The Evolving Presence of Women in Academic Plastic Surgery: A Study of the Past 40 Years

Natalie M. Plana, B.A.
Kimberly S. Khouri, B.S.
Catherine C. Motosko, B.S.
Marleigh J. Stern, B.A.
Lavinia Anzai, B.S.
Grace Poudrier, B.A.
Jonathan P. Massie, B.S.
J. Rodrigo Diaz-Siso, M.D.
Roberto L. Flores, M.D.
Alexes Hazen, M.D.

New York, N.Y.

Background: Among surgical subspecialties, plastic surgery holds the highest percentage of women, and, the female contingent of board-certified plastic surgeons and trainees has grown steadily. However, their academic impact has been underestimated. We present the academic footprint of female plastic surgeons over the past 40 years.
Methods: A list of female plastic surgeons currently active at, and retired from, Accreditation Council for Graduate Medical Education–accredited plastic surgery residency programs was compiled. Each surgeon was searched on PubMed to gather their total number of publications, journals, and topics of research after completion of training. Date of publication and 5-year impact factor for each journal were recorded. Publications were organized into 10-year periods (1976 to 1985, 1986 to 1995, 1996 to 2005, and 2006 to 2016).
Results: One hundred fifty-five currently active and 80 retired academic female plastic surgeons were identified, who published 2982 articles in 479 peer-reviewed journals. The average 5-year impact factor was 4.093. The number of publications increased with each decade: 37 (1976 to 1985), 218 (1986 to 1995), 472 (1996 to 2005), and 2255 (2006 to 2016). The most commonly published areas were hand/nerve (22 percent), craniofacial (21 percent), and breast (20 percent). Over time, publications in hand/nerve research decreased (76, 60, 38, and 14 percent, respectively); craniofacial-related publications increased (8, 11, 18, and 23 percent, respectively); and publications in breast research increased (0, 8, 9, and 24 percent, respectively). The 2006 to 2016 period yielded the most even distribution of research topics.
Conclusion: The academic contribution of female plastic surgeons has substantially increased in number and has become more evenly distributed across subspecialty topics. (*Plast. Reconstr. Surg.* 141: 1304, 2018.)

Women surgeons have practiced for millennia, with the first known depiction of a woman surgeon drawn within the tomb of Ramses II.[1] The American College of Surgeons first recognized women surgeons in 1931.[2] The field of plastic surgery welcomed the first woman surgeon, Alma Dea Morani, soon thereafter in 1948, when she joined the American Society of Plastic and Reconstructive Surgeons.[3] Her training was challenged by the scarce opportunities available to her; she sought out a plastic surgery fellowship for 6 years before successfully identifying a program that offered her observation-only privileges. Her persistence led her to a mentor willing to teach

From the Hansjörg Wyss Department of Plastic Surgery, New York University Langone Medical Center.
Received for publication May 12, 2017; accepted November 2, 2017.

DOI: 10.1097/PRS.0000000000004337

Disclosure: *The authors have no financial interest to declare in relation to the content of this article.*

Supplemental digital content is available for this article. A direct URL citation appears in the text; simply type the URL address into any Web browser to access this content. A clickable link to the material is provided in the HTML text of this article on the *Journal*'s website (www.PRSJournal.com).

A "Hot Topic Video" by Editor-in-Chief Rod J. Rohrich, M.D., accompanies this article. Go to PRSJournal.com and click on "Plastic Surgery Hot Topics" in the "Digital Media" tab to watch. On the iPad, tap on the Hot Topics icon.

women, but even then she was permitted to operate only on off-hours when her male colleagues were not using the operating rooms. Despite these obstacles, she earned the rank of clinical professor 44 years after receipt of her medical degree.[3] Dr. Dea Morani remained a staunch advocate of women in plastic surgery for the duration of her career, and opened the field to a generation of women who aspired to be surgeons.

Women have consistently constituted 50 percent of all United States medical school graduates for about a decade; however, their representation in surgical subspecialties remains low.[4] Women are most represented in plastic surgery,[5] and the specialty has historically included a higher proportion of female residents relative to other surgical fields. In 1990, plastic surgery ranked fifth among all medical residencies training women, with only 14 percent of female trainees.[6] Although the field has upheld a longstanding commitment to the recruitment of women, significant gender discrepancies remain prevalent. Women are reportedly less likely to follow a tenure-track trajectory, hold leadership positions,[7] or participate in research endeavors[8] despite expressed interest and qualifications equal to their male counterparts.

On average, female academicians have been found to have lower scores of academic productivity, as measured by bibliometric parameters, when compared head-to-head with male colleagues.[9] However, when adjusting for academic rank and career length, women not only meet but exceed the productivity of their male counterparts over the entire span of their careers.[10] Moreover, considering the abundance of gender comparative studies that have consistently concluded that women lag behind men academically, the objective of the current study is to examine the contributions of women in plastic surgery and evaluate the evolution of their academic interests. We used a temporal comparison of women in plastic surgery as a group, independent of men, to highlight female plastic surgeons' research patterns and changes in their productivity over time.

METHODS

Identification of Women in Plastic Surgery

Data resource books released by the Accreditation Council for Graduate Medical Education were reviewed for each available academic year.[11–18] The percentage of women training at integrated and independent plastic surgery programs was recorded for each year.

A roster of women in plastic surgery in academic practice in the United States from 1976 to 2016 was created. All Accreditation Council for Graduate Medical Education–accredited plastic surgery training programs were identified; program Web pages were referenced to identify currently active women in plastic surgery. To ensure complete collection, current program directors were contacted by email and asked to volunteer the names of women in plastic surgery who held academic appointments during the study period. In instances of ambiguity, faculty gender was inferred from online biographies and/or professional images.

Quantification of Academic Output

A search of the National Library of Medicine (PubMed) database was performed for each individual surgeon to quantify academic work. Faculty names were searched as "last name, first name, middle initial" whenever possible, and institutional affiliations were cross-referenced with faculty biographies. For each surgeon the following were collected: (1) the total number of articles published after training; (2) the number of journals featuring their work; (3) the current (2016) 5-year impact factor for each journal in which the article was published; and (4) the research category of each published article. The Web of Science database was referenced to obtain impact factor information.[19]

RESULTS

Presence of Women in Plastic Surgery

The percentage of women in plastic surgery residents at integrated plastic surgery programs increased from 22 percent in 2007 to 40 percent in 2015. In contrast, the percentage of women in plastic surgery residents at independent plastic surgery programs remained between 22 and 25 percent during this same period (Fig. 1).

A total of 235 women in plastic surgery faculty members were identified to have been in practice in the United States between 1976 and 2016. One hundred fifty-five faculty members were currently active and 80 were retired or no longer in academic practice. Seventeen faculty members (7 percent) held dual degrees and six faculty members (2 percent) held an M.D. or Ph.D. degree.

Academic Output of Women in Plastic Surgery

Over 40 years, the 235 women in plastic surgery faculty authored 2982 publications. Of these, 599 (20 percent) reported basic science work. Articles were published in 479 peer-reviewed journals with an average 5-year impact factor of 4.1.

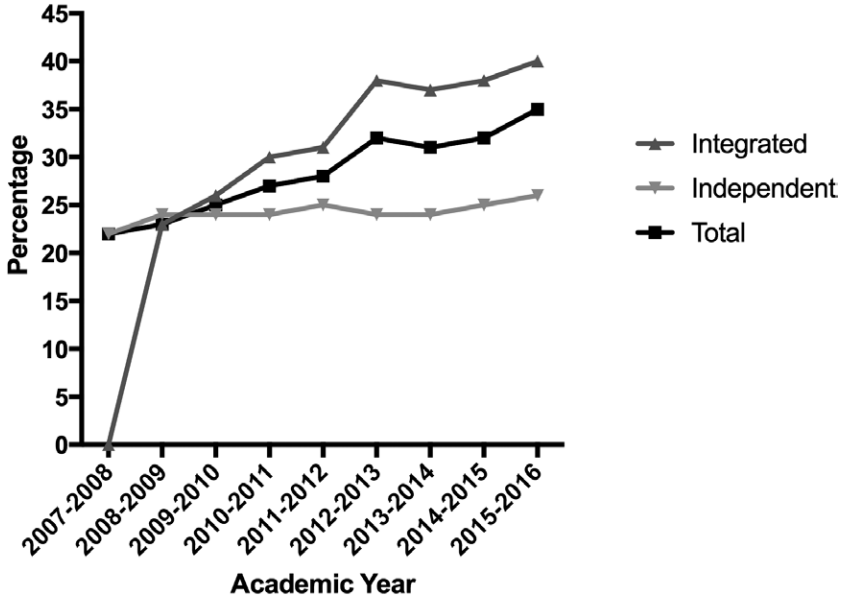

Fig. 1. Percentage of female residents at independent and integrated Accreditation Council for Graduate Medical Education–accredited plastic surgery programs for each academic year, and the total number of female residents at Accreditation Council for Graduate Medical Education–accredited plastic surgery programs between 2007 and 2016.

These publications included women as the first authors in 24 percent and as senior (corresponding) authors in 30 percent, whereas 55 articles (1.84 percent) were the work of solo women in plastic surgery authors.

The number of women authoring peer-reviewed publications and the number of publications increased exponentially over time (Figs. 2 and 3). On average, women in plastic surgery faculty authorship increased over time, typically peaking after 15 to 30 years in practice (Fig. 4).

Published women in plastic surgery research topics increased over time (Fig. 5), as did the number of authors publishing in each topic. (**See Figure, Supplemental Digital Content 1**, which shows the number of women publishing on each plastic surgery topic by decade studies, ***http://links.lww.com/PRS/C750***.) From 1976 to 1985, the majority of publications reported on hand surgery or peripheral nerve repair, and in the following decades there was a diversification of research, with publications reporting on nearly all areas

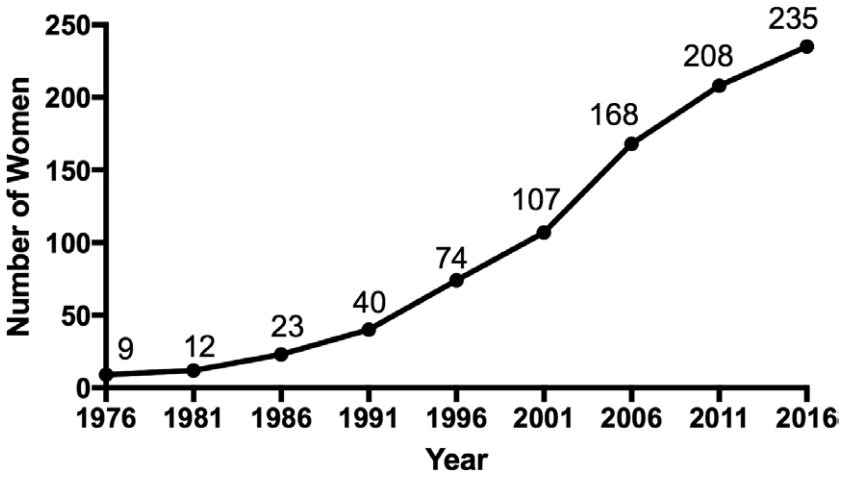

Fig. 2. Total number of female academic plastic surgeons publishing peer-reviewed articles from 1976 to 2016.

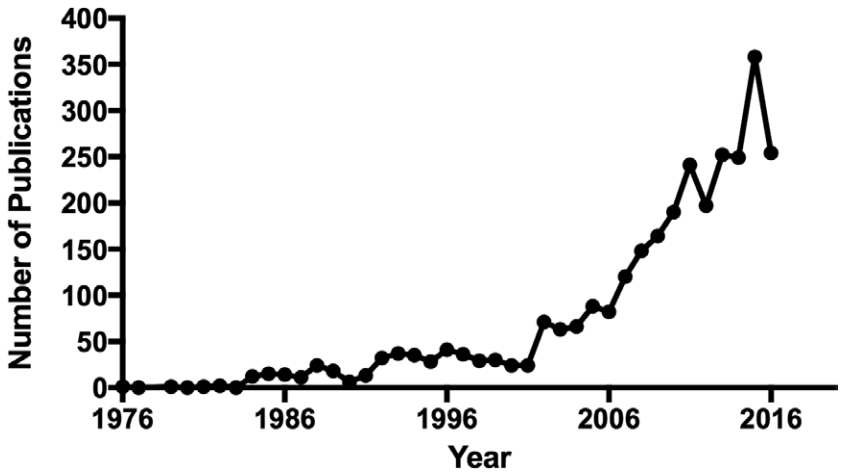

Fig. 3. Total number of peer-reviewed articles, per year, published by female academic plastic surgeons from 1976 to 2016.

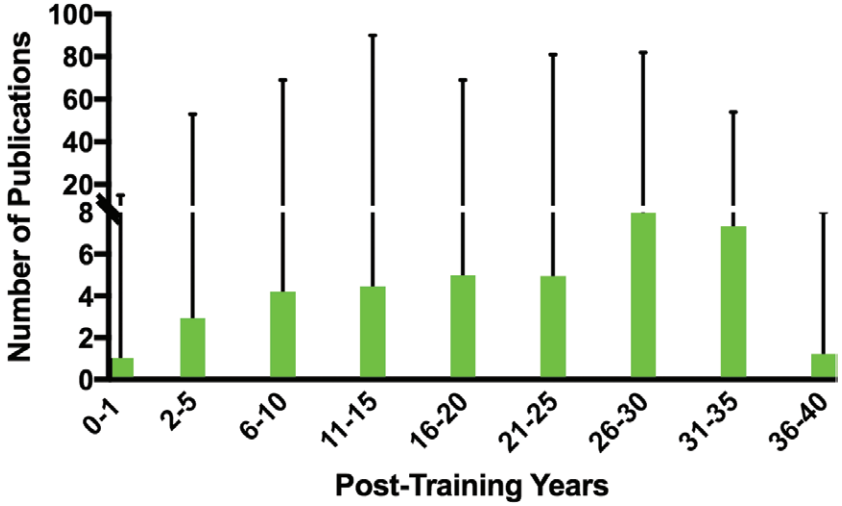

Fig. 4. Average number of publications authored by female academic plastic surgeons every 5-year period, following training. *Vertical lines* depict the range of articles published by the faculty cohort studied.

of plastic surgery. In the past decade, breast and craniofacial research equally yielded the greatest number of publications by women in plastic surgery faculty. The proportion of contributions in microsurgery, aesthetic surgery, and educational/academic plastic surgery all increased during the past 19 years, with microsurgery constituting less than 6 percent of all publications in each decade throughout the study period.

DISCUSSION

Women are increasingly pursuing surgical careers. Although women surgeons have not yet reached gender parity, plastic surgery harbors the highest percentage of women academicians.[5] This dynamic shift in gender distribution highlights the importance of identifying trends in research endeavors by women in plastic surgery for sustained productivity. In addition, identifying these trends over the entirety of a plastic surgery career are particularly important. We present the first summary of the academic productions of the entirety of women in plastic surgery faculty over the past 40 years. Women currently constitute 40 percent of integrated plastic surgery trainees, a 2-fold increase from the prior decade. Although gender distributions among independent plastic surgery residents have remained constant, the shift toward more integrated training programs and the dramatic rise in women at these programs shows a general progression toward greater female presence.

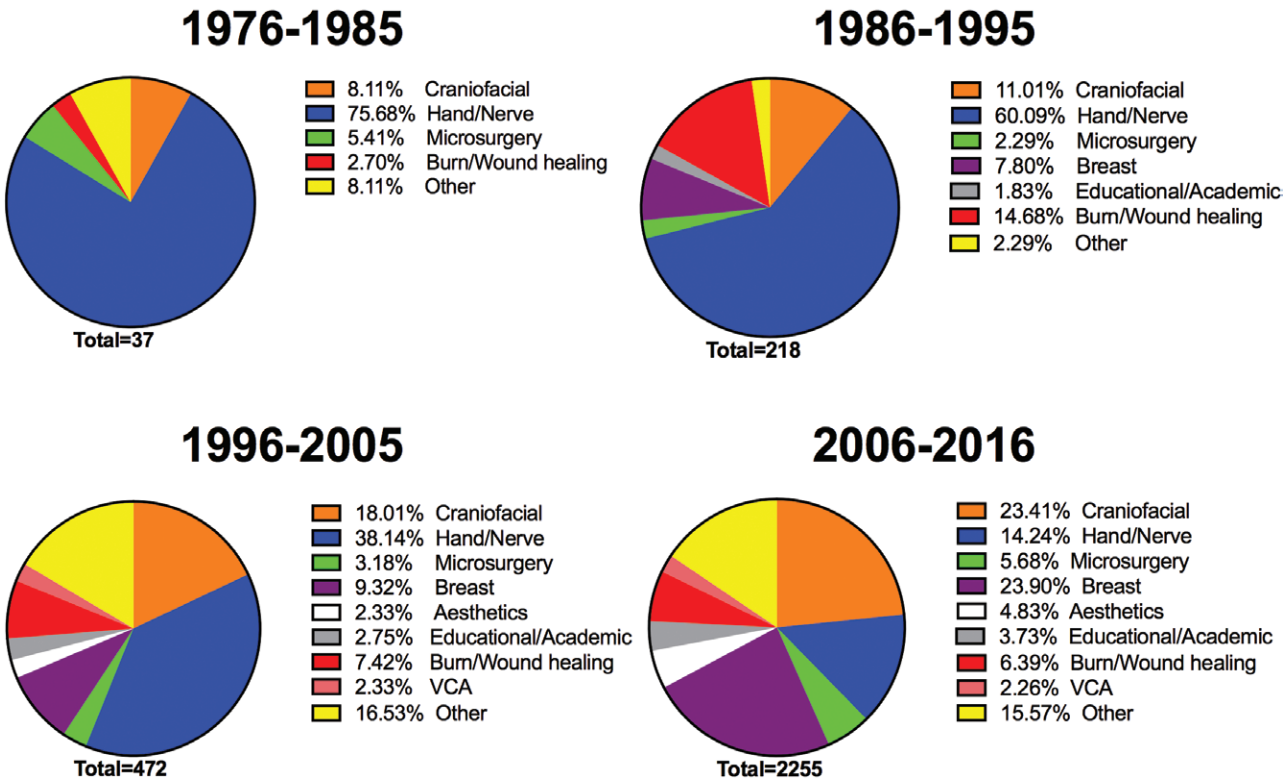

Fig. 5. Publications categorized by plastic surgery topic reported in (*above*, *left*) 1976 to 1985, (*above*, *right*) 1986 to 1995, (*below*, *left*) 1996 to 2005, and (*below*, *right*) 2006 to 2016. *VCA*, vascularized composite tissue allotransplantation.

A recent study demonstrated that the rigors of plastic surgery training can negatively impact women's pursuit of a spouse. Delaying marriage resulted in lowered expectations of a partner's level of education, income, and professional success.[19] Job constraints have been shown to specifically contribute to unmarried status in 50 percent of divorced female surgeons. To add to these challenges, residency training typically coincides with a woman's prime reproductive years, heightening pressures between starting a family when biologically appropriate and building a plastic surgery career. At present, no specific policy for maternity leave exists for residents at Accreditation Council for Graduate Medical Education–accredited programs. Little flexibility is afforded by the American Board of Plastic Surgery policy that offers the possibility of 2 additional weeks averaged over the last 2 years of training to be allotted for maternity/medical leave.[20] Despite these well-known issues that might deter surgical interest, women surgeons are overall satisfied with their careers and its impact on their personal lives.[6] In contrast, male academic surgeons are more disapproving, believing that a surgical career is not suitable for a woman.[21]

In the past 40 years, fewer than 300 women have held academic positions in Accreditation Council for Graduate Medical Education–accredited plastic surgery programs. Generally, women physicians enter academic practice at a higher rate than men[22]; however, within the field of plastic surgery, only 14.1 percent of current academicians are women.[9] Moreover, currently only 10 percent of the American Council of Academic Plastic Surgeons and 15 percent of the American Society of Plastic Surgeons members are women.[19,23] Nevertheless, the American Society of Plastic Surgeons has observed a 120 percent growth in female membership since 2000, further supporting women's increasing participation in academia of plastic surgery. The field continues to battle academic recruitment and startling attrition rates in light of the financial and flexible attractions of private practice, regardless of gender. Only 27 percent of male and female plastic surgery graduates are holding faculty positions within the first few years of practice,[24] and after 5 years as many as two-thirds of subspecialty-trained plastic surgeons abandon their academic roles.[9] Nevertheless, academic environments can be alluring to women surgeons who wish to strike a balance between their personal and professional goals, awarding them a degree of autonomy (in the form of protected research time) and

institutional support to engage in their research interests.

Altogether, in the present study, women in plastic surgery faculty published nearly 3000 articles after training, with an exponential increase in publications over time. The most dramatic publication increase was observed in the past decade, owing to a greater number of women involved in research. Importantly, the number of publications per author increased over the course of their careers, peaking in posttraining years 20 to 30, which demonstrates a headstrong commitment by women in plastic surgery to contribute to the academic literature. A similar phenomenon is reported in other medical specialties where research productivity among women flourishes later in their careers and can equal or exceed men's productivity once they enter senior-level positions.[10,25] Patterns such as these are important evidence that disfavor direct female-to-male comparisons of academic productivity, as they follow different research trajectories.[22] As a whole, this underscores the notion that women academicians should not be overlooked because of the slow acceleration of their research productivity during the early part of their careers.

The impact of women in plastic surgery faculty contributions has been quantitatively profound, but not at the expense of quality work. Their research was published in 479 peer-reviewed journals that reached an average 5-year impact factor of 4.1; this is nearly double the average impact factor of articles published in the top 10 plastic surgery journals (impact factor = 2.1) as of 2013.[26] Female authors have featured their work in a broad selection of journals, branching outside of the plastic surgery literature, and publishing in some of the top medical journals. Moreover, more than half of the publications included were spearheaded by the female surgeon as either the primary or the senior author; this indicates an active participation in research activities as the main driver of the study or senior advisor to a research team. Publications in which women in plastic surgery were the sole authors suggests that they not only participate in evidence-based studies, but are also regarded as experts and invited discussants for a series of plastic surgery topics.

Recognition of the academic achievements of women in plastic surgery faculty over the past 40 years is critical: it helps set standards to which future generations of women in plastic surgery should aspire. Inherently, mentorship by women is the key ingredient to foster ambition and provide younger women with the necessary tools to advance in the existing structures of academic plastic surgery. Female role models have been shown to be the most influential factor for female medical students interested in surgery,[27] and a lack of female mentors may explain some of the gender gaps in leadership among plastic surgery programs.[28]

Although it is the first of its kind, this study has several limitations. Importantly, there likely is an underrepresentation of active women in plastic surgery faculty accounted for at any time. In part, this can be attributed to our reliance on the memory and cooperation of current program directors for details regarding women in plastic surgery academic appointments dating back decades. In addition, as we only referred to a single academic database (PubMed), our bibliometric search may not be comprehensive; online scientific databases reporting academic metrics of productivity have been shown to be inconsistent,[29] and referencing a single database may not reflect a female plastic surgeon's entire academic contributions.

CONCLUSIONS

The presence of women in plastic surgery is steadily increasing both at the training level and in plastic surgery practice. Their academic contributions over the past 40 years have been profound, and their productivity increases the longer they hold their academic positions. More flexibility in promotion criteria and academic assessments will facilitate women, often balancing their early careers with significant family/parenting obligations, to remain in academia as valuable educators and mentors. Consistent with studies of women in other medical specialties, women's output flourishes later in their careers; thus, the field should focus on nurturing and retaining women faculty to allow them to reach their long-term potential of full and productive academic careers.

Alexes Hazen, M.D.
Hansjörg Wyss Department of Plastic Surgery
New York University Langone Medical Center
303 East 33rd Street
Lower Level
New York, N.Y. 10016
alexes.hazen@nyumc.org

REFERENCES

1. Kemeny MM. Jonasson, Braunwald, and Morani: Three firsts in American surgery. *Arch Surg.* 1993;128:643–646.
2. Ali AM, McVay CL. Women in surgery: A history of adversity, resilience, and accomplishment. *J Am Coll Surg.* 2016;223:670–673.

3. Solomon MP, Granick MS. Alma Dea Morani, MD: A pioneer in plastic surgery. *Ann Plast Surg.* 1997;38:431–436.
4. Association of American Medical Colleges. Total graduates by U.S. medical school and sex, 2011–2012 through 2015–2016. Available at: https://www.aamc.org/data/facts/enrollmentgraduate/148670/total-grads-by-school-gender.html. Accessed May 12, 2017.
5. Baerlocher MO. Does sex affect residency application to surgery? *Can J Surg.* 2007;50:434–436.
6. Capek L, Edwards DE, Mackinnon SE. Plastic surgeons: A gender comparison. *Plast Reconstr Surg.* 1997;99:289–299.
7. Silva AK, Preminger A, Slezak S, Phillips LG, Johnson DJ. Melting the plastic ceiling: Overcoming obstacles to foster leadership in women plastic surgeons. *Plast Reconstr Surg.* 2016;138:721–729.
8. Waljee JF, Chang KW, Kim HM, et al. Gender disparities in academic practice. *Plast Reconstr Surg.* 2015;136:380e–387e.
9. Gast KM, Kuzon WM Jr, Adelman EE, Waljee JF. Influence of training institution on academic affiliation and productivity among plastic surgery faculty in the United States. *Plast Reconstr Surg.* 2014;134:570–578.
10. Reed DA, Enders F, Lindor R, McClees M, Lindor KD. Gender differences in academic productivity and leadership appointments of physicians throughout academic careers. *Acad Med.* 2011;86:43–47.
11. American Council for Graduate Medical Education. ACGME Data Resource Book. Academic Year 2008–2009. Available at: http://www.acgme.org/About-Us/Publications-and-Resources/Graduate-Medical-Education-Data-Resource-Book. Accessed May 12, 2017.
12. American Council for Graduate Medical Education. ACGME Data Resource Book. Academic Year 2009–2010. Available at: http://www.acgme.org/About-Us/Publications-and-Resources/Graduate-Medical-Education-Data-Resource-Book. Accessed May 12, 2017.
13. American Council for Graduate Medical Education. ACGME Data Resource Book. Academic Year 2010–2011. Available at: http://www.acgme.org/About-Us/Publications-and-Resources/Graduate-Medical-Education-Data-Resource-Book. Accessed May 12, 2017.
14. American Council for Graduate Medical Education. ACGME Data Resource Book. Academic Year 2011–2012. Available at: http://www.acgme.org/About-Us/Publications-and-Resources/Graduate-Medical-Education-Data-Resource-Book. Accessed May 12, 2017.
15. American Council for Graduate Medical Education. ACGME Data Resource Book. Academic Year 2012–2013. Available at: http://www.acgme.org/About-Us/Publications-and-Resources/Graduate-Medical-Education-Data-Resource-Book. Accessed May 12, 2017.
16. American Council for Graduate Medical Education. ACGME Data Resource Book. Academic Year 2013–2014. Available at: http://www.acgme.org/About-Us/Publications-and-Resources/Graduate-Medical-Education-Data-Resource-Book. Accessed May 12, 2017.
17. American Council for Graduate Medical Education. ACGME Data Resource Book. Academic Year 2014–2015. Available at: http://www.acgme.org/About-Us/Publications-and-Resources/Graduate-Medical-Education-Data-Resource-Book. Accessed May 12, 2017.
18. American Council for Graduate Medical Education. ACGME Data Resource Book. Academic Year 2015–2016. Available at: http://www.acgme.org/About-Us/Publications-and-Resources/Graduate-Medical-Education-Data-Resource-Book. Accessed May 12, 2017.
19. Ridgway EB, Sauerhammer T, Chiou AP, LaBrie RA, Mulliken JB. Reflections on the mating pool for women in plastic surgery. *Plast Reconstr Surg.* 2014;133:187–194.
20. The American Board of Plastic Surgery, Inc. *ABPS Booklet of Information July 1, 2016 - June 30, 2017.* Philadelphia: The American Board of Plastic Surgery; 2016–2017.
21. Ahmadiyeh N, Cho NL, Kellogg KC, et al. Career satisfaction of women in surgery: Perceptions, factors, and strategies. *J Am Coll Surg.* 2010;210:23–28.
22. Nonnemaker L. Women physicians in academic medicine: New insights from cohort studies. *N Engl J Med.* 2000;342:399–405.
23. Wargo J. American Society of Plastic Surgeons membership statistics. Accessed August 10, 2017.
24. Herrera FA, Chang EI, Suliman A, Tseng CY, Bradley JP. Recent trends in resident career choices after plastic surgery training. *Ann Plast Surg.* 2013;70:694–697.
25. Eloy JA, Svider P, Chandrasekhar SS, et al. Gender disparities in scholarly productivity within academic otolaryngology departments. *Otolaryngol Head Neck Surg.* 2013;148:215–222.
26. Rymer BC, Choa RM. A worldwide bibliometric analysis of published literature in plastic and reconstructive surgery. *J Plast Reconstr Aesthet Surg.* 2015;68:1304–1308.
27. Neumayer L, Kaiser S, Anderson K, et al. Perceptions of women medical students and their influence on career choice. *Am J Surg.* 2002;183:146–150.
28. Arneja J, McInnes C, Carr Nj, et al. Do plastic surgery division heads and program directors have the necessary tools to provide effective leadership? *Plast Surg (Oakv.)* 2014;22:241–245.
29. Plana NM, , Massie JP, Bekisz JM, Spore S, Diaz-Siso JR, Flores RL. Variations in databases used to assess academic output and citation impact. *N Engl J Med.* 2017;376:2489-2491.