



Gender Diversity in Surgery: A Review

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Abstract

Purpose of Review This review aims to describe the gender disparity in surgery by highlighting the disparate treatment and experiences of women and men in both surgical practice and training. This review will discuss disparities in career advancement and compensation, leadership positions, and recognition in achievement, as well as the mistreatment of women, and challenges related to pregnancy and motherhood. Additionally, this review will provide individuals, hospitals, and societies with actionable advice on how to improve the surgical environment for female surgeons, and work toward gender parity in surgery.

Recent Findings Women comprise a greater proportion of medical students and residents nation-wide. However, the

percentage of female surgical residents is not yet proportionate to male surgical residents, and this gap only widens within surgical subspecialties. As academic surgeons, women are promoted within academia at rates slower than men, are less represented in leadership positions than men, and are disproportionately compensated compared to men. Female surgeons regularly encounter gender-based discrimination and mistreatment, which negatively impacts both their careers and psychological well-being. Compared to male surgical residents, female surgical residents have less support, are evaluated differently, are recognized for their achievements more infrequently, and are given less operative autonomy. Female surgeons additionally face a number of challenges with respect to childbearing and motherhood.

Summary Gender-based disparities are pervasive in surgery. However, recent attention to this important topic has shed light on the scope of the problem, and the many opportunities for change. With increased focus on workforce disparities, and the associated impact it has on recruitment, career satisfaction, and physical and psychological well-being, improvements can be made.

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Introduction

The increased representation of women in medicine is well celebrated in both public and academic platforms. In spite of this, women experience significant challenges to not only succeed but also exist in a historically male workplace. There is a growing body of literature that demonstrates a gender disparity in the surgical workforce, as well

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as a myriad of challenges disproportionately encountered by female surgeons. This review will define the disparity of women in surgery and describe the differential treatment of women and men, including compensation, career advancement and leadership opportunities, recognition of achievements, and gender-based mistreatment. Challenges surrounding pregnancy, motherhood, and a surgical career will also be explored. Lastly, we will discuss strategic actions to mitigate the gender disparity within surgery.

History of Women in Surgery in the United States

The history of women in surgery dates back to the mid-nineteenth century: Mary Edwards Walker graduated from medical school in 1855, only the second woman in the United States (US) to do so, and entered into surgical practice [1]. In 1871, Harriet Jones became the first woman licensed to practice surgery in the US [2]. In 1913, Alice Bryant, Emma Culbertson, Florence Duckering, Jane Sabine, and Mary Smith were inducted as the first female Fellows of the American College of Surgeons (ACS), a large national multispecialty scientific and educational association [3]. These pioneers of women in surgery paved the way for a future of female representation in the historically male-dominated field.

Women have demonstrated increased representation in medicine over time. While women constituted less than 10% of medical school applicants in the 1950s, the proportion of women in medical schools increased by approximately 10% each decade until the mid-2000s. Since then, the percentage of women in medical school has remained constant at approximately 50% [4, 5]. This increase in female medical school graduates was associated with an increased percentage of women residents, representing 46% of residents in all specialties in 2013 [5, 6]. The proportion of women as full-time academic faculty has also increased, from 30% in 2003 to 41% in 2018 [5, 6].

As women have become more prevalent within medicine, so have women become a larger proportion of the surgical workforce. The proportion of female general surgery trainees has increased 1.1% on average yearly from 1994 to 2014 [7], and currently women make up 43% of general surgery trainees [8]. With this steady increase in female surgeons, it is predicted that there may be equal proportions of men and women surgical residents by the year 2028 [9]. The proportion of female surgical subspecialty trainees has also increased over time, and this is illustrated in Fig. 1a [8, 10, 11, 12]. As of 2020, women represent 16% of orthopedic surgery, 19% of neurosurgery, 24% of cardiothoracic surgery, 27% of urology, 37% of otolaryngology, and 42% of integrated plastic surgery residents [8, 13]. Similarly, between 2007 and 2019, the

percentage of active female surgeons increased across many surgical specialties, including general surgery (13.6% to 22%), neurosurgery (5.6% to 9.3%), orthopedic surgery (3.6% to 5.8%), otolaryngology (11.2% to 18.3%), plastic surgery (11.9% to 17.2%), and urology (4.7% to 9.5%) [11, 14, 15]. This trend is illustrated in Fig. 1b.

Differences in Career Advancement and Compensation

Paralleling this rise of women entering into surgical practice is the entrance of women into academia. However, the rates at which women are doing so is disproportionately low compared to men [9, 12, 16]. Nationwide, general surgery has the second smallest proportion of full-time women faculty in academic medicine at 26%, just ahead of orthopedic surgery [6]. Women represent an even smaller percentage of faculty within surgical subspecialties, representing just 16% of urology, 17.6% of cardiothoracic

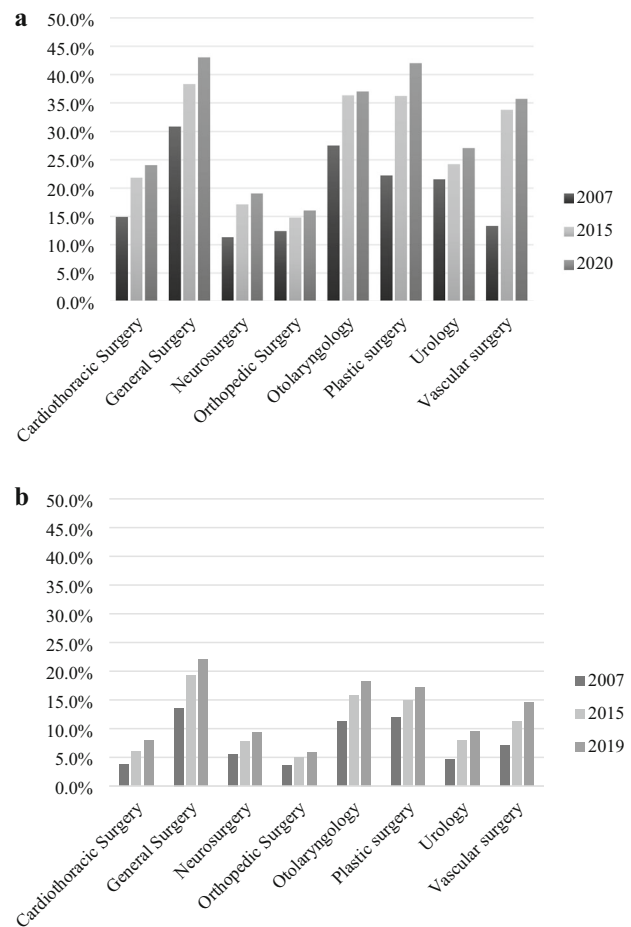


Fig. 1 **a** Percentage of female surgical residents by specialty, 2007–2020 [8, 11, 12]. **b** Percentage of active female surgeons by specialty, 2007–2019 [11, 14, 15]

surgery, and 18.6% of vascular surgery faculty [17–19]. Additionally, the percentage of female surgeons who are full-time faculty has not changed significantly in the last 5 years [6, 12].

Once entered into academic surgery, female surgeons advance through the ranks of academia at slower rates than male surgeons. When adjusting for age, time in practice, publications, National Institutes of Health (NIH) funding, and medical school ranking, female surgeons are less likely than male surgeons to attain the ranks of associate professor or full professor [16]. In fact, each year 30 more men than women are named as full professors of surgery, and estimates show that there will not be an equal number of male and female full professors in surgery until the year 2136 [7]. One possible explanation for these different paces of advancement is that women are more often placed on clinical tracks rather than research or tenure tracks, which may promote more slowly [20, 21]. This alone is a barrier to their promotion, as clinical work may not be as highly valued with regards to advancement [21].

Gender also impacts salaries. Even after accounting for years in practice, specialty, faculty rank, leadership positions, and measures of research productivity, female academic physicians earn significantly less than male academic physicians [22, 23]. Within general surgery, women earn an average of \$280,030 compared to \$312,411 for men; this gap widens to \$327,117 versus \$368,070 within orthopedic surgery and \$285,369 versus \$329,097 within other surgical subspecialties [22]. A significant pay gap also exists in specialties that are majority female: female obstetricians and gynecologists earn \$17.24 less per hour than male obstetricians and gynecologists, and female breast surgeons earn approximately \$65,000 less than male breast surgeons, despite comprising greater than 50% of the specialties' physicians [24, 25]. There also appears to be a negative correlation between surgical subspecialty compensation and percentage of female fellowship program directors, in which the lowest paying subspecialties had the greatest percentage of female fellowship directors [26]. A number of explanations for disparities in compensation have been posited, such as differences in practice types or lifestyle choices. However, a recent investigation into compensation differences in a fee-for-service system determined that female surgeons earned 24% less than male surgeons for each hour of clinical work, even after adjusting for surgical specialty [24]. This hourly difference in earnings is even more profound when examining specific fields: while male general surgeons earn \$18.52 more than female general surgeons, male cardiothoracic surgeons earn \$59.64 more per hour than their female counterparts [24].

A critical component to a career in academia is scientific investigation. Scholarly productivity and the receipt of

external funding are commonly considered markers of success. With regards to scholarly productivity, the percentage of female general surgery first and last authors is proportionate to the number of female general surgery residents and academic general surgeons [27]. Unfortunately, this is not true of all surgical subspecialties: female thoracic and trauma surgeons are less published than their male counterparts [28, 29]. Importantly, the lower presence of women in first and last authorship roles does not impact the H-indices of female surgeons, suggesting that women are producing equivalently strong, high-impact research [29, 30]. When examining grant funding, the percentage of women surgical society grant recipients and NIH grant recipients is proportionate to the percentage of female surgeons [18, 27, 31, 32]. This proportionate representation is highly encouraging; however, gender-based biases may exist hampering women surgeons' ability to progress. Although applications for NIH grant renewals submitted by female primary investigators (PIs) had stronger critiques with standout adjectives, male PIs applications received higher priority and significance scores and were accepted for grant renewal more often than female PI applications [33].

Diversity in Leadership Positions

While the number of women ascending the ladder in academic surgery has improved over time, the proportion of women at the highest levels of academia is still low, a phenomenon known as the glass ceiling [20]. Since 1987 when Dr Olga Jonasson became the first woman in the US to chair an academic department of surgery [34], 34 additional female surgeons have been titled Chair of the Department of Surgery [2]. As of 2019, women make up just 6% of active surgery department chairs [6]. Women are also underrepresented as leaders of surgical subspecialty divisions, representing just 1.8% of cardiothoracic surgery chiefs, 5.5% of vascular surgery chiefs, 7.7% of trauma/acute care surgery chiefs, 8.6% of surgical oncology chiefs, 12.2% of plastic surgery chiefs, 16.1% of pediatric surgery chiefs, and 17.6% of colorectal surgery chiefs [35]. In many of these divisions, the number of female division chiefs is disproportionately low compared to the number of subspecialized female surgeons [30, 35, 36].

Gender disparities persist within training program leadership positions. Just 25.4% of general surgery Program Directors (PD) are women, although 38.5% of Associate Program Directors are women [35]. Of the surgical subspecialty training programs, only obstetrics and gynecology (OB/GYN) has a majority female PD presence (63.5%) [37]. In other surgical subspecialty programs, such

as neurosurgery, otolaryngology, and urology, women hold only 5.9%, 29.5%, and 16.8% of PD positions, respectively [37]. Women are also underrepresented as general surgery subspecialty fellowship program directors, accounting for only 18% of those positions; in some subspecialties women surgeons compose fewer than 10% of fellowship program directors [26, 38]. Encouragingly, programs with a greater percentage of female faculty were more likely to have a female PD [39]. Thus, as the number of female surgeons continues to increase, it is possible that a corresponding increase in female surgical education leaders will also be seen.

Leadership extends beyond the walls of academic institutions to include academic surgical societies and journals. Selection to serve in a leadership position for a professional society or on a journal editorial board reflects an individual's academic accomplishments and status within the field, and simultaneously strengthens that individual's standing. Consequently, female representation in these positions is seen as "a valuable marker of the attainment of equity by female physicians within each field" [40]. Although the ACS was founded in 1913 [3, 41], it was not until 1992 that the first woman officer was selected, and not until 2005 that the ACS elected its first female President [42]. The poor representation of women at the highest levels of surgical leadership is pervasive: from 2000 to 2015 the American Association of Neurologic Surgeons, the American Academy of Orthopedic Surgeons, the Society of Thoracic Surgeons, and the American Urological Association had no women as their highest ranking officer, while the ACS, the American College of Obstetricians and Gynecologists and the American Surgeons of Plastic Surgeons had highest ranking women in rates disproportionately low compared to their member populations [43]. Female surgeons have high rates of representation at lower levels of leadership, both in the ACS and within subspecialty surgical societies [43, 44]. However, in many of these organizations the proportion of women in leadership positions is still lower than the proportion of female member surgeons [43].

Selection for service on a journal's editorial board reflects an individual's publication productivity and academic rank, and represents elevated standing within the field [40]. While the percentage of female editorial board members of surgical journals has increased over time, gender inequality remains [45, 46]. In 2020, women composed just 14.8% of surgical journal editorial board members, 13.3% of associate editors, and 4.8% of editors-in-chief [46]. Concerningly, 38.1% of surgical journals in 2020 had no women as associate editors, and only two journals had a female editor-in-chief [46]. While some have argued that this disparity reflects the lower research productivity or stature of female surgeons, there are no

differences in the H-indices or academic ranks of male and female editorial board members when accounting for years in practice [45]. Thus, the unequal representation in editorial board leadership is unlikely to be fully explained by disproportionate research productivity. As editorial boards continually elect new members, there is hope that the increasing number of female surgeons within academia will lead to increased female representation on editorial boards.

The paucity of female leaders in surgery has previously been explained by the pipeline effect, which argues that there are fewer women leaders because fewer women have practiced surgery over time [20]. However, this argument has been discredited as it does not explain the minority female leadership in specialties that are majority female: in 2018, 64% of OB/GYN faculty were women, yet women comprised only 27.6% OB/GYN department chairs during this time [6]. Furthermore, despite an increased number of women in academic surgery in the last several decades, the proportion of women professors of surgery has remained essentially unchanged [9]. As discussed previously, women are promoted at slower rates than men [9], even after adjusting for years since residency completion and academic productivity [16]. Thus, a lack of gender parity in surgical leadership cannot only be explained by the number of female surgeons or their accomplishments. As Dr. Keith Lillemoe states in his 2017 address, "The number of outstanding, qualified female candidates is more than adequate to fill every open surgical leadership position in America today. The problem is not the pipeline—it is the process" [47].

The dearth of female representation in leadership positions has important implications in terms of mentorship and career advancement. Exposure to women leaders in surgery demonstrates to female medical students and residents that success in a surgical career is attainable [21, 48]. There is a positive association between resident gender composition and surgical faculty gender and department chair gender [49], further emphasizing the significance of same-sex mentorship and its value to female surgical trainees [50]. Additionally, the presence of women in leadership positions itself is a boon to other women: female PDs and department chairs implement programs that provide resources to promote female leaders [38]. Similarly, increased numbers of female surgeons in leadership positions provides opportunity for increased sponsorship of junior female surgeons [51]. This in turn may lead to increased appointments of women to leadership positions and positively contribute to the race toward gender parity in surgery.

Disparities in Achievement Recognition

Although the national percentages of male and female surgical residents are almost equal [9], female surgical residents are underrepresented as award recipients within their training programs. A recent investigation into the awards of 24 general surgery programs over 20 years determined that female surgical residents are 55% less likely to receive an award from their institution's Department of Surgery than male surgical residents [52•], and are significantly less likely to receive awards for teaching, clinical excellence, and non-clinical excellence [52•, 53]. Systemic gender-based disparities in recognizing success may negatively impact female surgical trainees' confidence and career aspirations.

Disparate recognition continues as surgeons graduate from residency and become academic surgeons. An examination into awards presented by twenty national surgical societies over a 20-year period illustrates this point. Four societies gave no awards to women surgeons over a 10-year period, and three societies gave fewer than 10% of awards to female surgeons [54]. These low numbers suggest organization-level implicit bias. When examining achievement awards specifically, the percentage of female recipients is lower than the proportion of female surgeons [54]. This limited recognition is critical when considering the visibility of a national surgical society award, and its potential role in motivating young female surgeons to pursue careers in academic surgery or within a surgical subspecialty.

Invitation to speak at a department's grand rounds or at a surgical society meeting is an acknowledgment of accomplishment in the field. This featured presence also is a platform for surgical departments and societies to present female surgeons as role models. However, less than 25% of Department of Surgery grand rounds sessions are presented by women [55], and less than 16% of individuals invited to speak at surgical society meetings are women [56]. If exposure to successful female role models "may positively affect the retention of women in academic medicine" [55], inviting women to speak is one simple step toward achieving gender parity in academic surgery.

Biases, Microaggressions, and Mistreatment

Implicit biases, which are unconscious associations based upon previous or learned experiences that influence behavior, are pervasive throughout everyday life. A thorough discussion of the etiology of these biases is beyond the scope of this text. Within medicine, these biases are often seen in gender-based stereotypes: male clinicians are

more readily identified as doctors, while women clinicians are assumed to be nurses [57–61]. The stereotype of a male surgeon is so widely accepted that a cover of *The New Yorker* magazine which challenged this cultural norm sparked significant conversation. The March 2017 cover "Operating Theatre" by Malika Favre depicted the operating room from the patient's perspective, with four female surgeons looking down on a patient on the operating room table [62]. This cover was so provocative that it led Dr. Susan Pitt, an endocrine surgeon, to propose that fellow female surgeons replicate the cover illustration with their own pictures. Worldwide participation in the #NYerORCoverChallenge and #ILookLikeASurgeon Twitter campaigns brought significant visibility to women working in a traditionally male-dominated field [63, 64].

Even when women physicians are acknowledged as a doctor, they are more likely to be called by their first name rather than their title [65–67]. These actions, however unintentional, place women in a position of lower authority than their male colleagues, and perpetuate the historical stereotype that women surgeons are less competent and able than male surgeons [68, 69]. Consequently, many female surgeons feel pressure to over-perform in order to be considered equal to male surgeons [68, 70–72]. Additionally, many female surgeons believe that they need to adapt to a male-dominated culture in order to fit in [68, 71, 72].

These experiences are just some of the many microaggressions encountered by female surgeons. Microaggressions, which are "discriminatory or insulting actions that communicate demeaning or hostile messages often aimed at marginalized groups based on race, sexual orientation, or gender" [73•], occur daily and are generally "subtle snubs, slights or insults" [74]. The vast majority of female surgeons experience microaggressions every day [72, 73•]. Repeated exposure to microaggressions can negatively impact a person's mental and physical health [69, 70, 72].

Gender discrimination, defined as unequal treatment on the basis of gender, is ubiquitous in academic clinical medicine [75]. Examples of gender-based discrimination include belittling remarks, abusive treatment, pay discrimination, denial of opportunities, and sexual harassment [76–79]. Gender-based discrimination occurs at all levels of training and into surgical practice, and stems from colleagues, patients, patients' families, and ancillary staff [73•, 76–78, 80•]. For example, ancillary OR staff are more likely to write up female surgeons than male surgeons for their actions [79]. A recent survey of female surgeons reported that only 7% of respondents have never experienced gender-based discrimination in their career [76]. Sexual harassment, a type of gender discrimination in the form of unwanted sexual advances, requests for sexual favors, or sexual or physical jokes and commentary that

can impact an individual's employment or create a hostile work environment [81], is also prevalent [72, 75, 77]: 20–60% of female surgeons have experienced sexual harassment in the workplace [72, 75, 80, 82].

Women are especially vulnerable to gender-based discrimination early on in training. A recent survey of female surgical trainees reveals that they were discouraged from becoming surgeons, even during premedical education [73]. Once in surgical training, female surgeons were made to feel less welcome due to their gender [73]. As trainees, women surgeons are subject to differential treatment in the form of operative autonomy and constructive feedback. Female residents are granted less operative autonomy than male residents [83, 84], decreasing their opportunity for gaining technical skills and confidence. Male residents more often receive concrete feedback on how to improve their performance than female residents [60, 85]. Without explicit feedback, female residents have fewer opportunities to strengthen their clinical skills [52]. Instead, female residents are more likely to receive feedback on their personal qualities, such as suggesting that female residents need to become more assertive or express more confidence [60, 85]. However, female residents often refrain from advocating for more operative autonomy for fear of being perceived as arrogant and presumptuous [83, 84]. Overall, gender has a negative influence on the quality of women's surgical education [73, 77, 83, 84].

Not all gender-based discrimination is an overt action. The lack of a support structure for female surgeons plays an equally important role and contributes to a feeling of isolation among women surgeons [68, 70]. Only 23% of female surgeons 0–5 years out of training, and less than 10% of female surgeons younger than 30 years of age reporting having female role models and mentors [86]. This absence of mentors is a downstream effect of having few women in leadership positions, as discussed above, and contributes to an unfavorable work environment [68, 70, 73].

Women's heightened awareness of gender-based discrimination can have serious implications on their psychological well-being [87]. Gender-based discrimination is associated with emotional exhaustion and depersonalization, two forms of burnout [72, 87], which can negatively impact patient care [88]. As discussed above, gender-based discrimination also impacts career advancement and compensation [20, 49, 76, 77], and is negatively predictive of career satisfaction and well-being [75–77, 87]. Nearly half of female surgeons who experienced or witnessed gender-based discrimination considered leaving or declining a position as a result [76]. A majority of surgeons recently surveyed reported that they would advise that only men pursue many surgical specialties [86]. This is true even for

female surgeons [86], perhaps because of their minority status and perceived gender bias.

Challenges Surrounding Pregnancy and Motherhood

Female surgeons face a number of obstacles to childbearing, evidenced by the fact that female surgeons have fewer children than male surgeons [89]. Female surgical residents have higher rates of infertility (30–32% versus 10.9%) and are more likely to use assisted reproductive technologies to conceive (8–13% versus 1.7%) than the general population [90]. Once pregnant, female surgeons are more likely to have obstetrical complications that endanger their health and the health of their child. Female surgeons are more likely to experience preterm labor (10.5% vs. 5.9%), miscarriage (13.3% vs. 4.2%), placental abruption (5.2% vs. 0.0%), intrauterine growth restriction (10.5% vs. 3.9%), and intrapartum or post-partum complications than non-surgeons [89, 91]. Female surgeons report a pregnancy loss rate more than double the rate in the general population [89]. Working more than 60 hours a week, having longer operating hours and more overnight calls—all typical for a working surgeon's schedule—are associated with obstetrical complications [89, 91, 92].

Female surgical trainees are limited when it comes to maternity leave. Individual residency programs may not allow for prolonged absences, and many programs do not have formal maternity leave policies [93]. With limited redundancy built in to general surgery residency programs, residents often see their time taken for maternity leave as a burden to their co-residents [94, 95]. Ultimately, only a minority of general surgery residents who have taken parental leave feel supported by co-residents and faculty [94]. Compounding this are challenges faced with the need to fulfill requirements for board certification, which are set by the American Board of Surgery (ABS). Historically, the ABS policies have been reported as a major barrier to taking the desired duration of leave [96]. According to the most recent "Leave Policy," residents may take up to 16 weeks off during their first 3 years of training and up to 12 weeks off during their last 2 years of training [97]. This time off includes allotted vacation as well as family or medical leave, and maternity leave must fit into this time. The ABS has recently established options to extend surgical training for a year to allow for prolonged absence from work, but this presents logistical challenges with regards to income and insurance coverage.

Unfortunately, the compounded effect of these obstacles has resulted in female surgeons being more likely than male surgeons to delay having children until surgical training is completed [89]. The obstacles women face with

regard to childbearing are not entirely alleviated after completion of training. The majority of female attending surgeons do not have maternity leave included in their contracts, and consequently experience a decrease in income associated with maternity leave [98].

Female surgeons also face challenges with regards to breastfeeding/lactation and childcare, and fewer than 10% of surgery programs have a breastfeeding/lactation policy to support breastfeeding residents [93]. Female surgical residents report difficulty identifying opportunities to express breast milk while at work; residents also have concerns about the stigma associated with needing to step away from clinical duties to express milk [89•, 94•]. Identifying adequate lactation facilities and places to store expressed milk is also a challenge [95•]. Ultimately many residents stop breastfeeding earlier than desired. Finding childcare that accommodates a surgical trainee's schedule is also a challenge, as a minority of surgery programs have on-site childcare [93].

Compounding these issues is the associated maternal discrimination, defined as discrimination based on pregnancy, maternity leave, and breastfeeding [94•, 99], and is experienced by greater than one-third of physician mothers [99]. Surgical residents most commonly reference other surgeons as the source of maternal discrimination [80•]. Many residents felt others perceived them as not committed, less motivated, and weak during their pregnancy and upon return from maternity leave [95•]. These concerns are not unfounded: 61% of surgical PDs report that becoming a parent negatively affects female trainee's work, compared to 34% of PDs who felt that becoming a parent negatively impacted male trainees [93]. The discrimination and lack of support women surgeons perceive negatively influences career satisfaction [20, 100]. The difficulty that comes with balancing surgical training and motherhood is so intense that some residents choose to change their fellowship plans to a less demanding specialty, or choose not to pursue fellowship training at all in order to accommodate family life [80•, 94•, 95•, 99–102]. Female surgical faculty, however, face additional challenges associated with childbearing and motherhood, including less opportunity for career advancement [102].

Solutions

The pervasive nature of gender discrimination and gender bias means there are a wealth of opportunities to ameliorate these disparities. Table 1 outlines these disparities with solutions for change. To address implicit biases, hospitals and academic medical centers can develop training programs for individuals to address microaggressions, and offer strategies for bystanders to intervene in these

situations [69]. Implicit bias training for all faculty, including department and division leaders, can draw awareness to biases in the evaluation of male and female physicians, which can impact recognition and career advancement [49•, 73•, 77, 87]. Addressing implicit biases can also affect surgical education, and attention should be paid to disparate training of male and female residents and ensure that women are appropriately recognized for their achievements [52•, 103]. Institutions can also create zero tolerance policies to hold individuals accountable for discriminatory actions [20, 73•, 77, 104]. Institutions and departments can become more family friendly through structural measures such as on-site or backup childcare, increased scheduling flexibility, and establishment of paid parental leave [20, 99]. Additionally, creation of convenient lactation facilities is a necessary step to support post-partum physicians [95•].

Given the well-established gender-based disparities in career advancement, academic institutions should pay more attention to ensure gender parity of promotions. Clearly defining criteria for promotion eligibility to reduce ambiguity, blinding selection committees, or using merit-based strategies will help combat gender bias in the promotion process [45, 49•, 78, 105]. Similarly, implementation of a structured compensation plan can narrow the pay gap [106]. Additional measures to reduce disparities in compensation include transparent criteria for initial and successive salaries, and regular assessments of pay equity within departments [106].

Organizational culture is a primary driving force affecting professional advancement [21]. Creating a supporting environment may help modify the organizational culture in a positive way. Mentoring has shown significant promise in improving gender parity within academic medicine [107, 108]. However, a significant portion of junior female surgeons report they do not have adequate female mentors within their department [86]. Women can also look to men as mentors and sponsors, and men must be willing and open to doing so [47]. The #HeForShe movement exemplifies the instrumental role men have in advancing the careers of women surgeons, with respect to acknowledging and eliminating gender biases, mentorship, and sponsorship [105, 109, 110].

Networking through social media, joining a professional society, and attending annual society meetings provide additional opportunities to identify a mentor [49•, 108, 111]. The Association of Women Surgeons (AWS) recently established a formal mentorship program that offers surgical trainee members the opportunity to connect with faculty members of the AWS who provide guidance on research projects and professional development [112]. Similarly, the Association for Academic Surgery (AAS), often in conjunction with the Society of University

Table 1 Solutions for gender disparities in surgery

Problems	Solutions	Impact
Gender discrimination in the workplace and in professional societies	<ul style="list-style-type: none"> - Creation and enactment of zero tolerance policies [73•, 77, 104] - Implicit bias training [49•, 52•, 69, 73•, 103, 105, 106, 111, 116] - DEI initiatives—program-driven, professional society-driven [43•, 115, 116] 	<ul style="list-style-type: none"> - Accountability can foster change, decrease sexual harassment, and improve overall work environment - Improved mental and physical health of female surgeons with infrequent encounters involving microaggressions - Increased recognition of female surgeons with opportunity for career advancement - Equality in surgical resident education and training - More women surgeons and surgical trainees receiving awards - Improved career satisfaction
Disparate promotion, career advancement, and compensation of female surgeons	<ul style="list-style-type: none"> - Clearly define criteria for promotion eligibility or use merit-based strategies for promotion [49•, 105, 116] - Blinding selection committees [49•, 116] - Individualize placement onto clinical or research tracks based on personal career aspirations [20, 21] - Transparency in salary measures [49•, 106] - Regular assessments of pay equity within departments [49•, 106] 	<ul style="list-style-type: none"> - Improved career satisfaction and academic stature with awarding more women NIH and surgical society grants, and increasing the promotion of women to full-time faculty and full professors of surgery - Increased visibility of female role models and improved mentorship of women surgeons with the greater presence of women in institutional leadership roles (i.e., division chiefs, program/fellowship directors, department chairs), professional society leadership boards, and journal editorial boards - Equal compensation of male and female surgeons with similar credentials
Lack of female mentorship	<ul style="list-style-type: none"> - Networking—social media, professional societies, annual society meetings [20, 49•, 108, 111] - Formal mentorship programs—program-driven, professional society-driven [49•, 105] - Promote women to leadership positions within departments and societies [20, 40, 43•, 49•, 106] - Increase exposure of women in expert positions (i.e. invite women to speak at grand rounds conferences and surgical society meetings) [49•, 55, 111] 	<ul style="list-style-type: none"> - Improved mentorship of women surgeons - Increased retention of academic women surgeons - Improved visibility of successful female surgeons - Increased exposure to women surgeon role models
Pregnancy and motherhood	<ul style="list-style-type: none"> - Paid parental leave [99, 111] - On-site childcare facilities [49•, 95•, 99] - Creation of convenient lactation facilities [49•, 95•, 99, 111] 	<ul style="list-style-type: none"> - Increased support for childbearing and post-partum women - Improved career satisfaction - Improved mental and physical health of female surgeons with infrequent encounters involving microaggressions

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Surgeons, provides members with formal mentorship programs and courses dedicated to academic advancement, career development, education, and basic and translational research [113, 114].

Surgical societies can promote gender equity beyond the provision of mentorship. The Society of Thoracic Surgeons (STS) Executive Committee and the Workforce on Diversity and Inclusion has developed an organized approach for cardiothoracic surgery to “assess, improve, and sustain

progress in diversity and inclusion” at the global, societal, institutional, and individual levels [115]. This framework, which can be formatted to apply to all surgical specialties, suggests that surgical societies devote attention to the recruitment and advancement of women within their fields, and ensure women are included as moderators and panelists at national meetings [115]. Surgical societies should also evaluate their leadership positions for appropriate representation of women at all levels, and should work to ensure that awards are presented to men and women in an equitable manner [40, 43, 116].

Conclusion

Increasing numbers of women are entering the surgical workforce, however they continue to face many obstacles and challenges to succeed. There is work to be done to eliminate the biases against women in surgery to promote gender parity in surgical training and the professional careers of academic surgeons. The importance of women at the forefront of academic surgery cannot be understated, with intention of ongoing promotion of women surgeons placed on creating a promising environment for future generations of women surgeons.

Compliance with Ethical Guidelines

Conflict of interest The authors declare that they have no conflict of interest.

Human and Animal Rights and Informed Consent This article does not contain any studies with human or animal subjects performed by any of the authors.

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