Original Research

Disparities in Access to High-Volume Surgeons Within High-Volume Hospitals for Hysterectomy

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OBJECTIVE: To examine access to high-volume surgeons in comparison with low-volume surgeons who perform hysterectomies within high-volume hospitals and to compare perioperative morbidity and mortality between high-volume and low-volume surgeons within these centers.

METHODS: Women who underwent hysterectomy in New York State between 2000 and 2014 at a high-volume (top quartile by volume) hospital were included. Surgeons were classified into quartiles based on average annual hysterectomy volume. Multivariable models were used to determine characteristics associated with treatment by a low-volume surgeon in comparison with a high-volume surgeon and to estimate the association between physician volume, and morbidity and mortality.

RESULTS: A total of 300,586 patients cared for by 5,505 surgeons at 59 hospitals were identified. Women treated by low-volume surgeons, in comparison with high-volume surgeons, were more often Black (19.4% vs 14.3%; adjusted odds ratio [aOR] 1.26; 95% CI 1.09–1.46) and had Medicare insurance (20.6% vs 14.5%; aOR 1.22; 95% CI 1.04–1.42). Low-volume surgeons were more likely to perform both emergent–urgent procedures (26.1% vs 6.4%; aOR 3.91; 95% CI 3.26–4.69) and abdominal hysterectomy, compared with minimally invasive hysterectomy (77.8% vs 54.7%; aOR 1.91; 95% CI 1.62–2.24). Compared with patients cared for by high-volume surgeons, those operated on by low-volume surgeons had increased risk of a complication (31.0% vs 10.3%; adjusted risk ratios [aRR] 1.84; 95% CI 1.71–1.98) and mortality (2.2% vs 0.2%; aRR 3.04; 95% CI 2.20–4.21). In sensitivity analyses, differences in morbidity and mortality remained for emergent–urgent procedures, elective operations, cancer surgery, and noncancer procedures.

CONCLUSION: Socioeconomic disparities remain in access to high-volume surgeons within high-volume hospitals for hysterectomy. Patients who undergo hysterectomy at a high-volume hospital by a low-volume surgeon are at substantially greater risk for perioperative morbidity and mortality.

(Obstet Gynecol 2021;138:208–17)
DOI: 10.1097/AOG.0000000000004456

A body of literature has demonstrated an association between higher hospital and surgeon procedural volume and decreased morbidity and mortality.[1–3] The association between surgical volume and outcomes is most pronounced for procedures associated with significant morbidity and mortality, such as cardiovascular operations and high-risk oncologic surgeries.[4–6] Outcomes for hysterectomy, for both benign and malignant disease, are improved when the procedure is performed at high-volume hospitals and by high-volume surgeons; however, the magnitude of this association is lower than for other procedures.[7–9]

Despite the benefits of treatment by high-volume surgeons, there are significant disparities in access to

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Each author has confirmed compliance with the journal's requirements for authorship.

Dr. Wright, Editor-in-Chief Elect of Obstetrics & Gynecology, *was not involved in the review or decision to publish this article.*

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Financial Disclosure
Ana I. Tergas received funds from Auro vaccines. Dr. Wright has served as a consultant for Clovis Oncology and received research funding from Merck and royalties from UpToDate. Dr. Hou has served as a consultant for Foundation Medicine. No other authors have any conflicts of interest or disclosures. The other authors did not report any potential conflicts of interest.

ISSN: 0029-7844/21

such care. Black patients, those without commercial insurance, and patients with lower socioeconomic status are less likely to be referred to high-volume hospitals for cancer and other complex surgeries.[10–12] For hysterectomy, Black and Hispanic patients are more likely to undergo open hysterectomies at smaller hospitals, resulting in increased perioperative complications.[13] A recent study examining survival in endometrial cancer found that the effect of race on mortality was mitigated, albeit not eliminated, by treatment at a higher volume hospital.[14] An important goal of regionalization of surgical procedures to high-volume centers is to reduce disparities and improve care for all patients. To date, data describing whether disparities in care and outcomes exist within high-volume hospitals are limited.

The objective of our study was to examine disparities in access to care and outcomes for patients who are undergoing hysterectomy at high-volume hospitals. Specifically, we examined access to high-volume surgeons in comparison with low-volume surgeons within high-volume hospitals, and we compared perioperative morbidity and mortality between high and low-volume surgeons within these high-volume centers.

METHODS

For this analysis, we used data from SPARCS (the Statewide Planning and Research Cooperative System), which is maintained by the New York State Department of Health.[15] SPARCS is an all-payer database that captures patient characteristics, diagnoses, services, and charges for hospital inpatient admissions and outpatient visits. Encrypted physician and hospital identifiers, and limited hospital information are included. Data quality is ensured through periodic reviews and by comparing SPARCS data with data from other Department of Health databases. This study used deidentified data and was classified as nonhuman subject research by the Columbia University Institutional Review Board.

Women who underwent hysterectomy (abdominal, robot-assisted, laparoscopic, and vaginal) from 2000 to 2014 were selected. Annualized hospital procedural volume was then estimated for each hospital. The annualized hysterectomy volume was calculated as the number of hysterectomies a given center performed divided by the total number of years in which the hospital performed at least one hysterectomy. Hospital volume was then visually inspected, and the top quartile by volume hospitals were selected as high-volume centers for further analysis. Among the high-volume hospitals, patients were excluded if they had a hysterectomy before admission or if they had an obstetric-related hysterectomy (Fig. 1). The attending surgeon for each hysterectomy was then identified. Within SPARCS, each physician is assigned a unique identification number that can be tracked across hospitals. Patients with an invalid or missing physician identifier also were excluded. The surgeons at the high-volume hospitals were then selected, and their annualized hysterectomy volume across all hospitals in New York State was estimated. The data were visually inspected, and the surgeons were categorized into four quartiles based on the annualized hysterectomy volume. The lowest-volume quartile performed a mean of one procedure per year, the second quartile 1.5 per year (range 1.1–1.9), the third quartile 3.7 per year (range 2.0–6.8), and the high-volume quartile 20.7 per year (range 6.9–248.9).

The outcomes of interest were perioperative morbidity and mortality. Perioperative morbidity was defined as the occurrence of an intraoperative complication, surgical site complication, or medical complications as previously defined during the index admission.[16] Intraoperative complications included vascular, gastrointestinal, genitourinary, or neurologic injury, or reoperation during the index admission. Surgical site complications included wound complications, abscess, hemorrhage, gastrointestinal bleeding, hemorrhage, bowel obstruction, and ileus. Medical complications included myocardial infarct, cardiopulmonary arrest, respiratory failure, renal failure, stroke, sepsis, pneumonia, and arrhythmia. We defined inpatient mortality as death during the index admission. Blood transfusion during the index admission was also examined.

Patient demographic characteristics included year of surgery, age at surgery (younger than 40 years, 40–49, 50–59, 60–69, 70 or older), race and ethnicity (White, Black, Hispanic, other, unknown), and insurance type (none, Medicare, Medicaid, private insurance, other). Comorbidity score was estimated using the Elixhauser Comorbidity Index and categorized as 0, 1, or 2 or higher.[17] Each procedure was classified as elective or emergent–urgent. Indications for surgery included leiomyoma, endometriosis, abnormal bleeding, ovarian cysts, pelvic organ prolapse, uterine cancer, cervical cancer, and ovarian cancer (including fallopian tube and primary peritoneal). These indications were not mutually exclusive. The route of hysterectomy was categorized as abdominal, laparoscopic, robotic-assisted, or vaginal. Performance of concomitant oophorectomy was noted for each patient.

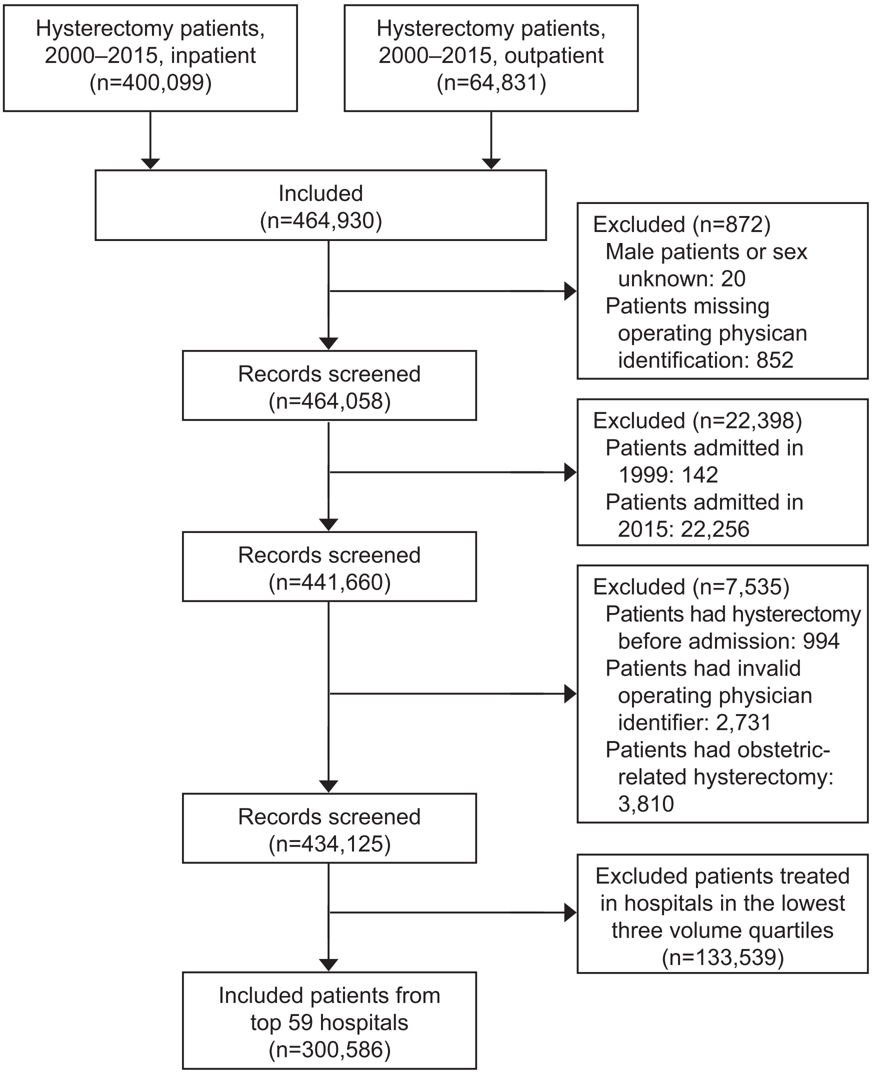

Fig. 1. Cohort selection diagram.
Knisely. Disparities Within High-Volume Hospitals. Obstet Gynecol 2021.

Clinical and demographic characteristics of the patients were compared across the surgeon volume quartiles using chi square tests. A multinomial logistic regression model using generalized estimation equation to account for hospital clustering was used to estimate clinical and demographic characteristics associated with treatment by a low-volume surgeon in comparison with a high-volume surgeon.

The associations between surgeon volume, and morbidity and mortality were examined using marginal log-linear regression models with Poisson distribution and the log link function, adjusting for hospital clustering. Covariates in the model included age, race, health insurance, year of surgery, Elixhauser comorbidity score, admission type, indication for surgery, and performance of oophorectomy. Results are reported as adjusted risk ratios.

Given the association between surgeon volume and urgency of the procedure and presence of cancer, sensitivity analyses were performed stratified by surgical urgency (emergent–urgent vs elective) and presence of cancer. All analyses were conducted with SAS 9.4. All statistical tests were two-sided. $P<.05$ was considered statistically significant.

RESULTS

We identified a total of 300,586 patients who underwent hysterectomy by 5,505 surgeons at 59 high-volume hospitals in New York State between 2000 and 2014 (Table 1). There were 2,105 (38.2%) low-volume surgeons who treated 2,900 (1.0%) patients. In contrast, 1,377 (25.1%) high-volume surgeons operated on 262,005 (87.2%) of the patients.

The majority of cases were abdominal hysterectomies (57.5%), followed by laparoscopic (23.9%),

Table 1. Patient Demographics and Clinical Characteristics, Stratified by Surgeon Volume Quartile

	Quartile (Range)				
	1st (1–1)	2nd (1.1–1.9)	3rd (2.0–6.8)	4th (6.9–248.9)	*P*
Surgeons	2,105 (38.2)	560 (10.2)	1,463 (26.6)	1,377 (25.1)	
Patients	2,900 (1.0)	3,566 (1.2)	32,114 (10.7)	262,005 (87.2)	
Age (y)					<.001
Younger than 40	319 (11.0)	340 (9.5)	3,622 (11.3)	34,137 (13.0)	
40–49	1,009 (34.8)	1,272 (35.7)	16,701 (52.0)	105,776 (40.4)	
50–59	669 (23.1)	821 (23.0)	7,441 (23.2)	60,037 (22.9)	
60–69	424 (14.6)	546 (15.3)	2,648 (8.3)	35,309 (13.5)	
70 or older	479 (16.5)	587 (16.5)	1,702 (5.3)	26,747 (10.2)	
Race					<.001
White	1,658 (57.2)	2,102 (59.0)	16,285 (50.7)	171,349 (65.4)	
Black	563 (19.4)	582 (16.3)	6,757 (21.0)	37,480 (14.3)	
Hispanic	266 (9.2)	290 (8.1)	3,164 (9.9)	21,720 (8.3)	
Other*	255 (8.8)	372 (10.4)	3,548 (11.1)	20,115 (7.7)	
Unknown	158 (5.5)	220 (6.2)	2,360 (7.4)	11,342 (4.3)	
Health insurance					<.001
Private	2,018 (69.6)	2,548 (71.5)	26,632 (82.9)	201,500 (76.9)	
Medicare	596 (20.6)	718 (20.1)	2,669 (8.3)	37,919 (14.5)	
Medicaid	213 (7.3)	203 (5.7)	2,049 (6.4)	12,917 (4.9)	
None	37 (1.3)	69 (1.9)	516 (1.6)	3,303 (1.3)	
Other or unknown†	36 (1.3)	28 (0.8)	248 (0.8)	6,367 (2.4)	
Year of surgery					<.001
2000	236 (8.1)	260 (7.3)	3,087 (9.6)	15,477 (5.9)	
2001	234 (8.1)	265 (7.4)	2,802 (8.7)	16,198 (6.2)	
2002	223 (7.7)	247 (6.9)	2,806 (8.7)	17,327 (6.6)	
2003	214 (7.4)	258 (7.2)	2,602 (8.1)	16,636 (6.4)	
2004	212 (7.3)	265 (7.4)	2,598 (8.1)	17,150 (6.6)	
2005	197 (6.8)	257 (7.2)	2,328 (7.3)	17,453 (6.7)	
2006	199 (6.9)	261 (7.3)	2,199 (6.9)	16,976 (6.5)	
2007	172 (5.9)	225 (6.3)	2,087 (6.5)	17,131 (6.5)	
2008	183 (6.3)	245 (6.9)	1,843 (5.7)	17,484 (6.7)	
2009	180 (6.2)	240 (6.7)	1,848 (5.8)	18,209 (7.0)	
2010	152 (5.2)	220 (6.2)	1,787 (5.6)	18,903 (7.2)	
2011	152 (5.2)	214 (6.0)	1,702 (5.3)	18,404 (7.0)	
2012	157 (5.4)	197 (5.5)	1,491 (4.6)	18,268 (7.0)	
2013	182 (6.3)	222 (6.2)	1,471 (4.6)	18,622 (7.1)	
2014	207 (7.1)	190 (5.3)	1,463 (4.6)	17,768 (6.8)	
Comorbidity score					<.001
0	846 (29.2)	1,123 (31.5)	14,423 (44.9)	108,698 (41.5)	
1	796 (27.5)	1,029 (28.9)	9,998 (31.1)	76,945 (29.4)	
2 or higher	1,258 (43.4)	1,414 (39.7)	7,693 (24.0)	76,363 (29.2)	
Admission type					<.001
Elective	2,016 (69.5)	2,869 (80.5)	28,179 (87.8)	206,980 (79.0)	
Emergent–urgent	758 (26.1)	595 (16.7)	2,366 (7.4)	16,855 (6.4)	
Other or unknown	126 (4.3)	102 (2.9)	1,569 (4.9)	38,171 (14.6)	
Leiomyoma	1,424 (49.1)	1,932 (54.2)	23,440 (73.0)	143,740 (54.9)	<.001
Endometriosis	523 (18.0)	647 (18.1)	7,783 (24.2)	68,298 (26.1)	<.001
Abnormal bleeding	686 (23.7)	856 (24.0)	13,151 (41.0)	88,686 (33.9)	<.001
Benign cyst	688 (23.7)	913 (25.6)	9,088 (28.3)	72,822 (27.8)	<.001
Pelvic prolapse	251 (8.7)	301 (8.4)	3,425 (10.7)	44,443 (17.0)	<.001
Uterine cancer	264 (9.1)	189 (5.3)	1,439 (4.5)	35,835 (13.7)	<.001
Cervical caner	33 (1.1)	19 (0.5)	140 (0.4)	4,787 (1.8)	<.001
Ovarian cancer	235 (8.1)	166 (4.7)	458 (1.4)	14,195 (5.4)	<.001
Hysterectomy					<.001
Abdominal	2,255 (77.8)	2,914 (81.7)	24,360 (75.9)	143,433 (54.7)	
Robotic	77 (2.7)	90 (2.5)	303 (0.9)	15,421 (5.9)	

(*continued*)

Table 1. Patient Demographics and Clinical Characteristics, Stratified by Surgeon Volume Quartile (*continued*)

	Quartile (Range)				
	1st (1–1)	2nd (1.1–1.9)	3rd (2.0–6.8)	4th (6.9–248.9)	*P*
Laparoscopic	360 (12.4)	369 (10.4)	4,397 (13.7)	66,846 (25.5)	
Vaginal	208 (7.2)	193 (5.4)	3,054 (9.5)	36,306 (13.9)	
Oophorectomy					<.001
No	817 (28.2)	1,106 (31.0)	13,751 (42.8)	97,309 (37.1)	
Yes	2,083 (71.8)	2,460 (69.0)	18,363 (57.2)	164,697 (62.9)	

Data are n (%) unless otherwise specified.
* Other includes American Indian or Alaska Native, Asian, Native Hawaiian or Pacific Islanders, or not otherwise specified.
† Other includes patients receiving other government insurance type.

vaginal (13.2%), and robotic-assisted (5.3%) procedures. A minority of cases were performed for gynecologic cancer (19.1%), with the remainder performed for benign indications. The majority of patients (64.4%) were 40–59 years of age. White patients accounted for 63.7% of the cohort, 15.1% of patients were Black, and 8.5% were Hispanic. Most patients (77.4%) had commercial insurance, and 28.9% of patients had a comorbidity score of 2 or higher.

Women treated by low-volume surgeons, in comparison with high-volume surgeons, were more often Black (19.4% vs 14.3%; adjusted odds ratio [aOR] 1.26; 95% CI 1.09–1.46) and had Medicare insurance (20.6% vs 14.5%; aOR 1.22; 95% CI 1.04–1.42) (Table 2). Low-volume surgeons were more likely to perform both emergent–urgent procedures (26.1% vs 6.4%; aOR 3.91; 95% CI 3.26–4.69) and abdominal hysterectomy, in comparison with minimally invasive hysterectomy (77.8% vs 54.7%; aOR 1.91; 95% CI 1.62–2.24). Lower volume surgeons were also more likely to perform surgery on patients with greater comorbidity (comorbidity score higher than 2; 43.4% vs 29.2%; aOR 1.67; 95% CI 1.47–1.89).

The overall complication rate was 31.0% for patients treated by low-volume surgeons, compared with 10.3% for those treated by high-volume surgeons (*P*<.001) (adjusted risk ratios [aRR] 1.84; 95% CI 1.71–1.98) (Table 3). Intraoperative complications (10.2% vs 3.3%; aRR 2.15; 95% CI 1.90–2.44), surgical site complications (14.9% vs 4.3%; aRR 1.85; 95% CI 1.67–2.04), medical complications (19.6% vs 5.1%; aRR 2.09; 95% CI 1.88–2.31), and transfusion (37.1% vs 11.6%; aRR 1.68; 95% CI 1.52–1.86) were all more common in patients operated on by low-volume surgeons. The perioperative mortality rate was 2.2% for patients treated by low-volume surgeons, compared with 0.2% for those operated on by high-volume surgeons (*P*<.001) (aRR 3.04; 95% CI 2.20–4.21).

Because low-volume surgeons were more likely to perform urgent and emergent procedures, we performed sensitivity analyses stratified by urgency of the procedure. Among patients who underwent procedures classified as emergent–urgent, those operated on by low-volume surgeons were more likely to experience any complications (53.2% vs 22.1%; aRR 1.62; 95% CI 1.47–1.78) and had a higher inpatient mortality rate (6.7% vs 1.1%; aRR 2.76; 95% CI 1.91–3.99) (Table 4). Similar findings were noted for elective procedures; any complications (24.2% vs 10.7%; aRR 1.97; 95% CI 1.81–2.14), and inpatient mortality (0.6% vs 0.1%; aRR 2.76; 95% CI 1.91–3.99) were higher for low-volume surgeons, in comparison with high-volume surgeons.

In another series of sensitivity analyses limited to cancer patients, both complications (43.2% vs 20.6%; aRR 1.36; 95% CI 1.22–1.51) and mortality (5.1% vs 0.6%; aRR 2.59; 95% CI 1.63–4.12) were higher for low-volume surgeons compared with high-volume surgeons (Table 4). Similar findings were seen for noncancer surgery; complications (28.4% vs 7.7%; aRR 2.15; 95% CI 1.98–2.34) and mortality (1.6% vs 0.04%: aRR 3.84; 95% CI 2.41–6.14) were higher for the low-volume surgeons compared with high-volume surgeons.

DISCUSSION

These findings suggest that within high-volume hospitals, disparities in access to high-volume surgeons as well as outcomes remain. Within high-volume hospitals, women treated by low-volume surgeons were more often Black, had Medicare insurance, had more comorbidities, and were more likely to undergo abdominal hysterectomy. Of concern, those patients who underwent surgery with low-volume surgeons

Table 2. Factors Associated With Performance of Hysterectomy by Lower-Volume Surgeons Compared With High-Volume (4th Quartile) Surgeons

	Quartile		
	1st	2nd	3rd
Age (y)			
Younger than 40	0.95 (0.80–1.12)	0.84 (0.69–1.01)	0.76 (0.70–0.82)*
40–49	Ref	Ref	Ref
50–59	1.17 (1.05–1.31)†	1.30 (1.19–1.43)*	1.05 (0.98–1.11)
60–69	1.36 (1.19–1.55)*	1.92 (1.64–2.25)*	0.98 (0.89–1.09)
70 or older	1.78 (1.47–2.16)*	2.68 (2.22–3.23)*	0.95 (0.83–1.07)
Race			
White	Ref	Ref	Ref
Black	1.26 (1.09–1.46)†	0.97 (0.81–1.15)	1.28 (1.04–1.57)†
Hispanic	1.15 (0.99–1.34)	1.01 (0.83–1.25)	1.30 (0.99–1.70)
Other‡	1.23 (1.04–1.45)†	1.40 (1.16–1.68)†	1.70 (1.38–2.10)*
Unknown	1.23 (0.91–1.66)	1.43 (0.84–2.42)	1.74 (0.94–3.22)
Health insurance			
Private	Ref	Ref	Ref
Medicare	1.22 (1.04–1.42)†	1.10 (0.91–1.34)	1.17 (0.98–1.41)
Medicaid	1.07 (0.95–1.21)	1.04 (0.91–1.18)	0.91 (0.84–0.99)†
None	0.86 (0.61–1.23)	1.47 (1.01–2.13)†	1.15 (0.88–1.51)
Other or unknown§	1.44 (0.87–2.40)	1.35 (0.80–2.26)	0.56 (0.39–0.80)†
Year of surgery	0.98 (0.96–0.99)†	0.99 (0.97–1.01)	0.97 (0.95–0.98)*
Comorbidity score			
0	Ref	Ref	Ref
1	1.23 (1.09–1.39)†	1.21 (1.10–1.35)†	1.02 (0.95–1.09)
2 or higher	1.67 (1.47–1.89)*	1.51 (1.33–1.72)*	0.94 (0.84–1.05)
Admission type			
Elective	Ref	Ref	Ref
Emergent–urgent	3.91 (3.26–4.69)*	2.19 (1.81–2.66)*	1.14 (0.95–1.36)
Other or unknown	0.63 (0.42–0.93)†	0.39 (0.26–0.59)*	0.60 (0.46–0.78)†
Leiomyoma	0.66 (0.59–0.72)*	0.71 (0.62–0.81)*	1.28 (1.18–1.39)*
Endometriosis	0.72 (0.63–0.82)*	0.71 (0.62–0.80)*	0.83 (0.75–0.91)†
Abnormal bleeding	0.60 (0.53–0.69)*	0.57 (0.50–0.65)*	1.03 (0.93–1.15)
Benign cyst	0.64 (0.56–0.73)*	0.64 (0.53–0.76)*	0.89 (0.81–0.97)†
Pelvic prolapse	0.42 (0.34–0.53)*	0.38 (0.29–0.51)*	0.72 (0.61–0.85)†
Uterine cancer	0.24 (0.20–0.29)*	0.11 (0.09–0.14)*	0.33 (0.25–0.43)*
Cervical caner	0.30 (0.21–0.43)*	0.13 (0.08–0.20)*	0.22 (0.16–0.30)*
Ovarian cancer	0.36 (0.28–0.47)*	0.18 (0.13–0.24)*	0.21 (0.15–0.29)*
Hysterectomy			
Abdominal	1.91 (1.62–2.24)*	2.42 (2.01–2.92)*	1.85 (1.59–2.15)*
Robotic	0.70 (0.53–0.93)†	0.76 (0.51–1.12)	0.34 (0.25–0.46)*
Laparoscopic	Ref	Ref	Ref
Vaginal	0.92 (0.72–1.18)	0.64 (0.48–0.85)†	1.08 (0.87–1.35)
Oophorectomy	1.19 (1.07–1.32)†	0.98 (0.85–1.13)	0.91 (0.82–1.01)

Ref, referent.
Data are adjusted odds ratio (95% CI).
* $P<.001$. Multinomial logistic regression model using generalized estimation equation accounting for hospital clustering. Year of surgery was included as a continuous variable.
† $P<.05$.
‡ Other includes American Indian or Alaska Native, Asian, Native Hawaiian or Pacific Islanders, or not otherwise specified.
§ Other includes patients receiving other government insurance type.

were at substantially greater risk for perioperative morbidity and mortality.

The relative importance of hospital and surgeon volume on outcome varies across procedures.[2] Recently, a number of studies have demonstrated that individual surgeon experience is more important in achieving better outcomes than performance of the procedure at a high-volume hospital. An analysis of patients undergoing pancreaticoduodenectomy noted that the benefits of a high-volume hospital can accompany high-volume surgeons when they relocate to a low-volume hospital; the study concluded that

Table 3. Association Between Surgeon Annualized Volume and Perioperative Outcomes

	Any Complication		Intraoperative Complication		Surgical Site Complications		Medical Complications		Transfusion		Mortality	
Quartile	Rate (%)	aRR (95% CI)	Rate (%)	aRR (95% CI)	Rate (%)	aRR (95% CI)	Rate (%)	aRR (95% CI)	Rate (%)	aRR (95% CI)	Rate (%)	aRR (95% CI)
1st	31.0	1.84 (1.71–1.98)*	10.2	2.15 (1.90–2.44)*	14.9	1.85 (1.67–2.04)*	19.6	2.09 (1.88–2.31)*	37.1	1.68 (1.52–1.86)*	2.2	3.04 (2.20–4.21)*
2nd	28.4	1.94 (1.75–2.15)*	11.4	2.70 (2.44–2.99)*	13.3	1.96 (1.70–2.26)*	15.8	2.00 (1.74–2.29)*	33.9	1.93 (1.69–2.21)*	1.0	2.10 (1.54–2.85)*
3rd	10.7	1.11 (1.03–1.19)†	3.4	1.16 (1.04–1.28)†	4.2	1.03 (0.94–1.13)	5.4	1.17 (1.05–1.30)†	14.5	1.22 (1.07–1.38)†	0.1	1.03 (0.65–1.65)
4th	10.3	Ref	3.3	Ref	4.3	Ref	5.1	Ref	11.6	Ref	0.2	Ref

aRR, adjusted risk ratios; Ref, referent.

Unadjusted rate. Marginal log-linear regression model with Poisson distribution and the log link function, adjusting for hospital clustering and covariates in Table 1, including age; race; health insurance; year of surgery; Elixhauser comorbidity score; admission type; leiomyoma; endometriosis; abnormal bleeding; benign cyst; pelvic prolapse; uterine cancer; cervical cancer; ovarian, fallopian tube, or peritoneal cancer; hysterectomy; and oophorectomy.

* $P<.001$.

† $P<.05$.

optimal outcomes are more a result of the "who" not "where."[18] In another study, within a single high-volume center, acute type A aortic dissection repair by low-volume surgeons had a nearly fourfold increase in in-hospital mortality compared with procedures performed by high-volume teams, emphasizing the critical importance of surgeon experience for high-risk surgeries. For hysterectomy, our findings also suggest that the benefits of treatment at a high-volume center may be blunted when the procedure is performed by a low-volume gynecologic surgeon. Both morbidity and mortality were substantially higher for low-volume surgeons in comparison with high-volume surgeons.

The current study also highlights the racial and socioeconomic disparities in access to high-volume surgeons for hysterectomy. Underinsured patients and non-White patients have consistently been noted to be less likely to receive care at either a high-volume hospital or by a high-volume surgeon.[19] This disparity in access can be explained in part by systematic barriers including geography and financial incentives, as higher-quality health care professionals tend to attract patients with commercial insurance coverage, who are disproportionately White.[20] A survey of Medicare patients who underwent high-risk operations reported that their referring physician was more likely to be the main decision maker about where and with whom the patient would have surgery[21]; as such, White patients and those with private insurance may have access to better-informed referral networks. Additionally, underinsured patients may be more likely to reside in rural areas with limited access to high-volume surgeons.[22,23] However, our data are disturbing in that, even when patients receive care at a high-volume center, these disparities in access to high-volume surgeons remain. Paradoxically, regionalization of surgical care for disadvantaged patient groups may have little effect on improving outcomes if these patients still do not have access to high-volume surgeons.[1]

Even within high-volume hospitals, a significant number of gynecologic surgeons who perform hysterectomy had a very low volume. Within our cohort, 38% of the surgeons were classified in the lowest volume quartile, which was defined as an annualized volume of one hysterectomy per year. We have previously demonstrated that outcomes for very low-volume surgeons who perform hysterectomy are poor.[8] The low-volume surgeons in our cohort performed a disproportionate number of urgent and emergent surgeries, suggesting that at least a proportion of these physicians may simply be providing emergent coverage rather than performing elective procedures. However, even among the lowest volume surgeons, 70% of these cases were elective and outcomes were inferior to higher volume surgeons for both elective and nonelective procedures. It is unclear why such a large number of surgeons performing hysterectomy at high-volume centers have such a low-volume, and this phenomenon clearly warrants investigation in other procedures.

In this study, low-volume surgeons were more likely to perform abdominal hysterectomy compared with a minimally invasive approach. Minimally invasive hysterectomy, when feasible, has been shown to have several advantages over abdominal hysterectomy including shorter length of stay, decreased hospital costs, and more rapid recovery.[24] Concordant with our data, previous research has demonstrated racial and

Table 4. Association Between Surgeon Annualized Volume Quartile and Outcomes, Stratified by Admission Type and Cancer Status

Quartile	Any Complication Rate (%)	Any Complication aRR (95% CI)	Intraoperative Complication Rate (%)	Intraoperative Complication aRR (95% CI)	Surgical Site Complications Rate (%)	Surgical Site Complications aRR (95% CI)	Medical Complications Rate (%)	Medical Complications aRR (95% CI)	Transfusion Rate (%)	Transfusion aRR (95% CI)	Mortality Rate (%)	Mortality aRR (95% CI)
Emergent–urgent surgery cohort (n=20,574)												
1st	53.2	1.62 (1.47–1.78)*	16.8	1.92 (1.62–2.27)*	27.8	1.59 (1.39–1.82)*	36.4	1.83 (1.61–2.08)*	66.5	1.41 (1.29–1.54)*	6.73	2.76 (1.91–3.99)*
2nd	51.9	1.68 (1.51–1.86)*	20.3	2.38 (1.98–2.85)*	28.1	1.73 (1.48–2.04)*	31.4	1.72 (1.46–2.02)*	65.6	1.53 (1.40–1.67)*	3.53	1.68 (1.03–2.74)†
3rd	20.8	1.11 (1.00–1.24)	5.71	1.09 (0.91–1.31)	10.4	1.11 (0.95–1.29)	11.9	1.19 (1.02–1.38)†	43.3	1.27 (1.16–1.40)*	0.38	0.64 (0.29–1.41)
4th	22.1	Ref	6.16	Ref	11.1	Ref	12.6	Ref	33.2	Ref	1.06	Ref
Elective surgery cohort (n=240,044)												
1st	24.2	1.97 (1.81–2.14)*	8.2	2.21 (1.90–2.58)*	11.0	2.07 (1.85–2.31)*	14.3	2.26 (2.00–2.55)*	28.2	2.07 (1.76–2.42)*	0.64	2.76 (1.91–3.99)*
2nd	24.4	2.00 (1.78–2.24)*	9.9	2.69 (2.41–3.00)*	10.7	2.01 (1.70–2.38)*	13.1	2.09 (1.78–2.45)*	28.5	2.15 (1.78–2.60)*	0.45	1.68 (1.03–2.74)†
3rd	10.3	1.11 (1.02–1.20)†	3.3	1.17 (1.05–1.31)†	3.9	1.01 (0.92–1.12)	5.1	1.16 (1.03–1.30)†	12.8	1.20 (1.03–1.39)†	0.07	0.64 (0.29–1.41)
4th	10.7	Ref	3.3	Ref	4.4	Ref	5.3	Ref	11.8	Ref	0.12	Ref
Cancer cohort (n=55,696)												
1st	43.2	1.36 (1.22–1.51)*	12.2	1.39 (1.11–1.75)†	20	1.19 (0.98–1.45)	32	1.66 (1.43–1.92)*	54.4	1.28 (1.16–1.42)*	5.13	2.59 (1.63–4.12)*
2nd	38.5	1.36 (1.20–1.54)*	12.7	1.61 (1.24–2.07)†	18	1.27 (1.01–1.61)†	25	1.51 (1.31–1.74)*	47.1	1.28 (1.12–1.48)†	3.32	2.36 (1.37–4.08)†
3rd	17.5	0.84 (0.74–0.94)†	4.51	0.76 (0.61–0.94)†	8.7	0.90 (0.74–1.09)	10	0.91 (0.77–1.08)	20.6	0.74 (0.64–0.85)*	0.66	1.04 (0.52–2.08)
4th	20.6	Ref	6.24	Ref	9.5	Ref	11	Ref	25.2	Ref	0.64	Ref
Noncancer cohort (n=244,890)												
1st	28.4	2.15 (1.98–2.34)*	9.82	2.65 (2.29–3.05)*	14	2.32 (2.08–2.58)*	17	2.37 (2.11–2.65)*	33.4	1.98 (1.74–2.26)*	1.59	3.84 (2.41–6.14)*
2nd	27.3	2.16 (1.93–2.42)*	11.3	3.11 (2.78–3.48)*	13	2.27 (1.95–2.65)*	15	2.18 (1.87–2.54)*	32.4	2.20 (1.89–2.55)*	0.69	2.25 (1.48–3.43)†
3rd	10.3	1.17 (1.08–1.27)*	3.3	1.23 (1.10–1.38)†	3.9	1.08 (0.98–1.19)	5.1	1.24 (1.10–1.40)†	14.1	1.32 (1.15–1.51)*	0.06	1.12 (0.67–1.87)
4th	7.7	Ref	2.57	Ref	2.9	Ref	3.5	Ref	8.2	Ref	0.04	Ref

aRR, adjusted risk ratios; Ref, referent.
* *P*<.001.
† *P*<.05.

socioeconomic disparities in access to minimally invasive hysterectomy, even after accounting for clinical differences.[13,25–29] Based on the results of this study, it is plausible that these disparities in access to minimally invasive hysterectomy may be mitigated, at least in part, by surgeon volume.

This study has a number of important limitations. First, as with any study of observational data, there may have been under coding of some of the outcomes of interest. To mitigate this bias, we only included major perioperative outcomes that were likely to generate a billing claim. Second, we lack data on some unmeasured confounders that undoubtedly influenced outcomes including clinical characteristics, such as surgical history and complexity. Third, a unique strength of SPARCS is the ability to track surgeons across hospitals; however, we lack more detailed information on surgeon characteristics that may have influenced outcomes. Fourth, our study spanned 15 years, a relatively long period in which practice patterns evolved. Additionally, as some outcomes, such as mortality, were relatively rare, our power to detect differences is limited in some cohorts, and our models are subject to overfitting. Lastly, our analysis was limited to New York State. Although the cohort includes a diverse sociodemographic makeup, these findings may not be generalizable to other states.

In conclusion, this study demonstrates increased perioperative morbidity and mortality for patients who underwent hysterectomy by low-volume surgeons, in comparison with high-volume surgeons, at high-volume hospitals. Importantly, patients operated on by lower volume surgeons were more likely to be Black or to have Medicare insurance, have more comorbidities, and undergo abdominal hysterectomy. Although centralization of complex surgical care to higher volume hospitals may have benefit, there are additional surgeon-level factors that must be considered to address disparities in access to high-quality care for patients undergoing hysterectomy. Further work is needed to implement initiatives to ensure all women who are undergoing hysterectomy receive guideline-adherent care and to investigate referral patterns to identify areas for intervention to reduce disparities.

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PEER REVIEW HISTORY

Received February 1, 2021. Received in revised form March 25, 2021. Accepted April 1, 2021. Peer reviews are available at http://links.lww.com/AOG/C344.