The American Journal of Surgery 220 (2020) 69–75

Contents lists available at ScienceDirect

The American Journal of Surgery

journal homepage: www.americanjournalofsurgery.com

Practice patterns and work environments that influence gender inequality among academic surgeons

Biqi Zhang [a], Maggie L. Westfal [b, c], Cornelia L. Griggs [d], Ya-Ching Hung [e], David C. Chang [b], Cassandra M. Kelleher [b, c, *]

[a] Department of Surgery, Brigham and Women's Hospital/Harvard Medical School, 75 Francis Street, Boston, MA, 02115, USA
[b] Department of Surgery, Massachusetts General Hospital/Harvard Medical School, 165 Cambridge Street, Suite 403, Boston, MA, USA
[c] Department of Pediatric Surgery, Massachusetts General Hospital for Children, 55 Fruit Street, Boston, MA, USA
[d] Department of Pediatric Surgery, Columbia University College of Physicians & Surgeons, New York, NY, USA
[e] Department of Surgery, Sinai Hospital of Baltimore, Baltimore, MD, 21215, USA

ARTICLE INFO

Article history:
Received 19 August 2019
Received in revised form
5 October 2019
Accepted 13 October 2019

Keywords:
Gender disparity
Pediatric surgery
Practice patterns

ABSTRACT

Background: Practice pattern and work environment differences may impact career advancement opportunities and contribute to the gender gap within highly competitive surgical specialties.
Methods: Using a 2000–2015 New York statewide dataset, we compared board-certified pediatric surgeons by specialist case volume and Herfindahl-Hirschman Index (HHI), which quantifies surgeon focus within specialist case mix.
Results: 51 pediatric surgeons were analyzed for 461 surgeon-years. Female surgeons had lower case volume (159 cases/year versus 214, $p < 0.01$), lower shares of specialist cases (14.1% versus 16.7%, $p = 0.04$), and less focused practices (HHI 0.16 versus 0.20, $p = 0.03$). Female surgeons' networks had fewer colleagues (7.2 versus 12.1, $p < 0.01$), and lower annual total (388 versus 726, $p < 0.01$) and specialist case volume (83 versus 159, $p < 0.01$), even after accounting for career length. However, female surgeons performed more cases within their networks (49% versus 36%, $p = 0.04$) and worked at major teaching hospitals as often as men (76% versus 76%, $p = 0.97$).
Conclusion: The challenges that female surgeons face may be reflective of organizational inequities that necessitate intentional scrutiny and change.

Introduction

Despite a narrowing gap in the number of men and women working in health professions,[1,2] women remain underrepresented in the upper echelons of academic practice and receive lower salaries in equal posts.[1,3–5] For example, while 40% of all full-time clinical faculty in 2015 were women, only 22% of full professors and 16% of department chairs were women.[1] In academic surgery, while 37% of all full-time faculty were women, only 20% of full professors and 3% of department chairs—ten surgery chairs—were women.[1] With respect to pay, female surgeons have been found to earn less than male surgeons even after adjusting for age, "caliber" of medical school, years since completion of residency training, faculty rank, specialty, National Institutes of Health funding, clinical trial participation, and publication count.[3,6,7] Although likely multifactorial in etiology, this advancement gap may be a result of inequalities in aspects of physicians' practice environments that facilitate referrals for expertise-building work, such as complex cases, or that influence renown.

The goal of this study was to identify modifiable factors that directly contribute to a physician's promotional eligibility and compare these factors by surgeon gender. Variables that impact career advancement were identified based on promotion criteria used by leading US academic medical centers.[8–10] We used easily identified, objective, and reproducible data. We specifically analyzed attributes of a physician's clinical practice and aspects of a physician's organizational network[8–10] to test the hypothesis that relative to their male counterparts, female physicians work in smaller clinical networks and have clinical practices with less expertise-building work.

* Corresponding author. Pediatric Surgical Services, Massachusetts General Hospital for Children Boston, MA, 02114-2696, USA.
E-mail address: ckelleher3@partners.org (C.M. Kelleher).

https://doi.org/10.1016/j.amjsurg.2019.10.029

Methods

Study population

As the measures and methods used in this study are new, we chose to conduct a feasibility study using a subset of surgeons. We focused on pediatric surgeons, a group of specialized surgeons whose scope of practice includes both general surgery and specialist cases. All data were derived from the 2000–2015 New York (NY) Statewide Planning and Research Cooperative System (SPARCS) dataset. In brief, SPARCS is an all-payer reporting system that catalogues detailed information on all inpatient and outpatient care encounters occurring at hospitals throughout NY state. SPARCS is one of the few US data registries that contains physician identifiers and therefore enables analysis of individual surgeons and their practice patterns. Physician identification numbers maintained in SPARCS were matched to physician names in the NY Physician License database. A list of pediatric surgeons was then compiled by querying the American Pediatric Surgical Association membership directory. Pediatric surgery board certification dates were verified using the American Board of Surgery Online Verification website. Data were analyzed for each surgeon, for each year they practiced in the state of NY. Therefore, the data are displayed as average volume per surgeon per year, rather than the group's average yearly, per surgeon. This allowed for analysis of surgeons who crossed from early to late career, or who had years in practice when their volume was affected by leave or other commitments, to be retained in the analysis for all other years and mitigated bias due to these circumstances. When a surgeon's total case volume was less than the 10th percentile (n = 20 cases/year), that year was excluded from the analysis, as low case volume likely represents incomplete capture of a surgeon's caseload by the NY SPARCS dataset (e.g. a surgeon who practices in both NY and New Jersey).

Surgeon specialization

Our primary endpoints were measures of surgeon specialization, which are considered indicators of a surgeon's specialist expertise, an important aspect of career advancement.[11,12] We compared two measures of surgeon specialization: percent pediatric specific cases (% peds) and a surgeon's Herfindahl Hirschman Index (HHI).

The % peds measurement represents how often a pediatric surgeon performs a case that requires skills acquired during their pediatric surgery specialist training. It was calculated by dividing the volume of pediatric surgery "specialist" cases performed by total case volume (% peds) per year for each individual surgeon. Non-operative services such as radiologic studies and consultations were excluded from total case volume. Specialist cases were defined using the Accreditation Council for Graduate Medical Education (ACGME) list of case types that should be completed by all pediatric surgery fellows prior to graduation (i.e., aortopexy, tracheoesophageal fistula repair, Heller myotomy; Supplementary Data Table 1); the listed cases are those focused in infancy, childhood, and patients with "special health needs arising from congenital and acquired pediatric surgical conditions" in which board-certified pediatric surgeons should be competent.[13] We excluded appendectomy, ovarian and fallopian tube operations (e.g., ovarian torsion), and non-operative management of multisystem trauma from designation as specialist cases. We intended for the focus of this study to be on modifiable aspects of a surgeon's case load, therefore these cases were excluded because they are non-elective and may be divided with other specialists differently between hospitals. All remaining cases were classified as non-specialist cases. International Classification of Disease, Ninth Edition procedure (ICD9p) codes were matched to these lists of specialist and non-specialist cases (Supplementary Data Table 2). Of note, patient age parameters were not used in case designation because some pediatric surgeons care for older patients with special needs arising from pediatric surgical conditions; doing so demonstrates specialist expertise, and to exclude these cases might minimize measures of surgeon specialization.

HHI represents a pediatric surgeon's degree of focus within their specialist case mix beyond what is captured by % peds. HHI is a measure widely used in economics to assess market concentration.[14] Its application to measuring surgeon specialization is modeled by Hall et al.[12] An HHI close to 1 indicates a surgeon who performs a small variety of specialist cases and therefore has a narrowly focused practice; this surgeon is someone who would be considered an expert in those specific disease processes and case types. An HHI closer to 0 indicates a surgeon who performs a large variety of specialist cases, has a less focused practice, and is therefore less likely to be an expert in any specific disease process or case type. HHI is calculated by summing the squares of each fraction of a surgeon's caseload that is accounted for by a particular specialist procedure. For example, the HHI of a surgeon who performs a total of 6 pediatric surgery specialist cases, comprising 1 aortopexy, 2 pyloromyotomies, and 3 splenectomies, would be 0.389:

$$= \left(\frac{1\ aortopexy}{6}\right)^2 + \left(\frac{2\ pyloromyotomies}{6}\right)^2 + \left(\frac{3\ splenectomies}{6}\right)^2$$

$$= 0.389$$

For analyses of HHI, when a surgeon's specialist caseload was less than the 10th percentile (n = 8 specialist cases/year), that year was excluded, because HHI calculations using low case volumes is mathematically imprecise and introduces extreme values into the analyses.

Practice environment

Additional study endpoints were characteristics of a surgeon's network. Many surgeons in the US operate at more than one hospital, and which hospitals any particular surgeon operates at may change from year to year. Surgeon network was therefore defined yearly and for each pediatric surgeon as the group of all pediatric surgeon colleagues who operated at the same hospitals (Fig. 1). We examined five distinct measures of practice environment: 1) number of pediatric surgeon colleagues in the network 2) total network case volume 3) network specialist case volume 4) proportion of total network case volume performed by an individual surgeon 5) whether a surgeon performed the majority of their cases at a major teaching hospital. As in prior studies, major teaching hospital was defined as belonging to the Council of Teaching Hospitals of the Association of American Medical Colleges (Supplementary Data 3).[15,16]

Statistical analysis

To compare surgeons who have been in pediatric surgery practice for similar lengths of time, we characterized surgeons as either early (<10 years) or late career (≥10 years) based on time since initial pediatric surgery board certification. Subset analyses by career length were performed also to elucidate how career length may impact surgeons' practice patterns and practice environments independent of surgeon gender. Ten years was selected

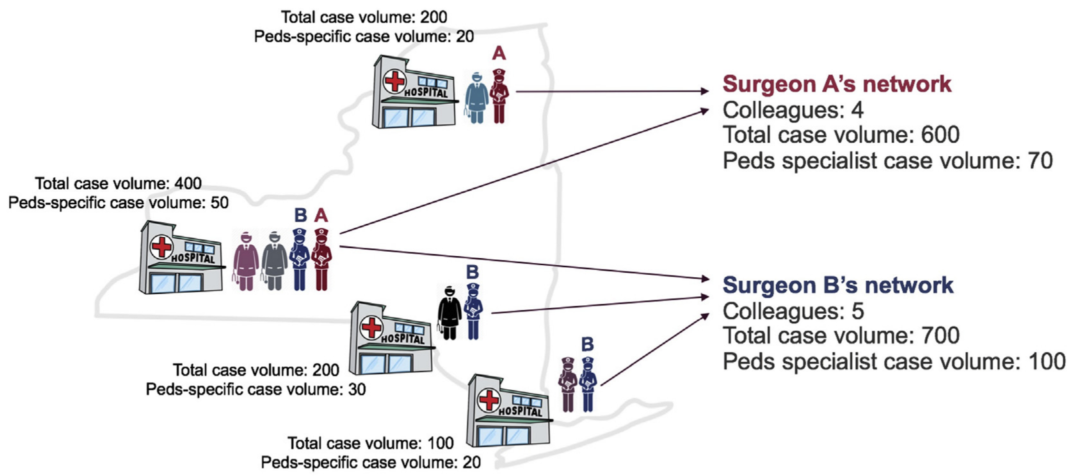

Fig. 1. Practice environment measures were calculated yearly and based on surgeon network, which was also defined yearly and for each pediatric surgeon as the group of all pediatric surgeon colleagues who operated at the same hospitals. Depicted are practice environment measures for two example surgeons A and B. Abbreviation: peds – pediatric surgery.

as the cut-off since promotion from assistant to full professor at a typical US academic department of surgery has been cited to occur after 10–14 years.[17]

Comparisons of surgeon specialization and practice environment as continuous variables were made using the Student t-test. Significance level was set at alpha ≤0.05. All statistical analyses were performed using STATA 13/IC (StataCorp, College Station, TX).

Results

Fifty-one surgeons were analyzed (10 female, 19.6%) for a total of 461 surgeon-years (64 female, 14.0%), and 94,979 cases (10,151 female, 10.7%). Mean career length was 12.5 years and 17.7 years for female and male surgeons, respectively (p = 0.19) (Table 1). On average, surgeon case volume was 206 ± 7 cases/year and contained 16.4 ± 1.0% pediatric surgery specialist cases (% peds).

Overall, female surgeons' case volumes were lower (159 ± 14 versus 214 ± 8 cases/year, p < 0.01) and contained a lower percentage of specialist cases (14.1 ± 1.0 versus 16.7 ± 0.5% peds, p = 0.04). These differences were pronounced among early career surgeons (female 168 ± 24 versus male 257 ± 14 cases/year, p = 0.01; female 14.7 ± 1.6 versus male 18.3 ± 0.7% peds, p = 0.04) but did not reach statistical significance among late career surgeons (female 153 ± 16 versus male 193 ± 9 cases/year, p = 0.12; female 13.8 ± 1.2 versus male 16.0 ± 0.6% peds, p = 0.18). Female surgeons' practices were also less focused within pediatric surgery specialist cases (HHI 0.16 ± 0.02 versus 0.20 ± 0.01, p = 0.03) (Fig. 2). These differences trended in the same direction after accounting for career length but did not achieve statistical significance, likely due to limitations in sample size (early career female HHI 0.14 ± 0.02 versus male 0.18 ± 0.01, p = 0.10; late career female HHI 0.18 ± 0.02 versus male 0.22 ± 0.01, p = 0.13). Notably, female surgeons did not experience significant change in HHI throughout their careers (+0.001 HHI/year, p = 0.81) while male surgeons exhibited increasing HHI over time (+0.002 HHI/year, p < 0.01) (Fig. 2).

At the network level, female surgeons practiced in smaller networks with significantly fewer surgeon colleagues (7.2 ± 0.7 versus 12.0 ± 0.5, p < 0.01), even after accounting for career length (early career female 8.4 ± 1.3 versus male 15.5 ± 0.8 colleagues, p < 0.01; late career female 6.6 ± 0.8 versus male 10.4 ± 0.6 colleagues, p < 0.01) (Fig. 3). Female surgeons' networks also had lower total case volume (388 ± 38 versus 726 ± 29 cases/year, p < 0.01) and lower specialist case volume (62 ± 8 versus 133 ± 6 specialist cases/year, p < 0.01). These trends persisted in early career (458 ± 75 versus 906 ± 49 total cases/year, p < 0.01; 69 ± 12 specialist cases/year versus 173 ± 11, p < 0.01) and late career (349 ± 41 versus 642 ± 34 total cases/year, p = 0.01; 59 ± 11 versus 114 ± 7 specialist cases/year, p = 0.05) (Fig. 3).

Upon comparing practice patterns for surgeons within their own networks, we found that female surgeons performed, on average, a greater percentage of their network's total case volumes early in their careers (48.8 ± 5.8% versus 36.2 ± 2.3%, p = 0.04) (Fig. 4). To elaborate, in networks where early career female surgeons operated, they performed 48.8% of all cases, while their network colleagues—either male or female—performed the remaining cases. In networks where early career male surgeons operated, they performed 36.2% of the network's case volume. Further, early career female surgeons performed a greater share of their networks' non-specialist caseloads than their male peers (48.6 + 5.8% versus early career male surgeons 36.2 + 2.3%, p = 0.04). These associations trended in the same direction among late career surgeons but did not reach statistical significance (50.8 + 4.8% network non-specialist caseload versus male surgeons 45.7 + 2.1%, p = 0.37).

Finally, the percentage of female surgeons who worked at major teaching hospitals was not different from that of the male cohort (76% and 76%, p = 0.97). After stratifying by career length, a greater proportion of early career female than male surgeons practiced at major teaching hospitals (100% versus 92%, p < 0.01); the inverse was seen among late career surgeons, although the association did not reach statistical significance (60% versus 71%, p = 0.10).

Table 1
Demographic distribution of board-certified pediatric surgeons in New York.

	Total	Female	Male	p-value
No. surgeons n (%)	51	10 (19.6%)	41 (80.4%)	n/a
Length of career mean ± SD	16.7 ± 1.6	12.5 ± 2.4	17.7 ± 1.8	0.19
Annual case volume mean ± SD	206 ± 7.2	159 ± 13.6	214 ± 7.6	**<0.01***

*Student t-test, p < 0.05.
Abbreviation: SD – standard deviation, n/a – not available.

Discussion

Our study complements the descriptive studies on gender

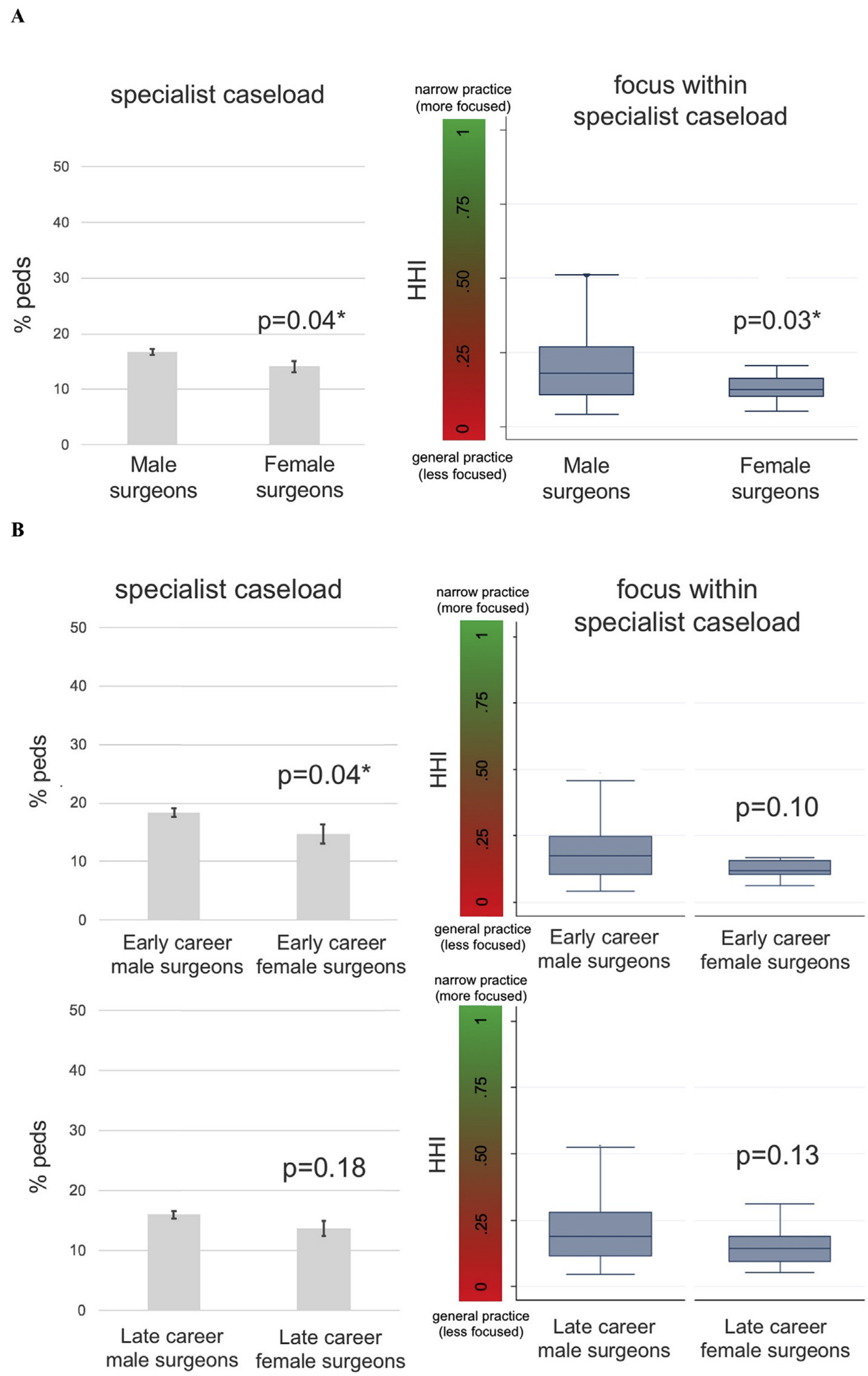

Fig. 2. Practice pattern differences by surgeon gender as measured by percent of annual caseload comprised of expertise-building, pediatric surgery specialist cases and, within the subset of these specialist cases, case mix focus as quantified by HHI for **A**) all surgeons and **B**) surgeons stratified by career length. *Student t-test, $p < 0.05$.

inequality in the current literature by using objective and reproducible data to evaluate modifiable factors affecting career trajectory in the academic workplace. We found that despite achieving the same levels of specialized training and performing a greater share of all available work, female pediatric surgeons have less specialized and less focused practices than their male peers. Further, despite working in the primary teaching hospitals of academic institutions in equal proportion, female pediatric surgeons operate in smaller networks with fewer available expertise-building cases. Collectively, the data suggest that unequal access to expertise-building work and large physician networks may be associated with the career advancement gap.

Little attention has been paid to aspects of the surgery workplace and the modifiable organizational factors that may be associated with disparity. Our study suggests that the particular network of hospitals in which a surgeon operates may affect their

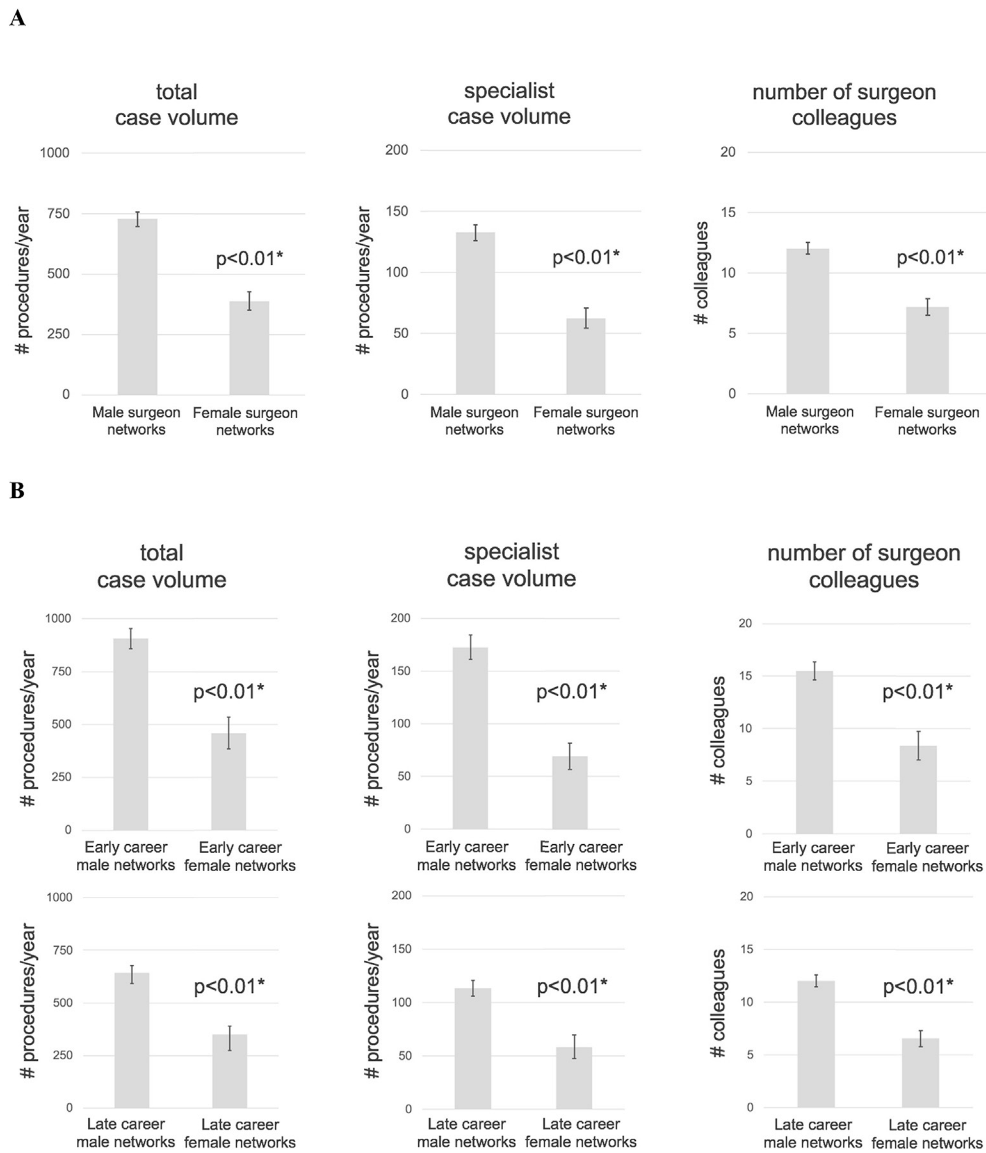

Fig. 3. Practice environment differences by surgeon gender as measured by total network case volume, network pediatric surgery-specific case volume, and number of surgeon colleagues for **A**) all surgeons **B**) surgeons stratified by career length. *Student t-test, $p < 0.05$.

case volume and case mix. Visibility to surgical colleagues, referring physicians, and the medical community may be diminished for surgeons who work in smaller networks. The measurable differences in workplace attributes by gender (i.e., network specialist case volume, number of surgeon colleagues) are evident within and across networks and may thereby contradict the dogma that surgeons' practices can be built solely by fostering relationships with surgeon colleagues, primary care physicians, and medical specialists in the local community. It is very likely that a physician's skillset and achievements are a result of more than their individual efforts. This is further underscored by our data revealing that female pediatric surgeons work at major teaching hospitals in equal proportion to their male pediatric surgeon peers and that female pediatric surgeons perform an equal share of all available work. In fact, early career female pediatric surgeons perform substantially more cases than their early career male counterparts. Rather than comparing the efforts or prowess of individuals, it may be prudent to investigate those modifiable external workplace influences that may sustain inequity in surgery.

Consistent with recent literature about the narrowing gender gap, we found that male and female pediatric surgeons work in academic environments in equal measure (74% versus 72%, respectively). Given that the majority of pediatric surgeons in the US work in academic tertiary care centers, this finding may not be surprising. Despite the finding, however, female pediatric surgeons in our cohort have caseloads that are much less specialized and focused within pediatric surgery. Given the payment contracts and promotion criteria most widely used in surgery, our study conclusions may explain why gaps in rank and pay have persisted. Firstly, promotion criteria for many major academic centers focus on regional, national, and international renown.[8–10] Renown is assessed by the number of research publications and invited lectureships that a surgeon accrues, which are often based upon a surgeon being an expert in a specific area of their field secondary to performing more specialist cases and seeing more patients with specialist needs. Surgeons whose caseloads are less specialized are at an inherent disadvantage when it comes to having specialist expertise and thus advancing professionally. Secondly,

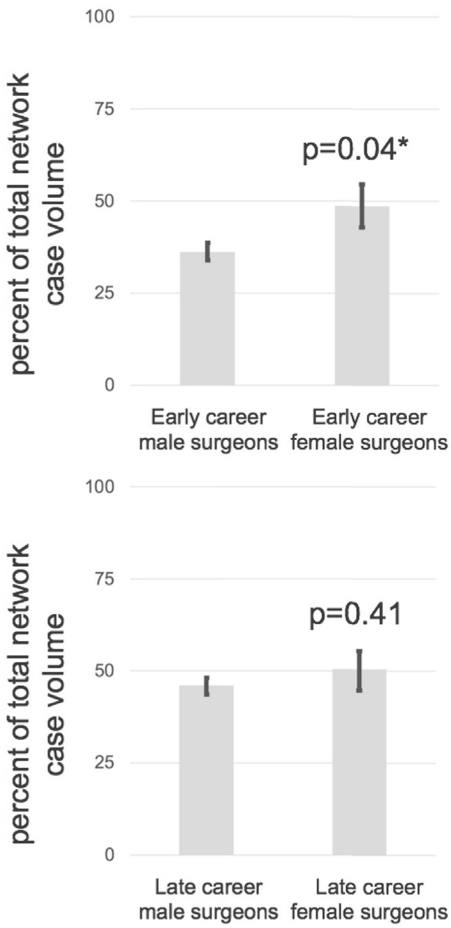

Fig. 4. Proportion of total network case volume performed by male versus female surgeons after stratification by career length. In networks where early career female surgeons operated, they performed 48.8% of all cases, while their network colleagues—either male or female—performed the remaining cases. In networks where early career male surgeons operated, they performed 36.2% of the network's case volume. *Student t-test, $p < 0.05$.

reimbursement is higher for specialist cases. Since female surgeons' caseloads have fewer specialist cases, it is not surprising that female surgeons have lower compensation even after accounting for years in practice.

Our study has several important implications. Numerous interventions at the system-level may mitigate gender disparities in surgery career advancement. Specialization differences between male and female surgeons may reflect unequal referral patterns for subspecialty cases. A centralized referral system may help equalize the distribution of expertise-building cases. In addition to redistributing expertise-building cases, academic medical centers might consider revising promotion criteria to value the greater volume of generalist procedures that female surgeons have disproportionally taken on well as expertise and academic renown. These generalist cases contribute significant financial value to hospital systems at-large, and academic promotion criteria could better recognize these "citizenship" contributions.

Systemic remedies may be complemented by sponsorship initiatives at the level of individual physicians. Sponsorship occurs when a powerful person uses their professional clout to lift up lesser known talent by giving them high-visibility, high-profile work. The practice of sponsorship has been studied extensively in the corporate world where ceiling effects felt by accomplished businesswomen parallel the career advancement challenges faced by female surgeons.[18,19] Businesses that have adopted sponsorship programs in addition to traditional mentorship efforts have seen significant progress in accelerating deserving women up their corporate ladders.[20] In surgery, established surgeons should be encouraged to share and transfer new patient cases to their junior colleagues without regard to surgeon gender. Faculty recruitment and hiring processes, which are also critical inflection points in surgeons' careers, should be encouraged to consider the need for female surgeons to be granted opportunities to join larger provider networks as often as their male counterparts.

Our study conclusions are to be taken in the context of their limitations as well as with the understanding that the metrics used here are new. Methods used to describe surgeon practice patterns and work environments are novel, including the designation of specialist cases (Supplementary Data Table 1) and the definition of surgeon network. The study of NY pediatric surgeons may not be generalizable to other physician populations; for instance, NY state is arguably an oversupplied market given that it contains New York City, where it may be difficult for early career surgeons to join larger provider networks. While it would be useful to study a larger population of pediatric surgeons, such arguments should be carefully considered; market oversaturation would be expected to impact both genders equally, which our data refute (see Fig. 3B). Unfortunately, very few population datasets capture physician identifiers that enable detailed analysis of clinician level practice patterns and work environments. Given the results of this feasibility study, however, investigation of providers in other geographic settings as well as in other medical and surgical specialties may offer complementary insight. Data on the latter cohorts would be particularly useful since most US pediatric surgeons work in academic tertiary care centers, rendering our study biased towards academic provider populations. Lastly, our study was inherently limited by the data available in SPARCS. We had no data on leaves of absence such maternity and paternity leave, military deployments, or medical absences which may have affected specific years of a surgeon's practice. We also had no data to determine which surgeons were full-time equivalent employees (i.e., 100% clinical effort); as a result, it was not possible to adjust for the effects of extra-clinical commitments such as research obligations or pursuit of additional education on surgeons' practice patterns that may render some surgeons less than 100% clinical in professional obligation. By analyzing the data for each surgeon by year rather than by group averages, we were able to mitigate some, but certainly not all, of these confounding factors.

Conclusion

Gender disparity in academic promotion and salary is well documented in medicine and surgery. While a growing body of literature has successfully described the imbalance in numbers, our study evaluates objective, reproducible, and modifiable aspects of the academic workplace to uncover where actionable change may be effective. We reveal substantial differences in clinical practice patterns and practice environment between male and female physicians that may underlie the career advancement gap in a highly competitive surgical subspecialty. Given our findings, leadership may have an opportunity to combat gender disparity by ensuring equal sponsorship for female and male physicians to join larger practices and take on expertise-building opportunities; revisiting referral patterns; and revising criteria for academic promotion to recognize generalists and specialists equally.

Declaration of competing interestCOI

The authors have no conflicts of interests to declare.

Funding sources

This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.amjsurg.2019.10.029.

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