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Systematic Review

Incidence and Risk Factors of Pelvic Organ Prolapse Surgery After Hysterectomy: A Systematic Review and Meta-Analysis

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Abstract

Background: The link between hysterectomy and the later need for pelvic organ prolapse (POP) surgery remains unclear, with inconsistent findings across studies. This systematic review and meta-analysis aimed to (1) compare the incidence of subsequent POP surgery in women with versus without hysterectomy, (2) assess the risk of POP surgery across different hysterectomy routes, and (3) identify key risk factors for secondary POP surgery. **Methods:** We conducted a comprehensive search of PubMed, Embase, the Cochrane Central Register of Controlled Trials (CENTRAL), the International Clinical Trials Registry Platform (ICTRP), and ClinicalTrials.gov from inception to December 10, 2024, in accordance with preferred reporting items for systematic reviews and meta-analyses (PRISMA) guidelines. Two reviewers independently screened studies, extracted data, and assessed study quality. Pooled hazard ratios (HRs) were calculated using R version 4.2.3. **Results:** Thirteen studies involving 2,131,981 participants met the inclusion criteria. A history of hysterectomy was associated with a higher risk of subsequent POP surgery compared with no hysterectomy (HR: 1.61, 95% confidence interval (CI): 1.57–1.65). Subgroup analyses by surgical route suggested differences in absolute risk. However, direct comparisons showed no significant differences between laparoscopic and abdominal hysterectomy (HR: 1.05, 95% CI: 0.85–1.42), or between vaginal and abdominal hysterectomy (HR: 1.08, 95% CI: 0.80–1.45). Vaginal birth (HR: 4.65, 95% CI: 1.45–14.89) and delivery of a macrosomic infant (>4 kg; HR: 2.06, 95% CI: 1.62–2.63) were significant risk factors for secondary POP surgery. **Conclusion:** Hysterectomy for benign conditions is associated with a higher risk of subsequent POP surgery, especially in women with high-risk obstetric histories. No significant differences were found between surgical routes. This suggests that patient-related factors and perioperative selection may matter more than the route itself. In particular, women with pre-existing pelvic floor laxity may be more likely to undergo certain procedures. These findings highlight the need for individualized preoperative counseling and risk-based preventive strategies to reduce long-term morbidity. **Registration:** The study has been registered on https://www.crd.york.ac.uk/PROSPERO/ (registration number: CRD42024551041; registration link: https://www.crd.york.ac.uk/PROSPERO/view/CRD42024551041).

Keywords: pelvic organ prolapse; hysterectomy; systematic reviews as topic; incidence; risk factors; meta-analysis as topic

1. Introduction

Pelvic organ prolapse (POP) is a common condition in women [1,2]. It is defined as the descent of pelvic organs, such as the bladder, uterus, or rectum, into the vaginal canal due to weakened pelvic floor support. Hysterectomy is one of the most commonly performed gynecological procedures [3]. It has been linked to an increased risk of subsequent POP, which may require surgical treatment [4,5]. However, the incidence of POP surgery after hysterectomy and its associated risk factors remain uncertain. Findings vary across studies, likely due to differences in surgical approaches and patient populations. Some studies suggest that women who undergo hysterectomy especially via certain routes, such as vaginal hysterectomy may have a higher risk of later POP surgery compared with those who do not undergo the procedure [4,6,7,8]. Other factors, including vaginal delivery, macrosomia, and surgical technique, may also contribute to this risk [4,7,9].

Despite these findings, comprehensive meta-analyses that synthesize global data on POP surgery after hysterectomy are still limited. In addition, many registry-based studies reflect region-specific practices, which limits generalizability. A broader synthesis that integrates diverse populations is therefore needed. This systematic review addresses these gaps with three aims. First, to compare the incidence of POP surgery between women with and without hysterectomy. Second, to evaluate differences across surgical routes, including abdominal, vaginal, and laparoscopic approaches. Third, to identify key risk factors using multivariable analysis. Unlike prior large registry studies that are mainly descriptive, this study quantifies specific obstetric risk factors and explores their clinical relevance. The findings may support risk stratification before surgery. By integrating evidence from diverse populations, this review aims to improve risk prediction and guide surgical decision-making, ultimately helping to preserve pelvic floor function after hysterectomy.

2. Methods

2.1 Protocol Registration

This meta-analysis was conducted in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA 2020) guidelines and was registered in the International Prospective Register of Systematic Reviews (PROSPERO) (CRD42024551041, https://www.crd.york.ac.uk/PROSPERO/view/CRD42024551041).

2.2 Eligibility Criteria

All potentially eligible studies published in English were considered, including cohort and case-control studies. Studies were included if they (1) reported the incidence or risk factors for POP surgery after hysterectomy, and (2) compared outcomes between women with and without hysterectomy, or across different surgical approaches (e.g., abdominal, laparoscopic, vaginal, or laparoscopic-assisted vaginal hysterectomy). Studies were excluded if they (1) were duplicate publications, in which case only the dataset with the largest sample size was retained; (2) had incomplete data; or (3) were conference abstracts or review articles.

2.3 Search Strategy and Study Selection

A comprehensive systematic literature search was performed in PubMed, Embase, and Web of Science from inception to December 10, 2024. Independent cross-verification was further conducted through manual searches of major clinical trial registries and reference lists. This process was repeated twice. It ensured that the final inclusion of 13 studies represents the most comprehensive body of published peer-reviewed literature meeting our criteria. Considerable effort was made to minimize the omission of any relevant large-scale clinical reports available up to the search cutoff date. The reference lists of published reviews and retrieved articles were also checked for additional trials. The search terms were as follows: "prolapse", "uterine descent", "pelvic floor descent", "pelvic organ descent", "pelvic floor disorder", "pelvic bulge", "hysterectomy", "risk factor", "predictor", "predictive factor", and "indicator".

To investigate potential sources of heterogeneity, prespecified subgroup analyses were performed. Studies were stratified based on key characteristics, including publication year, geographic region, follow-up duration, and the primary indication for hysterectomy. Subgroup differences were assessed using chi-squared tests or interaction tests, as appropriate. Furthermore, meta-regression analyses were conducted to explore the impact of continuous covariates on the pooled hazard ratios. The variables included mean age of participants, average follow-up duration, and publication year. These analyses aimed to provide additional insight into sources of between-study heterogeneity that were not fully explained by categorical subgroup analyses.

Two researchers (TTL and MYW) independently screened the titles and abstracts to assess the eligibility of the studies. After initial selection, the full texts of all potential articles were independently read by two researchers (TTL and MYW) for further evaluation. Disagreements between authors were resolved by discussion with HXC and LH.

2.4 Data Extraction

Data extraction was performed independently by two reviewers (TTL and MYW) in duplicate. A predefined extraction table was used to collect detailed information, including: (1) first author and publication year; (2) study country; (3) study design; (4) quality assessment; (5) participant characteristics; (6) surgical details; and (7) outcomes.

The study periods of the included literature ranged from 1965 to 2018. Although incidence (per person-year) was the primary outcome measure, reflecting the nature of the included cohort studies, prevalence was also assessed when comparable data were available. Additionally, the following risk factors and variables were systematically extracted and analyzed: age, body mass index (BMI), parity, mode of delivery (vaginal versus cesarean), infant birth weight (macrosomia), and surgical indication.

2.5 Risk of Bias Assessment

Two reviewers (TTL and MYW) independently assessed the quality of the included studies. Discrepancies were resolved through discussion, and if consensus could not be reached, a third reviewer (HXC) was consulted. Cohort studies were evaluated using the Newcastle-Ottawa Scale (NOS), which considers three domains: selection of participants, comparability of groups, and outcome assessment [10]. Studies receiving six or more stars were classified as high quality. In addition to the standard NOS scoring, particular attention was given to the rigor of surgical outcome assessment and the adequacy of covariate adjustment for baseline pelvic floor integrity.

2.6 Statistical Analysis

All meta-analyses were conducted using R version 4.2.3 (R Foundation for Statistical Computing, Vienna, Austria). Data synthesis was based on hazard ratios (HRs) or odds ratios (ORs) with their respective 95% confidence intervals (CIs). The primary synthesis prioritized HRs derived from cohort data. When primary studies reported only ORs, synthesis was performed under the rare disease assumption (baseline incidence of pelvic organ prolapse surgery <0.3%), to ensure numerical compatibility for exploratory risk estimation. Subgroup or sensitivity analyses excluding non-HR estimates were conducted when necessary to confirm consistency. Statistical significance was defined as a p-value <0.05. Heterogeneity between studies was assessed using the I^2 statistic: I^2 <30% indicated low heterogeneity, 30% $\leq I^2$ <50% indicated moderate heterogeneity, and $I^2 \geq 50\%$ indicated high heterogeneity. A random-effects model was applied when substantial heterogeneity was present; otherwise, a fixed-effects model was used. To evaluate potential publication bias, funnel plot analysis was performed. According to the Cochrane Handbook [11], tests for funnel plot asymmetry have low statistical power when fewer than ten studies are included. As our primary outcome analysis involved fewer than ten studies, the interpretability of the funnel plot is limited. Although no obvious asymmetry was visually observed, these findings should be interpreted with caution due to the limited power to reliably detect publication bias. Instead, a strict qualitative appraisal of individual study designs and reporting patterns was used to safeguard the integrity of the findings. Results that could not be included in meta-analysis were presented either in tables or in a narrative format.

3. Results

3.1 Study Selection and Characteristics

The study selection process is summarized in Fig. 1. After removing duplicates and non-English articles, 2832 articles were identified and screened based on titles and abstracts. Twenty-nine full-text articles were then retrieved for further assessment, of which 16 were excluded after detailed evaluation. Ultimately, 13 studies, including a total of 2,131,981 participants, were included in the analysis. Studies that focused solely on reoperation rates following concomitant prolapse repairs without a distinct non-hysterectomy control group (e.g., comparisons of different concurrent procedures) were excluded to ensure the specificity of the hysterectomy risk assessment. The general characteristics of the included studies are presented in Table 1 (Ref. [3,4,5,6,7,8,12,13,14,15,16,17,18]). The included studies comprised retrospective cohorts, prospective cohort studies, case-control studies, and matched cohort studies and received six or more stars according to the NOS.

A total of 13 studies met the inclusion criteria and were analyzed in this review. The detailed selection process is shown in the PRISMA flow diagram (Fig. 1). The included studies were published between 2007 to 2024 and predominantly covered populations from Europe and North America. Study designs included retrospective cohorts, prospective registry-based cohorts, and case-control studies.

Table 1 summarizes the characteristics of the included studies, including the specific covariates and risk factors adjusted for in each analysis. Sample sizes varied widely, ranging from small clinical series to large nationwide registry studies. Most studies used multivariate regression models to control for potential confounders such as age, parity, and BMI.

3.2 Incidence of POP Surgery Between Hysterectomy and Non-Hysterectomy Groups

The clinical incidence of subsequent POP surgery ranged from 192 to 225 cases per 100,000 person-years in the hysterectomy group, compared with 127–164 cases per 100,000 person-years in the non-hysterectomy control group [8,18]. Consistent with this absolute risk, meta-analysis showed that POP surgery rates were significantly higher in the total hysterectomy group than in the non-hysterectomy group (HR: 1.6073, 95% CI: 1.5672–1.6484). To assess the robustness of the pooled data, a leave-one-out sensitivity analysis was performed. Systematic removal of individual high-weight registry studies did not cause clinically meaningful changes in the pooled hazard ratio (~1.61), confirming that the overall trend is consistent across data sources. However, as precision is primarily driven by large Nordic datasets, the confidence intervals should be interpreted as reflecting systemic registry patterns rather than absolute clinical certainty across all independent clinical series. This increased risk persisted across different surgical approach subgroups. Fig. 2 total abdominal hysterectomy was associated with HR 1.6002 (95% CI: 1.3518–1.8944), total vaginal hysterectomy with HR 3.0034 (95% CI: 1.7469–5.1636), and total laparoscopic-assisted vaginal hysterectomy with HR 2.0183 (95% CI: 0.6091–6.6872), all compared with the non-hysterectomy group. For subtotal hysterectomy, meta-analysis indicated significantly higher POP surgery rates in the subtotal abdominal hysterectomy group compared to the non-hysterectomy group (HR: 1.7510, 95% CI: 1.3968–2.1950). Incidence rates in this subgroup ranged from 195 to 314 per 100,000 person-years.

3.3 Incidence of POP Surgery Between Different Hysterectomy Approaches

Subgroup analysis by follow-up duration suggested a trend toward higher risk in studies with longer follow-up, although this did not reach statistical significance. No significant differences were observed across geographic regions or publication year subgroups. Meta-regression analysis indicated that publication year and mean participant age were not significantly associated with the pooled hazard ratios for POP surgery. This suggests that the observed risk has remained relatively stable over time and across the studied age spectrum. Meta-analysis showed no significant difference in POP surgery rates between the total laparoscopic hysterectomy group (HR: 1.0492, 95% CI: 0.8528–1.4236) and the total abdominal hysterectomy group. This was true for both anterior POP repair (HR: 0.9970, 95% CI: 0.8040–1.2362) and posterior POP repair (HR: 1.1470, 95% CI: 0.5678–2.3171). Similarly, no significant differences were found between the total vaginal hysterectomy group (HR: 1.0788, 95% CI: 0.8028–1.4496) and the total abdominal hysterectomy group, whether for anterior POP repair (HR: 1.1566, 95% CI: 0.9954–1.3438) or posterior POP repair (HR: 1.4366, 95% CI: 0.7317–2.8204). Fig. 3 regarding vaginal vault suspension, data on the impact of concomitant prophylactic procedures (e.g., uterosacral or sacrospinous ligament suspension) were inconsistently reported across studies. As a result, a quantitative meta-

Table 1. Characteristics of included studies and analyzed covariates/risk factors.

First author (Year)	Country	Study period	Study design	Participants (Hysterectomy/Control)	Covariates/Risk factors analyzed
Dällenbach (2007) [12]	Switzerland	1982–2005	Nested Case-Control	104 (Cases)/236 (Controls)	Age, BMI, parity, mode of delivery (Forceps), family history, indication
Blandon (2007) [13]	USA	1965–2002	Retrospective Cohort	5336 (Hyst)/NA	Age, parity, race, BMI, indication, smoking status
Altman (2008) [4]	Sweden	1973–2003	Prospective Cohort	162,488 (Hyst)/470,519 (Control)	Age, parity, vaginal delivery, uterine weight, diabetes, stroke, SES
Forsgren (2008) [14]	Sweden	1996–2005	Case-Control	117 (Cases)/326 (Controls)	Age, parity, surgical indication, macrosomia, asthma/COPD, BMI
Blandon (2009) [15]	USA	1965–2002	Case-Control	144 (Cases)/144 (Controls)	Age, parity, race, BMI
Lukanovič (2010) [16]	Slovenia	2000–2003	Case-Control	82 (Cases)/124 (Controls)	Age, parity, BMI
Forsgren (2012) [6]	Sweden	1973–2003	Matched Cohort	108,411 (Hyst)/579,200 (Control)	Age, parity, number of vaginal deliveries
Lykke (2017) [7]	Denmark	1977–2016	Retrospective Cohort	158,968 (Total Hyst)	Age, parity, hysterectomy route, indication
Huang (2018) [5]	Taiwan	2000–2012	Matched Cohort	7298 (Hyst)/29,192 (Control)	Age, parity, income, urbanization, comorbidities
Gabriel (2021) [17]	USA	2001–2008	Retrospective Cohort	2158 (Total Hyst)	Age, race, BMI, route of hysterectomy
Husby (2022) [8]	Denmark	1977–2018	Matched Cohort	9535 (Hyst)/47,370 (Control)	Age, calendar year, education, parity
Aagesen (2023) [18]	Denmark	1977–2018	Matched Cohort	80,444 (Hyst)/396,303 (Control)	Age, income, education, parity, indication
Kuittinen (2023) [3]	Finland	2006–2016	Retrospective Cohort	3582 (Total Hyst)	Age, BMI, parity, route of hysterectomy

Note: NA, not applicable (no non-hysterectomy control group used in main comparison); BMI, body mass index; COPD, chronic obstructive pulmonary disease; SES, socioeconomic status.

analysis to assess the protective effect of apical suspension techniques could not be performed. Additionally, although prevalence was assessed as a secondary outcome, it was not consistently reported across the included cohorts. Therefore, pooled prevalence analysis was not possible, and the results focus primarily on incidence rates.

Prespecified subgroup analyses stratified by publication year and geographic region (North America vs. Europe) did not identify significant sources of heterogeneity for the primary outcome. Risk estimates remained consistent across these subgroups, suggesting that the observed association is robust across different settings and time periods.

3.4 Exploratory Analysis of Risk Factors Influencing POP Surgery Rates

Meta-analysis identified vaginal birth (HR: 4.6546, 95% CI: 1.4546–14.8933) and delivery of a macrosomic infant (HR: 2.0622, 95% CI: 1.6217–2.6296) as potential contributors to the observed high rates of POP surgery. Although a greater number of vaginal births was associated with higher point estimates, these findings remain exploratory due to limited data and imprecision. The result for BMI (HR: 0.9000, 95% CI: 0.8353–0.9697) appears biologically counterintuitive and likely reflects residual confounding or clinical selection bias Fig. 4.

3.5 Assessment of Publication Bias

Visual inspection of the funnel plot for POP surgery rates after hysterectomy suggested no clear evidence of major publication bias. However, slight asymmetry was observed. Fig. 5 interpretation is limited by the small number of included studies (n = 5) and substantial between-study heterogeneity. In addition, the funnel plot was based on crude effect estimates derived from event counts rather than the adjusted hazard ratios used in the primary analysis. Therefore, although no obvious publication bias was detected, potential small-study effects and selective reporting cannot be ruled out. These findings should be interpreted with caution.

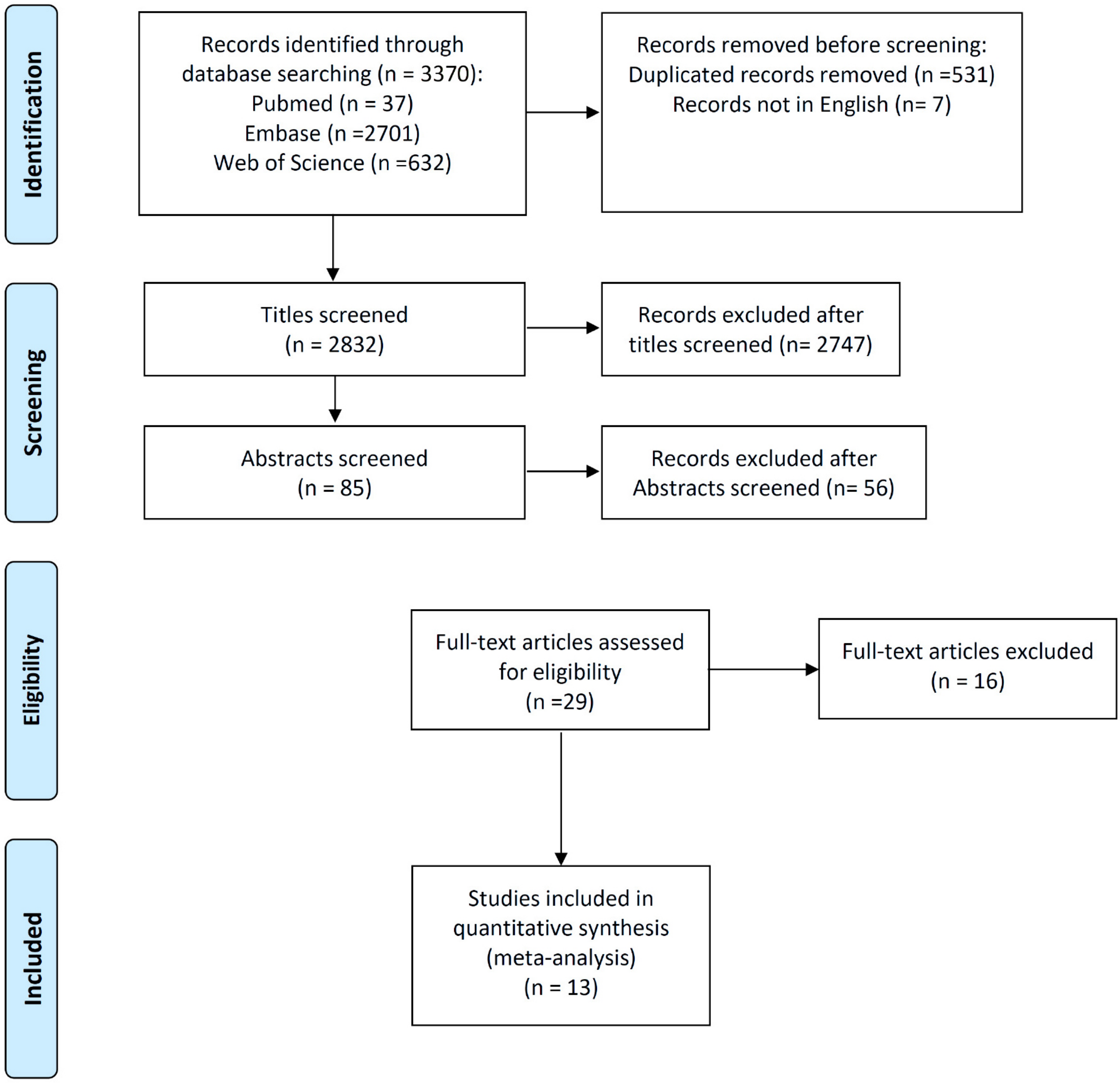

Fig. 1. PRISMA 2020 flow diagram illustrating the systematic study search and selection process. PRISMA, preferred reporting items for systematic reviews and meta-analyses.

4. Discussion

4.1 Summary of Key Findings

This systematic review and meta-analysis aimed to synthesize the existing literature on the incidence and risk factors for POP surgery following hysterectomy. Our findings indicate that women who undergo hysterectomy for benign indications have a higher subsequent need for POP surgery compared with women without hysterectomy. Specifically, the incidence of POP surgery was 192–225 per 100,000 person-years in the hysterectomy group, compared with 127–164 per 100,000 person-years in the non-hysterectomy control group. Meta-analysis confirmed a higher risk of POP surgery in the total hysterectomy group (HR: 1.6073, 95% CI: 1.5672–1.6484) and in the subtotal abdominal hysterectomy group (HR: 1.7510, 95% CI: 1.3968–2.1950). Several mechanisms may explain the increased risk of POP surgery following hysterectomy. First, hysterectomy disrupts pelvic floor anatomy, particularly the cardinal and uterosacral ligaments, which are essential for apical support [5,19]. This disruption can reduce support for the vaginal apex and increase the likelihood of prolapse. Second, surgical trauma and manipulation during hysterectomy may further compromise pelvic floor muscles and ligaments, exacerbating pre-existing weaknesses [2,18]. Third, the absence of the uterus itself may alter the biomechanical balance of the pelvic floor, contributing to prolapse development [20]. Further analysis by surgical approach showed effect estimates consistent with the

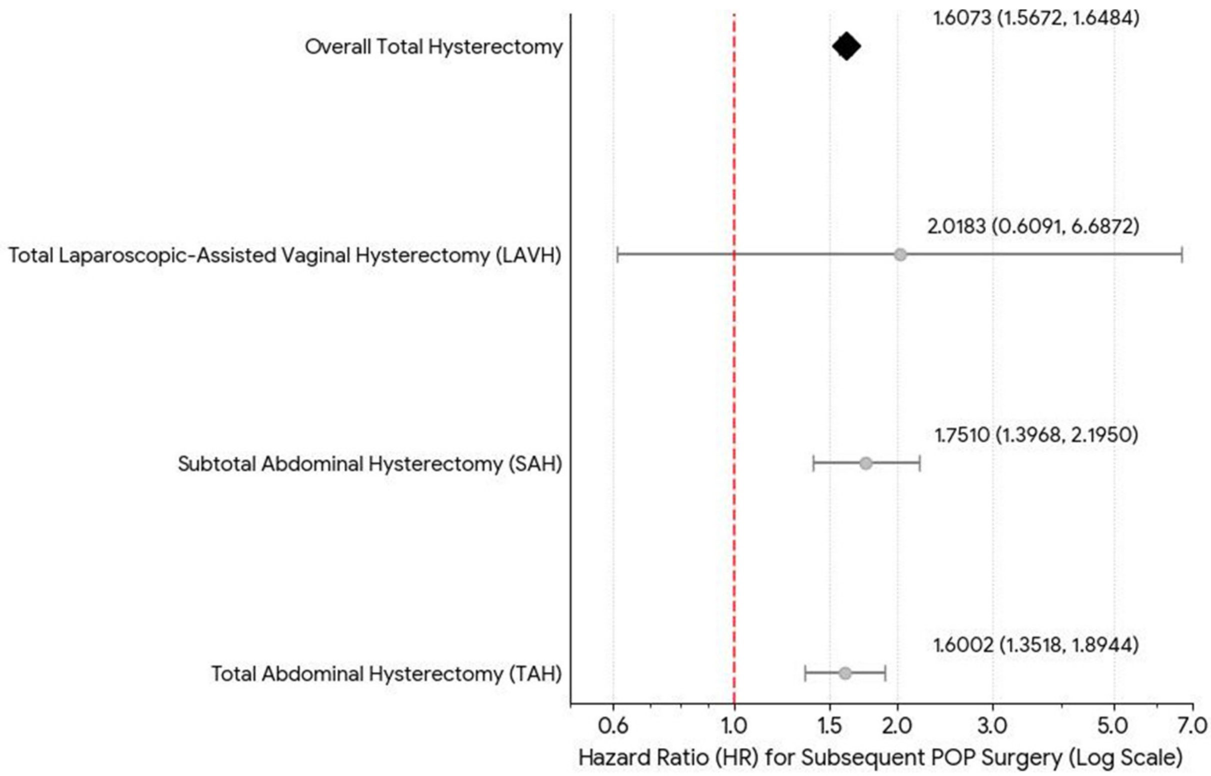

Fig. 2. Forest plot of the risk of POP surgery between hysterectomy and non-hysterectomy groups. POP, pelvic organ prolapse.

overall direction of effect, although not all comparisons reached statistical significance. Compared with the non-hysterectomy group, total abdominal hysterectomy was associated with HR 1.6002 (95% CI: 1.3518–1.8944), total vaginal hysterectomy with HR 3.0034 (95% CI: 1.7469–5.1636), and total laparoscopic-assisted vaginal hysterectomy with HR 2.0183 (95% CI: 0.6091–6.6872). Reported incidence rates in the literature are as follows: for total abdominal hysterectomy, approximately 250 cases per 100,000 person-years [4,6]; for total vaginal hysterectomy, 254–468 cases per 100,000 person-years [4,18]; and for total laparoscopic-assisted vaginal hysterectomy, 183–211 cases per 100,000 person-years [4,18]. Forsgren et al. [14] further classified total vaginal hysterectomy by indication and found that the incidence of subsequent POP surgery in patients who underwent hysterectomy for POP was 680 per 100,000 person-years. In contrast, for those who had hysterectomy for other indications, the incidence was significantly lower at 360 per 100,000 person-years (HR: 3.6, 95% CI: 2.0–6.5). Because most included registry studies did not provide stratified reporting by indication, a formal subgroup meta-analysis comparing POP versus other benign indications could not be reliably performed. This limitation restricts our ability to isolate the independent contribution of preoperative anatomic laxity from the effect of the surgical intervention itself. Clinically, emphasis should remain on recognizing the chosen surgical approach as a secondary factor relative to the primary pelvic floor integrity that necessitated the original procedure. Only one study compared laparoscopic total hysterectomy with non-hysterectomy women, showing a similar trend, with POP rates of 287 and 164 per 100,000 person-years, respectively [4].

When examining the association between hysterectomy and subsequent POP surgery, it is important to consider confounding by indication. A key challenge in route-specific comparisons is that vaginal hysterectomy is often the preferred approach for women who already show evidence of pelvic floor laxity or occult prolapse. This selection bias suggests that the elevated risk observed in these subgroups may primarily reflect their baseline physiological susceptibility and higher parity, rather than a causal effect of the vaginal surgical technique itself. Therefore, without consistent stratification for baseline pelvic floor integrity across all included studies, these findings should be interpreted as associations conditioned on surgical selection criteria. Future prospective studies with robust adjustment for preoperative prolapse status are needed to isolate the independent contribution of each surgical route. Despite these selection factors, the higher risk observed in the total vaginal hysterectomy (TVH) group may also relate to the inherent technical challenges of vaginal surgery. TVH often requires applying significant tension to the apical vaginal support, which can result in inadequate reconstruction of the upper vaginal segment [21]. In addition, limited access to the narrow surgical field during TVH may hinder proper repair of the pelvic floor [22].

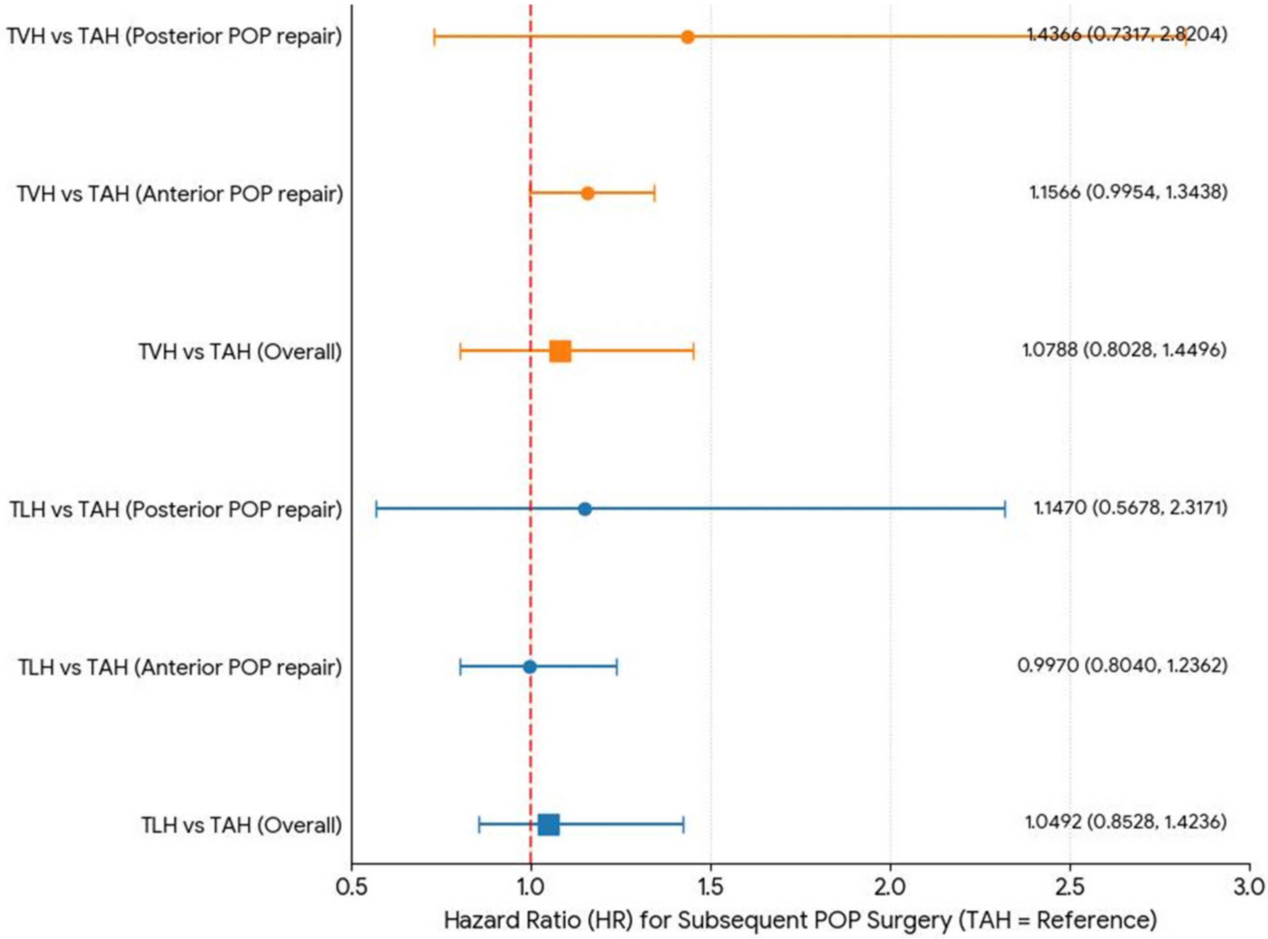

Fig. 3. Forest plot comparing the risk of POP surgery between different hysterectomy routes. TAH, total abdominal hysterectomy.

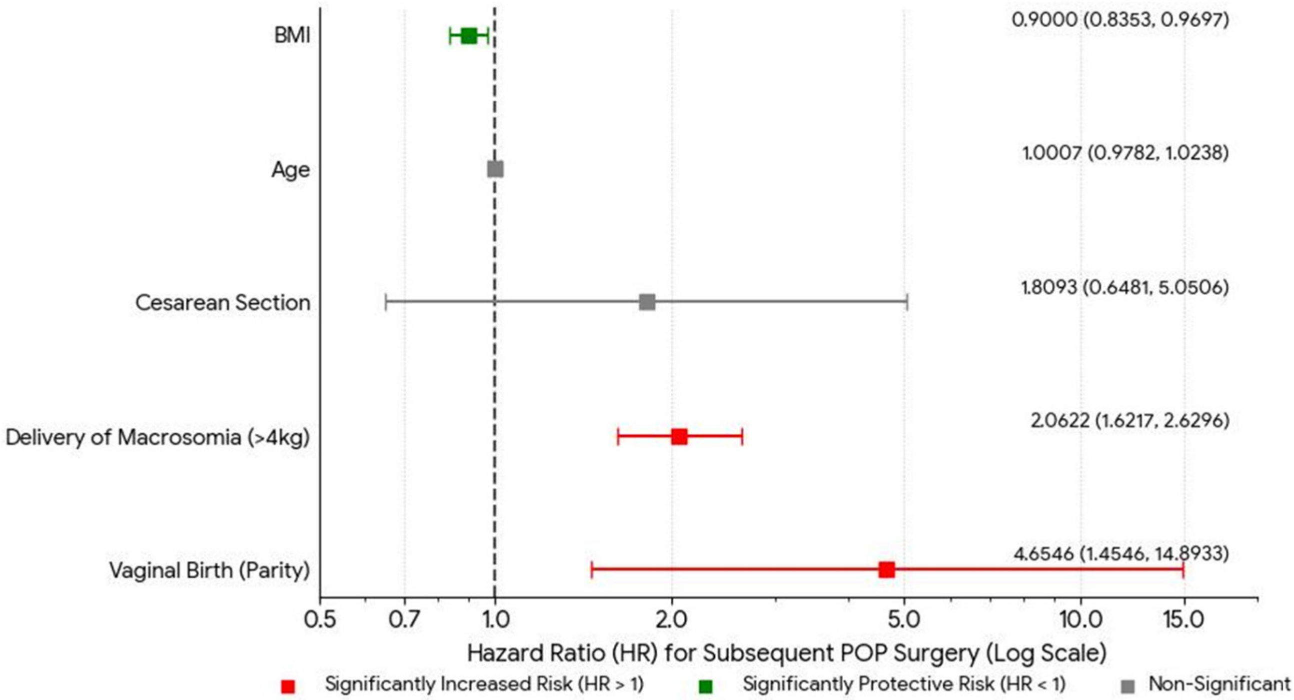

Fig. 4. Risk factors influencing POP surgery rates after hysterectomy.

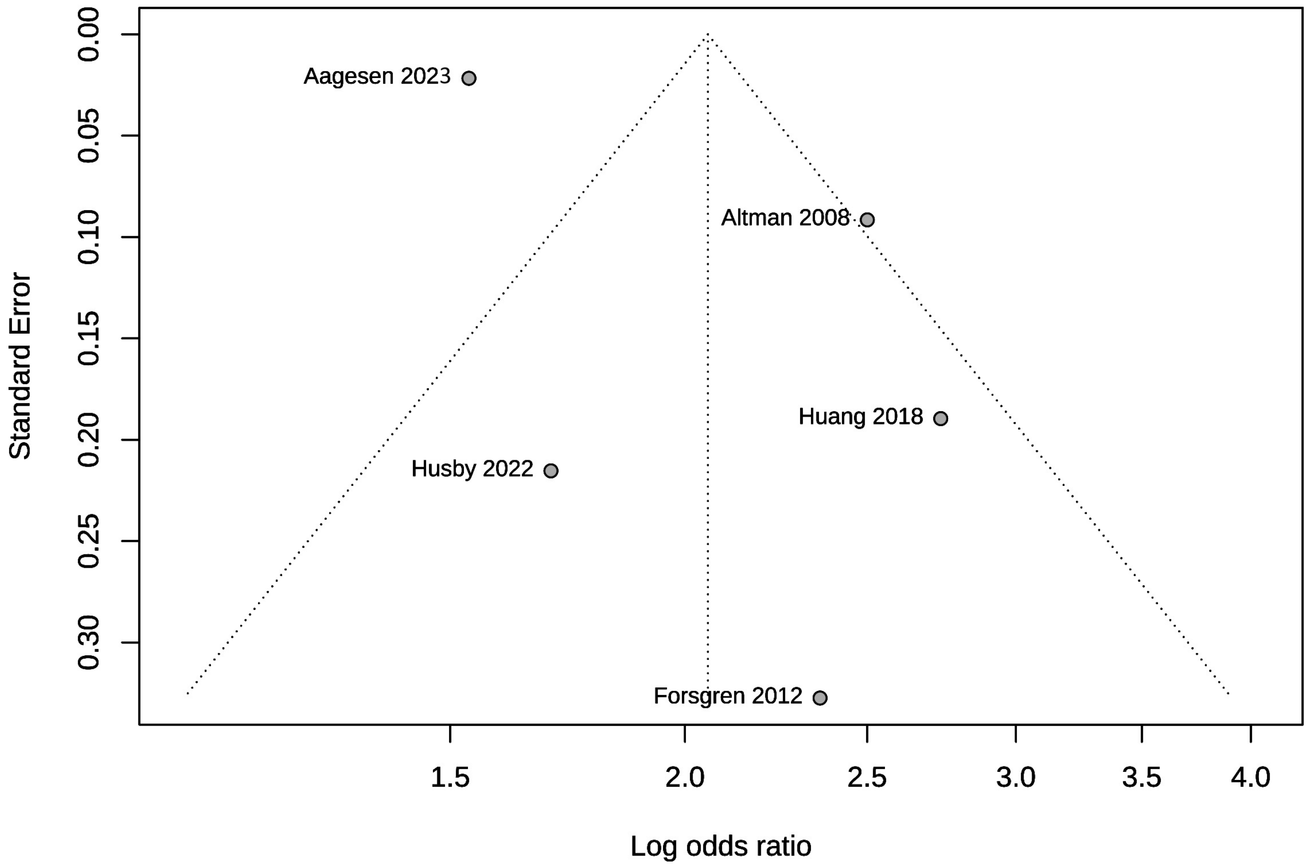

Fig. 5. Funnel plot assessing publication bias for POP surgery rates after hysterectomy.

Furthermore, when interpreting the higher hazard ratios observed in hysterectomy cohorts, it is important to distinguish between the risk of surgical intervention and the true biological incidence of anatomical prolapse. The reported incidence of POP surgery likely reflects a combination of prolapse development and healthcare utilization patterns. Surgical intervention thresholds vary across countries and healthcare systems, and women who undergo hysterectomy often remain under systematic gynecologic follow-up. This intensified surveillance may introduce detection bias, leading to more frequent identification of prolapse and subsequent surgical repair, regardless of the biological severity of the underlying condition. Therefore, the findings of this meta-analysis should be interpreted as an assessment of the risk of undergoing surgical intervention rather than a direct measure of the biological pathophysiology of pelvic floor failure.

Variability in surgical technique represents another critical factor in interpreting these data. In many of the analyzed cohorts, information on concomitant apical suspension procedures, such as uterosacral or sacrospinous ligament fixation or vault suspension, was inconsistently reported or entirely absent. These procedures are fundamental for maintaining vaginal support and often have a greater impact on preventing subsequent prolapse than the hysterectomy route itself. Consequently, treating the surgical route as a homogeneous exposure may obscure the protective benefits of robust apical reconstruction. Additionally, surgeon-related factors, including case volume, specialized urogynecologic training, and the reconstructive intent during benign hysterectomy, remain unmeasured in most registry studies. Without accounting for these co-interventions and the quality of apical support, comparisons between total laparoscopic hysterectomy (TLH), total abdominal hysterectomy (TAH), and TVH remain incomplete and should be interpreted with caution.

Interpreting the association between hysterectomy and subsequent POP surgery requires careful consideration of potential confounding factors that may have influenced the pooled estimates. Meta-regression findings suggest that the risk of post-hysterectomy POP reflects a fundamental anatomical consequence rather than historical surgical practices, as indicated by the lack of significant association with publication year. Moreover, the stability of risk across different age groups highlights the need for vigilance in all women who undergo hysterectomy, regardless of age at the time of surgery. Differences in the indication for hysterectomy, the surgical technique used, surgeon expertise, and concomitant procedures may all partially explain the variation observed between studies.

First, regarding the indication for hysterectomy, women undergoing the procedure for pre-existing prolapse or pronounced vaginal laxity are inherently at higher risk of subsequent POP repair compared with those operated on for non-prolapse conditions, such as fibroids or dysfunctional bleeding. This is especially relevant for vaginal hysterectomy, which is often the preferred route for women with pre-existing laxity or occult prolapse. Consequently, studies that did not stratify by indication may have overestimated the effect size for this group, reflecting baseline susceptibility rather than a causal effect of the surgical route itself.

Second, surgical technique is critical, particularly the adequacy of apical support. Procedures incorporating active apical suspension (e.g., uterosacral or sacrospinous ligament fixation) at the time of hysterectomy provide greater pelvic support and reduce the likelihood of subsequent prolapse. The omission of prophylactic vaginal vault suspension in many historical cohorts represents a significant confounding factor that likely contributes to higher prolapse rates. Variability in how these techniques were applied or reported across studies introduces heterogeneity, complicating direct comparisons between surgical routes.

Third, surgeon experience represents an important but often unmeasured factor. High-volume or subspecialized surgeons are more likely to select appropriate candidates and perform secure reconstructions, potentially reducing recurrence risk. Without adjustment for such operator-level factors, residual confounding remains possible.

Finally, concomitant procedures, such as pelvic floor repairs or anti-incontinence surgeries, significantly modify the pelvic biomechanical environment. The included studies varied widely in the distribution of these procedures, which could bias comparisons.

Most primary datasets adjusted for age and parity, yet few accounted for indication, detailed surgical techniques (such as vault suspension), or surgeon expertise. This limitation in the primary data likely results in residual confounding and can substantially influence the pooled estimates, potentially biasing comparisons between different hysterectomy routes. Therefore, caution is warranted when interpreting direct causal relationships based solely on surgical route without comprehensive adjustment for these factors. Interestingly, no significant difference in POP surgery rates was observed between total TLH and TAH groups, nor between TVH and TAH groups. The meta-analysis of individual risk factors requires cautious interpretation due to sparse data and considerable imprecision. Vaginal birth and delivery of macrosomic infants (fetus >4 kg) were significantly associated with subsequent surgery; however, the relationship should be interpreted as a trend rather than a definitive dose-response effect. This aligns with previous studies highlighting the role of parity in pelvic floor integrity [1,8], despite the limited data. Notably, the point estimate for BMI below unity contradicts established biological knowledge and likely reflects residual confounding or selection bias. For example, surgeons may be less inclined to offer elective prolapse surgery to patients with significantly elevated BMI due to higher perioperative and anesthetic risks. Consequently, risk factors such as BMI, age, and cesarean section should be considered preliminary and exploratory rather than definitive biological effects, particularly as the impact of various delivery modes remains a subject of ongoing clinical debate [23].

4.2 Clinical Implications

The findings of this review have several implications for clinical practice and patient management.

First, preoperative counseling is central to optimizing patient expectations and supporting informed decision-making. Women should be advised that hysterectomy, particularly when performed for prolapse-related indications, may increase the long-term risk of subsequent POP surgery. Counseling should address modifiable risk factors, including maintaining a healthy body weight, avoiding activities that elevate intra-abdominal pressure, and engaging in pelvic floor muscle training during recovery. Clear communication about the potential need for concomitant apical support procedures, as well as discussion of alternative surgical options, allows patients to make balanced decisions aligned with their personal risk profiles and preferences.

Second, early identification of women at greatest risk for postoperative POP is equally important. Clinical factors such as multiparity, delivery of macrosomic infants, pre-existing pelvic floor laxity, and hysterectomy performed for prolapse indications consistently predict higher recurrence risk. A structured preoperative evaluation that includes obstetric history, symptom assessment, and objective pelvic examination can help clinicians stratify patients according to their individual risk level.

Third, technical refinement represents a critical avenue for prevention. In high-risk individuals, proactive incorporation of apical suspension or other supportive measures during the index hysterectomy may be warranted. Ensuring robust apical support through techniques such as uterosacral ligament suspension, sacrospinous fixation, or vault suspension should be considered standard practice whenever anatomically feasible, regardless of the chosen hysterectomy route. Attention to preserving paravaginal attachments, avoiding excessive vaginal shortening, and reinforcing fascial integrity may further reduce the risk of postoperative descent. The effectiveness of these modifications depends largely on surgical expertise, highlighting the importance of consistent training and adherence to evidence-based reconstructive principles.

Fourth, postoperative surveillance is key to mitigating long-term morbidity. Regular pelvic examinations within the first two years after hysterectomy, especially in women with recognized risk factors, can facilitate early detection of prolapse and timely intervention before advanced stages develop. Incorporating patient-reported outcome tools or symptom questionnaires into follow-up visits may improve sensitivity for subclinical recurrence.

Finally, pelvic floor physical therapy should be regarded as an integral preventive strategy rather than solely a rehabilitative measure. Early, supervised training of pelvic floor muscles can strengthen connective tissue support, enhance recovery, and potentially delay prolapse recurrence. Although current evidence remains limited, integrating physiotherapy into perioperative care protocols appears both feasible and beneficial. Taken together, these measures comprehensive counseling, targeted risk assessment, meticulous surgical technique, structured follow-up, and pelvic floor rehabilitation provide a multifaceted approach to reducing the burden of post-hysterectomy POP and improving long-term pelvic health outcomes.

4.3 Consistency With Current Clinical Practice Guidelines

Our results align broadly with major international clinical practice guidelines, including American College of Obstetricians and Gynecologists (ACOG), Royal College of Obstetricians and Gynaecologists (RCOG), and National Institute for Health and Care Excellence (NICE), which emphasize the importance of restoring apical support. Specifically, our findings support the recommendation that prophylactic apical suspension such as uterosacral ligament suspension or sacrospinous fixation should be performed at the time of hysterectomy, particularly for prolapse-related indications. While current guidelines typically favor minimally invasive surgical (MIS) routes, such as vaginal or laparoscopic approaches, for their perioperative benefits, our data suggest that the quality of apical support, rather than the surgical route itself, is the primary determinant of long-term outcomes.

To guide clinical decision-making, we propose a stratified preoperative strategy based on individualized patient risk profiles. For high-risk candidates defined as patients with significant obstetric factors, such as multiparity or delivery of macrosomic infants, or baseline pelvic floor laxity the choice of surgical route should be paired with robust apical reinforcement to counteract anatomical susceptibility. In these subgroups, prophylactic apical suspension should be considered a standard component of surgery, ensuring optimal long-term pelvic floor preservation, whether a vaginal or laparoscopic approach is used. Conversely, for low-risk or nulliparous patients, the focus may remain on optimizing perioperative recovery via minimally invasive approaches. Additionally, our findings reinforce the need for longitudinal surveillance in high-risk patient subgroups, consistent with evidence-based guidance, to support structured follow-up and protect lifetime pelvic health in women who undergo hysterectomy.

4.4 Strengths and Limitations

The strengths of this study include a comprehensive search strategy, strict adherence to PRISMA guidelines, and the inclusion of a large number of participants from 13 studies. In addition, quality assessment using the Newcastle-Ottawa Scale ensured that only high-quality studies were included in the meta-analysis. Our findings highlight the importance of counseling women about the risk of POP surgery following hysterectomy, particularly those with multiple vaginal births. Alternative treatments for benign gynecological conditions should be considered before proceeding with hysterectomy. For example, uterine artery embolization or myomectomy can be viable options for women with uterine fibroids [8]. Furthermore, prophylactic measures, such as pelvic floor exercises and lifestyle modifications including weight management and smoking cessation should be emphasized to reduce the risk of pelvic floor disorders [24]. However, several limitations warrant consideration. First, the retrospective nature of the included studies introduces potential biases, including selection bias and information bias [10]. Detection bias cannot be excluded either; women who undergo hysterectomy may be subject to closer gynecological surveillance than the general population, which could lead to higher identification and treatment rates of subsequent POP compared with non-hysterectomized controls. Importantly, many primary datasets did not differentiate between POP-indicated and non-POP-indicated hysterectomies. This structural limitation means that surgical outcomes following hysterectomy should be interpreted as associations conditioned on preoperative risk profiles, rather than as isolated technical or procedural effects. This limitation is particularly relevant when attempting to compare surgical routes independent of their specific clinical indications. Second, the lack of standardized clinical assessments such as Pelvic Organ Prolapse Quantification (POP-Q) staging, BMI, and smoking status across studies restricts comparability [25]. Third, the surgical approach cannot be evaluated independently of concomitant apical support. Due to inconsistent reporting, the impact of proactive apical suspension (such as sacrospinous or vault fixation) could not be included as a controlled variable. Therefore, the comparative risk reported in this analysis must be interpreted in conjunction with the quality of apical support provided, rather than as an effect of the surgical route alone. This methodological gap likely contributes to unmeasured heterogeneity in our meta-analysis. Finally, the observed narrow confidence intervals (HR: 1.61, 95% CI: 1.57–1.65) are largely driven by the statistical dominance of large Nordic registry cohorts. While this provides high statistical precision, it may obscure local heterogeneity present in smaller clinic-based studies. Distinguishing between these standardized registry-based outcomes and more granular clinical cohort data is essential for a balanced interpretation of the cumulative evidence.

5. Conclusion

In conclusion, this systematic review and meta-analysis provide evidence that hysterectomy performed for benign indications is associated with an increased risk of subsequent POP surgery, particularly among women with multiple vaginal deliveries. However, as most contributing studies are retrospective, establishing a definitive cause-and-effect relationship between hysterectomy and subsequent POP remains challenging. Importantly, the observed risk appears more closely related to intrinsic patient factors and the clinical indications for selecting specific surgical routes than to the routes themselves. These findings emphasize the critical importance of assessing baseline pelvic floor integrity during surgical decision-making. Given the current heterogeneity in unmeasured surgical parameters such as inconsistent use of concomitant apical suspension and variations in surgeon expertise these outcomes should be interpreted as associations influenced by selection mechanisms rather than isolated procedural effects. Future research using prospective registries with robust adjustment for preoperative prolapse status is essential to refine clinical guidelines and improve strategies for long-term pelvic floor preservation.

6. Future Directions

Further studies are needed to evaluate the long-term outcomes of different hysterectomy approaches and to validate the effectiveness of prophylactic measures in preventing POP. In addition, research should aim to standardize clinical assessments and surgical definitions to improve comparability across studies. Investigating the impact of cesarean delivery on pelvic floor disorders and elucidating the underlying mechanisms may also provide valuable insights to enhance patient care.

Availability of Data and Materials

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

Author Contributions

TTL and MYW designed the literature-screening and data-extraction procedures, and contributed to the analysis and interpretation of data. HXC and LH contributed to the acquisition and interpretation of data, including the eligibility and quality-assessment criteria; HXC served as the final adjudicator. All authors contributed to drafting and critically revising the manuscript for important intellectual content. All authors read and approved the final version and agree to be responsible for all aspects of the work.

Ethics Approval and Consent to Participate

Not applicable.

Acknowledgment

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Conflicts of Interest

The authors declare no conflicts of interest.

Declaration of AI and AI-Assisted Technologies in the Writing Process

We transparently acknowledge that ChatGPT-4 was utilized during the preparation of this manuscript solely for the purposes of scientific language polishing, editorial refining, and ensuring grammatical accuracy. The intellectual content, data analysis, and interpretative conclusions remain entirely the original work and responsibility of the authors.

Supplementary Material

Supplementary material associated with this article can be found, in the online version, at https://doi.org/10.31083/CEOG49510.

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