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National Surgical Quality Improvement Program (NSQIP) Analysis of Benign Hysterectomy Trends in Surgical Route, Patient Factors, Operative Characteristics and Complications among Gynecologic Surgeons and by Subspecialty between 2014-2022

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1. Abstract

1.1. Background

Hysterectomy rates for benign gynecologic conditions are declining in favour of less invasive management, but higher surgeon volume is associated with fewer adverse outcomes. Minimally invasive hysterectomy rates are increasing and associated with improved perioperative outcomes. Published data detailing comprehensive trends of hysterectomies is limited.

1.2. Objective

We analysed benign hysterectomy trends stratified by surgical route and subspecialty.

1.3. Methods

National Surgical Quality Improvement Program clinical registry was used to analyze benign hysterectomies from 2014-2022 by surgical route, patient factors, perioperative metrics, and postoperative complications. Trends were further stratified by gynecologic specialists and gynecologic oncologists after excluding cancer procedures and malignancy. Chi-square and t-test were used with $p<0.05$.

1.4. Results

Vaginal and abdominal hysterectomy rates decreased while laparoscopic rates increased, comprising 64.5% of 206,119 hysterectomies. Abdominal hysterectomy patients were more likely to be non-White (55% vs. 33.5%) and have higher morbidity probability scores (0.077 vs. 0.048). Laparoscopic hysterectomy was preferred in patients with prior abdominopelvic surgery or endometriosis ($p<0.001$). Abdominal hysterectomy patients had longer procedures (141 vs. 139/129 minutes), larger uteri (603 vs. 198/107 grams), and longer hospitalizations (2.54 vs. 0.79/1.05 days) compared to laparoscopic and vaginal, respectively. Laparoscopic hysterectomy patients had the lowest composite

complication rates.Gynecologic oncologists performed 20.9% of benign hysterectomies. Their patients had higher morbidity probability scores, age, body mass index, and rates of prior abdominal surgery ($p<0.001$). Gynecologic oncologists removed larger uteri (302 vs. 279 grams) with shorter operative times (130 vs. 135 minutes) and lower rates of urinary tract infection and thrombosis.

1.5. Conclusions

Laparoscopic hysterectomy is the most common surgical route with increasing utilization. Abdominal hysterectomy remains an essential surgical technique but with increased postoperative risks. Gynecologic oncologists operated on higher-risk patients while maintaining shorter operative times and fewer postoperative complications. Additional surgical training may improve care of complex patients with lower surgical morbidity.

2. Introduction

The National Surgical Quality Improvement Program (NSQIP) was first developed by the Department of Veteran Affairs in the early 1990s [1-3]. In 2004, the American College of Surgeons National Surgical Quality Improvement Program (ACS NSQIP) was developed and became the first validated, variable-based database that provides perioperative details on the adult surgical populations within the U.S. and is available for enrolment to all private-sector hospitals that meet outlined requirements [2,4]. NSQIP data includes case details from 10 urgical specialties, including gynecology. There is little published data documenting the trends and rates of gynecologic surgical outcomes since the implementation of ACS NSQIP over 20 years ago. Nakayama et al, [5].Evaluated the trends of gynecologic procedures within the database between the years of 2010 and 2015, specifically the trends of hysterectomy routes during this time. Minimally invasive surgery, either by vaginal hysterectomy (VH) or laparoscopic hysterectomy (LH), is the standard of care for hysterectomy.6 Recent publications have shown a significant decrease in rates of abdominal hysterectomy (AH) and resulting increase in minimally invasive, specifically laparoscopic, techniques [5,7,8,9,10]. Laparoscopic hysterectomy is associated with less blood loss, lower risk of infection, shorter time to discharge, and faster return to normal activity than abdominal hysterectomy[6]. Carey et al. [8] also evaluated racial disparities associated with the recent increase in LH performed, demonstrating that the transition to minimally invasive surgery was less likely to occur for Black and Hispanic patients. A few studies also evaluated surgical outcomes related to hysterectomy trends and the rise in laparoscopic surgery. Tyan et al [9].Focused on length of hospital stay and readmission, demonstrating the lowest rates for LH. However, there is a paucity of published research detailing a more comprehensive list of NSQIP surgical outcomes, including perioperative and postoperative measures, among benign hysterectomies. Each year between 2010-2015, hysterectomy common procedural terminology (CPT) codes were included within the top-10 utilized surgical codes, emphasizing that hysterectomies are among the most performed surgical procedures in the U.S [7]. Additional information is sorely needed regarding national hysterectomy surgical outcomes, which is accessible from the more than 700 NSQIP-participating institutions. Identifying where an institution's surgical outcome measures lie compared to the rest of the national database is an important evaluation tool that allows for identifications of areas for quality improvement. This allows for data to be easily obtained and evaluated, with the goal of better surgical care quality and superior patient outcomes [4]. Surgical subspecialties within gynecologic surgery include urogynecology and gynecologic oncology (GO), whose patient populations and perioperative outcomes may differ from gynecologic specialists (GS) [7,10]. Our study aimed to evaluate the trends and rates of benign hysterectomies of all surgical routes within the NSQIP database from 2014-2022 by gynecologic surgeons, including by subspecialty, and their associated surgical outcomes.

3. Methods

A retrospective ACS NSQIP database study was performed under Department of Defense IRB protocol #23-17546 to evaluate trends in benign hysterectomy performed by gynecologic surgeons including annual rates, preoperative patient characteristics, perioperative metrics, and 30-day postoperative complications by surgical routes between 2014 and 2022. The secondary objective was to examine trends and differences in outcomes in benign hysterectomy between GS vs. GO.All patients within the de-identified ACS NSQIP database who underwent a benign hysterectomy with a gynecologic surgeon between 2014 and 2022 were included. Gynecologic surgeons included general gynecologic surgeons also known as gynecologic specialists (GS), gynecologic oncologists (GO), and urogynecologists. Patients excluded from this population were those undergoing a hysterectomy for any gynecologic cancer, using NSQIP cancer procedures and common procedural terminology (CPT) codes for malignancy. Preoperative characteristics selected for analysis included age, race, smoking status, body mass index (BMI), American Society of Anesthesiologist (ASA) Class, NSQIP morbidity probability score, history of prior abdominal or pelvic surgery, and history of endometriosis. See footnotes "a-e" of Tables 1 and 2 for more information on the preoperative characteristics categories and subgroups. The perioperative metrics selected were operative time, uterine weight, and total days from surgery to discharge from the hospital. Postoperative complications within 30 days of surgery included urinary tract infections (UTI) and thromboses, to include pulmonary embolism (PE) and deep venous thromboses (DVT), as well as surgical site infections, wound dehiscence, readmission, and a composite complication outcome (1 or more complications

in the same patient was considered a composite complication). These trends in surgical routes, preoperative characteristics, perioperative metrics, and 30-day postoperative complications were then analyzed across all benign hysterectomies performed by gynecologic surgeons (gynecologic specialist, GS; gynecologic oncologist, GO; and urogynecologist) by three hysterectomy routes: abdominal hysterectomy (AH), laparoscopic hysterectomy (LH), and vaginal hysterectomy (VH). The data was then used to evaluate the differences in the above listed factors that were performed by GS vs. GO overall and by surgical route. The categorical variables (e.g. race, smoking status, ASA class) were compared using Chi-square test and the continuous variables (e.g. age, BMI, morbidity probability score, operative time, uterine weight, and time to discharge) were compared using t-test. Statistical significance was set at $p<0.05$. All statistical tests were performed with R software (version 4.0).

Table 1: Preoperative characteristics, intra-operative findings and post-operative complications by route in the 206,119 patients who underwent a benign hysterectomy performed by a gynecologic surgeon (gynecologic specialist, gynecologic oncologist or urogynecologist) between 2014-2022 in the National Surgical Quality Improvement Program (NSQIP).

	Benign Hysterectomy Route with Cases (%) or [Mean ± Standard Deviation]			**Pairwise *p-value* [g]**	
	AH N = 43,624	**LH N = 132,991**	**VH N = 29,584**	**AH vs. LH**	**AH vs. VH**
	Pre-Operative Characteristics				
Age in years [a]	[48.0 ± 9.58]	[47.3 ± 10.8]	[54.2 ± 13.9]	<0.001	<0.001
Race Groups				<0.001	<0.001
White Patients	19,770 (45%)	88,054 (66%)	19,918 (67%)		
Non-White Patients [b]	23,854 (55%)	44,937 (34%)	9,666 (33%)		
Current Smoker Status within 1 year				0.254	<0.001
No	37,362 (86%)	114,195 (86%)	26,108 (88%)		
Yes	6,262 (14%)	18,796 (14%)	3,476 (12%)		
Body Mass Index [c]	[31.6 ± 7.81]	[31.4 ± 7.98]	[29.5 ± 6.59]	<0.001	<0.001
ASA Class Composite Score [d]				<0.001	<0.001
3+	13,216 (30%)	33,985 (26%)	7,003 (24%)		
<3 or Not Available	30,363 (70%)	99,006 (74%)	22,581 (76%)		
Morbidity Probability Score [e]	[0.0773 ± 0.0329]	[0.0416 ± 0.0180]	[0.0537 ± 0.0222]	<0.001	<0.001
Prior Abdominal Operations				<0.001	<0.001
No	32,837 (75%)	95,522 (72%)	21,479 (73%)		
Yes	10,787 (25%)	37,469 (28%)	8,105 (27%)		
Prior Pelvic Operations				<0.001	<0.001
No	19,779 (45%)	55,718 (42%)	15,847 (54%)		
Yes	23,845 (55%)	77,273 (58%)	13,737 (46%)		
History of Endometriosis				<0.001	<0.001
No	37,975 (87%)	110,979 (83%)	28,323 (96%)		
Yes	5,649 (13%)	22,012 (17%)	1,261 (4%)		
	Peri-Operative Metrics				
Operative Time (minutes)	[141 ± 70.4]	[139 ± 66.1]	[129 ± 63.6]	<0.001	<0.001
Uterine Weight (grams)	[603 ± 724]	[198 ± 222]	[107 ± 94.8]	<0.001	<0.001
Days to Discharge	[2.54 ± 2.18]	[0.793 ± 1.32]	[1.05 ± 1.40]	<0.001	<0.001
Post-Operative Complications					
Urinary Tract Infection				<0.001	<0.001
No	42,804 (98%)	129,879 (98%)	28,233 (95%)		
Yes	820 (2%)	3,112 (2%)	1,351 (5%)		

Pulmonary Embolism				<0.001	0.058
No	43,426 (100%)	132,740 (100%)	29,544 (100%)		
Yes	198 (0%)	251 (0%)	40 (0%)		
Other Venous Thrombosis				<0.001	0.218
No	43,495 (100%)	132,811 (100%)	29,553 (100%)		
Yes	129 (0%)	180 (0%)	31 (0%)		
Composite Post-Operative Complication [f]				<0.001	0.261
No	40,672 (93%)	126,041 (95%)	27,518 (93%)		
Yes	2,952 (7%)	6,950 (5%)	2,066 (7%)		

Abbreviations: AH: abdominal hysterectomy, LH: laparoscopic hysterectomy, VH: vaginal hysterectomy.

a. Age of patients in years with patients over the age of 89 codes as 90+.

b. Includes Black or African American, Asian, American Indian or Alaska Native, Mixed Race, or Unknown race as captured in the National Surgical Quality Improvement Program (NSQIP) Participant Use Data File 2022 user guide (https://www.facs.org/media/1nrdyqmr/nsqip_puf_userguide_2022.pdf).

c. Body mass index was calculated using the variables height in inches and weight in pounds provided by NSQIP.

d. American Society of Anesthesiologists (ASA) Class Composite score 3+ was inclusive of ASA Class 3, ASA Class 4, and ASA Class 5. ASA Class composite score <3 was inclusive of ASA class composite score ASA class 1, ASA class 2, and "none assigned" as provided by NSQIP.

e. Morbidity probability score was estimated by NSQIP for all cases based on a logistic regression analysis using the patient's pre-operative characteristics as the independent or predictive variables. Only cases included in the logistic regression analysis had the associated probabilities of morbidity as provided by NSQIP.

f. Composite post-operative complication includes: urinary tract infection, surgical site infection, wound dehiscence, thrombosis, and readmission.

g. Differences in patient characteristics between hysterectomy routes were compared using Chi-square test for categorical variables or t-test for continuous variables.

Table 2: Preoperative characteristics, intra-operative findings and post-operative complications in the subset of 189,517 patients who underwent a benign hysterectomy by a gynecologic specialist or a gynecologic oncologist between 2014-2022 in the National Surgical Quality Improvement Program (NSQIP).

	Benign Hysterectomy Surgeon with Cases (%) or [Mean ± Standard Deviation]		***p-value*** [g]
	Gynecologic Specialist N = 149,820	**Gynecologic Oncologist N = 39,697**	
Pre-Operative Characteristics			
Age in years [a]	[52.4 ± 11.9]	[46.2 ± 9.95]	<0.001
Race Groups			<0.001
White Patients	87,326 (58%)	27,810 (70%)	
Non-White Patients [b]	62,494 (42%)	11,887 (30%)	
Current Smoker Status within 1 year			<0.001
No	128,013 (85%)	34,376 (87%)	
Yes	21,807 (15%)	5,321 (13%)	
Body Mass Index [c]	[31.1 ± 7.46]	[32.3 ± 9.25]	<0.001
ASA Class Composite Score [d]			<0.001
3+	33,210 (23%)	16,407 (41%)	
<3 or Not Available	133,040 (77%)	23,290 (59%)	
Morbidity Probability Score [e]	[0.0484 ± 0.0236]	[0.0604 ± 0.0355]	<0.001
Prior Abdominal Operations			<0.001
No	109,577 (73%)	28,238 (71%)	
Yes	40,243 (27%)	11,459 (29%)	

Prior Pelvic Operations			<0.001
No	64,175 (43%)	18,330 (46%)	
Yes	85,645 (57%)	21,367 (54%)	
History of Endometriosis			<0.001
No	127,304 (85%)	34,115 (86%)	
Yes	22,516 (15%)	5,582 (14%)	
Peri-Operative Metrics			
Operative Time (minutes)	[135 ± 65.6]	[130 ± 61.9]	<0.001
Uterine Weight (grams)	[279 ± 388]	[302 ± 553]	<0.001
Days to Discharge	[1.13 ± 1.64]	[1.54 ± 2.01]	<0.001
Post-Operative Complications			
Urinary Tract Infection	0.0239 (±0.153)	0.0196 (±0.139)	<0.001
Thrombosis			
Pulmonary Embolism	0.00216 (±0.0464)	0.00315 (±0.0560)	0.001
Other DVT	0.00149 (±0.0386)	0.00217 (±0.0465)	0.008
Composite Post-Operative Complication [f]			0.0602
No	141,294 (94%)	37,535 (95%)	
Yes	8,526 (6%)	2,162 (5%)	

Abbreviations: AH: abdominal hysterectomy, LH: laparoscopic hysterectomy, VH: vaginal hysterectomy, DVT: deep venous thrombosis.

a. Age of patients in years with patients over the age of 89 codes as 90+.

b. Includes Black or African American, Asian, American Indian or Alaska Native, Mixed Race, or Unknown race as captured in the National Surgical Quality Improvement Program (NSQIP) Participant Use Data File 2022 user guide (https://www.facs.org/media/1nrdyqmr/nsqip_puf_userguide_2022.pdf).

c. Body mass index was calculated using the variables height in inches and weight in pounds provided by NSQIP.

d. American Society of Anesthesiologists (ASA) Class Composite score 3+ was inclusive of ASA Class 3, ASA Class 4, and ASA Class 5. ASA Class composite score <3 was inclusive of ASA class composite score ASA class 1, ASA class 2, and "none assigned" as provided by NSQIP.

e. Morbidity probability score was estimated by the NSQIP Program for all cases based on a logistic regression analysis using the patient's pre-operative characteristics as the independent or predictive variables. Only cases included in the logistic regression analysis had the associated probabilities of morbidity as provided by NSQIP.

f. Composite post-operative complication includes: urinary tract infection, surgical site infection, wound dehiscence, thrombosis, and readmission.

g. Differences in patient characteristics between hysterectomy routes were compared using Chi-square test for categorical variables or t-test for continuous variables.

4. Results

4.1. Hysterectomy Trends by Surgical Route

A total of 206,199 patients underwent a benign hysterectomy with a gynecologic surgeon between 2014 and 2022 in the NSQIP database. There were 132,991 laparoscopic hysterectomies (LH, 64.5%), 43,624 abdominal hysterectomies (AH, 21.2%), and 29,584 vaginal hysterectomies (VH, 14.3%) performed during this period. Table 1 highlights the patient and preoperative characteristics, perioperative metrics, and 30-day postoperative complications by hysterectomy route. The average age of patients undergoing LH was younger at 47.3 years compared to 48.0 years ($p<0.001$) and 54.2 years ($p<0.001$) undergoing AH and VH, respectively. The AH cohort had a larger percentage of non-white patients than LH (due to the large number of cases with race not specified, the groups were divided into white vs non-white). The LH group had a higher average BMI than VH ($p<0.001$) and lower than AH ($p<0.001$). Patients undergoing LH had a higher percentage of ASA Class 3+ patients than VH and lower percentage than AH ($p<0.001$). LH was more common than AH or VH in patients with history of prior pelvic surgery (58% vs. 55%/46%, $p<0.001$) or endometriosis (17% vs. 13%/4%, $p<0.001$). Laparoscopic surgery was also more common in patients with a history of prior abdominal surgery (28% vs. 25%/27%, $p<0.001$). Patients undergoing AH were more likely to have longer procedures than laparoscopic and vaginal (141 vs. 139/129 minutes, $p<0.001$) and longer hospitalizations (2.54 vs. 0.79/1.05 days, $p<0.001$). Abdominal hysterectomies were performed on larger uteri (603 vs. 198/107 grams, $p<0.001$). Figure 1 demonstrates the differences in perioperative metrics among the three hysterectomy routes. AH also had higher 30-day complications than LH or VH, including UTI (4.6% vs. 2.9/2.6%) and thrombosis (0.38% vs. 0.16/0.12%, both $p<0.001$). Hysterectomies performed laparoscopically had the lowest composite 30-day complication rate of 5% compared

to abdominal and vaginal hysterectomies (6.8/6.9%, p<0.001). The trends in hysterectomy routes performed by all gynecologic surgeons were examined from 2014 to 2022 and are depicted in Figure 2A. Over time, the rates of VH decreased 3.9%, from 16.1% to 12.2%, and AH decreased 13.5% (29.5% to 16.0%). The amount of LH concomitantly increased 17.4%, from 54.4% to 71.8%.

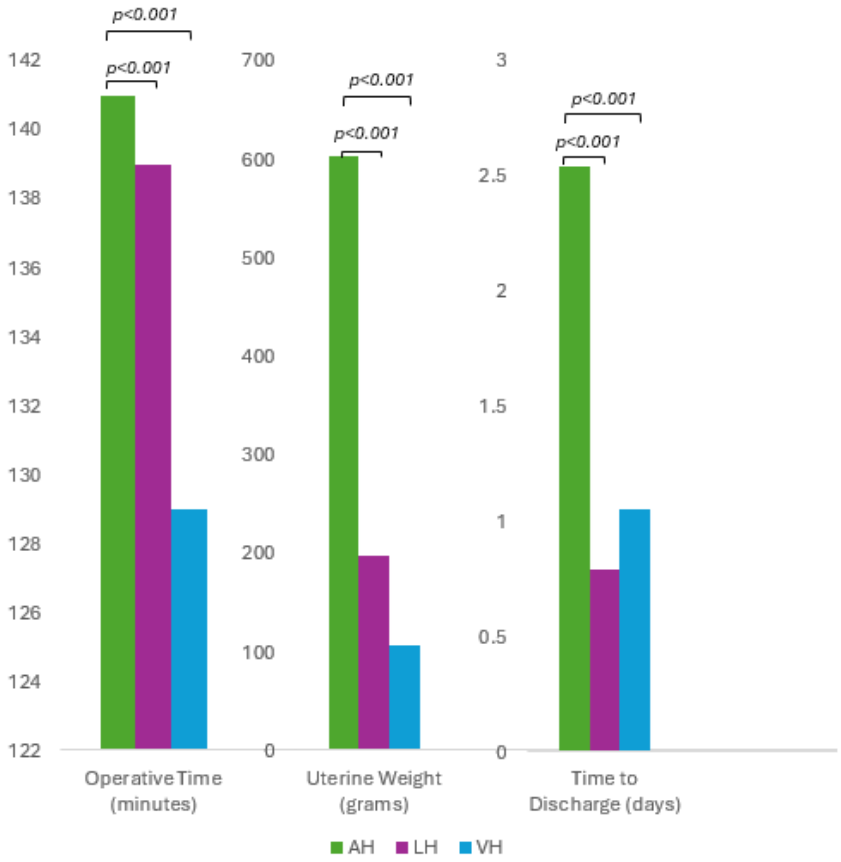

Figure 1: Rates of perioperative metrics by surgical route in the 206,119 patients who underwent a benign hysterectomy performed by a gynecologic surgeon (gynecologic specialist, gynecologic oncologist or urogynecologist) between 2014-2022 in the National Surgical Quality Improvement Program (NSQIP).

Abbreviations: AH: abdominal hysterectomy, LH: laparoscopic hysterectomy, VH: vaginal hysterectomy.

*A significant difference (p<0.001) when compared with the AH group.

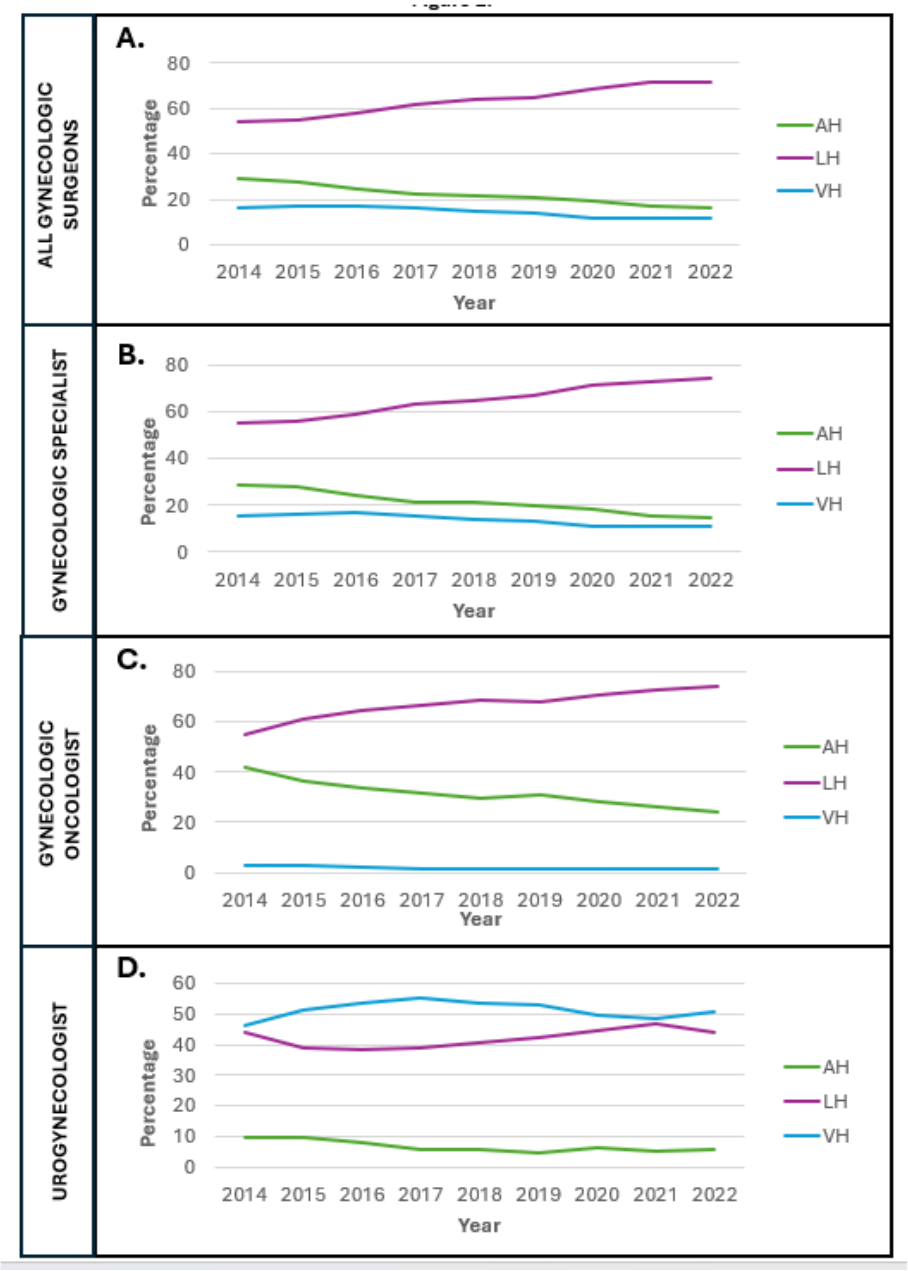

Figure 2: Trends by surgical routes among all 206,199 benign hysterectomies performed by any gynecologic surgeon (**A**), gynecologic specialist (**B**), gynecologic oncologist (**C**), or urogynecologist (**D**) annually between 2014-2022 in the National Surgical Quality Improvement Program (NSQIP).

Abbreviations: AH: abdominal hysterectomy, LH: laparoscopic hysterectomy, VH: vaginal hysterectomy.

4.2. Trends Among Gynecologic Specialists and Gynecologic Oncologists

The trends in hysterectomy routes were then evaluated overtime by subspecialty training. Figure 2B displayed the increased use of LH by gynecologic specialists (GS) and reductions in both AH and VH. Figure 2C shows the increased use of LH and corresponding reductions in use of AH with low utilization of VH by gynecologic oncologists (GO). Figure 2D illustrates how frequently urogynecologists utilize VH or LH with ≤ 10% of their patients undergoing AH.Data was then further analyzed to elucidate differences in patient factors, operative information, and 30-day postoperative complications of benign hysterectomies performed by GS compared with GO. Urogynecology was not included as a separate subspecialty in this analysis due to low numbers (8.1% of all hysterectomies). Of the total 206,199 benign hysterectomies performed by gynecologic surgeons (including urogynecologists) between 2014 and 2022, 189,517 were performed by GO and GS. Figure 3A depicts total case numbers between GO and GS by year. Figure 3B displays an average proportion of 20.9% of benign hysterectomies performed by GO vs 80.1% by GS, with the highest annual rate at 23% by GO in 2020. Table 2 displays the preoperative characteristics, perioperative metrics, and postoperative complications of benign hysterectomies performed by GO vs GS. Patients undergoing surgical procedures with GO

had significantly higher BMI (32.3 vs. 31.1, p<0.001), mean age (52.4 vs. 46.2, p<0.001), rate of ASA Class 3+ (41% vs. 22%, p<0.001), NSQIP morbidity probability score (0.060 vs. 0.048, p<0.001), and history of prior abdominal surgery (29% vs. 27%, p<0.001). Gynecologic oncologists were more likely to perform hysterectomies on larger uteri by weight than GS (302 vs. 279 grams, p<0.001), with shorter operative times (130 vs. 135 minutes, p<0.001), as demonstrated in Figure 4. GO also had lower rates of postoperative UTI than GS (p<0.001) with similar thrombosis rates and composite postoperative complications (p=0.0602).

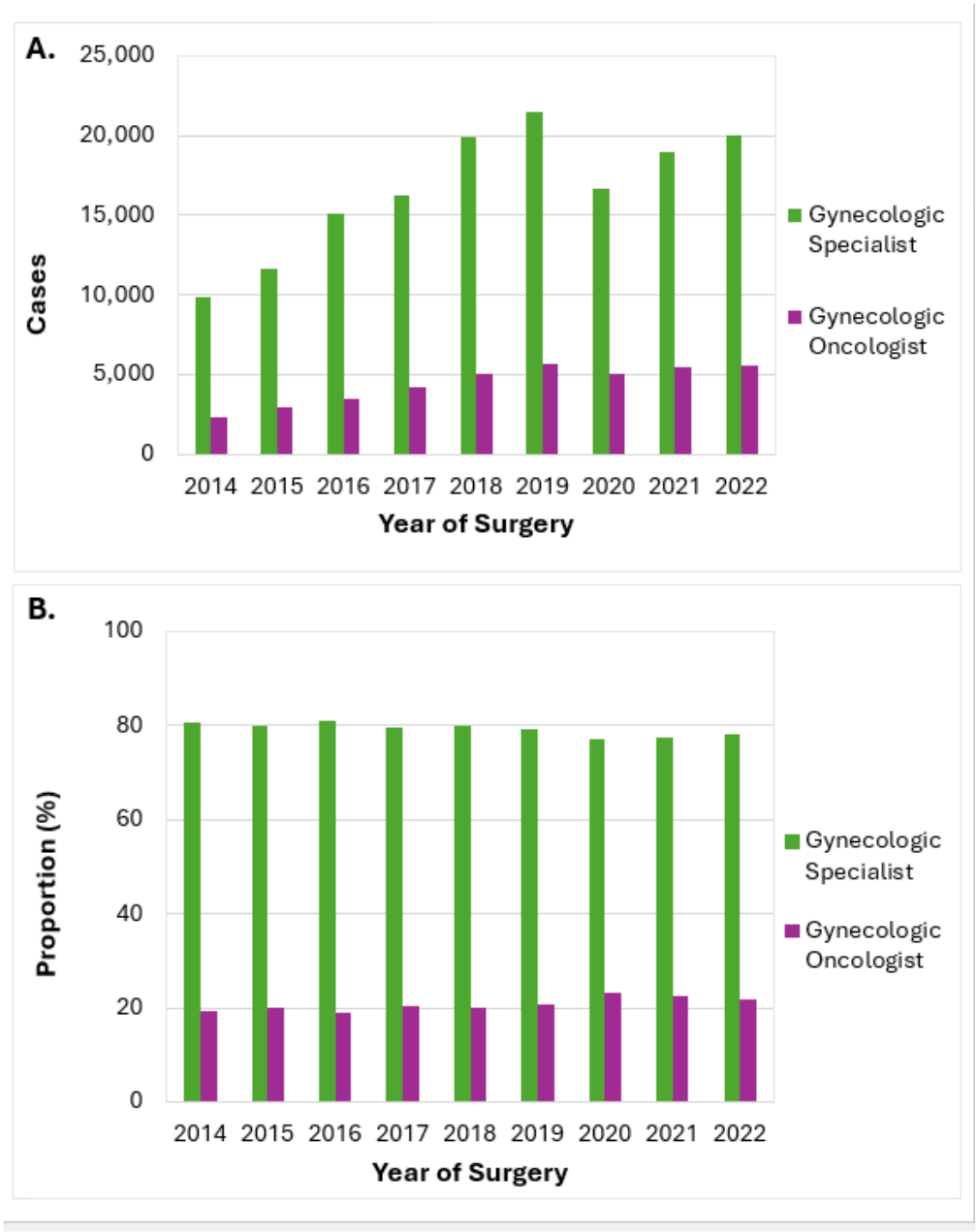

Figure 3: Trends of surgical routes by case numbers (**A**) and proportion of cases (**B**) in the subset of 189,517 patients who underwent a benign hysterectomy by a gynecologic specialist or a gynecologic oncologist between 2014-2022 in the National Surgical Quality Improvement Program (NSQIP).

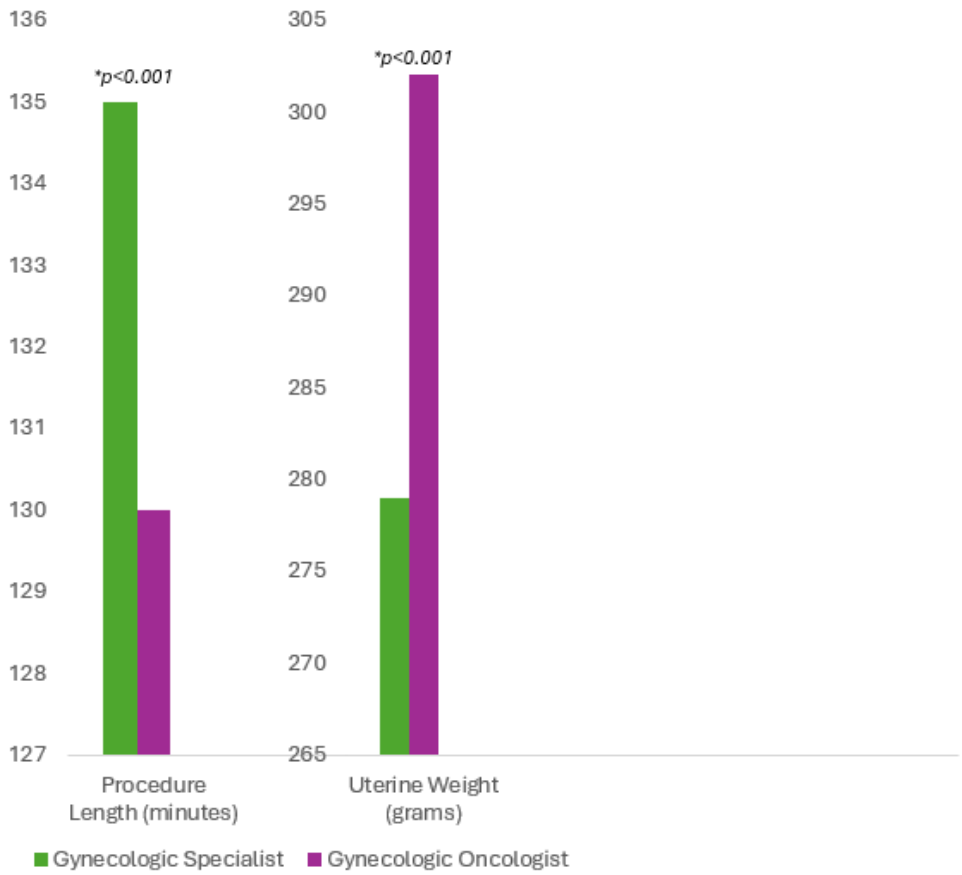

Figure 4: Rates of perioperative metrics in the subset of 189,517 patients who underwent a benign hysterectomy by a gynecologic specialist or a gynecologic oncologist between 2014-2022 in the National Surgical Quality Improvement Program (NSQIP).

*A significant difference ($p<0.001$) when compared with gynecologic oncologists.

5. Comment

5.1. Principal Findings

In our study, we demonstrated that minimally invasive approaches to hysterectomy, both laparoscopic (LH) and vaginal (VH), are associated with shorter procedure times and days to discharge than abdominal hysterectomy (AH). Use of robotic assistance was not reliably reported in NSQIP prior to 2022 so these cases were all listed as “laparoscopic”, with no further subgroups. Minimally invasive hysterectomy, particularly the laparoscopic approach, is associated with lower composite postoperative complications than abdominal. Non-white patients were more likely to undergo AH than white patients, redemonstrating racial disparities highlighted by previous studies during this period of increasing preference for minimally invasive surgery [11]. We also made evident there has been an increasing proportion of benign hysterectomies being performed via laparoscopy while the rates of AH and VH have decreased since 2014.In addition, our study demonstrated the differences in benign hysterectomies performed by GS compared to GO. Overall, the rates of benign hysterectomies performed by the two groups of surgeons remained stable between 2014 and 2022. The highest proportion of benign hysterectomies performed by GO was in 2020, which likely coincides with the COVID-19 pandemic and reduced surgical cases performed by GS nationwide [12]. Overall, GO were more likely than GS to operate on higher-risk patients with larger uteri and history of prior abdominal surgery. Despite this, GO had shorter operative times, lower 30-day complication rates for UTI, and similar thrombosis and composite complication risk.

5.2. Results in the Context of what is Known

Our results reaffirmed the previous trends of increasing utilization of minimally invasive surgery for hysterectomy over the traditional open approaches, with even higher rates of LH performed in recent years than previous decades. Laparoscopic hysterectomy is associated with shorter operative times and lower postoperative complication rates than AH.

5.3. Clinical Implications

Although AH rates have decreased in recent years in favor of laparoscopy, we still endorse that AH is an essential skill for all

gynecologic surgeons to maintain. The abdominal approach may be favored in certain clinical situations, such as patients with large uteri, or in more urgent circumstances when minimally invasive surgery is not prudent. However, surgeons performing AH should appreciate the increased procedure length and associated postoperative complications, and take steps to mitigate these risks.We postulate that GO shorter operating times and fewer postoperative complications on higher-risk patients compared to GS may be attributed to additional years of surgical training received during GO fellowship as well potentially a higher volume surgical practice [13-19].

5.4. Research Implications

Given the spectrum of benign hysterectomies, future investigations may access data from newer PUF files or focus on specific CPT codes (i.e. 58662 when significant endometriosis lesions are excised or fulgurated) or ICD-10 codes (i.e. N80.0) without or with the use of modifiers (i.e. 22 and/or 51 related to endometriosis), for example. Studies may also incorporate multivariable modeling to adjust for confounding factors or incorporate propensity score balancing to reduce bias. In addition, the rates of robotic-assisted laparoscopic hysterectomies were not able to be distinguished from traditional LH given lack of reliable reporting to the ACS NSQIP database prior to 2022. Therefore, the impact of robotic surgery in the increasing utilization of LH is unknown during this timeframe and we plan to evaluate in future studies.

5.5. Strength and Limitations

There are some limitations of this study to discuss. First, the data included in this study is subject to the inclusive criteria of the ACS NSQIP database and only includes hysterectomy trends and outcomes provided by participating private-sector hospitals. Also, there is likely to be missing or incomplete data due to human error in reporting outcomes to ACS NSQIP. Our study did not fully encompass all patient factors and other demographics that may impact surgical morbidity and mortality. The morbidity probability score from NSQIP is a proprietary system that is web-based and continually updated. For example, further research into the impact of socioeconomic status, medical insurance status, and distance from patient residence to medical center on hysterectomy trends may highlight other healthcare disparities besides race that may impact surgical outcomes, and this can change over time. Also, evaluating the relationship between the surgical volume among individual surgeons or institutions on the perioperative metrics and postoperative outcomes may provide further insight for quality improvement. An advantage of this study is the easy reproducibility for any researcher with access to the ACS NSQIP database. Other strengths include the large sample size and generalizability to the standard population of patients undergoing benign hysterectomies.

6. Conclusions

We report the largest published collection to date of NSQIP benign hysterectomy trends and rates over the last decade, including data as recent as 2022. Our results highlight the increasing utilization of minimally invasive surgical routes for benign hysterectomies, particularly the laparoscopic approach. Additional investigation should evaluate the impact of robotic platforms on the rising preference for LH, as this data was not available for all years of this study. This study also highlights that the ability of gynecologic oncologists to perform more complex benign hysterectomies on high-risk patients with shorter operative times than gynecologic specialists and improved or equivalent postoperative complication rates. This suggests that additional surgical training, to include high-fidelity simulations, may help gynecologic specialists maintain or improve surgical skills and care for higher-risk patients while maintaining low surgical morbidity and mortality.

7. Acknowledgement(s):

The American College of Surgeons National Surgical Quality Improvement Program and the hospitals participating in the ACS NSQIP are acknowledged as the source of the data used herein.

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