
POP operation <i>n</i> (%)						
Any prolapse repair						
Yes	58 (1.6)	12 (0.9)	19 (1.6)	9 (3.6)*	18 (2.2)	0.01
No	3524 (98.4)	1292 (99.1)	1202 (98.4)	244 (96.4)	786 (97.8)	
Type of repair						
Colporrhaphy anterior						
Yes	24 (0.7)	6 (0.5)	9 (0.7)	2 (0.8)	7 (0.9)	0.69
No	3558 (99.3)	1298 (99.5)	1212 (99.3)	251 (99.2)	797 (99.1)	
Colporrhaphy posterior						
Yes	39 (1.1)	7 (0.5)	14 (1.1)	5 (2.0)*	13 (1.6)	0.05
No	3543 (98.9)	1297 (99.5)	1207 (98.9)	248 (98.0)	791 (98.4)	
Vaginal vault repair						
Yes	11 (0.3)	1 (0.1)	1 (0.1)	5 (2.0)*	4 (0.5)	<0.01
No	3571 (99.7)	1303 (99.9)	1220 (99.9)	248 (98.0)	800 (99.5)	
Time, years, median (IQR)	6.4 (4.1–9.4)	5.1 (2.5–8.2)	6.0 (3.6–9.5)	6.4 (3.5–9.2)	7.9 (5.9–9.8)	0.29
POP visits <i>n</i> (%)						
Prolapse visit						
Yes	92 (2.6)	21 (1.6)	34 (2.8)	12 (4.7)*	25 (3.1)	0.01
No	3490 (97.4)	1283 (98.4)	1187 (97.2)	241 (95.3)	779 (96.9)	
Type of prolapse						
Cystocele						
Yes	35 (1.0)	9 (0.7)	12 (1.0)	6 (2.4)	8 (1.0)	0.10
No	3547 (99.0)	1295 (99.3)	1209 (99.0)	247 (97.6)	796 (99.0)	
Rectocele						
Yes	58 (1.6)	13 (1.0)	21 (1.7)	6 (2.4)	18 (2.2)	0.11
No	3524 (98.4)	1291 (99.0)	1200 (98.3)	247 (97.6)	786 (97.8)	
Vaginal vault prolapse						
Yes	20 (0.6)	2 (0.2)	7 (0.6)	4 (1.6)*	7 (0.9)	0.02
No	3562 (99.4)	1302 (99.8)	1214 (99.4)	249 (98.4)	797 (99.1)	
Time, years, median (IQR)	6.1 (2.8–9.0)	4.0 (1.9–7.3)*	6.8 (5.2–9.4)	4.6 (1.0–8.7)	7.1 (4.8–9.3)	<0.01

Abbreviations: AH, abdominal hysterectomy; All hyst, all hysterectomies; IQR, interquartile range; LAVH, laparoscopic-assisted vaginal hysterectomy; LH, laparoscopic hysterectomy; POP, pelvic organ prolapse; VH, vaginal hysterectomy.

*Significant.

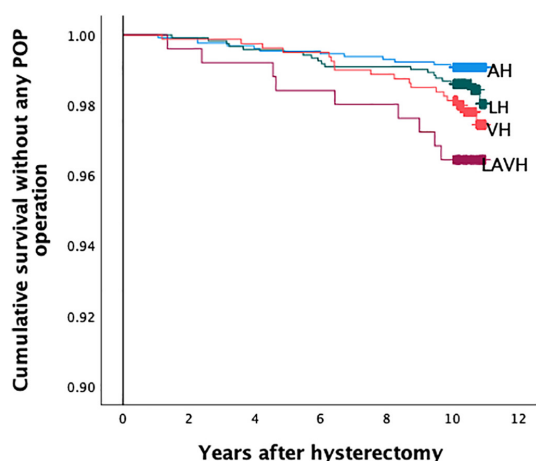


FIGURE 2 Kaplan-Meier cumulative survival without any pelvic organ prolapse (POP) operation after hysterectomy during more than 10 years of follow-up time. AH, abdominal hysterectomy; LAVH, laparoscopic-assisted vaginal hysterectomy; LH, laparoscopic hysterectomy; VH, vaginal hysterectomy.

($n = 39$, 1.1%). Twenty of 58 (34.4%) women had more than one POP operation. The women with LAVH underwent post-hysterectomy POP operation ($n = 9$, 3.6%), more often than those with AH ($n = 12$, 0.9%) ($p < 0.01$) (Table 2, Figure 2). The women with LAVH experienced post-hysterectomy vaginal vault prolapse (2.0%) more often than those undergoing any other hysterectomy approach ($p < 0.01$) (Table 2).

In adjusted survival analysis the women with a history of LAVH had a three times higher risk for any POP operation (hazard ratio [HR] 3.0, confidence interval [CI]: 1.2–7.7) and 4.3 times higher risk for vaginal vault prolapse as compared to those women with AH (HR 4.3, CI: 1.4–13.9). For POP visits those with a history of LAVH had a 2.2 times higher risk for any POP visit than those with AH (HR 2.2, CI: 1.0–4.9) (Table 3).

In the univariate analysis only LAVH and VH approaches were associated with risk for POP operations (HR 3.9, CI: 1.2–11.6, and HR 2.4, CI: 1.2–5.1) and visits (HR 3.0, CI: 1.5–6.1, and HR 1.9, CI: 1.0–3.4) when AH was used as a reference, whereas no associations were found in the subanalysis with other patient and operation related risk factors, no associations were found (data not shown).

In the multivariate analyses LAVH, vaginal deliveries and concomitant SUI operations associated with risk for a POP operation whereas only LAVH associated with a twofold higher risk for POP visits (Table 4). We also conducted two-category risk factor analysis in which LAVH associated with a 2.2 times higher risk for any POP operation (CI: 1.1–4.6) and a 1.8 times higher risk for any POP visit (CI: 1.0–3.4). Vaginal deliveries and the combination of hysterectomy with SUI operation were associated with risk for any POP operations (HR 4.4, CI: 1.7–11.0, and HR 11.9, CI: 4.3–32.7, respectively) and POP visits (HR 3.9, CI: 2.0–7.8, and HR 7.2, CI: 2.7–20.0,

respectively), (Table 5). When we excluded all the women with a concomitant SUI operation ($n = 22$) from our analysis, the women with LAVH still had higher risk for any post-hysterectomy prolapse repair and visit (data not shown).

4 | DISCUSSION

We assessed rates and risk factors for POP operations and visits in a cohort of 3582 women with a history of hysterectomy for any other benign indication than POP. During more than 10 years of follow-up time, only 1.6% of the women underwent a POP operation, mainly in women with a history of LAVH. The rate of POP operations was approximately two-thirds of the rate of POP visits (2.6%), which indicates that some women were treated conservatively. A Danish national registry study with a 20-year follow-up observed that approximately one third of all POP operations after hysterectomy were performed within 5 years after hysterectomy, and the risk for POP operations decreased after 7 years.⁸ Also in our study, 58% of POP operations and 62% of POP visits occurred during the first 7 years of follow-up.

The number of POP operations and visits that were observed during follow-up was lower than in previous studies showing clearly higher post-hysterectomy POP operation rates (5%–13%).^{7,8,10} It is possible that our 10-year follow-up time, which was shorter than in previous studies,^{11,12} was not long enough to catch all post-hysterectomy POPs, since the mean age of the women in our cohort was only 58 years at the end of the follow-up. In the previous Finnish and U.S. studies the highest incidence peaks of POP surgeries are among women over 70 years.^{13,14} Thus, it is possible that some of the women in our cohort will still ensue a POP operation in the future. However, in contrast to previous studies, we excluded women with a prior POP operation or POP diagnosis, which could at least partly explain our low rate, since existing POP is a the significant risk factor for further pelvic floor problems.^{10,11,15,16} This explanation is supported by the Swedish study that reported low numbers of post-hysterectomy POP operations in women with a history of VH and AH for non-POP indication.¹² Furthermore, a smaller study population, larger number of excluded patients and participation partly based on only telephone interviews in the previous studies may also explain the difference.¹²

We were able to analyze four different hysterectomy approaches and found that women with LAVH had the highest risk for post-hysterectomy POP, even after adjusting for confounders like BMI, age, vaginal deliveries, uterus size, previous abdominal operations, and concomitant SUI operations. These findings contradicted those of Gabriel et al.¹⁶ where most of the POPs (17%) occurred in the women with a history of VH (including the women with a history of LAVH). We separated these surgical methods, since it is likely that some women with VH may have had occult POP. The risk associated with LAVH is likely true, since also outpatient visits for POP were highest among women with LAVH. Explanation for this LAVH-associated risk is unclear, since in LAVH, VH and AH, the

TABLE 3 Multivariate risk analysis for POP operations and visits after hysterectomy. All adjusted with each other.

Multivariate analysis for POP operations	Vaginal vault/anterior repair		Posterior repair		Any POP repair	
	Hazard ratio	95% CI	Hazard ratio	95% CI	Hazard ratio	95% CI
Tested factors						
Age (continuous)	1.0	1.0–1.1	1.0	1.0–1.1	1.0	1.0–1.1
BMI (continuous)	1.0	1.0–1.1	1.0	1.0–1.1	0.9	0.9–1.1
Uterus size						
<300 g	ref		ref		ref	
300–500 g	1.2	0.4–3.2	1.3	0.5–3.1	1.2	0.6–2.6
>500 g	1.5	0.5–4.8	1.4	0.4–4.3	1.3	0.5–3.2
Previous cesarean section	0.2	0.1–1.7	0.7	0.2–2.4	0.4	0.1–1.4
Vaginal deliveries						
No vaginal deliveries	ref		ref		ref	
1–2 vaginal deliveries	4.7	1.1–20.5*	2.9	0.8–10.0	3.6	1.2–10.4*
3 or more vaginal deliveries	3.8	0.8–18.7	6.2	1.8–22.1*	5.1	1.7–15.3*
Hysterectomy approach						
Abdominal	ref		ref		ref	
Laparoscopic	1.2	0.4–3.8	2.0	0.7–5.3	1.4	0.6–3.1
Laparoscopic-assisted vaginal	4.3	1.4–13.9*	2.5	0.7–9.0	3.0	1.2–7.7*
Vaginal	1.6	0.5–4.9	2.5	0.9–6.8	1.8	0.8–4.2
Concomitant SUI operation	1.0	<0.1–<0.1	7.9	1.8–34.2*	5.5	1.3–23.6*
Multivariate analysis for POP visits						
Age (continuous)	1.0	1.0–1.1	1.0	1.0–1.1	1.0	1.0–1.1
BMI (continuous)	1.0	1.0–1.1	1.0	1.0–1.1	1.0	1.0–1.1
Uterus size						
<300 g	ref		ref		ref	
300–500 g	1.2	0.5–3.0	1.1	0.5–2.3	1.1	0.6–2.0
>500 g	1.2	0.4–3.6	0.9	0.3–2.5	0.9	0.4–2.0
Previous cesarean section	0.2	0.03–1.5	0.5	0.2–1.5	0.5	0.2–1.2
Vaginal deliveries						
No vaginal deliveries	ref		ref		ref	
1–2 vaginal deliveries	5.2	1.6–17.5*	4.7	1.6–12.8*	4.0	1.8–9.0*
Three or more vaginal deliveries	4.4	1.2–15.8*	4.9	1.6–14.8*	3.9	1.6–9.1*
Hysterectomy approach						
Abdominal	ref		ref		ref	
Laparoscopic	1.1	0.4–2.9	1.7	0.8–3.6	1.5	0.8–2.8
Laparoscopic-assisted vaginal	3.1	1.1–9.2*	1.8	0.6–5.2	2.2	1.0–4.9*
Vaginal	1.1	0.4–3.1	1.8	0.8–4.0	1.5	0.8–2.9
Concomitant SUI operation	1.0	<0.1–<0.1	5.4	1.3–22.7	3.7	0.9–15.3

Abbreviations: BMI, body mass index; CI, confidence interval; HR, hazard ratio; POP, pelvic organ prolapse; ref, reference; SUI, stress urinary incontinence.

*Significant.

uterosacral ligament suspension, which is crucial for re-establishing apical support, is likely done in contrast to the technique of LH in 2006, when most vaginal cuff sutures were performed without cuff suspensions. In a recent study, however, the cuff suspension was found to be indifferent for subsequent prolapse.¹⁶ It is also possible

that the women selected for LAVH already had a more descending uterus preoperatively, and/or more vaginal laxity, since 27% of these women were multiparous, and we found that vaginal deliveries were also associated with a risk for POP. In contrast, women who underwent LH were more likely selected to this hysterectomy approach

TABLE 4 Survival analysis for POP operations and visits across four hysterectomy approaches.

Any POP repair					Vaginal vault/anterior repair					Posterior repair					
n	Crude HR (95%CI)	p-value	Adjusted HR (95%CI)		n	Crude HR (95%CI)	p-value	Adjusted HR (95%CI)		n	Crude HR (95%CI)	p-value	Adjusted HR (95%CI)	p-value	
Hysterectomy approach															
Abdominal n = 1304	12	1 ref	ref		7	1 ref		ref		7	1 ref		ref		
Laparoscopic n = 1221	19	1.7 (0.8–3.5)	0.15	1.4 (0.6–3.1)	0.42	10	1.5 (0.6–4.0)	0.03	1.2 (0.4–3.8)	0.67	14	2.2 (0.9–5.3)	0.10	2.0 (0.7–5.3)	0.17
LAVH n = 253	9	3.9 (1.6–9.2) ^a	<0.01	3.0 (1.2–7.7) ^a	0.02	7	5.2 (1.8–14.9) ^a	<0.01	4.3 (1.4–13.9) ^a	0.01	5	3.7 (1.2–11.6) ^a	0.03	2.5 (0.7–9.0)	0.16
Vaginal n = 804	18	2.4 (1.2–5.1) ^a	0.02	1.8 (0.8–4.2)	0.13	11	2.0 (0.8–5.6)	0.14	1.6 (0.5–4.9)	0.42	13	3.0 (1.2–7.6)	0.02	2.5 (0.9–6.8)	0.08
Any POP visit					Vaginal vault/cystocele visit					Rectocele visit					
Hysterectomy approach															
Abdominal n = 1304	21	1 ref	ref		11	1 ref		ref		13	1 ref		ref		
Laparoscopic n = 1221	34	1.7 (1.0–3.0) ^a	0.05	1.5 (0.8–2.8)	0.17	19	1.5 (0.7–3.6)	0.15	1.4 (0.6–3.2)	0.42	21	1.7 (0.9–3.5)	0.12	1.7 (0.8–3.6)	0.17
LAVH n = 253	12	3.0 (1.5–6.1) ^a	<0.01	2.2 (1.0–4.9) ^a	0.04	10	4.0 (1.5–11.0) ^a	<0.01	2.6 (0.9–7.3)	0.07	6	2.4 (0.9–6.3)	0.08	1.8 (0.6–5.2)	0.29
Vaginal n = 804	25	1.9 (1.0–3.4) ^a	0.03	1.5 (0.8–2.9)	0.21	15	1.6 (0.6–4.1)	0.11	1.4 (0.6–3.4)	0.46	18	2.2 (1.1–4.6) ^a	0.03	1.8 (0.8–4.0)	0.14

Abbreviations: CI, confidence interval; HR, hazard ratio; LAVH, laparoscopic-assisted vaginal hysterectomy; POP, pelvic organ prolapse; ref, reference.
^aAdjusted for BMI (continuous), age (continuous), previous cesarean section, indication, bilateral adnexal removal, uterus size, vaginal deliveries, surgeon experience, complications and concomitant stress urinary incontinence (SU) operation.

TABLE 5 Risk factor analysis for POP operations and POP visits after hysterectomy for two-category variables.

	No POP oper	Any POP oper	Crude OR (95% CI)	Adjusted HR (95% CI)	p-value
n (%)	n = 3524 (98.4)	n = 58 (1.6)			
LAVH					
No	3280 (91.5)	49 (1.4)	Reference	Reference	
Yes	244 (6.8)	9 (0.3)	2.4 (1.2–4.9)*	2.2 (1.1–4.6)*	0.03
Vaginal deliveries					
No	1089 (30.4)	5 (0.1)	Reference	Reference	
Yes	2435 (68.0)	53 (1.5)	4.7 (1.9–11.7)*	4.4 (1.7–11.0)*	<0.01
SUI operation ^a					
No	3506 (97.9)	51 (1.4)	Reference	Reference	
Yes	18 (0.5)	7 (0.2)	22.3 (10.1–49.2)*	11.9 (4.3–32.7)*	<0.01
	No POP visit	Any POP visit	Crude OR (95% CI)	Adjusted HR ^a (95% CI)	p-value
n (%)	3490 (97.4)	92 (2.6)			
LAVH					
No	3249 (90.7)	80 (2.2)	Reference	Reference	
Yes	241 (6.7)	12 (0.3)	2.0 (1.1–3.7)*	1.8 (1.0–3.4)*	0.05
Vaginal deliveries					
No	1089 (30.4)	5 (0.1)	Reference	Reference	
Yes	2435 (68.0)	53 (1.5)	4.1 (2.1–8.2)*	3.9 (2.0–7.8)*	<0.01
SUI operation ^a					
No	3472 (96.9)	88 (2.5)	Reference	Reference	
Yes	18 (0.5)	4 (0.1)	13.4 (6.2–29.0)*	7.2 (2.7–20.0)*	<0.01

Note: Adjusted with each other, body mass index (continuous) and age (continuous).

Abbreviations: CI, confidence interval; HR, hazard ratio; LAVH, laparoscopic-assisted vaginal hysterectomy; OR, odds ratio; POP, pelvic organ prolapse; SUI, stress urinary incontinence.

^aConcomitant SUI operation.

*Significant.

due to a narrower upper vaginal segment and not having any occult prolapse. Further, pulling and stretching of the supportive tissues in LAVH may add to the surgical trauma and the optional cuff suspension may be compromised.

Posterior vaginal wall prolapse was the most common post-hysterectomy POP operation and reason for visit after the hysterectomy approaches. This finding is in line with the Danish study.¹¹ Our data showed that women with LAVH also had a risk for vaginal vault repair, whereas anterior wall repair was the most common POP operation after all hysterectomy approaches in the Swedish nationwide cohort.¹² The differences between these studies are unknown, even if retrospective study design may be one explanation. Further, in the Swedish study¹² there were only two hysterectomy approaches and overall lower POP procedures. It is unclear why POP develops faster after AH than after other approaches, but there are possible explanations.¹⁷ The women with AH were older, had higher BMI and weight of the uterus, and had more complications. Moreover, time to prolapse was shortest after vaginal hysterectomy in the previous study,¹⁶ which contrasts our finding. The reason for this discrepancy might be that in their study, prolapse was the main indication for over 60% of vaginal hysterectomies and cancer for abdominal ones (30%).

The strengths of our study were the relatively large size of the prospective cohort, capability to analyze hysterectomy approaches with the exclusion of women with previous POP and clear end-point data from the reliable national care register. Moreover, our cohort included 79% of all women hysterectomized for benign indication in Finland in 2006. In most previous studies, POP has been an indication for almost all vaginal hysterectomies owing to a low number of no prior POP vaginal hysterectomies.¹⁶ Lykke et al.¹¹ determined the risk of subsequent prolapse across four approaches of hysterectomies (abdominal, subtotal abdominal, laparoscopic which included vaginal-assisted and vaginal hysterectomy) which differed from our study, and potential confounding factors such as BMI, parity and weight of uterus were not analyzed. This could potentially change the outcome. Further, the Swedish study had five approaches of hysterectomy but the valid risk analysis could not be performed for laparoscopic approaches could not be done due to insufficient numbers of subsequent prolapse surgeries.⁷

Our study had limitations. We were unable to identify POP in women who were not referred to specialized health care or were not seeking treatment. However, we believe that the operations

and visits represent well symptomatic POP well due to good access to healthcare in Finland. In the study of Lukanovic et al.¹⁸ post-hysterectomy prolapse was corrected in a median of 16 years with premenopausal women and in a median of 7 years with postmenopausal women, thus considering that half of the women in our cohort were pre-menopausal, it is likely that more POP operations will be performed in the future. Moreover, we lacked data on the stage of prolapses, but we postulate that operated patients represent well symptomatic, more advanced prolapses (stage 2, 3 and 4), since up to 73% of advanced prolapses are concomitant vaginal vault and anterior wall prolapses.¹⁹ In the recent review by Constantini et al.²⁰ concomitant vaginal repair when performing sacrocolpopexy is recommended in case of advanced apical prolapse, since most reoperations are isolated cystoceles. Further, it is demonstrated that advanced anterior prolapse is highly correlated with apical prolapses.²¹ To overcome this bias, we combined vaginal vault and anterior wall prolapses in the risk analysis. We found that LAVH was associated with risk for concomitant vaginal vault and anterior wall prolapses (HR 4.3, CI: 1.4–13.9) which covered 78% of the prolapses among the women with LAVH. Operation techniques have evolved since 2006 as LAVH is rarely used nowadays (approximately 20% of all benign hysterectomies in Finland 2020²²), and laparoscopic suturing has increased the enablement of re-establishing apical support. Thus, these data of LAVH cannot be directly utilized in patient counseling.

5 | CONCLUSION

Clinical implication of our study for women considering benign hysterectomy is that without preceding POP, the risk for post-hysterectomy prolapse is small, only 1.6%. Risk factors associated with LAVH, vaginal deliveries and concomitant SUI operations. Good preoperative patient information is important for benign indications because of availability of conservative treatment options and considering functional changes in pelvic floor after hysterectomy and aging. Future research should focus on the role and type of cuff suspension in different hysterectomy approaches and enlighten its possible effect on POP stages.

AUTHOR CONTRIBUTIONS

TK: Protocol and project development, data collection and management, data analysis, manuscript writing and editing. PH, MM, PR-S and JS: Protocol and project development, manuscript writing and editing. ST, TB, JJ, JM and ET: Data collection and management, manuscript writing and editing.

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CONFLICT OF INTEREST STATEMENT

All the authors declare that they have no conflict of interest.

ORCID

Tea Kuittinen  <https://orcid.org/0000-0001-8940-376X>

Sari Tulokas  <https://orcid.org/0000-0002-2039-8242>

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Recurrent pelvic organ prolapse after hysterectomy; a 10-year national follow-up study

Tea Kuittinen¹ · Maarit Mentula¹ · Sari Tulokas¹ · Tea Brummer² · Jyrki Jalkanen³ · Eija Tomas⁵ · Juha Mäkinen⁴ · Jari Sjöberg¹ · Päivi Härkki¹ · Päivi Rahkola-Soisalo¹

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Abstract

Purpose Hysterectomy may be a risk factor for pelvic organ prolapse (POP). We assessed the risk of recurrent POP (operations and visits) after hysterectomy among women with previous POP. We also studied patient and operation related risk factors for POP recurrence.

Methods This retrospective cohort study included 1697 women having previous POP diagnosis or POP at the time of hysterectomy (FINHYST 2006 cohort). Follow-up was until the end of 2016. The data was derived from the Finnish National Care register linked to the cohort. Hysterectomy approaches and other demographics were compared to the risk of a prolapse diagnosis and/or surgery. Cox regression model was used to identify hazard ratios.

Results Following hysterectomy, a total of 280 women (16.5%) had a POP reoperation and 359 (21.2%) had an outpatient visit due to POP. Vaginal vault prolapse repair was the most common POP reoperation (n = 181, 10.7%), followed by anterior wall repair (n = 120, 7.1%). Median time to POP reoperation was 3.7 years. Hysterectomy approach did not affect reoperations or visits. Previous cesarean section and anterior repair during hysterectomy were associated with decreased risk, whereas concomitant sacrospinous fixation and uterus prolapse as the main indication led to increased risk of anterior/vault prolapse reoperations. Concomitant posterior repair decreased posterior reoperations and visits, but uterus weight over 500 g caused a fivefold increased risk of posterior prolapse visit. Residential status was associated with elevated risk of any POP reoperations and visits.

Conclusions Approximately one out of five women suffering from POP ensue POP reoperation or visit after hysterectomy. These high rates are independent on hysterectomy approach, but probably indicate that hysterectomy may worsen previous pelvic floor dysfunction.

Keywords Pelvic organ prolapse · Laparoscopy · Hysterectomy · Surgical Techniques · Urogynecology

Abbreviations

POP Pelvic organ prolapse
AH Abdominal hysterectomy
LH Laparoscopic hysterectomy

LAVH Laparoscopic-assisted vaginal hysterectomy
VH Vaginal hysterectomy
BMI Body mass index
SSF Sacrospinous fixation

✉ Tea Kuittinen
tea.kuittinen@finnet.fi

¹ Women's Clinic, University of Helsinki and Helsinki University Hospital, Haartmaninkatu 2, 00290 Helsinki, Finland

² Central Hospital Østfold, Grålum, Norway

³ Hospital Nova of Central Finland, Jyväskylä, Finland

⁴ University of Turku, Turku, Finland

⁵ University of Tampere and Tampere University Hospital, Tampere, Finland

What does this study add to the clinical work

Approximately 20% of 1697 women who underwent hysterectomy for POP, experienced a subsequent POP reoperation or outpatient visits. High rates, irrespective of hysterectomy approach, suggest that hysterectomy may exacerbate known pelvic floor dysfunction. Additionally, apical repair was the primary reoperation (10.7% overall, 8.8% within the same compartment) highlighting the need for vaginal vault suspensions during hysterectomy.

Introduction

Pelvic organ prolapse (POP) ensue when supporting structures, pelvic floor muscles, fascia and ligaments are weakened by different risk factors such as pregnancies, deliveries, multiparity, congenital connective tissue abnormalities, ageing, menopause and obesity [1–3]. Approximately 1 out of 4 US women has some pelvic floor disorder with a 12.6% lifetime likelihood for POP surgery [4]. With a similar lifetime risk of undergoing POP surgery in Finland (13%), the risk for POP reoperation during a ten-year follow-up is 10.8% [5]. However, it is estimated that the prevalence of POP will rise by 46% over the next decades due to the ageing in population [6].

Hysterectomy is one of the most frequently performed gynecological procedure (30% by the age of 60 in the USA) for benign indications such as abnormal uterine bleeding, POP, fibroids, and endometriosis [7]. The impact of hysterectomy on subsequent POP is under debate. Previous studies have suggested that hysterectomy per se elevates the risk of developing POP later in life [8–11], particularly when prolapse was the primary indication for the procedure [8, 10, 12]. Conversely, conflicting findings have been reported in large epidemiological studies [13, 14] indicating that concurrent POP repair at the time of index hysterectomy protects against subsequent POP. Furthermore, the effect of hysterectomy approach on POP recurrence remains uncertain.

Most previous studies regarding the risk of POP recurrence have limitations. These studies did not assess outpatient visits [8, 10, 12–15], failed to evaluate different hysterectomy approaches [8, 12, 15], exclusively focused on primary prolapses [9, 11], lacked information on key variables such as parity, vaginal deliveries, body mass index (BMI) or prior POP surgery [10, 13–15] and lacked long-term follow-up exceeding 10 years [13, 14]. These important factors can significantly influence the risk of POP recurrence following hysterectomy.

Therefore, our primary objective in this retrospective cohort study with long-term follow-up was to ascertain the frequencies of reoperations and outpatient clinical visits related to POP in women who had undergone hysterectomy for POP. We also examined the association of subsequent POP with the hysterectomy approach and other surgical and patient-related risk factors.

Methods

Our current study assessing the recurrence of POP following POP associated hysterectomy, represents a sub-analysis of the extensive nationwide prospective FINHYST cohort. This cohort involved 5279 women who underwent hysterectomy

for benign indications. This study was conducted across 53 Finnish hospitals in 2006 and encompassed approximately 79% of all benign hysterectomies performed in Finland during that year. The study was included in the ClinicalTrials.gov protocol, and written consent was obtained from each participating patient. Throughout the study period gynecological surgeons completed paper questionnaires on patient characteristics and surgical data (Brummer et al. [16]). The primary indications for hysterectomy were determined by these gynecological surgeons, as outlined in Table 1. Patient and operation characteristics were defined as previously described [16].

From this dataset we identified 1697 (32%) women who underwent hysterectomy for POP or had some form of POP diagnosis (N81*) or a concomitant operation code for POP (LEF*) within 10 years before or at time of the hysterectomy. Subsequent post-hysterectomy operations and outpatient clinical visits for POP were tracked until the end of 2016. The flow of sample collection is presented in Fig. 1.

We linked the cohort to the Finnish Care Register (HILMO) maintained by the Finnish Institute for Health and Welfare. This register contains information on hospital admission and discharge dates, diagnoses coded according to the International Classification of diseases (ICD) and operation codes based on the Nordic Classification of Surgical Procedures (NSCP) for all clinical in- and outpatient visits in specialized healthcare facilities throughout Finland. From the Care Register, we identified all POP diagnoses (ICD-10 N81*) and/or POP operations (NSCP codes LEF*) from 1996 until the end of 2016. While the Care Register allowed us to identify the affected prolapse compartment, it did not provide information on the stage of prolapse.

We categorized the hysterectomy approaches into abdominal (AH, including both total and subtotal hysterectomies and conversions), laparoscopic (LH), laparoscopic-assisted vaginal (LAVH) and vaginal (VH). The choice of hysterectomy approach was made by the surgeon based on anatomical findings and clinical indications. The surgeon provided the diagnosis, yet not the stage of the prolapse or the method of the vaginal vault suspension.

Data analysis was conducted using IBM SPSS Statistics 28.0. The primary outcome was the rate of post-hysterectomy POP reoperation and/or POP diagnosed at an outpatient clinical visit occurring 60 days or more after the index hysterectomy. We evaluated both the overall reoperation rate and the rate of reoperations within the same compartment. POP reoperations and diagnoses were categorized into three groups based on the affected compartment (anterior, apical, and posterior). We also calculated the number of second and third reoperations divided according to compartments.

To calculate the proportions of first reoperation for each compartment, all POP procedures were included considering

Table 1 Demographics of the 1697 women undergoing hysterectomy 2006 and included in this study

Type of hysterectomy	All hyst ^a	AH ^b	LH	LAVH	VH
	1697 (100)	46 (2.7)	70 (4.1)	47 (2.8)	1534 (90.4)
Pre-operative patient factors					
Age, mean (sd)	59.2 (11.6)	57.8 (13.0)	55.6 (11.6)	56.8	59.4 (11.6)
Age, <i>n</i> (%)					
Under 45	185 (10.9)	6 (13.0)	8 (11.4)	8 (17.0)	163 (10.6)
45–54	445 (26.2)	18 (39.1)	32 (45.7)	11 (23.4)	384 (25.0)
55 and over	1067 (62.9)	22 (47.8)	30 (42.9)	28 (59.6)	987 (64.3)
BMI, mean (Sd)	26.5 (4.1)	27.1 (5.1)	26.7 (4.9)	26.2 (3.3)	26.5 (4.1)
BMI > 30	320 (18.9)	13 (28.3)	18 (25.7)	8 (17.0)	281 (18.3)
Deliveries					
Cesarean Sections	115 (6.8)	4 (8.7)	7 (10.0)	4 (8.5)	100 (6.5)
Vaginal deliveries	1580 (93.1)	39 (84.8)	62 (88.6)	44 (93.6)	1435 (93.5)
Nulliparous or status unknown	102 (6.0)	5 (10.9)	6 (8.6)	2 (4.3)	89 (5.8)
1–2 vaginal deliveries	872 (51.4)	23 (50.0)	35 (50.0)	22 (46.8)	792 (51.6)
3 or more vaginal deliveries	708 (41.7)	16 (34.8)	27 (38.6)	22 (46.8)	643 (41.9)
Preceding operations					
Preceding POP operation	38 (2.2)	1 (2.2)	3 (4.3)	2 (4.3)	32 (2.1)
Any preceding operation	655 (38.6)	24 (52.2)	43 (61.4)	23 (48.9)	565 (36.8)
Hysterectomy-related factors					
Main indication					
Fibroids	85 (5.0)	24 (52.2)	17 (24.3)	3 (6.4)	41 (2.7)
AUB	62 (3.7)	5 (10.9)	10 (14.3)	4 (8.5)	43 (2.8)
Dysmenorrhea	11 (0.6)	1 (2.2)	2 (2.9)	2 (4.3)	6 (0.4)
Endometriosis	5 (0.3)	2 (4.3)	0 (0.0)	0 (0.0)	3 (0.2)
Adnexal mass or other	51 (3.0)	12 (26.1)	19 (27.1)	9 (19.1)	11 (0.7)
POP	1486 (87.6)	2 (4.3)	22 (31.4)	29 (61.7)	1433 (93.4)
Uterus size, median in grams (IQR)	103 (94)	296 (280)	171 (106)	136 (84)	94 (73)
Uterus > 400 g	24 (1.4)	12 (26.1)	2 (2.9)	0 (0.0)	10 (0.7)
Operations					
Any concomitant operation	1447 (85.3)	39 (84.8)	62 (88.6)	44 (93.6)	1302 (84.9)
Bilateral salpingectomy	105 (6.2)	22 (47.8)	34 (48.6)	27 (57.4)	22 (1.4)
SUI operation (TOT or TVT)	65 (3.8)	3 (6.5)	3 (4.3)	2 (4.3)	57 (3.7)
Any concomitant POP operation	1363 (80.3)	14 (30.4)	44 (62.3)	36 (76.6)	1269 (82.7)
Anterior repair	1137 (67.1)	5 (10.9)	24 (34.3)	28 (59.6)	1081 (70.5)
Posterior repair	846 (49.9)	12 (26.1)	28 (40.0)	21 (44.7)	785 (51.2)
Transvaginal mesh	31 (1.8)	0 (0.0)	0 (0.0)	0 (0.0)	31 (1.8)
Sacrospinous fixation	37 (2.2)	0 (0.0)	1 (1.4)	1 (2.1)	35 (94.6)
Operator status					
Specialist	1146 (67.5)	35 (76.1)	55 (78.6)	34 (72.3)	1022 (66.6)
Resident	450 (26.5)	9 (19.6)	11 (15.7)	9 (19.1)	421 (27.4)
not available	101 (6.0)				
Complications					
Minor	167 (9.5)	14 (30.4)	9 (12.9)	4 (8.5)	140 (9.0)
Major	36 (2.1)	1 (2.2)	4 (5.7)	0 (0.0)	31 (2.0)
Operating Hospital					
University	521 (30.7)	10 (21.7)	39 (55.7)	10 (21.3)	462 (30.1)
Central	739 (43.5)	21 (45.7)	28 (40.0)	28 (59.6)	662 (43.2)
Local	429 (25.3)	15 (32.6)	3 (4.3)	9 (10.1)	402 (26.2)
Private	8 (0.5)	0 (0.0)	0 (0.0)	0 (0.0)	8 (0.5)

AUB Abnormal uterine bleeding, BMI, Body mass index, Std Standard deviation, SUI Stress urinary incontinence, TOT Transobturator tape, TVT Tension free vaginal tape, AH Abdominal hysterectomy, LH laparoscopic hysterectomy, LAVH Laparoscopic assisted vaginal hysterectomy, VH Vaginal hysterectomy, SAH Subtotal abdominal hysterectomy

^aAll hysterectomies

^bincluding SAH and conversions

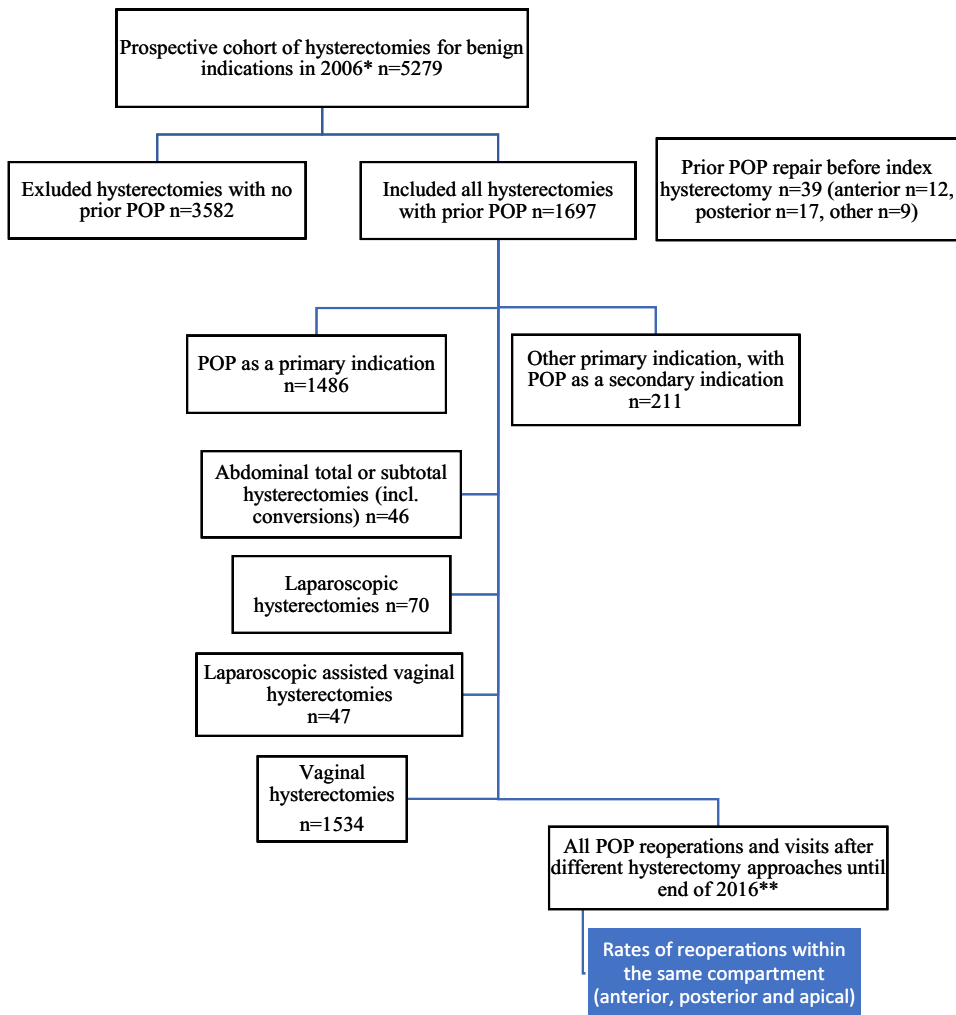


Fig. 1 Flow of the sample collection. *POP* Pelvic organ prolapse. *By data collected in the prospective cohort. **By data from the Care register for Health Care

that some women underwent surgery in multiple compartments. Type of POP surgery as follows:

1. Posterior vaginal prolapse (N81.6, rectoceles).
2. Anterior vaginal prolapse (N81.1, cystoceles).
3. Vaginal vault prolapse (N99.3; includes enteroceles, N81.5).
4. Multicompartment prolapse (posterior and/or anterior and/or vaginal vault prolapse).

The crude risk for POP (reoperations or visits) was analyzed according to the main indication of the hysterectomy

(POP and other indications), and patient or operation-related factors such as the hysterectomy approach, preceding and concomitant operations (prior POP surgery within 10 years before hysterectomy, concomitant anterior and/or posterior repair, sacrospinous fixation (SSF), mesh repair), age, body mass index (BMI), parity, vaginal deliveries, uterus size, some autoimmune disease, chronic obstructive pulmonary disease (COPD)/asthma, intra- and perioperative complications, experience of the surgeon, operator status and hospital type (data not shown).

The variables found to be significant in univariate models (concomitant anterior and posterior repairs, SSF operation,

uterus size, previous cesarean section, BMI, operator status) were tested in a multivariate Cox regression model and adjusted with each other, age, hysterectomy approach (with AH as the reference) and vaginal deliveries. For continuous variables, results were expressed as mean and standard deviation (Std) or as median and interquartile range (IQR), with significance determined using the independent t test. For ordinal variable, proportions were calculated using the Chi-squared or Fisher's exact test as appropriate. When comparing more than two groups, the one-way ANOVA was employed. A significance level of $p < 0.05$ was used for all analyses.

The study protocol received approval from the Ethical Committee of the Helsinki and Uusimaa Hospital District (Dnro 457/E8/04 on December 16, 2004, and 343/13/03/03/2015 on March 3, 2015). The study was registered in the Clinical Trials (NCT00744172). The Finnish Institute for Health and Welfare of Finland authorized the use of the data from the Care Register (THL/986/5.05.00/2018). The research adhered to the principles outlined in the Declaration of Helsinki and local statutory requirements, with all participants providing written informed consent to participate in the study.

Results

The mean age of all women was 59.2 years, with the youngest age group being those who underwent LH (Table 1). Among the women who had AH, a significantly lower percentage (84.5%) had experienced vaginal deliveries compared to those who had VH (93.5%) ($p = 0.02$). Additionally, women who opted for the VH approach had the fewest prior operations compared to other groups ($p < 0.01$, VH vs. LH). POP served as the most common primary indication for hysterectomy in all cases except for AH, where fibroids were the most common primary indication ($p < 0.01$). Concomitant prolapse repairs were most frequently performed for the VH approach ($p < 0.01$, VH vs. AH). The LH approach was most prevalent in university hospitals ($p < 0.01$, LH vs. others). Among 1697 women, subtotal hysterectomy was performed only on six (0.4%). Of these, one (0.4%, 1/280) required a reoperation for POP, and another (0.3%, 1/359) necessitated a POP-related visit.

During the ten-year follow-up time, 280 (16.5%) women had some POP reoperation and 359 women (21.2%) some POP visit (Table 2). The highest number of POP reoperations ($n = 15$, 21.4%) and visits ($n = 17$, 24.3%), were among LH approach, yet the difference was not statistically significant (Fig. 2). The most common POP reoperation was the vaginal vault repair ($n = 181$, 10.7%), followed by the anterior repair ($n = 120$, 7.1%). A median time to POP repair was

3.7 years (IQR). The most common reason for POP-visits following hysterectomy was cystocele (12%), followed by the vaginal vault prolapse (11%). A median time to any prolapse visit was 3.0 years (IQR). Altogether 23 of 280 women (8.2%) underwent a second reoperation which was only 1.4% of all women (23/1697). These were mostly vaginal vault repairs (9.4%, 17 of 181 primary vault repairs, 1.0%, 17 of 1697 all women). A total of three women (1.1%, 3/280 and of all women 0.2%, 3/1697) underwent a third reoperation.

When comparing the main pre-hysterectomy POP diagnosis (indication) with the post-hysterectomy one, women with anterior and apical POP required reoperations and visits more frequently (10.4%, 20/192 and 15.4%, 201/1309, respectively. Notably, POP reoperations were often associated with the same compartment that underwent repair concurrent with the hysterectomy (Table 3). Multicompartment reoperations were the most prevalent (11.2%, 153 out of 1363), whereas only 2.7% (23 out of 846) necessitated reoperation for the posterior compartment.

Among the total cohort, 38 women (2.2%) had previously undergone some POP operation before their hysterectomy (anterior repair 0.7%, 12/1697), posterior repair 1.0%, 17/1697 and other 0.5%, 9/1697), and among this subset, only 4 individuals (10.5%, 4/38 and of all women 0.2%, 4/1697) required a subsequent POP reoperation following the hysterectomy. The incidence of POP related reoperations or visits did not differ significantly between women with a history of pre-hysterectomy POP operation and those who had primary POP repair concomitant with the hysterectomy. Despite the relatively low frequency of POP operations before hysterectomy, 605 women (36%) had received some POP diagnosis during the 10 years before hysterectomy.

In the multivariate analysis, uterine prolapse identified as the primary indication exhibited an elevated risk for any POP reoperation, as well as vaginal vault/anterior reoperation (HR 1.3, CI 95% 1.0–1.6 and HR 1.3, CI 95% 1.0–1.7, respectively) (Table 4). Conversely, a history of cesarean section emerged as a protective factor, reducing the risk for the vaginal vault and anterior prolapse reoperation (HR 0.6, CI 95% 0.3–1.0) and visit (HR 0.5, CI 95% 0.3–1.0), as well as for any prolapse visit (HR 0.6, CI 95% 0.4–1.0). Concomitant anterior repair during hysterectomy reduced risk for the vaginal vault/anterior compartment reoperation and visit (HR 0.7, CI 95% 0.5–0.9 and HR 0.8, CI 95% 0.6–1.0, respectively). Similarly, concomitant posterior repair reduced risk for posterior reoperation and rectocele visit (HR 0.4 CI95% 0.3–0.8 and (HR 0.4, CI 95% 0.3–0.6, respectively), while concomitant sacrospinous fixation correlated with a 2.2-fold risk for vaginal vault/anterior repair (CI 95% 1.2–4.1) and any prolapse repair (CI 95% 1.2–3.9). Uterus weight exceeding 500 g was associated with a substantial 5.0-fold risk for rectocele visits (CI 95% 1.4–18.3). The resident surgeon status presented an elevated risk for

Table 2 Incidence and type of prolapse reoperations and visits after different hysterectomy approaches

	All hyst <i>n</i> = 1697	AH* <i>n</i> = 46	LH <i>n</i> = 70	LAVH <i>n</i> = 47	VH <i>n</i> = 1534	<i>p</i>
Any POP reoper						
Anterior repair	280 (16.5)	6 (13.0)	15 (21.4)	6 (12.8)	253 (16.5)	<i>p</i> = 0.55
Posterior repair	120 (7.1)	3 (6.5)	8 (11.4)	3 (6.4)	106 (6.9)	<i>p</i> = 0.55
Vaginal vault repair	76 (4.5)	2 (4.3)	6 (8.6)	1 (2.1)	67 (4.4)	<i>p</i> = 0.34
Time to reoperation yrs, median (IQR)	181 (10.7) 3.7 (1.4–6.8)	3 (6.5) 0.8 (0.7–3.0)	9 (12.9) 3.8 (2.7–7.8)	3 (6.4) 4.9 (3.5–7.1)	166 (10.8) 3.4 (1.5–6.8)	<i>p</i> = 0.55 <i>p</i> = 0.08*
POP visits						
Cystocele	359 (21.2)	7 (15.2)	17 (24.3)	10 (21.3)	325 (21.2)	<i>p</i> = 0.71
Rectocele	204 (12.0)	5 (10.9)	11 (15.7)	5 (10.6)	183 (11.9)	<i>p</i> = 0.79
Vag. Vault Prolapse	112 (6.6)	2 (4.3)	8 (11.4)	4 (8.5)	98 (6.4)	<i>p</i> = 0.33
Time to visit yrs, median (IQR)	186 (11.0) 3.0 (1.0–6.3)	2 (4.3) 0.7 (0.5–2.4)	7 (10.0) 3.6 (1.3–7.1)	5 (10.6) 3.2 (0.5–6.7)	172 (11.2) 3.0 (1.1–6.3)	<i>p</i> = 0.53 <i>p</i> = 0.08*

All hyst, all hysterectomies, AH* abdominal hysterectomy, includes SAH and conversions, POP Pelvic organ prolapse, AH Abdominal hysterectomy, LH Laparoscopic hysterectomy, LAVH Laparoscopic assisted vaginal hysterectomy, VH Vaginal hysterectomy, IQR Interquartile range, SAH subtotal abdominal hysterectomy

*significant, **p* values from Kruskal-Wallis test for time to prolapse, chi-square and Fischer's exact tests for prolapse type, log-rank test for prolapse visits and repairs and ANOVA test for differences between the groups

Fig. 2 Kaplan–Meier cumulative survival without any POP reoperation after hysterectomy during more than ten years of follow-up time

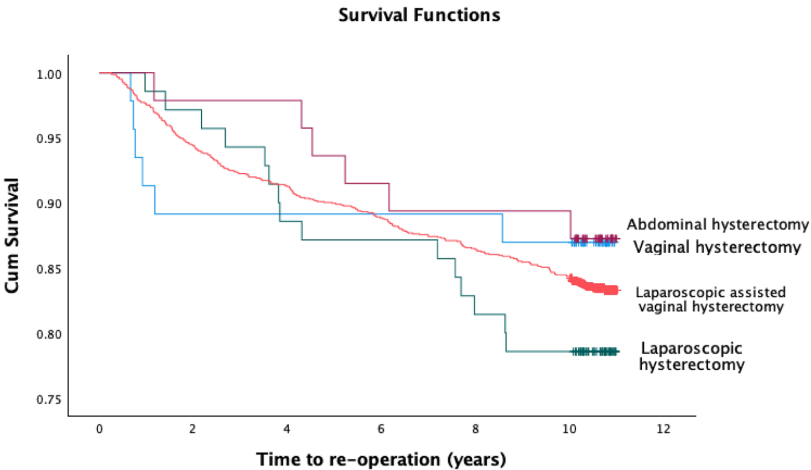


Table 3 Numbers of site-specific reoperations

Hysterectomy associated prolapse repair				
POP reoperation <i>n</i> = 280	Anterior <i>n</i> = 1137 (%)	Posterior <i>n</i> = 846 (%)	Vaginal vault* <i>n</i> = 1331 (%)	Multicompartment <i>n</i> = 1363 (%)
Anterior <i>n</i> = 120	68 (6.0)	58 (6.9)	89 (6.7)	89 (6.5)
Posterior <i>n</i> = 76	49 (4.3)	23 (2.7)	59 (4.4)	58 (4.3)
Vault <i>n</i> = 181	114 (10.0)	91 (10.8)	149 (8.8)	138 (10.1)
Multicompartment <i>n</i> = 202	125 (11.0)	99 (11.7)	165 (12.4)	153 (11.2)

*Includes sacrospinous fixations, mesh repairs and hysterectomies with indication as uterus prolapse
Bold value indicates the percentage of women requiring reoperation within the same compartment.

any POP reoperations (HR 2.3, CI 95% 1.1–5.0) and visits (HR 2.7, CI 95% 1.3–5.6). The choice of hysterectomy approach did not affect the rate of POP reoperations or visits when adjusting with confounders.

Discussion

During a ten-year follow-up period after hysterectomy, one in six women required a POP reoperation, and one in five women had a POP-related outpatient visit. The latter observation suggests that conservative treatment may have sufficed for some women. These numbers are considerably higher than those identified in our previous study involving women without pre-existing POP, wherein only 1.6% needed POP operation within the subsequent ten years following hysterectomy [17]. It is also noteworthy that only 2.2% of women underwent some POP operation during the ten years before the index hysterectomy 2006, although 36% of these women had some POP diagnosis. This aligns with previous findings reporting the prevalence of symptomatic POP to vary from 2–8% of adult women [1, 4, 18], and asymptomatic POP up to 50% when based upon pelvic examination [1].

Our data is consistent with previous studies reporting reoperation rates ranging from 10–19% [15, 19–23] with varying follow-up time between 5–32 years. Because damage to the pelvic supportive structures and innervation are established risk factors for primary prolapse and POP, it is likely that hysterectomy may exacerbate existing pelvic floor dysfunction [3]. It is notable that the number of women needing reoperation may even increase with longer follow-up time, as the incidence of POP typically peaks among women over 60–70 years [1, 4, 5], while up to 37% of the women in our study were under 54 years. On the other hand, most of recurrences take place within five years after hysterectomy [9, 15, 21, 22] and in our dataset, the median time for reoperation was three years, suggesting that we likely were able to capture most recurrences.

Vaginal vault prolapse repairs were the most common reoperations (10.7% overall), which is in line with prior studies (6.4–9.9%) [21, 22, 24]. This highlights the importance of reconstructing apical support through vaginal vault suspension to reduce the risk of POP recurrence. According to Eilber et al. [25] the absence of apical support doubles the risk of POP recurrence and performing McCall-type culdoplasty or high uterosacral ligament suspension during any type of hysterectomy, may reduce the risk of apical prolapse [26–28]. Although our data lacks information about vaginal vault suspensions, uterosacral ligament suspensions were likely performed in AH, LAVH, and VH during our study period in 2006, in contrast with the technique of LH where vaginal vault closure were performed without suspensions.

This difference may, at least in part, explain why the most POP reoperations and visits were in women with LH, even if the difference for other approaches was statistically insignificant.

Considering the advantages associated with vaginal vault suspension, it was surprising to observe an elevated risk for reoperation in women undergoing concurrent sacrospinous fixation. These women probably had an elevated risk of POP recurrence due to advanced prolapse and weak supporting tissue. Moreover, the failure rate of unilateral sacrospinous fixation is high (40–70%) [29, 30]. According to prior studies VH is associated with risk for POP operations later in life [8, 9, 31] but we found no difference between the approaches. This may be due to the differences in cohort sizes and due to patient selection; in this dataset, we only assessed women with pre-existing POP. Furthermore, we were able to separate LAVH from LH in contrast to Lykke et al. [31]. A recent long-term (17 years) follow-up study supports our data showing that not the hysterectomy approach but POP as an indication expose for recurrence [32].

When evaluating the recurrence in same vaginal wall compartment, the apical compartment exhibited the highest reoperation rate (8.8%), followed by the anterior wall at 6.0% and the posterior wall at 2.7%. The finding that only 2.7% of women with rectocele needed reoperation for the posterior wall aligns with the findings of Lavelle et al. [21] (5.8%) but contradicts those of Löwenstein et al. [19] (13%). Although the number of women requiring reoperation for posterior POP is relatively low, it is noteworthy that in women without pre-existing POP, rectocele is the most common POP following hysterectomy [9, 17, 22, 23]. Furthermore, in our dataset, we observed that uterine weight over 500 g suggested a posterior-wall related visit. While the explanation for this association is not entirely clear, it is possible that factors such as heavy straining on the pelvic floor (e.g., pregnancy, delivery, large uterus) may affect pelvic floor supporting structures, potentially contributing to rectocele. The higher incidence of anterior wall and apical recurrences are likely due to damage to common supporting structures such as uterosacral and cardinal ligaments and pericervical ring. This interpretation is supported by our findings and those of previous studies, such as Manodoro S et al. [19] indicating that women undergoing simultaneous repair of both the apical and anterior compartments experience a decreased risk for reoperation. Our data on the recurrence rates of apex and anterior wall largely correspond with previous studies, reporting rates ranging from 7.4% to 10.8% [20, 21].

In assessing the possible risk factors, we found that cesarean section not only protects for a primary [3, 34], but also for a secondary prolapse. This can be attributed to the fact that the women with cesarean deliveries experience less or no vaginal deliveries, thus avoiding the stretching and damage to pelvic floor structures associated with childbirth [35,

Table 4 Multivariate risk analysis for POP reoperations and visits after hysterectomy

Reoperations	Vaginal vault/ anterior repair		Posterior repair		Any prolapse repair	
	HR	95% CI	HR	95% CI	HR	95% CI
Age (yrs)						
< 50	ref		ref		ref	
> 50	1.1	0.8–1.5	1.1	0.6–2.0	1.1	0.8–1.5
BMI						
< 30	ref		ref		ref	
> 30	0.9	0.7–1.3	0.9	0.5–1.6	0.9	0.7–1.3
Uterus size (g)						
< 500	ref		ref		ref	
> 500	1.9	0.6–6.3	4.7	0.9–23.2 ($p=0.06$)	2.2	0.8–6.7
Cesarean section	0.6	0.3–1.0 ($p=0.05$)*	1.0	0.4–2.5	0.6	0.4–1.1
Uterine prolapse	1.3	1.0–1.7 ($p=0.04$)*	0.9	0.6–1.5	1.3	1.0–1.6 ($p=0.07$)
Vaginal deliveries						
No or unknown	ref		ref		ref	
1–2 deliveries	1.2	0.6–2.0	1.6	0.5–5.1	1.2	0.7–2.3
> 3 deliveries	1.0	0.5–1.7	1.3	0.4–4.4	1.1	0.6–1.9
Operation type *						
AH	ref		ref		ref	
LH	2.3	0.7–7.4	2.6	0.5–14.9	2.0	0.7–6.1
LAVH	1.2	0.3–5.0	0.7	0.1–8.8	1.2	0.4–4.4
VH	1.5	0.5–6.4	1.3	0.3–6.6	1.4	0.5–3.6
Conco AR	0.7	0.5–0.9 ($p=0.01$)*	0.9	0.6–1.4	0.8	0.6–1.0
Conco PR	1.1	0.8–1.4	0.4	0.3–0.8 ($p<0.01$)*	0.9	0.7–1.2
Conco SSF	2.2	1.2–4.1 ($p=0.01$)*	1.2	0.2–4.8	2.2	1.2–3.9 ($p=0.01$)*
Operator status						
Specialist	1.8	0.8–3.8	1.3	0.4–4.3	2.0	0.9–4.3 ($p=0.08$)
Resident	1.8	1.0–4.6 $p=0.06$	1.4	0.4–4.7	2.3	1.1–5.0 ($p=0.04$)*
POP visits	Vaginal vault/ cystocele visit		Rectocele visit		Any prolapse visit	
Age (yrs)	HR	95% CI	HR	95% CI	HR	95% CI
< 50	ref		ref		ref	
> 50	1.3	1.0–1.7	0.9	0.5–1.3	1.2	0.9–1.6
BMI						
< 30	ref		ref		ref	
> 30	0.9	0.7–1.3	0.6	0.3–1.1	0.9	0.6–1.1
Uterus size (g)						
< 500	ref		ref		ref	
> 500	1.1	0.3–5.0	5.5	1.5–19.8 ($p=0.01$)*	1.8	0.6–5.2
Cesarean section	0.5	0.3–1.0 ($p=0.04$)*	0.6	0.3–1.6	0.6	0.4–1.0 ($p=0.05$)*
Uterine prolapse	1.2	0.9–1.5	0.9	0.6–1.3	1.1	0.9–1.4
Vaginal deliveries						
No or unknown	ref		ref		ref	
1–2 deliveries	1.1	0.7–2.0	1.1	0.5–2.5	1.1	0.7–1.8
> 3 deliveries	1.0	0.5–1.7	0.9	0.4–2.2	0.9	0.6–1.5
Operation type **						
AH	ref		ref		ref	
LH	1.9	0.6–6.1	4.9	0.9–26.7 ($p=0.07$)	1.8	0.7–4.9
LAVH	1.1	0.3–4.3	3.2	0.5–20.8	1.2	0.4–3.8
VH	1.3	0.5–3.8	2.2	0.4–10.4	1.4	0.6–3.3

Table 4 (continued)

POP visits	Vaginal vault/ cystocele visit		Rectocele visit		Any prolapse visit	
	HR	95% CI	HR	95% CI	HR	95% CI
Age (yrs)						
Conco AR	0.8	0.6–1.0 ($p=0.05$)*	0.8	0.6–1.2	0.8	0.7–1.0
Conco PR	0.9	0.7–1.2	0.4	0.3–0.6 ($p<0.01$)*	0.8	0.7–1.0
Conco SSF	1.5	0.8–2.8	1.0	0.2–3.9	1.7	1.0–3.1 ($p=0.07$)
Operator status						
Specialist	2.4	1.1–5.1 ($p=0.03$)*	6.7	0.9–48.3 ($p=0.06$)	2.4	1.2–4.9 ($p=0.02$)*
Resident	2.8	1.3–6.1 ($p<0.01$)*	7.8	1.1–57.6 ($p=0.04$)*	2.7	1.3–5.6 ($p<0.01$)*

AH, abdominal hysterectomy, LH, laparoscopic hysterectomy, LAVH, laparoscopic assisted vaginal hysterectomy, VH Vaginal hysterectomy POP Pelvic organ prolapse, BMI Body mass index, CI Confidence interval, HR Hazard ratio, ref reference, Conco AR Concomitant anterior repair, Conco PR Concomitant posterior repair, Conco SSF Concomitant sacrospinous fixation * significant, ** Operation type adjusted with BMI, age, previous cesarean section, main indication as uterine prolapse, uterus size, vaginal deliveries, operator status and concomitant operations

36]. Previous studies have suggested that a high level of expertise in surgeons, surgical skills and techniques involving apical fixation and urogynecologists performing all POP procedures explains a reasonable part of their low reoperation rates [15, 37]. In line with this is our finding that the resident status was associated with increased risk of vaginal vault/anterior reoperation (1.8-fold) and any POP reoperation (2.3-fold).

Our study has limitations. We were unable to identify POP in women who were not referred to specialized health care or were not seeking treatment. Because patients with severe pelvic floor symptoms are more prone to seek treatment [38], it is likely that women with mild or moderate symptoms are missing. However, we believe that the operations and visits represent well symptomatic POP, due to good access to public healthcare in Finland. Moreover, we lacked data on the stage of prolapses and it is possible that women with advanced prolapse had higher rate of POP recurrence. VH approach was used in 90% of the hysterectomies, which might reduce the power of the study and explain the lack of difference between the approaches. However, Gabriel et al. [32] assessed the risk of POP after benign or malign AH, VH and LH and concluded that the approach has no effect on the POP risk. Additionally, hysterectomy approach was not randomized, and selection bias caused by surgeons could not be fully adjusted even if controlling several confounders.

Our study's strengths were the relatively large-sized cohort with prospectively collected information on several potential confounders and modifiers, ability to analyze separate hysterectomy approaches and including only women with existing POP, clear end-point data from reliable national care register and over ten years of follow-up. The data presented in the previous studies is limited only to women with POP surgeries [9, 15, 32], whereas we were also able to assess POP visits which indicated that almost 25 percent of women with POP diagnosis managed with conservative treatment options.

We found that pre-existing POP, not the hysterectomy approach, was associated with POP recurrence (reoperations and visits) in the hysterectomized women and the high rates of both reoperations and visits indicate that hysterectomy may exacerbate this existing pelvic floor dysfunction. Moreover, apical prolapse repair was the most common reoperation, which underscores the need for vaginal vault suspensions during hysterectomy.

Author contributions Kuittinen: Protocol and project development, data collection and management, data analysis, manuscript writing and editing. Mentula: Protocol and project development, manuscript writing and editing. Tulokas: Protocol and project development, manuscript writing and editing. Brummer: Data collection and management, manuscript writing and editing. Jalkanen: Data collection and management, manuscript writing and editing. Tomas: Data collection and management, manuscript writing and editing. Mäkinen: Data collection and management, manuscript writing and editing. Sjöberg: Data collection and management manuscript writing and editing. Härkki: Protocol and project development, manuscript writing and editing. Rahkola-Soisalo: Protocol and project development, manuscript writing and editing.

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Data availability Data supporting this study cannot be made available due to legal reasons. Please contact HUS Women's Clinic, PL140, 00029 Helsinki.

Declarations

Conflict of interests The authors have no relevant financial or non-financial interests to disclose.

Ethics approval This study was performed in line with the principles of the Declaration of Helsinki. The study protocol received approval from the Ethical Committee of the Helsinki and Uusimaa Hospital District (Dnro 457/E8/04 on December 16, 2004, and 343/13/03/03/2015 on March 3, 2015).

Consent to participate The study was registered in the Clinical Trials (NCT00744172). The Finnish Institute for Health and Welfare of Finland authorized the use of the data from the Care Register (THL/986/5.05.00/2018). All participants provided written informed consent to participate in the study.

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RESEARCH

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Patient-reported outcomes after hysterectomy due to pelvic organ prolapse versus other indications – a 10-year national follow-up study

Tea Kuittinen^{1,3*} , Sari Tulokas¹, Päivi Rahkola-Soisalo¹, Tea Brummer², Päivi Härkki¹ and Maarit Mentula¹

Abstract

Background We compared short- and long-term patient-reported satisfaction and outcomes after hysterectomy between women with and without pelvic floor dysfunction at the time of hysterectomy.

Methods The nationwide prospective FINHYST cohort was divided into two groups according to the indication for hysterectomy: those with pelvic organ prolapse (POP) with or without urinary incontinence (POPUI) ($n = 1323$) and those with other benign indications (non-POPUI, $n = 2641$). Outcomes were assessed via questionnaires at two months for all women and at ten years for the Helsinki University Hospital (HUU) subgroup ($n = 838$). The primary outcome was patient satisfaction measured by a visual analogue scale (VAS, 0–100); secondary outcomes included patient-reported outcomes and adverse events.

Results Satisfaction was high at two months (mean VAS 88.1 POPUI vs. 89.8 non-POPUI, n.s) and remained high at ten years (89.2 POPUI vs. 92.5 no POPUI, $p < 0.01$). Women without POPUI reported greater satisfaction at ten years. At two months, fewer women in POPUI group had VAS scores under 70 compared to those in non-POPUI group (9.0% vs. 11.5%, $p < 0.02$). In both groups, the strongest predictors of dissatisfaction were reoperation, wound infection, and inadequate pain relief. At ten years, women with POPUI reported more frequently low VAS scores, (VAS < 70: 11.7% vs. 7.0%), persisted pelvic floor symptoms (86.7% vs. 64.0%, $p < 0.01$), and reoperations for POP (20.7% vs. 2.3%, $p < 0.01$).

Conclusions Short- and long term satisfaction following hysterectomy is high. Hysterectomy due to POP was associated with recurrent patient-reported pelvic floor symptoms, reoperations and higher risk of complications, reducing long-term satisfaction.

Keywords Patient-reported outcome, Satisfaction, Pelvic organ prolapse, Urinary incontinence, Dissatisfaction, Visual analogue scale

*Correspondence:

Tea Kuittinen

tea.kuittinen@finnet.fi

¹University of Helsinki and Helsinki University Hospital, Helsinki, Finland

²Central Hospital Østfold, Grålum, Norway

³Helsinki University Hospital, Women's Clinic, Haartmaninkatu 2, Helsinki FI-00290, Finland



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Introduction

Hysterectomy for benign indication and POP (pelvic organ prolapse) surgery are common, with 30% of women undergoing hysterectomy and 12–19% POP surgery [1, 2]. If the indication for hysterectomy is benign, the risks and benefits must be weighed carefully, and the most important end points should be improved symptoms and quality of life. Subjective and objective outcomes are not always in concordance, and recent data suggest that subjective outcomes are more important [3]. Adverse events are known to have a marked impact on subjective outcome, although patient's and surgeons' perception of adverse events may differ [3].

The most common benign indications for hysterectomy are POP, myoma, abnormal uterine bleeding (AUB), pelvic pain, and endometriosis [1, 4], all of which may cause several symptoms affecting health-related quality of life (HRQoL). Hysterectomy and POP or UI (urinary incontinence) surgeries are known to improve HRQoL [5–8], but if subjective expectations are not fulfilled women may perceive the surgery as a failure [3]. Moreover, any adverse event during or after the operation may cause shame among women [3].

Hysterectomy may cause damage to the pelvic floor, and thus, increase risk for POP [9, 10]. POP is a dynamic process that evolves over time, and it may be influenced by several factors such as age, menopause, obesity, vaginal deliveries, pregnancies, parity, and congenital

connective tissue abnormalities [11–13]. Additionally, both POP and UI can significantly impair HRQoL [14, 15], and outcomes may be further negatively affected by de novo symptoms, reoperations, or pre-existing conditions [7, 14]. Given this, rather than focusing solely on anatomical outcomes, it is crucial to assess subjective long-term outcomes, including symptom improvement and patient satisfaction. However, data on these aspects remains limited.

This study aimed to evaluate short- and long-term patient-reported outcomes after hysterectomy for benign indications, with a focus on comparing patient satisfaction and the factors associated with satisfaction between women who underwent hysterectomy for POP and those with other benign indications.

Materials and methods

We used a nationwide prospective survey of 5279 hysterectomies for benign indications (FINHYST) performed in Finland during 2006 [4]. All women received a post-operative questionnaire two months after the hysterectomy. The study included a subgroup of women ($n=838$) undergoing hysterectomy in the Helsinki University Hospital region (HUH subgroup). These women received a second questionnaire ten years after their hysterectomy. The study flow is shown in Fig. 1.

The cohort and the HUH subgroup were linked to the Finnish Care Register to detect any POP or UI-related

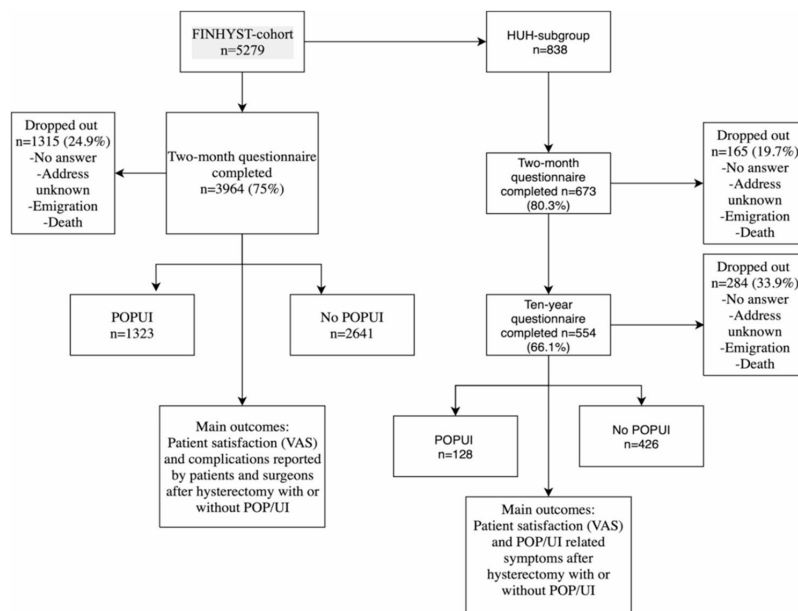


Fig. 1 Flowchart of the study population. HUH Helsinki University Hospital district, POP pelvic organ prolapse, UI urinary incontinence, VAS visual analogue scale

outpatient visits and surgical operations. This register contains information on hospital admission and discharge dates, diagnoses coded according to the International Classification of diseases (ICD), and operation codes based on the Nordic Classification of Surgical Procedures (NSCP) for all clinical in- and outpatient visits in specialized health care facilities throughout Finland. The diagnoses and operation codes included were N81.* (female genital prolapses), N39.3 (stress urinary incontinence), N39.4 (other specified urinary incontinence), and LEF* (prolapse procedures).

We divided the FINHYST cohort with completed two-month questionnaire ($n=3964$) into subgroups according to the primary indication of hysterectomy. The study group comprised women with POP and with or without UI (POPUI group), and the comparison group women with other indications (non-POPUI group).

Other indications for hysterectomy in the comparison group included myoma, abnormal uterine bleeding, dysmenorrhea, endometriosis, and adnexal mass. All women underwent total hysterectomy, and those with POPUI indication also underwent POP repair concurrently (anterior and/or posterior repair, sacrospinous ligament fixation, mesh repair). The choice of hysterectomy approach, abdominal (AH), laparoscopic (LH), or vaginal (VH), was made by the surgeon.

The two-month follow-up questionnaire assessed satisfaction with hysterectomy using a 10-cm VAS scale, ranging from very unsatisfied to very satisfied, and converted to a 0–100 mm score. In addition, the questionnaire inquired about the adequacy and duration of sick leave, hospital readmissions, and outpatient visits. Women who experienced surgery-related minor complications requiring treatment indicated one or more of the following: wound infection, urinary tract infection (UTI), wound dehiscence, heavy vaginal bleeding, postoperative anemia requiring transfusion, pelvic hematoma or infection, inadequate pain control, or other specified problems. Surgeons completed a postoperative questionnaire covering procedural details, short-term minor complications (wound infection, UTI, postoperative anemia requiring blood transfusion, pelvic hematoma or infection, other specified problem and fever of unknown origin) and major complications (deep vein thrombosis, pulmonary embolism, bladder/ureter/bowel/vascular injury or any other reason making a reoperation necessary) length of hospital stay, and sick leave. Complications requiring readmission were confirmed through electronic medical records. Responses were compared between the two study groups. All hysterectomy-related minor and major complications are described in detail in a previous study [16].

The HUH subgroup also received a non-validated 10-year follow-up questionnaire that contained questions

on the following: satisfaction with VAS, effect on quality of life, whether the patient would choose hysterectomy again (yes/no), urinary problems and their treatments, defecation problems and their treatments, symptoms of vaginal bulging, prolapse treatment (conservative and surgical), pain before and after hysterectomy, sexual activity, and surgical or gynecological operations performed after hysterectomy.

These outcomes of patient satisfaction were analyzed between POPUI and non-POPUI groups among the whole cohort and in the HUH subgroup. A cut-off point of 70 was set to define patient dissatisfaction with hysterectomy, based on earlier literature [17, 18]. Dissatisfaction (defined as VAS score under 70) and related factors were assessed at two months for the entire cohort and at ten years for the HUH subgroup. We also compared patient-reported outcomes, complications, and symptoms with those reported by the surgeons at two months. In the HUH subgroup, we further evaluated the occurrence of new symptoms, outpatient visits, and surgical procedures ten years after hysterectomy.

Data were analyzed using SPSS for Windows statistical software version 29.0 (SPSS, Inc., Chicago, IL, USA). Categorical variables were compared by the Chi-square or Fisher exact tests, as appropriate. Continuous variables were compared using either Student's T-test or the Mann–Whitney U test. When comparing more than two groups, one-way ANOVA was employed, and when comparing one continuous and two categorical variables the two-way ANOVA was used. Binary logistic regression model was used to identify independent predictors of visual analogue scale scores under 70. This analysis was performed on factors with a p -value < 0.10 in univariate analysis. A significance level of $p < 0.05$ was used for all analyses.

We initially attempted to generate a propensity score matched cohort; however, due to a significant reduction in sample size and persistent imbalance with standard matching, we utilized Inverse Probability of Treatment Weighting (IPTW) to estimate the causal effect.

To evaluate the robustness of our findings and control for the potential confounding effect of the surgical method and complications, a sensitivity analysis was performed excluding patients with early complications and stratifying by hysterectomy route (AH, LH, VH). A generalized linear model was fitted, adjusting for age, BMI, parity, and occupational status.

Additionally, we attempted multiple imputation to address missing data, but this yielded unstable estimates due to high missingness (Fraction Missing Info > 0.78). Therefore, 10-year results (HUH-subgroup) are reported based on complete case analysis ($n=554$).

Table 1 Demographics of the 3964 women in this study divided into two groups according to the benign indication for hysterectomy (POPUI=pelvic organ prolapse with or without urinary incontinence and non-POPUI=other indication)

<i>n</i> (%)	All 3964 (100)	POPUI 1323 (33.4)	non-POPUI 2641 (66.6)	<i>p</i>
Age mean (Sd)	52.0 (10.5)	59.1 (11.4)	48.9 (7.9)	< 0.01
BMI mean (Sd)	26.5 (4.7)	26.5 (4.1)	26.5 (4.9)	
Parity				
No deliveries* <i>n</i> (%)	671 (16.9)	79 (6.0)	592 (22.4)	< 0.01
One to two <i>n</i> (%)	2058 (51.9)	681 (51.5)	1377 (52.1)	< 0.01
Three or more <i>n</i> (%)	1235 (31.2)	563 (42.6)	672 (25.4)	< 0.01
Hysterectomy approach				
AH	947 (23.9)	30 (2.3)	917 (34.7)	< 0.01
LH	1234 (31.1)	95 (7.2)	1139 (43.1)	< 0.01
VH	1783 (45.0)	1198 (90.6)	585 (22.2)	< 0.01
Any complication [^]	577 (14.6)	155 (11.7)	422 (16.0)	< 0.01
Employed	152 (3.8)	26 (2.0)	126 (4.8)	< 0.01

BMI Body mass index, **AH** Abdominal hysterectomy, **LH** Laparoscopic hysterectomy, **VH** Vaginal hysterectomy, * no deliveries or status unknown, [^] reported by doctors. The difference between the groups is calculated using Chi-square test for categorical variables and Mann-Whitney U-test for continuous, numerical, and categorical variables

Table 2 Crude and IPTW adjusted comparison of patient-reported satisfaction by VAS scores from 0 (very unsatisfied) to 100 (very satisfied). A subgroup of Helsinki university hospital district (HUH) participants is shown separately. Differences between groups were analyzed using Pearson's Chi-square test or T-test

Whole cohort 2 mo	All <i>n</i> = 3964	POPUI <i>n</i> = 1323	non-POPUI <i>n</i> = 2641	<i>p</i>
Answered VAS question, <i>n</i> (%)	3886 (98.0)	1288 (97.4)	2598 (98.4)	
VAS (mean, Sd)	89.5 (16.7)	88.1 (19.9)	89.8 (16.3)	n.s.
VAS (crude under) 70, <i>n</i> (%)	415 (10.7)	116 (9.0)	299 (11.5)	0.02
VAS (IPTW adjusted) under 70, <i>n</i> (%)	2185 (18.3)	420 (11.8)	1765 (21.0)	< 0.001
HUH subgroup 2 mo	<i>n</i> = 838	<i>n</i> = 222	<i>n</i> = 616	
Answered VAS question, <i>n</i> (%)	673 (80.3)	179 (80.6)	494 (80.2)	n.s.
VAS (mean, Sd)	90.2 (16.0)	88.3 (18.7)	90.8 (15.0)	n.s.
VAS under 70, <i>n</i> (%)	74 (11.0)	22 (12.3)	52 (10.5)	n.s.
HUH subgroup 10 yrs				
Answered 10 yrs, <i>n</i> (%)	554 (66.1)	128 (57.6)	426 (69.2)	n.s.
VAS (mean, Sd)	91.7 (1.4)	89.2 (1.5)	92.5 (1.3)	< 0.01
VAS under 70, <i>n</i> (%)	45 (8.1)	15 (11.7)	30 (7.0)	n.s.
Would choose hysterectomy again?				
Yes, <i>n</i> (%)	521 (94.0)	117 (91.4)	404 (94.8)	< 0.01
No	24 (4.3)	9 (7.0)	15 (3.5)	n.s.

Sd Standard deviation, **Mo** Months, **VAS** Visual analogue scale, **POPUI** Pelvic organ prolapse with or without urinary incontinence. The difference between the groups is calculated using Chi-square test for categorical variables and Mann-Whitney U-test for continuous, numerical, and categorical variables

Results

The two-month questionnaire was completed by 75% of FINHYST participants (*n* = 3964): 1323 women with POPUI and 2641 women without POPUI. In the HUH subgroup, 66.1% (*n* = 554) of study participants answered the ten-year questionnaire: 57.7% (*n* = 128) of POPUI and 69.1% (*n* = 426) of no POPUI women.

The demographics of the study groups are presented in Table 1. The groups had significant differences in age, parity, method of hysterectomy, occupational status, and postoperative (short-term) complications. The differences were similar in the HUH subgroup.

Short-term PROMs – two-month outcomes

At two months post-hysterectomy, 98% of women (*n* = 3,886) completed the VAS assessment, with a mean satisfaction score of 89.5 (SD 16.7) (Table 2). Mean satisfaction after the two-month follow-up did not differ between groups in the entire cohort (88.1 POPUI and 89.8 no POPUI) or in the HUH subgroup (88.3 and 90.8) (Table 2). Evaluation of dissatisfaction (VAS < 70) showed a minor difference in the whole cohort. The POPUI group scored less dissatisfaction in crude comparison (9.0% vs. 11.5%, *p* = 0.02). In a separate crude analysis using IPTW, the weighted difference between POPUI (21%) and non-POPUI (11.8%) women was 9.2% and OR 0.56 (95% CI 0.5–0.6). After standard multivariable regression risk difference for dissatisfaction for two months was –1.0% (95% CI -5.0–2.0, *p* = 0.452) indicating that after adjusting for baseline imbalances, there was no significant difference in short-term dissatisfaction between POPUI and non-POPUI women. However, after rigorous adjustment for confounding using IPTW, women with POP as an indication for a hysterectomy had a significantly higher adjusted probability of dissatisfaction (20%) compared to those with other benign indications (17%). The adjusted risk difference was 2.0% points (95% CI 0.0–5.0, *p* = 0.021). Importantly, a separate model demonstrated that a mere history of POPUI (without POP being the primary indication for a hysterectomy) was not associated with dissatisfaction (*p* = 0.772) (Table 3). In the sensitivity analysis excluding patients with complications and stratified by hysterectomy route, the significant association between groups and VAS scores observed in the primary analysis was no longer present. The adjusted mean difference between the groups was negligible (mean difference 1%, 95%CI-0.02–0.04, *p* = 0.678). However, BMI (*p* = 0.04) and VH (*p* = 0.02) remained a significant predictor of the dissatisfaction. The HUH subgroup did not show a significant difference in dissatisfaction two months after hysterectomy in either the crude or IPTW analysis.

At two months, minor complications were reported by 29.3% (*n* = 387) of women in the POPUI group and 34.3% (*n* = 907) in the non-POPUI group, (*p* < 0.01). Among all

Table 3 Adjusted predictors of short-term patient dissatisfaction (VAS < 70) following hysterectomy: A doubly robust analysis using inverse probability of treatment weighting (IPTW)

Predictor Variable	Adjusted OR	95% CI	P-value
Surgical Indication			
Other Benign Indications (Ref)	1.00	—	—
POP Indication	1.18	1.03–1.36	0.020
Surgical Approach			
Abdominal (Ref)	1.00	—	—
Vaginal	0.57	0.48–0.67	< 0.001
Laparoscopic	0.35	0.29–0.41	< 0.001
Patient Characteristics			
Age (per year increase)	0.96	0.95–0.97	< 0.001
BMI (per unit increase)	1.17	1.05–1.08	< 0.001
Employed / Working (vs. No)	4.35	3.41–5.53	< 0.001
Clinical Factors			
Complications (Yes vs. No)	1.32	1.12–1.57	0.001
Parity (vs. Nulliparous)			
Parity 1	2.11	1.69–2.63	< 0.001
Parity 2+	1.34	1.04–1.73	0.023
POPUI history (non-POPUI ref)	0.98	0.85–1.13	0.772

VAS Visual analogue scale, BMI Body mass index, POPUI Pelvic organ prolapse with or without urinary incontinence, OR Odds ratio, CI Confidence interval

women, the most common complication was urinary tract infection (UTI) (6.1%), followed by wound infection (4.4%) and pelvic hematoma with or without infection (4.3%). Women in the POPUI group experienced more UTIs than those in the non-POPUI group (7.9% vs. 5.1%, $p < 0.01$) whereas women in the non-POPUI group had a greater rate of pelvic hematomas (2.9% vs. 5.0%, $p < 0.01$). Pain relief was reported as inadequate by 2.3% ($n = 90$)

of women, with no significant difference between the groups. Women in the POPUI group underwent fewer reoperations ($n = 20$, 1.5% vs. $n = 74$, 2.8%, $p < 0.01$) and experienced fewer major complications ($n = 30$, 2.3% vs. $n = 105$, 4.0%, $p < 0.01$). VAS scores were generally lower in women who experienced any complications than in those without complications. The lowest VAS scores (69.1, Sd 27.7) were observed in women who underwent reoperation or had other major complication (69.6, Sd 29.3) after hysterectomy. Women who experienced inadequate pain relief also had markedly lower VAS scores (73.7, Sd 26.7).

At two months, BMI over 30 kg/m² and parity (one or more) were associated with decreased dissatisfaction risk (VAS under 70) among all women and among women in the non-POPUI group (Table 3). Conversely, among the same women, urinary infection, pelvic hematoma, and older age were associated with increased risk for dissatisfaction. The greatest risk for dissatisfaction was observed among women who experienced reoperation (OR 3.4, 95% CI 1.7–7.1), wound infection (OR 2.8, 95% CI 1.9–4.1), or inadequate pain relief (OR 4.0, 95% CI 2.5–6.6) (Table 4).

The comparison of patient- and surgeon-reported complications showed that patients reported more minor complications (29–34% vs. 12–16%). Both reported the same complication (agreement score) only in 40–58% of cases ($p < 0.01$). UTI was the most common complication not reported by surgeons, whereas pelvic hematoma with or without infection and wound infection demonstrated the highest agreement rates.

Table 4 Risk factors for VAS scores under 70 at two months after hysterectomy identified in both the POPUI and non-POPUI groups

	All		POPUI		non-POPUI	
	VAS < 70	p	VAS < 70	p	VAS < 70	p
n (%)	415 (10.7)		116 (9.0)		299 (11.5)	0.02
	OR (95% CI)		OR (95% CI)		OR (95% CI)	
Age over 50 (under 50 ref)	1.2 (1.0–1.5)		0.9 (0.6–1.5)		1.3 (1.0–1.7)	0.05
BMI over 30 (under 30 ref)	0.6 (0.5–0.8)	< 0.01	0.6 (0.3–1.0)		0.7 (0.5–0.9)	0.02
Parity (zero or status unknown ref)						
One to two	0.7 (0.5–0.9)	< 0.01	0.6 (0.3–1.2)		0.7 (0.5–1.0)	0.04
Three or more	0.7 (0.5–1.0)	0.04	0.7 (0.3–1.4)		0.7 (0.5–1.0)	n.s.
Hysterectomy approach (AH/LH ref)						
VH	0.9 (0.6–1.6)		1.5 (0.7–3.3)		0.8 (0.6–1.1)	n.s.
Reoperation (no reoper ref)	3.4 (1.7–7.1)	< 0.01	7.0 (2.5–19.2)	< 0.01	5.1 (3.0–8.6)	< 0.01
Infection (no infection ref)	1.0 (0.6–1.7)		1.1 (0.4–2.9)		0.9 (0.5–1.6)	n.s.
Urinary infection (no UTI ref)	1.7 (1.2–2.5)	< 0.01	1.4 (0.7–2.7)		1.9 (1.2–3.0)	< 0.01
Wound opening (no opening ref)	1.6 (0.9–3.1)		2.0 (0.5–7.4)		1.4 (0.7–3.0)	n.s.
Wound infection (no wound inf. ref)	2.8 (1.9–4.1)	< 0.01	4.1 (2.0–8.4)	< 0.01	2.4 (1.5–3.8)	< 0.01
Heavy vaginal bleeding (no bleeding ref)	1.6 (0.9–2.8)		2.4 (0.8–7.3)		1.4 (0.7–2.7)	n.s.
Pelvic hematoma (no hematoma ref)	2.5 (1.7–3.7)	< 0.01	1.5 (0.6–3.8)		2.9 (1.8–4.6)	< 0.01
Inadequate pain relief (adequate ref)	4.0 (2.5–6.6)	< 0.01	3.9 (1.4–11.0)	< 0.01	4.1 (2.3–7.2)	< 0.01

Multivariate logistic regression analysis: each minor complication was adjusted for classified age, classified BMI, hysterectomy approach, parity, reoperation, and postoperative infection. VAS Visual analogue scale, BMI Body mass index, AH Abdominal hysterectomy, VH Vaginal hysterectomy, LH Laparoscopic hysterectomy, POPUI Pelvic organ prolapse with or without urinary incontinence, OR Odds ratio, CI Confidence interval

Table 5 Risk factors associated with VAS scores under 70 at ten years after hysterectomy identified in both the POPUI and non-POPUI groups (HUH subgroup)

	All		POPUI		non-POPUI	
	VAS < 70	<i>p</i>	VAS < 70	<i>p</i>	VAS < 70	<i>p</i>
n (%)	45 (8.1)		15 (11.7)		30 (7.0)	
	OR (95% CI)		OR (95% CI)		OR (95% CI)	
Age (continuous)	1.1 (1.0–1.1)	0.02	1.2 (1.0–1.5)	0.03	1.0 (0.9–1.1)	n.s.
BMI (continuous)	0.9 (0.8–1.0)	< 0.01	0.5 (0.3–0.9)	< 0.01	0.9 (0.8–1.0)	n.s.
Parity (0–2 ref)						
Three or more	1.3 (0.5–3.4)		0.7 (0.3–0.9)	< 0.01	1.0 (0.4–3.1)	n.s.
Complications (ref no compl)	1.5 (0.7–3.3)		5.1 (1.4–18.9)	0.02	1.4 (0.5–3.4)	n.s.
Hysterectomy approach (AH/LH ref)						
VH	0.8 (0.2–3.3)		ns		0.5 (0.1–2.6)	n.s.
Working (ref no working)	0.8 (0.3–2.5)		2.3 (0.5–11.0)		0.4 (0.1–1.1)	n.s.
Bulging (ref no bulking)	3.4 (1.7–7.1)	< 0.01	4.1 (1.1–15.9)	0.04	2.8 (1.0–7.7)	0.04
Any urinary symptoms (ref no symptom)	1.8 (0.9–3.4)		0.6 (0.2–2.4)		2.3 (1.1–5.1)	0.03
Any prolapse symptom (ref no symptom)	4.0 (1.5–10.5)	< 0.01	2.8 (0.3–25.2)		4.0 (1.4–11.9)	0.01
Any defecatory symptom (ref no symptom)	2.1 (1.1–3.9)	0.03	3.0 (0.9–10.2)		2.0 (0.9–4.4)	n.s.
POPUI visit in register (ref no visit)	2.4 (1.1–5.4)	0.04	2.6 (0.8–8.8)		1.9 (0.5 (6.8)	n.s.
POPUI operation register (ref no oper)	2.4 (0.9–6.4)		2.1 (0.5–8.0)		2.6 (0.2–45.2)	n.s.

Multivariate logistic regression analysis: each variable was adjusted for age, BMI, hysterectomy approach, parity, complications, and working status. VAS Visual analogue scale 0–100, BMI Body mass index, AH Abdominal hysterectomy, VH Vaginal hysterectomy, LH Laparoscopic hysterectomy, SU Stress urinary incontinence, POPUI Pelvic organ prolapse with or without urinary incontinence, OR Odds ratio, CI Confidence interval, HUH Helsinki University Hospital district

Long-term PROMs – ten-year outcomes

Ten years after hysterectomy, women in the POPUI group scored lower mean VAS scores (89.2 vs. 92.5, $p < 0.01$) and reported more dissatisfaction than women in the non-POPUI group (11.7% vs. 7.0%). The latter did not reach statistical significance. Adjusted IPTW analysis and adjusted original data analysis after imputation demonstrated a statistically significant difference in continuous 10-year satisfaction scores between the groups (mean difference -0.37 , 95% CI -0.73 to -0.01 , $p = 0.042$ and (mean difference -0.42 ; 95% CI -0.79 to -0.05 ; $p = 0.027$). This confirms the robustness of the primary findings. Overall, 94% of women would still choose to undergo hysterectomy (91.4% in the POPUI group and 94.8% in the non-POPUI group, $p < 0.01$) (Table 2).

Ten years after hysterectomy, among the HUH subgroup, 47.7% ($n = 264$) of participants reported urinary symptoms, 30.5% ($n = 169$) problems with defecation, and 15.3% ($n = 85$) symptoms of bulging. Women in the POPUI group reported more of these symptoms than those in the non-POPUI group (any POPUI symptoms: 86.7%, $n = 111$ vs. 64.0%, $n = 273$, $p < 0.01$). Constipation (32.0%, $n = 41$ vs. 21.1%, $n = 90$, $p < 0.01$) and urinary incontinence (32.8%, $n = 42$, vs. 23.9%, $n = 102$, $p = 0.04$) were the most common symptoms in both groups. Among women reporting bulging, urinary symptoms, or defecation problems, 61% to 75% experienced mild to severe bother with excretion while 30 to 37% reported mild to severe bother with sexual activity. In the adjusted model, women with POPUI were significantly more likely to report prolapse symptoms at the 10-year follow-up

compared to non-POPUI women (mean difference 12.0%; 95% CI 1.0–24.0; $p = 0.038$). This association persists even after adjusting for parity, age, BMI, and complications. Women in the POPUI group underwent more reoperations (20.7%, $n = 46$ vs. 2.3%, $n = 14$, $p < 0.001$) and had more health care visits due to POP or UI (31.1%, $n = 69$ vs. 6.2%, $n = 38$, $p < 0.001$). The concordance between patient-reported bulging and registry-based outpatient visits was negligible (Cohen's kappa = 0.03). Similarly, the agreement between bulging and registry-recorded reoperations was slight (kappa = 0.10). Additionally, women in the POPUI group reported significantly lower VAS scores than women in the non-POPUI group when experiencing urinary symptoms (87.3 vs. 90.1, $p < 0.01$) or bulging (83.8 vs. 86.4, $p = 0.02$). However, the need for a urinary incontinence operation significantly reduced VAS scores in the non-POPUI group (90.6 vs. 77.8, $p < 0.001$).

After ten years, older age and symptoms of bulging were associated with an increased risk of dissatisfaction, indicated by VAS scores under 70, among all women and among the women in the POPUI group (Table 5). Conversely, a larger BMI and parity with three or more children decreased dissatisfaction risk, while complications after hysterectomy increased the risk by 5-fold (OR 5.1, 95% CI 1.4–18.9, $p = 0.02$). Across the women in the non-POPUI group, any urinary or prolapse symptoms were associated with an increased risk of VAS scores under 70 (OR 2.3, 95% CI 1.1–5.1, $p = 0.03$ and OR 4.0, 95% CI 1.4–11.9, $p = 0.01$, respectively).

Discussion

We assessed patient satisfaction following hysterectomy for benign indications at two distinct intervals: short-term (two months) and long-term (ten years). The results showed that patient satisfaction measured by VAS was high (88–90) two months after surgery. Notably, this level of satisfaction remained stable, even ten years post-surgery (88–91), and is consistent with a previous study [19]. A large majority (94%) of women stated they would choose to undergo hysterectomy again if faced with the same decision. Additionally, our study was able to assess the influence of pre-existing POP on satisfaction after hysterectomy and examined the contribution of additional pelvic floor symptoms to dissatisfaction (VAS scores < 70). Separate analysis of the POPUI and non-POPUI groups enabled a more precise evaluation of surgical effectiveness, risk profiles, and the extent to which satisfaction and QoL outcomes depend on surgical indication rather than procedure alone. However, given the large sample size, small differences in continuous variables may reach statistical significance without necessarily implying clinical relevance. The 3.3-point difference in VAS scores between POPUI and non-POPUI women after ten years, while statistically distinct, falls below the threshold typically considered perceptible to patients (usually defined as 5–10 points on a 0–100 scale) [20, 21].

When evaluating the entire cohort at two months post-hysterectomy, women in the POPUI group demonstrated significantly greater short-term satisfaction in crude comparison (more VAS scores over 70) than women in the non-POPUI group, but this was not seen after adjusted analysis or at the ten-year follow-up in the HUH subgroup. Likely the persistence or recurrence of pelvic floor symptoms led to a decline in satisfaction [22], although the mean satisfaction in all women remained high. However, these excellent short- and long-term satisfaction rates were comparable to findings in previous reports, despite the different study set-ups [5, 7].

Interestingly, according to doubly robust analysis women undergoing hysterectomy for POP as a primary indication had 1.18 times the odds of being dissatisfied after two months compared to women with other benign indication. This finding contrasts with the previous studies [5, 19, 22, 23], suggesting that when confounding and likely protective factors (such as age, parity, and surgical approach) are fully balanced, the POP with itself carries a slightly higher inherent risk of short-term dissatisfaction that is masked in less rigorous analyses. Additionally, this may be attributable to a mismatch between patient expectations and surgical outcomes, whereby the achieved result does not align with pre-operative anticipations, resulting in patient disappointment [3]. When excluding complications the crude difference in VAS scores between the groups disappeared suggesting that

the higher dissatisfaction observed in the non-POPUI group in the primary analysis may also be mediated by the occurrence of complications and surgical approach (AH). The adjusted model revealed LH and VH being strongly protective against dissatisfaction compared to AH. However, Belayneh et al. [23] reported that improvement in the patient satisfaction and QoL is independently associated with reductions in prolapse symptoms, not with age, surgery approach or prolapse stage.

Complications most strongly reduced short-term satisfaction, varying significantly across groups due to the predominance of VH and related surgical differences. UTIs were associated with dissatisfaction only among women in the non-POPUI group. Preoperative POP and urinary symptoms may influence UTI perception: symptomatic women view postoperative UTIs as expected, while probably more asymptomatic non-POPUI women report them distinctly. Additionally, vaginal approach often involves more pelvic floor manipulation and may prolong catheterization, increasing noticeable dysuria and pyuria often misinterpreted as infection. A higher rate of abdominal hysterectomy may lead to more wound healing problems.

Notably, physicians reported only one-fourth of the minor complications identified by patients. Many minor complications were likely managed in primary health care and were not documented in hospital records. However, these findings suggest that complications and adverse events that have impact to the patient may be underrecognized or underreported by healthcare professionals [3, 24, 25]. It has been previously noted [3] that patients may consider functional outcomes, such as incontinence, sexual dysfunction, and symptom recurrence, as severe adverse events. This phenomenon likely occurred in our study as well since both the recurrence of pelvic floor symptoms and complications were found to decrease satisfaction among women in the POPUI group, even ten years postoperatively.

Although pain relief was adequate in 98% of women, inadequate pain relief was associated with patient dissatisfaction across all groups, consistent with previous studies linking effective postoperative pain management to improved satisfaction and lower mortality [26]. Notably, there is no pain-specific instrument for assessing patient-reported outcomes in women with POP or SUI [27, 28]. After hysterectomy or transvaginal POP surgery, insufficient pain control increases the risk of chronic pain [29, 30], which women rate as a particularly severe adverse outcome [3]. This may explain the higher rates of dissatisfaction seen in our study among women in the POPUI group, especially among those with persistent complications even ten years after surgery.

After ten years, experienced recurrent or de novo pelvic floor symptoms were common, and decreased

satisfaction was observed among all women. These findings corresponded with objective healthcare utilization patterns, suggesting that the results are not driven solely by reporting bias. The relapse rates of POP symptoms in previous studies have ranged from 12.5% to 36.7% [19, 31, 32], which is consistent with our observed rate of bulging symptoms. Women in the POPUI group who experienced bulging symptoms reported the lowest VAS scores and the highest levels of dissatisfaction, although bulging was associated with a higher risk for dissatisfaction across all women. This finding is supported by earlier research showing that the absence of postoperative vaginal bulge symptoms is one of the most consistent predictors of improvement [7, 33]. Furthermore, it is well established that a history of hysterectomy for POP is a significant risk factor for subsequent reoperation for POP [9, 10]. This was particularly notable in our study, as nearly one-fifth of women in the POPUI group underwent reoperation for POP, compared with only 2.3% of women in the non-POPUI group. Additionally, nearly twice as many women in the study were managed conservatively. It is possible that the symptoms of POP or UI themselves, rather than the surgery, contribute to decreased long-term satisfaction. Although this aspect was not directly examined here, previous research suggests that this is likely one of the main reasons for decreased satisfaction [34, 35].

Contrary to some previous studies, we found associations of older age, larger BMI, and parity with satisfaction [34–36]. Age over 60 years is a significant predictor of POP progression [37], and it likely explained decreased long-term satisfaction among older women in our study. Of course, it is possible that age as such had a negative effect on quality of life, thus also affecting the measured satisfaction. In contrast, higher BMI and three or more deliveries both had positive effects on long-term satisfaction. The explanation for these findings remains unclear but may be linked to overall satisfaction with family life. Moreover, the number of deliveries might influence the severity of prolapse [38], and these women likely got more relief for their symptoms. In contrast to our findings, obesity has been associated with increased risk of prolapse [39] and lower satisfaction following prolapse surgery [40]. However, the associations are probably more complex since conflicting results have also been reported by others [41, 42].

A strength of this study is the long (over ten-year) study period, allowing short- and long-term outcomes to be captured. The combination of patient-reported outcomes and registry-based data provides a comprehensive picture of pelvic floor prolapse outcomes that neither source can achieve independently (only slight/minimal agreement in Cohen's kappa). The rather high response rate to the questionnaires adds to the reliability of the findings. Importantly, this study provides the patient perspective

to hysterectomy outcomes in relation to the feared risks of urinary incontinence and prolapse. To our knowledge, this is the first study of hysterectomy to compare the perceptions of both patients and their surgeons. The study design also enriched a prospective FINHYST study performed in 2006 by including two-month and ten-year questionnaires, which were linked to comprehensive registry data. However, we did not examine the gynecological status of participants, and minor complications not requiring secondary surgery or hospitalizations may have been missed, especially if treated outside the specialized health care system.

A limitation of our study is the use of non-validated questionnaires, which are prone to bias, including incomplete data and response bias, potentially limiting the generalizability of our findings. This may partly explain the discrepancies in complication reporting between patients and physicians, as documentation required completion of a specific form. Notably, Barber et al. [33] found a higher rate of missing data (25%) with validated questionnaires than with simpler patient-reported outcomes. VAS scores are widely used in urogynecologic research and provide reliable, reproducible measures of patient satisfaction; however, they are not fully validated for this specific application [43, 44]. Additionally, various cut-off points for dissatisfaction have been reported [17, 18], and no consensus exists regarding the appropriate threshold. Finally, although women in the POPUI group underwent significantly more reoperations compared to controls (20.7% vs. 2.3), a key limitation is our reliance on patient-reported experience. The questionnaire data cannot distinguish between the recurrence of original symptoms and the development of *de novo* conditions, making it difficult to determine if reported dissatisfaction stems from the failure of previous repairs or the onset of new pelvic floor disorders.

Conclusion

This study demonstrates that long-term satisfaction after hysterectomy is generally high and enduring, regardless of the indication for the procedure. However, both minor and major postoperative complications tend to reduce patient satisfaction, not only short-term but probably also long-term. Additionally, women undergoing hysterectomy for POP, face a higher risk of urinary and pelvic floor symptoms as well as additional surgical interventions. These issues can negatively affect long-term satisfaction. Therefore, it is essential to thoroughly discuss both short- and long-term consequences of hysterectomy for POP with patients before surgery. These results enhance our understanding of the patient perspective of the benefits and challenges associated with hysterectomy and concurrent POP repair.

Abbreviations

VAS	Visual analogue scale
POP	Pelvic organ prolapse
UI	Urinary incontinence
HUJH	Helsinki University Hospital district
BMI	Body mass index
HRQoL	Health-related quality of life

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Authors' contributions

Kuittinen: Protocol and project development, data collection and management, data analysis, manuscript writing and editing Tulokas: Protocol and project development, manuscript writing and editing Rahkola-Soisalo: Protocol and project development, manuscript writing and editing Brummer: Data collection and management, manuscript writing and editing Härkki: Protocol and project development, data collection and management, manuscript writing and editing Mentula: Protocol and project development, manuscript writing and editing.

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Data availability

The datasets used and analyzed during the current study are available from the corresponding author on reasonable request.

Declarations

Ethics approval and consent to participate

The FINHYST research adhered to the principles outlined in the Declaration of Helsinki and local statutory requirements. All women provided written informed consent before the study. The study protocol was approved by the Ethics Committee of the Helsinki and Uusimaa Hospital District (Dnro 457/E8/04 and 343/13/03/03/2015) and was registered in the ClinicalTrials (NCT00744172). The use of data from the Care Register was authorized by the national health authorities, and all data were used in accordance with national and institutional regulations. Institutional approval was obtained from each participating hospital.

Consent for publication

Not applicable.

Competing interests

The authors declare no competing interests.

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