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Surgeon Sex and Long-Term Postoperative Outcomes Among Patients Undergoing Common Surgeries

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Supplemental content

IMPORTANCE Sex- and gender-based differences in a surgeon's medical practice and communication may be factors in patients' perioperative outcomes. Patients treated by female surgeons have improved 30-day outcomes. However, whether these outcomes persist over longer follow-up has not been assessed.

OBJECTIVE To examine whether surgeon sex is associated with 90-day and 1-year outcomes among patients undergoing common surgeries.

DESIGN, SETTING, AND PARTICIPANTS A population-based retrospective cohort study was conducted in adults in Ontario, Canada, undergoing 1 of 25 common elective or emergent surgeries between January 1, 2007, and December 31, 2019. Analysis was performed between July 15 and October 20, 2022.

EXPOSURE Surgeon sex.

MAIN OUTCOMES AND MEASURES An adverse postoperative event, defined as the composite of death, readmission, or complication, was assessed at 90 days and 1 year following surgery. Secondarily, each of these outcomes was assessed individually. Outcomes were compared between patients treated by female and male surgeons using generalized estimating equations with clustering at the level of the surgical procedure, accounting for patient-, procedure-, surgeon-, anesthesiologist-, and facility-level covariates.

RESULTS Among 1 165 711 included patients, 151 054 were treated by a female and 1 014 657 by a male surgeon. Overall, 14.3% of the patients had 1 or more adverse postoperative outcomes at 90 days and 25.0% had 1 or more adverse postoperative outcomes 1 year following surgery. Among these, 2.0% of patients died within 90 days and 4.3% died within 1 year. Multivariable-adjusted rates of the composite end point were higher among patients treated by male than female surgeons at both 90 days (13.9% vs 12.5%; adjusted odds ratio [AOR], 1.08; 95% CI, 1.03-1.13) and 1 year (25.0% vs 20.7%; AOR, 1.06; 95% CI, 1.01-1.12). Similar patterns were observed for mortality at 90 days (0.8% vs 0.5%; AOR 1.25; 95% CI, 1.12-1.39) and 1 year (2.4% vs 1.6%; AOR, 1.24; 95% CI, 1.13-1.36).

CONCLUSIONS AND RELEVANCE After accounting for patient, procedure, surgeon, anesthesiologist, and hospital characteristics, the findings of this cohort study suggest that patients treated by female surgeons have lower rates of adverse postoperative outcomes including death at 90 days and 1 year after surgery compared with those treated by male surgeons. These findings further support differences in patient outcomes based on physician sex that warrant deeper study regarding underlying causes and potential solutions.

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The sociodemographic characteristics of physicians, including age and sex, are associated with patients' health care outcomes. Across many medical contexts, female physicians have better patient outcomes[1-5] than male physicians. The reasons underpinning this are multifactorial but appear to include differences in communication, practice style, and the physician-patient relationship[6,7] and may also include qualitative differences in practice including patient selection.

In an observational study including more than 1 million adults undergoing common surgeries in Canada, patients treated by female surgeons had better postoperative outcomes (captured as a composite of 30-day mortality, readmission, and complications) than those treated by male surgeons (adjusted odds ratio [AOR], 0.96; 95% CI, 0.92-0.99), including a detectable association with mortality (AOR, 0.88; 95% CI, 0.79-0.99).[3] However, previous work has noted that surgeon characteristics associated with short-term postoperative outcomes[8] may not be predictive of longer-term outcomes.[9] Thus, understanding whether observations regarding the association between surgeon sex and surgical outcomes persist over a longer term is an important step in evaluating the broader implications of diversifying surgical practice in health care delivery.

We therefore performed a population-based retrospective cohort study among patients undergoing common surgeries in Ontario, Canada, to assess whether there was an association between surgeon sex and adverse postoperative outcomes at 90 days and 1 year following surgery, specifically asking whether differences observed using 30-day outcomes persist.

Key Points

Question Is there an association between surgeon sex and patients' long-term postoperative outcomes?

Findings In this cohort study of 1 million patients, those treated by a female surgeon were less likely to experience death, hospital readmission, or major medical complication at 90 days or 1 year after surgery. This association was seen across nearly all subgroups defined by patient, surgeon, hospital, and procedure characteristics.

Meaning The findings of this study suggest that patients treated by female surgeons have a lower risk-adjusted likelihood of adverse postoperative outcomes at 90 days and 1 year following surgery.

Methods

Overview

This study used the same design, methods, and sample as previous work examining 30-day outcomes.[1-4] That is, we identified adults undergoing 1 of 25 common surgeries between January 1, 2007, and December 31, 2019, in Ontario to examine the association between the sex of the operating surgeon and 90-day and 1-year postoperative outcomes. Ontario residents receive insurance for physician and hospital services through a single government payer, the Ontario Health Insurance Program, providing comprehensive health administrative data. We used multidisciplinary consensus to identify included procedures with intentional focus to including surgeries from low to high perioperative risk, inclusive of elective and emergent procedures across all surgical subspecialties to ensure generalizability, including both open and laparoscopic approaches. We report this study according to the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) reporting guideline and the Reporting of Studies Conducted Using Observational Routinely-Collected Health Data (RECORD) statement. The Mount Sinai Hospital Research Ethics Board approved this study protocol with waiver of consent on the basis of the use of deidentified administrative data that are reported in aggregate.

Data Sources

We relied on health administrative data that were linked using unique encoded identifiers and analyzed at ICES. We included the Ontario Health Insurance Plan database (physician billings, laboratories, and out-of-province services),[10] the Canadian Institute for Health Information (CIHI) Discharge Abstract Database (DAD) (hospitalizations),[11] the CIHI National Ambulatory Care Reporting System (emergency department visits), the Registered Persons Database (demographic information),[12] and the Corporate Provider Database (physician-level data).

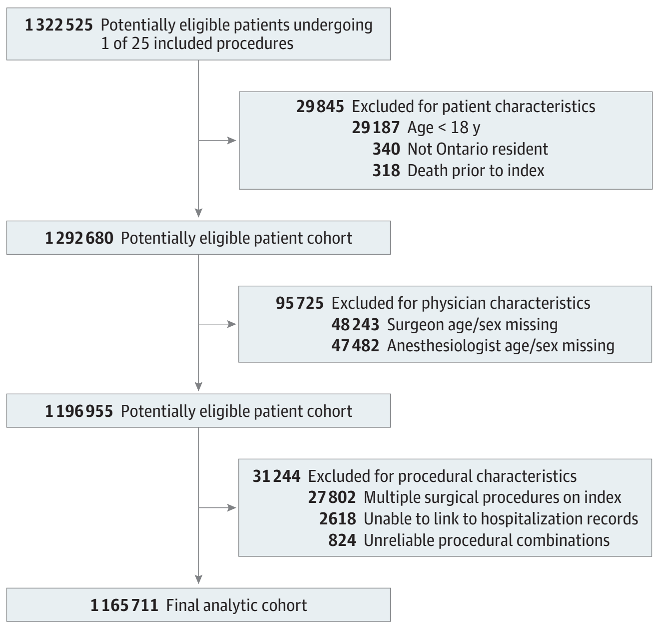
Cohort Derivation

Among patients undergoing 1 of the procedures, we included those for whom we could identify the treating surgeon and anesthesiologist (n = 1 322 525). We then excluded pediatric patients (age <18 years) (n = 29 187), non-Ontario residents (n = 340), patients who died before the date of surgery (n = 318), and those whose operative procedure could not be reliably linked to a treating institution (n = 2618). Additionally, we excluded patients if we could not determine the sex or age of the treating surgeon (n = 48 243) or anesthesiologist (n = 47 482), given the association between these factors and short-term perioperative outcomes. To provide generalizable results, patients undergoing multiple concomitant surgical procedures (n = 27 802) or with unreliable combinations of surgical specialty and procedure (eg, urology and abdominal aortic aneurysm repair; n = 824) were excluded. The overall study cohort comprised 1 165 711 unique patients (**Figure 1**).

Outcomes

As our primary outcome, we defined adverse postoperative outcomes as a composite of death, readmission, or complication within 1 year after surgery.[13] To define surgical complications, we applied a previously used definition representing major morbidity, including reoperation (eTable 1 in Supplement 1).[13] We used health administrative data for outcome ascertainment, relying on a combination of uniformly collected procedural and diagnostic codes.[13,14] Secondarily, we examined the composite end point at 90 days and the individual components of the composite outcome at 90 days and 1 year following surgery.

Figure 1. Cohort Derivation



Exposure

We determined physician sex using the Corporate Provider Database, derived from physician self-report at the time of credentialing and registration with the Ontario Ministry of Health. Due to the information in the data set, we were unable to assess the social construct of physician gender.

Covariates

We obtained patient-level covariates including age, sex, general comorbidity (Johns Hopkins aggregate disease group), rurality, geographic location (local health integration networks[15]), and geographically derived socioeconomic status. Furthermore, we collected surgeon-level data including sex, age, years in practice, specialty, and surgical volume. Data on race and ethnicity were not available. Surgeon- and procedure-specific surgical volumes were calculated by identifying the number of identical procedures the operating surgeon performed in the previous year, operationalized in quartiles. We further collected anesthesiologist-level details including sex, age, years in practice, and annual case volume, as these have been associated with short-term perioperative outcomes.[16] Finally, we accounted for facility-level variability using hospital institution identifiers. Surgical procedures were defined as emergent or elective using the CIHI-DAD database admission variables. Same-day surgical procedures were considered elective. The duration of surgery (in minutes) was further collected.

Statistical Analysis

Data analysis was conducted between July 15 and October 20, 2022. We compared the characteristics of patients, surgeons, anesthesiologists, and hospitals according to the sex of the surgeon, using standardized differences. This represents the difference in the mean of a variable between 2 groups divided by an estimate of the SD of that variable among both groups.[17] We considered a standardized difference of greater than 0.10 to be clinically important.[17]

We examined the occurrence of the primary composite adverse postoperative outcome and each secondary outcome (death, readmission, or complication) at 90 days and 1 year following surgery, stratified by surgeon sex. We used multivariable regression using generalized estimating equations with an independent correlation structure to estimate the association between surgeon sex and outcomes while clustering on the specific procedure performed. These models were adjusted for patient-, surgeon-, anesthesiologist-, and hospital-level covariates (as listed previously and determined a priori) and procedure year. We used models with a Poisson distribution and log link to estimate adjusted absolute event rates (presented with 95% CI) and with binomial distribution and logit link to estimate relative effect size (presented as AORs with 95% CIs). Adjusted absolute rates were estimated using the median value for continuous variables and the third quartile/quintile for categorical variables. All models used a patient-level unit of analysis.

A priori–determined subgroup analyses were performed to test the hypothesis that patient-, surgeon-, anesthesiologist-, procedure- (including urgency and complexity), and facility-level characteristics may play a role in the association between surgeon sex and postoperative outcomes. We further performed sensitivity analysis by adding the duration of surgery as a covariate among the subset of 1 100 193 patients (94.3%) with complete data on this variable.

We used an α level of .05 as the threshold for statistical significance based on a 2-tailed comparison. All analyses were performed using Enterprise Guide, version 6.1 (SAS Institute Inc).

Results

Among the 1 165 711 included patients, 151 054 were treated by a female surgeon (700 [23.3%]) and 1 014 657 were treated by a male surgeon (2306 [76.7%]). As previously described,[3] patients treated by female surgeons were younger, as were the surgeons themselves. Additionally, these patients were more likely to be female and had fewer comorbidities compared with those treated by male surgeons (**Table 1**). There were also differences in surgical specialties, reflecting the distribution of female surgeons (eTable 2 in Supplement 1).

At 90 days following surgery, 166 905 patients (14.3%) had 1 or more adverse postoperative outcomes: 23 743 (2.0%) died, 94 253 (8.1%) were readmitted, and 77 010 (6.6%) had a major complication. At 1 year following surgery, 25.0% of the patients had experienced 1 or more adverse postoperative outcomes: 4.3% had died, 18.9% had been readmitted, and 7.9% had a major complication.

After adjusting for patient-, surgeon-, anesthesiologist-, and hospital-level covariates, we observed significantly higher rates of adverse postoperative outcomes at 90 days following surgery in patients treated by male surgeons (13.9%; 95% CI, 11.3%-17.2%) than those treated by female surgeons (12.5%; 95% CI, 9.9%-15.6%; AOR, 1.08; 95% CI, 1.03-1.13) (**Table 2**). Similar results were obtained when we examined rates of adverse postoperative outcomes at 1 year following surgery: patients treated by male surgeons were significantly more likely to experience an adverse postoperative outcome (25.0%; 95% CI, 22.4%-27.9%) than those treated by female surgeons (20.7%; 95% CI, 17.2%-24.8%; AOR, 1.06; 95% CI, 1.01-1.12). This association was observed across each of the secondary end points, including mortality at both 90 days (males: 0.8%; 95% CI, 0.4%-1.6% vs females: 0.5%; 95% CI, 0.3%-1.1%; AOR, 1.25; 95% CI, 1.12-1.39) and 1 year (males: 2.4%; 95% CI, 1.2%-4.8% vs females: 1.6%; 95% CI, 0.8%-3.1%; AOR, 1.24; 95% CI, 1.13-1.36). Differences in crude event rates were comparable across all end points and both time periods (eTable 3 in Supplement 1). Sensitivity analyses including surgical duration as a covariate were consistent with the primary analysis (eTable 4 in Supplement 1).

In subgroup analyses using the primary composite end point at 1 year, we found no evidence of outcome modification when analyses were stratified according to surgical specialty, surgeon age, surgeon volume, surgeon years in practice, case complexity, patient age, patient comorbidity, anesthesiologist age, anesthesiologist sex, anesthesiologist years in practice, or anesthesiologist volume (**Figure 2**). However, we observed associations between surgeon sex and patient outcomes according to patient sex, surgical procedure type (elective vs emergent), and hospital status (academic or community). When stratified by patient sex, there was no association between surgeon sex and outcomes for male patients (AOR, 0.99; 95% CI, 0.92-1.07) whereas female patients had significantly higher rates of adverse postoperative events when treated by male surgeons (AOR, 1.09; 95% CI, 1.05-1.14) (test for subgroup differences, *P* = .01). Despite heterogeneity of effect (*P* = .04), the direction of effect size was comparable for elective (AOR, 1.05; 95% CI, 0.99-1.11) and emergent (AOR, 1.02; 95% CI, 0.98-1.06) cases (*P* = .04). In addition, there was an association between surgeon sex (test for subgroup differences *P* = .009) among patients treated in community hospitals (AOR, 1.11; 95% CI, 1.04-1.18) that was not observed in academic hospitals (AOR, 1.00; 95% CI, 0.93-1.08). Owing to loss of statistical power, many comparisons were no longer statistically significant in these subgroup analyses.

Discussion

This large population-based multidisciplinary cohort study found that patients treated by female surgeons had significantly lower long-term (90-day and 1-year) rates of adverse postoperative outcomes than those treated by male surgeons. To our knowledge, these are the first data to assess the association between surgeon sex and outcomes beyond 30 days following surgery. Multiple studies have assessed the association between surgeon sex and short-term surgical outcomes.[1-3,18,19] In the study most comparable with ours,[3] also using an Ontario-based cohort, patients treated by female physicians had lower rates of 30-day adverse postoperative outcomes, including death. This outcome was noted primarily with elective surgeries (AOR, 0.94; 95% CI, 0.89-0.98), without evidence of an association between surgeon sex and outcomes following emergent operations (AOR, 1.01; 95% CI, 0.96-1.08). In comparable analyses of the US health care system, an association between female surgeon sex and patient outcomes was seen among elective operations[18] but not emergent operations.[19] In the present analysis, the effect size of surgeon sex was larger among elective surgeries (AOR, 1.05; 95% CI, 0.99-1.11) than emergent surgeons (AOR, 1.02; 95% CI, 0.98-1.06), with evidence of statistically significant heterogeneity (*P* = .04).

While assessment of surgical outcomes has typically focused on a short period following the procedure, there is increasing interest and focus on longer-term perioperative outcomes.[20] This, in part, acknowledges that the outcomes of surgical care may have prolonged ramifications for patients and set them on new health trajectories. Extrapolation from short- to long-term outcomes in surgery has not always been consistent. In seminal work examining patients undergoing gastric bypass, Birkmeyer and colleagues[8] showed that video-based assessment of technical skills was associated with the risk of 30-day complications. However, longer-term follow-up of these patients noted that peer-adjudicated surgical skill was not associated with patient outcomes at 1 year following surgery.[9] These findings suggest potential underlying explanations for observations relating to surgeon sex and patient outcomes: while technical ability is associated with short-term surgical outcomes, other factors, including patient selection, may contribute more meaningfully to longer-term patient outcomes.[9] Prior work[6,7] has reported differences in communication, practice style, and the physician-patient relationship between female and male physicians. We postulate that these differences, along with potential qualitative differences in practice,

Table 1. Baseline Characteristics of Study Cohort

Characteristic	No. (%)			Standardized difference
	Male surgeon (n = 1 014 657 patients)	Female surgeon (n = 151 054 patients)	Total (n = 1 165 711)	
Surgeon				
Age, y				
Mean (SD)	49.8 (9.5)	45.1 (8.3)	49.2 (9.5)	0.519
Median (IQR)	49 (42-57)	44 (38-51)	48 (41-56)	0.503
Years in practice				
Mean (SD)	16.2 (8.6)	12.6 (8.1)	15.7 (8.6)	0.431
Median (IQR)	17 (9-23)	11 (6-19)	17 (8-23)	0.427
Annual case volume quartile				
1 (Lowest)	225 407 (22.2)	56 528 (37.4)	281 935 (24.2)	0.337
2	257 544 (25.4)	44 758 (29.6)	302 302 (25.9)	0.095
3	254 327 (25.1)	30 976 (20.5)	285 303 (24.5)	0.109
4 (Highest)	277 379 (27.3)	18 792 (12.4)	296 171 (25.4)	0.380
Specialty				
Cardiothoracic surgery	3775 (0.4)	203 (0.1)	3978 (0.3)	0.047
General surgery	324 155 (31.9)	61 666 (40.8)	385 821 (33.1)	0.185
Neurosurgery	56 049 (5.5)	2863 (1.9)	58 912 (5.1)	0.193
Obstetrics and gynecology	86 673 (8.5)	54 696 (36.2)	141 369 (12.1)	0.704
Orthopedic surgery	379 088 (37.4)	12 862 (8.5)	391 950 (33.6)	0.730
Otolaryngology	16 410 (1.6)	2708 (1.8)	19 118 (1.6)	0.014
Plastic surgery	41 543 (4.1)	13 485 (8.9)	55 028 (4.7)	0.197
Thoracic surgery	13 559 (1.3)	1476 (1.0)	15 035 (1.3)	0.034
Urology	89 339 (8.8)	1080 (0.7)	90 419 (7.8)	0.387
Vascular surgery	4066 (0.4)	15 (0.0)	4081 (0.4)	0.086
Anesthesiologist				
Age, y				
Mean (SD)	48.9 (10.1)	49.2 (10.4)	48.9 (10.1)	0.032
Median (IQR)	48 (41-57)	48 (41-57)	48 (41-57)	0.022
Sex				
Female	267 330 (26.3)	44 492 (29.5)	311 822 (26.7)	0.069
Male	747 327 (73.7)	106 562 (70.5)	853 889 (73.3)	0.069
Years in practice				
Mean (SD)	14.6 (9.3)	14.9 (9.6)	14.6 (9.4)	0.038
Median (IQR)	14 (6-22)	14 (6-23)	14 (6-22)	0.034
Annual case volume quartile				
1 (Lowest)	234 001 (23.1)	37 563 (24.9)	271 564 (23.3)	0.042
2	262 277 (25.8)	43 735 (29.0)	306 012 (26.3)	0.070
3	257 338 (25.4)	38 867 (25.7)	296 205 (25.4)	0.008
4 (Highest)	261 041 (25.7)	30 889 (20.4)	291 930 (25.0)	0.125
Patient				
Age, y				
Mean (SD)	60.0 (17.2)	52.5 (16.3)	59.0 (17.3)	0.446
Median (IQR)	62 (48-73)	51 (41-64)	60 (47-72)	0.469
Sex				
Female	600 293 (59.2)	120 922 (80.1)	721 215 (61.9)	0.466
Male	414 364 (40.8)	30 132 (19.9)	444 496 (38.1)	0.466

(continued)

Table 1. Baseline Characteristics of Study Cohort (continued)

Characteristic	No. (%) Male surgeon (n = 1 014 657 patients)	Female surgeon (n = 151 054 patients)	Total (n = 1 165 711)	Standardized difference
Comorbidity[a]				
ADG 0-5	263 940 (26.0)	40 900 (27.1)	304 840 (26.2)	0.024
ADG 6-7	240 746 (23.7)	37 511 (24.8)	278 257 (23.9)	0.026
ADG 8-10	304 439 (30.0)	45 875 (30.4)	350 314 (30.1)	0.008
ADG ≥11	205 532 (20.3)	26 768 (17.7)	232 300 (19.9)	0.065
Rurality				
Urban	893 124 (88.0)	137 951 (91.3)	1 031 075 (88.5)	0.109
Rural	121 533 (12.0)	13 103 (8.7)	134 636 (11.5)	0.109
Income quintile				
1 (Lowest)	194 036 (19.1)	28 275 (18.7)	222 311 (19.1)	0.010
2	205 328 (20.2)	30 195 (20.0)	235 523 (20.2)	0.006
3	204 020 (20.1)	30 152 (20.0)	234 172 (20.1)	0.004
4	206 707 (20.4)	31 030 (20.5)	237 737 (20.4)	0.004
5 (Highest)	204 566 (20.2)	31 402 (20.8)	235 968 (20.2)	0.016
Other				
Hospital status				
Community	679 253 (66.9)	94 522 (62.6)	773 775 (66.4)	0.092
Academic	335 404 (33.1)	56 532 (37.4)	391 936 (33.6)	0.092
Surgical procedure type				
Elective	795 460 (78.4)	122 144 (80.9)	917 604 (78.7)	0.061
Urgent	219 197 (21.6)	28 910 (19.1)	248 107 (21.3)	0.061
Case complexity				
Low	348 450 (34.3)	61 132 (40.5)	409 582 (35.1)	0.127
High	666 207 (65.7)	89 922 (59.5)	756 129 (64.9)	0.127
Year of index surgery				
2007	89 521 (8.8)	10 337 (6.8)	99 858 (8.6)	0.074
2008	85 735 (8.4)	11 238 (7.4)	96 973 (8.3)	0.037
2009	85 322 (8.4)	11 492 (7.6)	96 814 (8.3)	0.030
2010	84 360 (8.3)	11 471 (7.6)	95 831 (8.2)	0.027
2011	85 119 (8.4)	11 492 (7.6)	96 611 (8.3)	0.029
2012	82 446 (8.1)	11 723 (7.8)	94 169 (8.1)	0.013
2013	84 742 (8.4)	12 600 (8.3)	97 342 (8.4)	0.000
2014	82 275 (8.1)	13 307 (8.8)	95 582 (8.2)	0.025
2015	78 693 (7.8)	13 376 (8.9)	92 069 (7.9)	0.040
2016	73 790 (7.3)	12 109 (8.0)	85 899 (7.4)	0.028
2017	66 313 (6.5)	11 314 (7.5)	77 627 (6.7)	0.037
2018	61 085 (6.0)	10 633 (7.0)	71 718 (6.2)	0.041
2019	55 256 (5.4)	9962 (6.6)	65 218 (5.6)	0.048

Abbreviation: ADG, aggregate disease group.

[a] The ADG categorical division of comorbidity is based on the number and health service use associated with comorbid conditions.

including patient selection, may contribute to these variations in patient outcomes. Our subgroup analyses further emphasize this: the magnitude of the effect estimate for surgeon sex (ie, the AOR) was larger among elective than emergent operations in which differences in the preoperative care process and surgical selection may manifest. Ongoing qualitative and quantitative work is aimed at better understanding these differences, including anthropologic observation, focused interviewing, and surveys of surgeons, patients, and other health care team members. Prior work[21] has reported that female surgeons undertake additional efforts (termed a status-leveling burden) within the context of the health care ecosystem to ad-

Table 2. Multivariable Adjusted Event Rates and Outcomes[a]

Outcome	Outcome within 90 d			Outcome within 1 y		
	Adjusted event rate (95% CI)[b]		Adjusted odds ratio (95% CI)[c]	Adjusted event rate (95% CI)[b]		Adjusted odds ratio (95% CI)[c]
	Male surgeon	Female surgeon		Male surgeon	Female surgeon	
Composite end point	13.9 (11.3-17.2)	12.5 (9.9-15.6)	1.08 (1.03-1.13)	25.0 (22.4-27.9)	20.7 (17.2-24.8)	1.06 (1.01-1.12)
Death	0.8 (0.4-1.6)	0.5 (0.3-1.1)	1.25 (1.12-1.39)	2.4 (1.2-4.8)	1.6 (0.8-3.1)	1.24 (1.13-1.36)
Readmission	8.4 (7.0-10.2)	7.1 (6.0-8.4)	1.05 (1.01-1.10)	19.6 (16.7-23.1)	15.5 (12.6-19.1)	1.04 (0.98-1.10)
Complications	6.1 (4.2-8.9)	6.0 (4.0-9.0)	1.09 (1.03-1.16)	7.4 (5.4-10.1)	7.0 (4.9-10.0)	1.09 (1.03-1.14)

[a] Adjusted odds ratio greater than 1 indicates a higher likelihood of the event among patients treated by male surgeons.

[b] Using generalized estimating equation (GEE) modeling dealing with clustering based on procedure fee code (Poisson distribution with log link), adjusted for surgeon age (using the median age), surgeon annual case volume (using third quartile), surgeon years of practice (using the median value), anesthesiologist age (using the median age), anesthesiologist annual case volume (using third quartile), anesthesiologist years of practice (using the median value), patient age (using the median age), patient comorbidity (using aggregate disease groups 8-10), rurality (using urban), income quintile (using third quintile), and hospital status (using academic).

[c] Using GEE modeling dealing with clustering based on procedure fee code (logistic regression with binomial distribution and logit link), adjusted for surgeon age (continuous), surgeon annual case volume (quartiles), surgeon specialty, surgeon years of practice (continuous), anesthesiologist age (continuous), anesthesiologist sex, anesthesiologist annual case volume (quartiles), anesthesiologist years of practice (continuous), patient age (continuous), patient sex, patient comorbidity (categorical), rurality (rural vs urban), income quintile (quintiles), local health integration network, hospital status (academic vs community), and index year.

dress challenges within the profession and these additional efforts may translate to patient outcomes.

There are notable patient- and surgeon-level differences between patients treated by female and male surgeons. Many of these relate to the unequal distribution of women in the surgical workforce, however, other differences may relate to differences in the way that female and male surgeons practice, implicating them along the causal pathway rather than as confounders.

A previous study[1] noted the association between surgeon sex and short-term patient outcomes is not equally distributed between male and female patients: while male patients have better outcomes when treated by female surgeons, this outcome is significantly larger for female patients. Subgroup comparisons in this analysis suggest differences between male and female patients, with the lower rates of adverse outcomes associated with female surgeons seen most among female patients. However, further exploration of these dyadic outcomes will require specific dedicated study.

It is, however, clearly not feasible for all women requiring surgery to be treated by female surgeons. Thus, these data emphasize the importance of better understanding the underlying differences in surgical practice for male and female surgeons. In addition to potentially allowing improvements in surgical care delivery by both male and female surgeons, these insights may have wider implications for general medical care. However, in the meantime, these data support the importance of ongoing diversification of the surgical workforce and particularly retention efforts to support women in surgery. While specific data from surgery are not available, some work has shown that female physicians are substantially more likely to work part time (and to be considering moving to part time despite currently working full time) than male physicians[22] for a multitude of reasons including inflexibility to accommodate familial obligations.

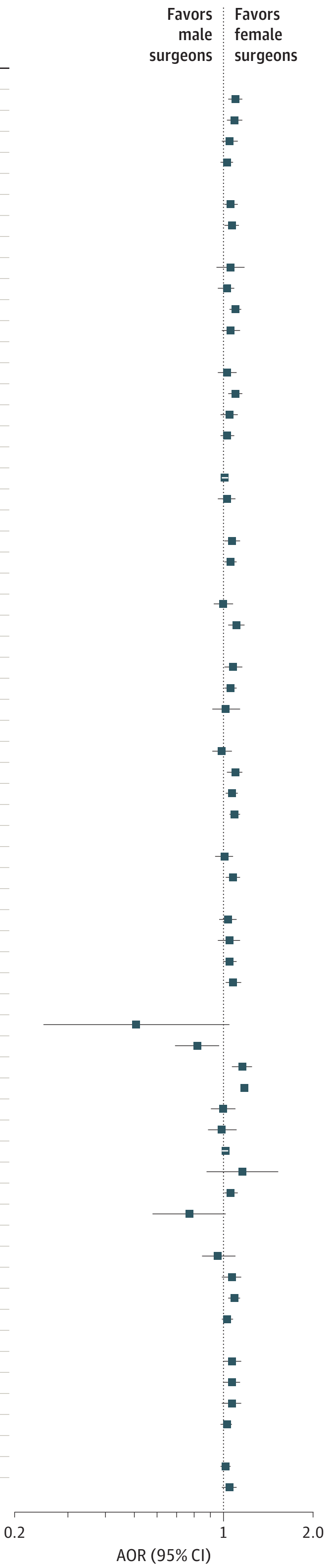
Strengths and Limitations

This study has important strengths that bolster both its external and internal validity. First, by using a large population-based data set in a universal health care system and including elective and emergent procedures across all surgical subspecialties, we were able to provide highly generalizable results. Second, the data sets used provide comprehensive identification of readmissions or complications anywhere in the province, whether at the initial hospital where the patient underwent surgery or elsewhere. This is particularly important for the assessment of longer-term outcomes as, over time, patients are increasingly likely to seek care at institutions other than the one in which they underwent their initial surgery.

There are inevitable limitations due to this study's observational design. First, with the observational method, there is the potential for residual confounding. However, we used generalized estimating equations with clustering according to the specific procedure performed to allow comparisons between patients undergoing the same procedures by male or female surgeons. Beyond this, we used robust case-mix adjustment accounting for patient factors including age, sex, geographic location, socioeconomic status, rurality, and general comorbidity as well as important surgeon, anesthesiologist, procedure, and hospital characteristics. Second, due to the administrative data sets used, we captured binary biologic sex and are unable to assess either patient or surgeon gender, a characteristic that may be more meaningfully associated with interpersonal interactions. Additionally, we could not capture race and ethnicity, professional hierarchy, experience, disability, fellowship training, or other potentially important aspects of identity. Third, we were unable to assess case complexity, although as mentioned previously, we clustered based on the specific surgery performed (according to billing codes). Fourth, we accounted for anesthesiologists in the analysis but could not account for other team members (including residents and nurses) who may have made important contributions to the patients' outcomes but were not captured by administrative health care data sets. Our subgroup analyses showed that the AORs between surgeon sex and outcomes were lower in academic teaching hospitals, suggesting that either differences in the practice environment or contributions of other team members, including residents, may mitigate the role of surgeon sex. Fifth, the use of administrative data sets precluded us from examining issues relating to unconscious bias and communication styles.

Figure 2. Subgroup Analysis Assessing the Association Between Surgeon Sex and Composited Adverse Postoperative Outcomes

	AOR (95% CI)	*P* value
Anesthesiologist age, y		
>61	1.10 (1.04-1.16)	.09
51-60	1.09 (1.03-1.16)	
41-50	1.05 (0.99-1.12)	
≤40	1.03 (0.98-1.08)	
Anesthesiologist sex		
Male	1.06 (1.01-1.12)	.39
Female	1.07 (1.01-1.13)	
Anesthesiologist volume		
Fourth quartile	1.06 (0.95-1.18)	.22
Third quartile	1.03 (0.96-1.09)	
Second quartile	1.10 (1.05-1.15)	
First quartile	1.06 (0.99-1.14)	
Anesthesiologist time in practice, y		
>5 to ≤10	1.03 (0.96-1.11)	.09
>15	1.10 (1.04-1.16)	
>10 to ≤15	1.05 (0.98-1.12)	
≤5	1.03 (0.98-1.09)	
Case complexity		
Low	1.01 (0.99-1.04)	.13
High	1.03 (0.96-1.10)	
Era of year of surgery		
2013-2019	1.07 (1.01-1.14)	.12
2007-2012	1.06 (1.01-1.11)	
Hospital status		
Teaching	1.00 (0.93-1.08)	.01
Community	1.11 (1.04-1.18)	
Patient age, y		
>65	1.08 (1.01-1.16)	.47
36-64	1.06 (1.01-1.11)	
18-35	1.02 (0.92-1.14)	
Patient comorbidity		
ADG: 8-10	0.99 (0.92-1.07)	.38
ADG: 6-7	1.10 (1.03-1.16)	
ADG: 0-5	1.07 (1.02-1.12)	
ADG: ≥11	1.09 (1.05-1.14)	
Patient sex		
Male	1.01 (0.94-1.08)	.01
Female	1.08 (1.02-1.14)	
Surgeon age, y		
>61	1.04 (0.97-1.11)	.78
51-60	1.05 (0.96-1.14)	
41-50	1.05 (1.00-1.11)	
≤40	1.08 (1.02-1.15)	
Surgeon specialty		
Vascular surgery	0.51 (0.25-1.05)	.22
Urology	0.82 (0.69-0.97)	
Thoracic surgery	1.16 (1.07-1.25)	
Plastic surgery	1.18 (1.18-1.18)	
Otolaryngology	1.00 (0.91-1.10)	
Orthopedic surgery	0.99 (0.89-1.11)	
Obstetrics and gynecology	1.02 (0.99-1.04)	
Neurosurgery	1.16 (0.88-1.53)	
General surgery	1.06 (1.01-1.12)	
Cardiothoracic surgery	0.77 (0.58-1.02)	
Surgeon volume		
Fourth quartile	0.96 (0.85-1.10)	.19
Third quartile	1.07 (0.99-1.15)	
Second quartile	1.09 (1.04-1.14)	
First quartile	1.03 (0.99-1.08)	
Surgeon time in practice, y		
>5 to ≤10	1.07 (1.00-1.15)	.99
>15	1.07 (1.00-1.14)	
>10 to ≤15	1.07 (0.99-1.15)	
≤5	1.03 (0.98-1.07)	
Surgical procedure type		
Emergent	1.02 (0.98-1.06)	.04
Elective	1.05 (0.99-1.11)	



ADG indicates aggregate disease group; AOR, adjusted odds ratio.

Conclusions

In this large population-based cohort study, patients treated by female surgeons had significantly lower long-term (90-day and 1-year) rates of adverse postoperative outcomes than those treated by male surgeons. These data add to the growing literature showing that patients cared for by female physicians (including surgeons) appear to fare better than those being cared for by male physicians. Despite these data, women continue to be marginalized in the workplace in many ways. To provide the best patient care, organizations should support women physicians and learn how they accomplish these improved outcomes.

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