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Disparities in the Operative Experience Between Female and Male General Surgery Residents:

A Multi-institutional Study From the US ROPE Consortium

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Abstract

Objective: To examine differences in resident operative experience between male and female general surgery residents.

Background: Despite increasing female representation in surgery, sex and gender disparities in residency experience continue to exist. The operative volume of male and female general surgery residents has not been compared on a multi-institutional level.

Methods: Demographic characteristics and case logs were obtained for categorical general surgery graduates between 2010 and 2020 from the US Resident OPerative Experience Consortium database. Univariable, multivariable, and linear regression analyses were performed to compare differences in operative experience between male and female residents.

Results: There were 1343 graduates from 20 Accreditation Council for Graduate Medical Education-accredited programs, and 476 (35%) were females. There were no differences in age, race/ethnicity, or proportion pursuing fellowship between groups. Female graduates were less likely to be high-volume residents (27% vs 36%, $P < 0.01$). On univariable analysis, female graduates performed fewer total cases than male graduates (1140 vs 1177, $P < 0.01$), largely due to a diminished surgeon junior experience (829 vs 863, $P < 0.01$). On adjusted multivariable analysis, female sex was negatively associated with being a high-volume resident (OR = 0.74, 95% CI: 0.56 to 0.98, $P = 0.03$). Over the 11-year study period, the annual total number of cases increased significantly for both groups, but female graduates (+16 cases/year) outpaced male graduates (+13 cases/year, $P = 0.02$).

Conclusions: Female general surgery graduates performed significantly fewer cases than male graduates. Reassuringly, this gap in operative experience may be narrowing. Further interventions are warranted to promote equitable training opportunities that support and engage female residents.

Keywords

case logs; operative experience; residency training; sex disparities

An increasing number of women have entered general surgery over the past 2 decades. In 2000, 14% of surgical residents were females, and this tripled to 45% by 2020.[1] At the same time, the proportion of female practicing general surgeons in the United States increased from 5% in 1997 to 19% in 2017.[2] Despite this improvement in representation, sex and gender disparities in the experiences of female surgeons remain.[3] Several studies demonstrate that female surgical residents lack equal training experiences, including receiving less autonomy in the operating room, poorer quality evaluations, and less academic recognition compared with male residents.[4–6] Unfortunately, these disparities persist into practice and impact professional development and early career advancement, as female surgeons receive fewer operative referrals and hold fewer leadership positions in surgical societies.[7–9]

Operative experience is a key component of surgical training. However, limited work exists comparing the operative volume of female versus male general surgery residents. A recent single-center study suggests that male and female residents graduate with differences in case volume.[10] However, larger-scale studies have not been performed; this is mostly due to the lack of individual and program-level information contained in case logs, which have been utilized in previous analyses of resident operative experience.[11,12] The US Resident OPerative Experience (ROPE) Consortium was established in 2021 to address these methodologic barriers and allow a more thorough examination of variability among general surgery resident training experiences. In this multi-institutional study, we evaluated disparities between female and male general surgery residents' operative experiences. We hypothesize that despite increased female representation in general surgery training, female residents graduate with fewer cases than male residents.

METHODS

Database Characteristics

Twenty Accreditation Council for Graduate Medical Education (ACGME)-accredited general surgery programs in the US ROPE Consortium were analyzed to explore the resident operative experience. Resident demographics, program characteristics, and case logs were submitted by each program for the graduating classes from 2010 through 2020. Male general surgery residents were compared with female general surgery residents using information reported to the US ROPE Consortium by each participating program. In addition, individual-level variables included age at the time of graduation, race/ethnicity (Asian, Black, Hispanic, White, and Other), graduation year, location of medical school [US graduate or international medical graduate (IMG)], completion of a dedicated research experience, and fellowship plans. Residents were categorized as low, medium, or high-volume residents based on the tertile of total case volume among all graduates. Program-level data included the program region (Midwest, Northeast, Southeast, Southwest, and West), program volume, program size, and National Institutes of Health (NIH) funding status. Program volume was

categorized into tertiles of low (< 1094 cases), medium (1095–1264 cases), or high (> 1265 cases) based on the program's average operative volume per graduate within the entire cohort. Although these thresholds are well above the ACGME case minimum requirement of 850 cases, this minimum was established for program accreditation, not as a standard of competency. The purpose of stratifying programs by volume in this study was not to make any inferences about competency but rather to control for hospital volume and cases available to residents. Program size was defined by the distribution of the program's average yearly graduates, categorized as small (< 5 average graduates per year), medium (5–6 average graduates per year), or large (≥ 7 average graduates per year). NIH funding status for each program was obtained from the Research Portfolio Online Reporting Tool (RePORT), which provides a list of NIH-funded surgery programs in the United States, and programs were categorized as being within the top 50, bottom 50, or none (nonfunded).[13]

Case Log Information

Residents at ACGME-accredited programs are required to self-report the number and types of cases they perform during residency as an indication of their operative experience. Each case is logged as "surgeon junior," "surgeon chief," and "teaching assistant" (TA), which are summed together to calculate a resident's "total cases." Cases are categorized into 12 operative domains (abdomen, alimentary tract, breast, endocrine, endoscopy, pediatrics, plastics, thoracic, transplant, trauma, skin and soft tissue, and vascular), with subdomains for the alimentary tract (esophagus, stomach, small intestine, large intestine, and anorectal) and abdomen (biliary, hernia, liver, pancreas, spleen, and general). The ACGME case log system also captures whether operations are open versus laparoscopic, but laparoscopic cases count toward their respective domain. Therefore, the reported "total laparoscopy" domain does not contribute toward total case counts.

Statistical Analyses

Continuous data are reported as the median and interquartile range (IQR) and analyzed using the Wilcoxon rank sum test. Categorical data are reported as total (n) and percentage (%) and analyzed using the $\chi 2$ test or Fischer exact tests for rare occurrences. Multivariable linear regression analyses were performed to compare operative volume (total, surgeon junior, surgeon chief, and TA) between male and female residents. A multivariable logistic regression analysis was also performed to determine whether resident sex was associated with being a high-volume graduate (defined as top-tertile for individual operative volume). All regression models were adjusted for an individual program, IMG status, completion of dedicated research, and pursuing a fellowship. A time-trend analysis was performed using 2 complementary analyses. First, a multivariable linear regression model was performed to evaluate operative volumes for male and female graduates with an interaction term for the graduation year. Second, the operative volume between female and male graduates was compared in the early (2010–2015) and late (2016–2020) periods. Statistical significance was set at $P<0.05$. Statistical analyses were performed using JMP Pro 16 (SAS institute). This study was approved by the University of Cincinnati Institutional Review Board (#2020–1197) and by each institution as required by the respective local Institutional Review Board.

RESULTS

Resident and Program Demographics

The US ROPE Consortium included 1343 general surgery residents who graduated from 20 programs between 2010 and 2020. There were 476 (35.4%) female residents and 867 (64.6%) male residents. Over the 11-year study period, the proportion of female general surgery graduates ranged from 27.1% in 2012 to 48.5% in 2019, but no statistically significant trend was found on linear regression (Supplemental Digital Content Fig. 1, http://links.lww.com/SLA/E482). There were no differences in age or race/ethnicity between male and female residents, although fewer IMGs were females (5.5% vs 13.4%, $P < 0.01$) (Table 1). More female residents completed dedicated research time (49.4% vs 41.0%, $P = 0.01$) during residency. Although the proportion of residents pursuing fellowship was not different between female and male residents (82.1% vs 80.5%, $P = 0.51$), there were differences in career choice between male and female residents ($P < 0.01$) (Supplemental Digital Content Fig. 2, http://links.lww.com/SLA/E483). For example, more male graduates pursued cardiothoracic (11.7% vs 5.5%) and vascular (12.6% vs 5.5%) fellowships, whereas more female graduates pursued breast fellowship (8.4% vs 0.6%).

Operative Experience Between Male and Female Residents

On univariable analysis, female residents logged fewer median total cases compared with male residents [1140 (IQR: 1044–1265) vs 1177 (1063–1320), $P < 0.01$], largely due to differences at the surgeon junior level [829 (745–935) vs 863 (766–974), $P < 0.01$]. There were no differences in the median number of surgeon chief cases [263 (223–301) vs 261 (229–302), $P = 0.56$] or TA cases [40 (28–57) vs 43 (29–61) $P = 0.06$] (Fig. 1). After adjustment by multivariable linear regression analysis, female residents graduated with fewer total, surgeon junior, and TA cases than male residents (Table 2). Furthermore, multivariable logistic regression demonstrated that females were less likely to be high-volume residents (OR = 0.74, 95% CI: 0.56 to 0.98, $P = 0.03$).

Comparing operative composition, female residents logged fewer abdomen cases [318 (276–371) vs 329 (278–386), $P = 0.06$], with a significant difference in the biliary subdomain [125 (95–158) vs 131 (99–168), $P = 0.03$] (Table 3). Female residents also performed fewer thoracic [32(23–48) vs 37, (25–55) $P < 0.01$], trauma [27 (18–40) vs 31 (20–47), $P = 0.01$], and vascular [102 (78–133) vs 113 (86–151), $P < 0.01$] cases compared with male residents. In contrast, female residents performed more breast [53 (42–71) vs 49 (39–64), $P < 0.01$] and anorectal cases [33 (25–44) vs 30 (22–41), $P < 0.01$] than male residents.

Operative Trends Over Time

On adjusted multivariable linear regression, female graduates were estimated to perform 12.8 fewer cases than male graduates in 2010 (95% CI: −21.5 to −4.2, $P < 0.01$) (Fig. 2A). Both female and male graduates performed increasing numbers of cases over the study period, but the rate of change for female graduates (+16 cases/year) was greater than that for male graduates (+13 cases/year, $P = 0.02$). A similar relationship was found for surgeon junior cases, with female graduates estimated to perform 11.6 fewer cases than male graduates in 2010 (95% CI: −19.4 to −4.0, $P < 0.01$) (Fig. 2B); female resident surgeon

junior cases increased more rapidly than male residents (+10 vs +8 cases/year), but the difference in the rates of change did not reach statistical significance ($P = 0.08$). There was no difference in the starting point for surgeon chief cases in 2010, and the annual increase in cases for female and male residents was not significant (+5.1 vs +4.2 case/year, $P = 0.11$) (Fig. 2C). Female graduates were estimated to perform fewer TA cases than male residents (−1.82 cases, 95% CI: −3.3 to −0.32, $P = 0.02$), but the differences in the rate of change were not significant ($P = 0.47$) (Fig. 2D).

Cohorts were compared in the early (2010–2015) and late periods (2016–2020). This demonstrated a significant difference in total cases between males and females during the early period (1135 [1027–1277] vs 1077 [991–1192], $P < 0.01$) but no difference no difference during the late period the late period [1218 (1110–1345) vs 1193 (1101–1311), $P = 0.18$] (Fig. 3).

DISCUSSION

The increasing number of publications on sex and gender disparities in residency education has brought awareness to these issues, but few studies have quantitatively examined differences in operative experiences between male and female residents. In this multi-institutional study from the US ROPE Consortium, we identified disparities in the operative experience between male and female general surgery graduates. Female residents graduated with significantly fewer total cases than male residents, and female sex was negatively associated with being a high-volume resident. Although operative case volumes increased for both groups during the study period, growth was more rapid for female residents, suggesting that the operative gap may be narrowing.

Sex disparities, and to a lesser degree, gender disparities, have been studied across multiple facets of general surgery training. One multi-institutional study found that female residents received less autonomy in the operating room compared with male residents.[14] Prior work also found that female residents report less access to mentorship and research experiences, which may have a large impact on career advancement opportunities.[15] A recent single-institution study revealed that female general surgery residents graduate with fewer chief and TA cases,[10] but to our knowledge, this is the first multi-institutional study to identify differences in the operative volumes of female versus male general surgery residents. Similar work related to this topic is otherwise limited to analyses among surgical subspecialty trainees. Gurgel et al[16] found that female otolaryngology residents logged fewer “key indicator” cases, operations deemed most important for independent practice. An analysis of case logs from ophthalmology residents at 24 US programs found that female residents performed significantly fewer cataract operations and total procedures. Despite the commonly held belief that parental obligations reduce training experiences for women, this study did not show an association between maternity leave and case volume disparity.[17] At the fellowship level, female colorectal surgery fellows also report a less robust robotic operative experience compared with male fellows.[18] These examples highlight that sex and gender disparities are pervasive across surgical specialties and not solely limited to one specialty or institution.

In this study, female graduates were 25% less likely to be high-volume surgical residents. Although the absolute difference in case volume between male and female general surgery residents is small and the educational impact can be debated, the presence of this phenomenon is noteworthy and warrants discussion. Historically, the operating room has not been a hospitable learning environment for women due to discrimination, sex and gender bias, and harassment.[19] Even among a contemporary cohort, 88% of female residents report being subject to microaggressions—covert insults or slights—, the majority of which originate from attending physicians.[20,21] Common microaggression themes include workplace exclusion and needing to justify choices related to work-life balance and family planning.[20] These findings reflect national survey data demonstrating that female general surgery trainees are more prone to social isolation, slurs, negative comments, discouragement from having families, and negative reactions to pregnancy and/or childcare needs.[19] In addition, female surgeons face difficulty in their relationships with ancillary staff due to the expectation for socialization and to remain likable, which requires them to develop “status-leveling behaviors” to assure cooperation in patient care tasks.[22] Although this conduct may build rapport, it is emotionally taxing and disproportionately demanding of the female surgeon’s time, which may hamper efficiency, interfere with operative learning, and impede educational development. In the current study, similar surgeon chief case volumes indicate that as residents take on more senior-level responsibilities, such as assigning cases and delegating patient care tasks, female chief residents may bypass some of these structural barriers.

Unfortunately, sex and gender disparities persist in surgical practice. Historic and contemporary analyses of the American Board of Surgery-certified practicing general surgeons show that female surgeons perform fewer cases than male surgeons.[2,23] A recent study out of Japan also uncovered disparities in operative volume between male and female surgeons.[24] Female surgeons are less likely to hold academic or leadership positions, and they receive fewer referrals than their male colleagues.[25] In addition, female surgeons perform fewer complex cases than their male counterparts, even after accounting for specialty, personal and professional obligations, and seniority, suggesting that referring providers may lack confidence in the abilities of female surgeons.[26] Although in the present study there was a negative association between female general surgery residents and operative volume, this does not suggest that women are under-prepared for practice. In fact, prior work demonstrates improved outcomes for female surgeons across an array of surgical specialties, citing lower 30-day mortality with similar outcomes for the length of stay, complications, and readmission compared with male surgeons.[27]

There were also several promising findings from this case log analysis. Differences in the operative experiences of male and female residents seem to dissipate by the final, and arguably most important, year of surgical training as indicated by the near equal surgeon chief and TA case volumes. In fact, on adjusted analysis, female residents performed more sugeon chief cases than male residents. Compared with male residents, a higher proportion of female residents completed dedicated research time, which may lay the foundation for future research, funding, and career advancement opportunities. The compositional analysis found that female residents outperformed male residents in breast and anorectal cases. This discrepancy could be driven by resident interest, such that those pursuing fellowship

"prespecialize" in their future specialty.[28,29] A recent study from Woeste et al demonstrated that residents who were matched to breast fellowship complete more breast cases than those doing non-breast fellowships.[29] In that study, 87% of breast fellowship matriculants were females, which may explain why female residents perform more breast cases than male residents. This same observation could explain why male residents perform a greater number of thoracic, trauma, and vascular cases, as a generally higher proportion of male residents enter these specialties.

Most encouragingly, the time-trend analyses within this multi-institutional study demonstrate that female trainees are outpacing male trainees in case volume, and that case volume differences subside among the more contemporary graduate cohort. Notwithstanding this progress, steps to provide more equitable training can be implemented at the program and institutional levels. This would include implicit bias training for faculty, which has been demonstrated to help surgical educators.[30] In addition, with a push toward entrustment as the new paradigm of surgical training, faculty must be intentional about entrusting female trainees with more operative autonomy.[31] It is promising that 2 recent publications found that entrustable professional activity evaluations may limit sex bias in resident evaluations.[32,33] Programs should also consider intentional case allocation and frequent audits of case logs to ensure equitable distribution and adequate time to correct deficiencies. For example, our time-trend analysis indicates that starting in 2015, there was a significant upswing in female resident surgeon junior cases, which coincides with when the ACGME implemented its new requirement for residents to complete at least 250 cases by the end of the second year of residency. This observation is a favorable example of how external requirements and accountability for both programs and residents may equalize training opportunities.

There are several limitations to this study. First, because this analysis is based on self-reported case logs, it is possible that female surgery residents underreport their total case numbers or underrepresent their true participation in the operating room (ie, they may assign themselves as a first assistant instead of surgeon junior based on perceived lack of performing the case). This behavior is consistent with studies showing that female residents underestimate their operative ability compared with males without an objective difference in skill.[34] Second, ACGME case logs do not indicate the level of autonomy or case difficulty and, therefore, we cannot draw conclusions about differences between male and female residents regarding these metrics. Third, the US ROPE Consortium database, while representing a large multi-institutional consortium, does not include all program types and may introduce a bias toward the programs that are included. However, the consortium is well-aligned to the demographics of US general surgery residents with regard to sex, race/ethnicity, age, proportion IMG, and proportion entering fellowship.[35] Fourth, this study relied on sex demographics (male or female) reported by participating programs to the US ROPE Consortium. Therefore, the database and subsequent analyses are limited to the biological description of sex (ie, chromosomal and sex organ-based) rather than gender, which encompasses a social construct including presentation and behaviors.[36] As such, this study does not encompass all gender identities, such as "nonbinary," which facilitates optimal and inclusive reporting. Future studies should directly obtain gender identity information, as well as examine interactions with race, to better represent gender

diversity and intersectionality. Finally, this is a retrospective analysis, and as such, the conclusions demonstrate association but not causation. Further mixed-methods studies are needed to explore the mechanisms behind sex and gender disparities in surgical training.

CONCLUSIONS

In this multi-institutional study of 20 ACGME-accredited general surgery programs from the US ROPE Consortium, we found that female general surgery residents perform fewer total cases compared with their male counterparts throughout residency training. Encouragingly, female residents are recently outpacing male residents with regard to total case volume, suggesting this gap may be closing. Further mixed-methods research is needed to determine why sex and gender-based disparities exist in general surgery training. This will help inform targeted interventions to better support and engage female surgery residents during residency.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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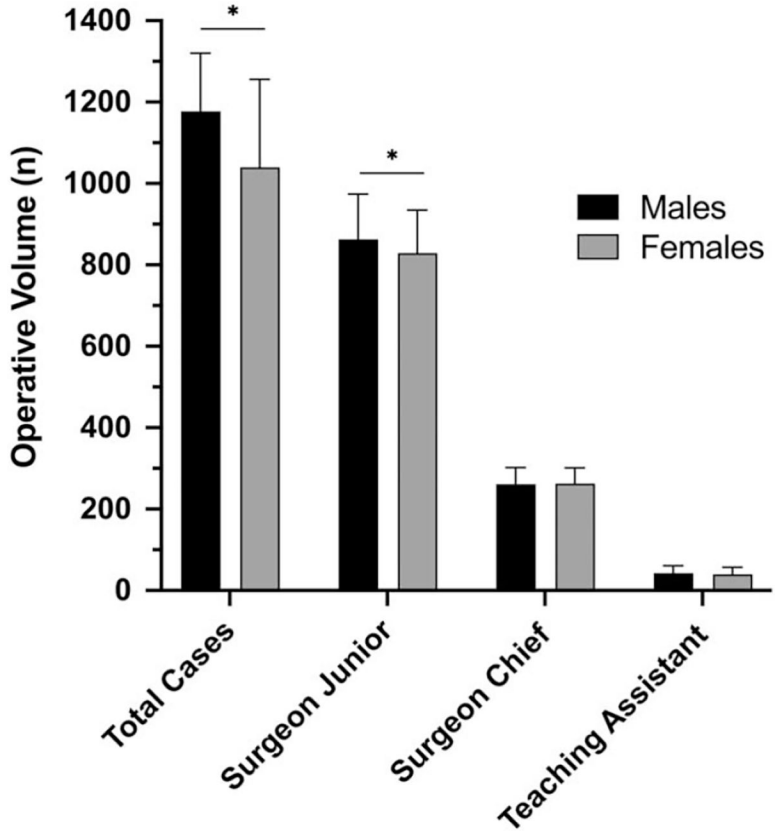

FIGURE 1.

The operative experience of general surgery residents differs for female versus male general surgery residents. Male residents logged more total cases than female residents (1177 vs 1140, $P < 0.01$), largely due to differences in surgeon junior cases (863 vs 829, $P < 0.01$). *$P < 0.05$.

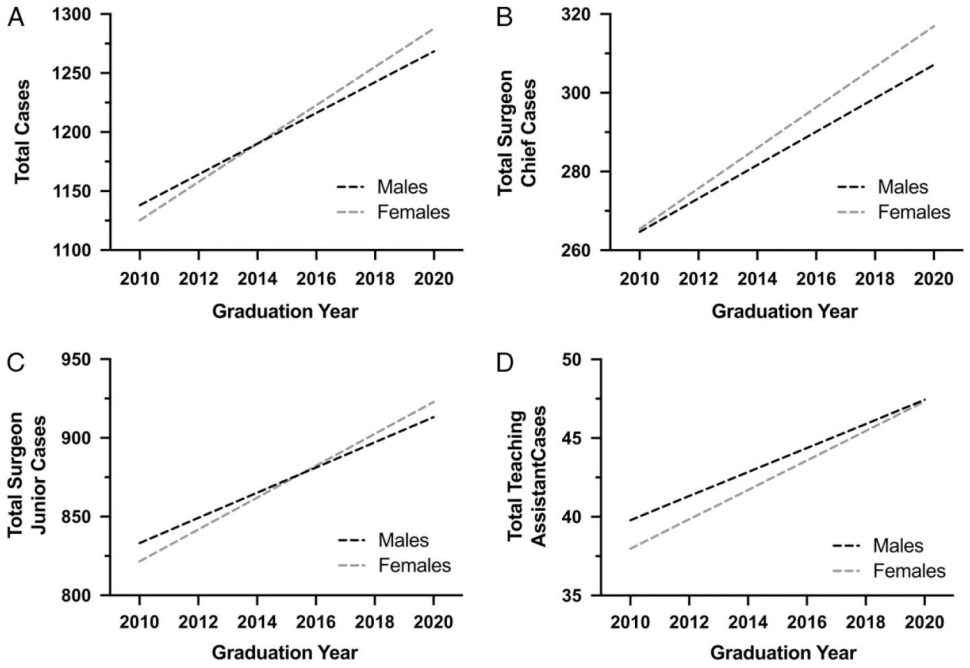

FIGURE 2.

The operative volume for male and female residents has increased over the past decade. On adjusted multivariable linear regression, (A) female graduates performed 13 fewer cases than male graduates in 2010 ($P < 0.01$), but the rate of increase for female graduates (+16 cases/yr) outpaced that of male graduates (+13 cases/yr, $P = 0.02$). (B) A similar relationship was found for surgeon junior cases, with female graduates performing 12 fewer cases than male graduates in 2010 ($P < 0.01$), but the differences in the rate of change did not reach statistical significance ($P = 0.08$). (C) There was no difference in the 2010 starting point or year-to-year trends for surgeon chief cases. (D) Female graduates performed 2 fewer TA cases than male residents ($P = 0.02$), but the differences in the rate of change were not different ($P = 0.47$).

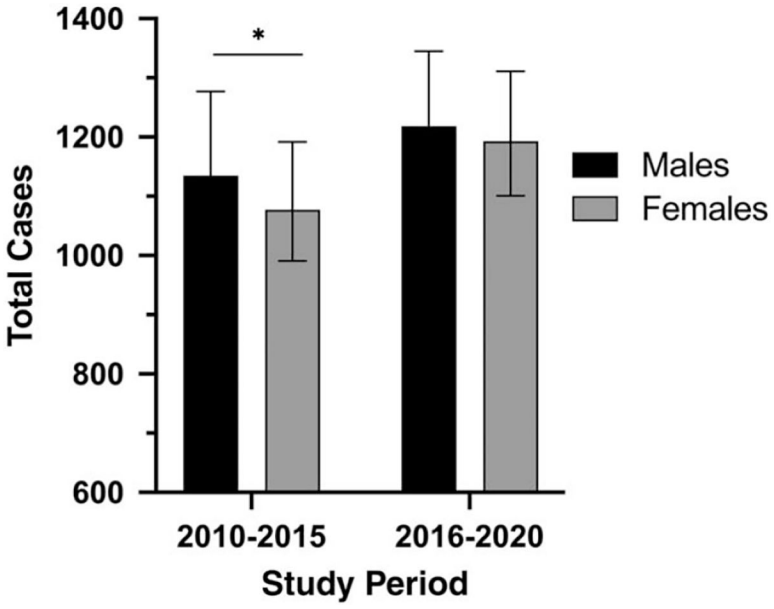

FIGURE 3.

The difference in operative volume between female and male general surgery residents decreased with time. There was a significant difference in total cases between males and females (1135 vs 1077, $P < 0.01$) in the early period (years 2010 to 2015) but no difference (1218 vs 1193, $P = 0.18$) in the late period (years 2016–2020).

TABLE 1.

Individual and Program Demographics of General Surgery Residency Graduates by Male Versus Female

	N (%)		
	Female	**Male**	***P***
Age (yr), median (IQR)	33 (31–34)	33 (32–35)	0.21
Race/ethnicity			0.05
Asian	75 (15.8)	136 (15.7)	
Black	30 (6.3)	35 (4.0)	
Hispanic	30 (6.3)	43 (4.9)	
White	325 (68.3)	598 (70.0)	
Other	16 (3.4)	55 (6.3)	
IMG	26 (5.5)	125 (14.4)	< 0.01*
Dedicated research experience	235 (49.4)	355 (41.0)	< 0.01*
Pursued fellowship	391 (82.1)	698 (80.5)	0.46
Resident volume			< 0.01*
Low	173 (36.3)	270 (31.1)	
Medium	172 (36.3)	287 (33.1)	
High	130 (27.3)	310 (35.8)	
Program region			0.13
Midwest	130 (27.3)	272 (31.4)	
Northeast	76 (16.0)	98 (11.3)	
Southwest	85 (17.9)	156 (18.0)	
Southeast	167 (35.1)	303 (35.0)	
West	18 (3.8)	38 (4.4)	
Program size			< 0.01*
Small	40 (8.4)	120 (13.8)	
Medium	224 (47.1)	402 (46.4)	
Large	212 (44.5)	345 (39.8)	
Residency volume			< 0.01*
Low	184 (38.7)	247 (28.5)	
Medium	155 (32.6)	300 (34.6)	
High	137 (28.8)	320 (36.9)	
NIH funding			0.29
Top 50	266 (55.8)	452 (52.1.8)	
Bottom 50	112 (23.5)	206 (23.8)	
None	98 (20.6)	209 (24.1)	

*$P < 0.05$.

TABLE 2.

Multivariable Linear Regression Comparing Operative Volume for Male and Female Graduates

	Unadjusted estimates			Adjusted estimates		
	Female	**Male**	***P***	**Female**	**Male**	***P***
Total cases	1164 (1143–1184)	1181 (1171–1191)	< 0.01*	1197 (1171–1223)	1206 (1189–1223)	0.04*
Total surgeon chief	271 (263–279)	272 (268–276)	0.71	289 (278–299)	287 (280–294)	0.03*
Total surgeon junior	846 (823–865)	862 (853–871)	< 0.01*	866 (843–888)	875 (860–890)	0.01*
Total TA	46 (42–49)	48 (46–49)	0.06	42 (38–47)	44 (41–47)	0.04*

Data are reported as parameter estimates (95% CI) and are adjusted for an individual program, IMG status, completion of dedicated research, andpursuing a fellowship.

*$P < 0.05$.

TABLE 3.

Comparison of Operative Composition for General Surgery Residency Graduates by Male Versus Female

	Median (IQR)		
	Female	**Male**	***P***
Abdomen	318 (277–371)	329 (278–386)	0.06
Biliary	125 (95–158)	131 (99–168)	0.03 *
General	41 (30–53)	39 (28–52)	0.14
Hernia	123 (102–148)	126 (105–150)	0.29
Liver	9 (6–14)	9 (6–13)	0.95
Pancreas	11 (7–17)	12 (7–18)	0.35
Spleen	3 (1–4)	3 (1–4)	0.88
Alimentary tract	269 (228–308)	267 (225–313)	0.88
Anorectal	33 (25–44)	30 (22–41)	< 0.01 *
Esophagus	11 (7–17)	12 (7–17)	0.61
Large intestine	147 (120–171)	148 (122–175)	0.36
Small intestine	40 (31–50)	39 (32–50)	0.88
Stomach	31 (23–45)	30 (22–43)	0.35
Breast	53 (42–71)	49 (39–64)	< 0.01 *
Endocrine	38 (22–55)	37 (21–56	0.95
Endoscopy	119 (105–143)	124 (106–153)	0.02 *
Pediatric	23 (16–31)	23 (17–33)	0.25
Plastics	24 (14–44)	25 (15–42)	0.78
Skin and soft tissue	56 (41–75)	54 (40–73)	0.20
Thoracic	32 (23–48)	37 (25–55)	< 0.01 *
Transplant	12 (6–18)	11 (6–18)	0.46
Trauma	27 (18–40)	31 (20–47)	0.01 *
Vascular	102 (78–133)	113 (86–151)	< 0.01 *
Total laparoscopy †	279 (226–344)	287 (221–30)	0.48
Basic laparoscopy	171 (129–220)	179 (125–226)	0.39
Complex laparoscopy	107 (80–137)	108 (78–135)	0.90

* $P < 0.05$.

† Laparoscopy includes operations within the other listed domains that are coded as open versus laparoscopic and, therefore, total laparoscopy is not counted toward total case counts.