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Research

Gender and academic promotion of Canadian general surgeons: a cross-sectional study

Nada Gawad MD MAEd, Alexandre Tran MD MSc, Andre B. Martel MD, Nancy N. Baxter MD PhD, Molly Allen MD MSc, Neraj Manhas BSc, Fady K. Balaa MD MEd

Abstract

Background: Gender disparities in faculty rank have yet to be studied among Canadian physicians. The purpose of this study was to determine whether differences in region, training, research productivity and years in practice explain gender differences in academic promotion among Canadian general surgeons.

Methods: We developed a cross-sectional database of faculty-appointed general surgeons practising in the hospitals affiliated with the 17 universities within the Association of Faculties of Medicine of Canada in 2017 using publicly available directories, university and hospital websites, and direct communication. The data were collected between October and December 2018 and included gender, residency completion year, graduate education, fellowships, number of publications and Scopus h-index; faculty lists and professorship status were verified by program administrators or division heads of their respective divisions. The dependent variable was binary: full professor or not. A combined outcome of associate or full professor was also analyzed. We analyzed all variables in a multivariable logistic regression model.

Results: Of the 17 institutions contacted, all but 1 confirmed the faculty lists and professorship status. A total of 405 surgeons were included, of whom 111 (27.4%) were women. Sixty-eight women (61.3%) and 120 men (40.8%) were assistant professors, and 9 women (8.1%) and 75 men (25.5%) were full professors. Although on average women had completed residency more recently than men (15.2 yr v. 19.2 yr, $p < 0.001$), there was no difference between men and women in the mean number of publications as residents (2.98 v. 2.74, $p = 0.7$) or per year of practice (3.12 v. 2.09, $p = 0.2$), number of fellowships pursued ($p = 0.7$) or graduate education ($p = 0.2$). In the multivariable model (C-statistic = 0.88), gender remained significantly associated with full professorship (odds ratio 2.79, 95% confidence interval 1.13 to 6.92), along with years in practice (odds ratio 1.61, 95% confidence interval 1.13 to 2.30).

Interpretation: After controlling for years in practice, training and research productivity measures, we found that female surgeons with faculty appointments in Canada were less likely than their male counterparts to receive promotion to full professor. Pervasive inequities in systems of promotion must be addressed.

Gender disparity in academic promotion has been investigated among physicians in the United States.[1,2] After age, experience, specialty and research productivity are accounted for, women are less likely than men to be full professors.[2] Markers suggestive of inequity, defined as a lack of fairness, in academia also exist among Canadian professors, with women representing only 27.6% of full professors[3] and receiving on average $10 263 less than men in annual salary.[4] In addition, women account for just 12% of faculty of medicine deans.[5] With respect to specialty-specific disparity, the barriers faced by women are more pronounced in surgical careers.[6] Despite recent increases, women still represent only 27% of Canadian surgeons[7] and an even lower proportion of academic surgeons.[6] Studies show consistent challenges faced by women, such as the perception of fewer career advancement opportunities,[8] suboptimal maternity leave and child care,[7,9] gender-based discrimination,[10] an "old boys' club" culture of practice[11] and a lack of female mentors.[12,13]

Despite similarities in gender disparity within Canadian and US academia, perhaps the long-standing female majority among medical graduates and increased proportion of female surgical trainees in Canada have allowed for the correction of the inequities of the previous era (i.e., the pipeline effect).

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Correspondence to: Fady Balaa, fbalaa@toh.ca

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Thus, the purpose of this study was to determine whether differences in region, training, research productivity and years in practice explain gender differences in academic promotion among Canadian general surgeons.

Methods

Setting and research team

This study included all hospitals affiliated with the 17 universities within the Association of Faculties of Medicine of Canada.[14] Data were collected between October and December 2018. Professorship designation was determined as of October 2018. Markers of research productivity were gathered in December 2018.

The research team consisted of general surgeons with faculty appointments, general surgery residents and medical students. Graduate credentials of the team ranged from 1 PhD to master's degrees in epidemiology, education and basic science. Three team members were female and 4 were male. There was a wide range of relevant experience, including expert knowledge of the gender equity research field and the academic promotion process.

Study population

The study population consisted of all currently practising Canadian adult general surgeons with a faculty appointment designated as assistant, associate or full professor. We excluded pediatric, vascular and thoracic surgeons from our database, since, for the majority of Canadian institutions, these surgeons exist in separate divisions. Community surgeons with clinical, part-time or adjunct university affiliations, as well as those holding status as professor emeritus, clinical instructor or associate, or a locum position were also excluded. We could not accurately determine the number of surgeons excluded based on these criteria as there was substantial heterogeneity between institutions with respect to listing excluded surgeons on their divisional website.

We obtained lists of general surgeons included in this study from publicly available directories (Appendix 1, available at www.cmajopen.ca/content/8/1/E34/suppl/DC1). We contacted program administrators or division heads of their respective divisions to verify faculty lists and professorship status in order to maximize accuracy and completeness.

Data sources

We created a cross-sectional database using a standardized data abstraction form in Microsoft Excel to include all academic Canadian general surgeons.[15] We hand-searched first university, then hospital and provincial college registries. For each surgeon, data were gathered by 3 authors (N.G., A.T., A.B.M.) with respect to institution of practice; faculty appointment and rank; year of residency completion described by year of becoming a Fellow of the Royal College of Physicians and Surgeons of Canada (FRCSC); completion of graduate degrees (master's, PhD) or certificates; gender; and number, subspecialty and location of fellowship training.

After faculty lists and academic designations were verified by the respective divisions, 1 of 2 study authors (M.A., N.M.) conducted a quantitative citation analysis of markers of research productivity for each surgeon using the Scopus database. Scopus was used because its citation analysis includes more articles and more citations per article than other databases.[16,17] The citation analysis used evaluative bibliometrics[18,19] and included number of authored publications (first author, last author, total), both in-residency and overall, as well as the Scopus h-index as a time-based metric of publication impact. The h-index is defined as the maximum value of h such that the author has published h papers that have each been cited h times.[20] Group discussion and consensus among authors (N.G., A.T., A.B.M.) were used to make a judgment in areas of uncertainty regarding whether a given publication was attributable to the surgeon in question or represented a publication by someone with the same name.

Since data were compiled from multiple sources, a second study author (N.G., A.T. or A.B.M.) performed a 10% audit of all participants in the data independently and in duplicate to confirm interrater reliability. No discrepancies were observed. Of note, we searched Scopus for authorship under both maiden and married names when available in provincial directories.

Statistical analysis

For descriptive analyses, we described categorical variables using proportions and χ^2 testing, and defined continuous variables using means, standard deviations (SDs) and t testing. Possible confounders for differences in professorship status between men and women may include number of years since residency completion, graduate degrees, fellowship training and markers of research productivity. Thus, we created a multivariable logistic regression model to evaluate the relation between gender and likelihood of promotion to full professorship (binary dependent variable) while controlling for level of graduate study (none, master's, PhD), fellowship training (yes or no), years in practice (continuous), total number of publications (continuous) and h-index (continuous). We determined variables for confounding adjustment a priori based on previously demonstrated importance in the literature.[2,21,22]

All missing data points were considered missing at random. There was less than 5% missing data for all variables of interest. As such, this was handled with case-wise deletion, resulting in an effective sample size greater than 95% for analysis. We tested assumptions of logistic regression. In particular, we evaluated potential multicollinearity using variance inflation factors.[23] In addition, we avoided arbitrary categorization of continuous variables and evaluated potential inflection points for consideration of flexible modelling. Last, we considered sample size limitations when determining available degrees of freedom for analysis.[24] We adhered to an event-per-variable ratio of about 10 to 1 to minimize potential overfitting.

As in existing literature on gender difference in academic rank,[2] the primary outcome was full professorship, as this represents the highest rank of academic promotion. We performed a secondary analysis to evaluate the relation between

gender and the composite outcome of promotion to either associate or full professorship, as described in a previous study.[2] To do so, we fit a secondary multivariable logistic regression model using the same predictor variables previously described, though with the composite outcome as the dependent variable. The absolute adjusted difference between men and women with full professor status is reported, along with the 95% confidence intervals (CIs). Statistical significance was defined as $p < 0.05$. We used SAS 9.4 software (SAS Institute) for all analyses.

Ethics approval

Given the publicly available nature of the data, a request for waiver of ethics approval was granted by the Ottawa Health Science Network Research Ethics Board.

Results

Of the 17 institutions contacted, all but 1 responded to our request for confirmation of faculty lists and professorship status. The study population consisted of 405 academic general surgeons, of whom 111 (27.4%) were women. On average, women had been in practice for fewer years than men (15.20 [SD 8.92] yr v. 19.24 [SD 11.08] yr, $p < 0.001$) and were less likely than men to be full professors (9 [8.1%] v. 75 [25.5%], $p < 0.001$). Similar proportions of women and men had completed graduate degrees and fellowship training. An overview of the characteristics of the study population is provided in Table 1.

Research productivity is presented in Table 2. As residents, there was no difference between men and women in the average number of first-author publications (1.45 [SD 2.94] v. 1.41 [SD 2.16], $p = 0.9$) or last-author publications (0.1 [SD 0.47] v. 0.18 [SD 0.57], $p = 0.5$), or the total number of publications (2.98 [SD 5.48] v. 2.74 [SD 4.71], $p = 0.7$). Over entire careers, there was no difference between men and women in the median number of first-author publications (5.0 [interquartile range 11.0] v. 4.5 [interquartile range 7.0]). However, men published significantly more last-author publications (4.0 [11.3] v. 2.0 [5.0]), and total publications (25.0 [54.0] v. 15.0 [28.3]) over their careers than women. Figure 1 shows the relation between number of publications and number of years in practice among male and female general surgeons. In addition, the h-index was significantly higher for men than for

Table 1: Characteristics of practising Canadian academic general surgeons by gender

Characteristic	No. (%) of surgeons*		p value
	Men n = 294	Women n = 111	
Year of FRCSC graduation			< 0.01
Before 1990	68 (23.1)	10 (9.0)	
1990–1999	69 (23.5)	27 (24.3)	
2000–2009	97 (33.0)	41 (36.9)	
2010–2017	45 (15.3)	33 (29.7)	
Missing	15 (5.1)	0 (0.0)	
No. of years in practice (after FRCSC), mean ± SD	18.5 ± 18.0	13.5 ± 14.3	< 0.001
Graduate education			0.2
None	153 (52.0)	45 (40.5)	
Master's	93 (31.6)	48 (43.2)	
PhD	28 (9.5)	14 (12.6)	
Other	48 (16.3)	22 (19.8)	
No. of fellowships			0.7
0	83 (28.2)	31 (27.9)	
1	176 (59.9)	70 (63.1)	
≥ 2	35 (11.9)	10 (9.0)	
Professorship level			< 0.001
Assistant	120 (40.8)	68 (61.3)	
Associate	99 (33.7)	34 (30.6)	
Full	75 (25.5)	9 (8.1)	

Note: FRCSC = Fellow of Royal College of Physicians and Surgeons of Canada, SD = standard deviation.
*Except where noted otherwise.

Table 2: Research productivity by gender and professorship status

Variable	Professorship status; median (IQR)		
	Assistant *n* = 188	Associate *n* = 133	Full *n* = 84
Publications before FRCSC			
All surgeons			
First author	0.0 (2.0)	0.0 (2.0)	0.0 (2.0)
Last author	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)
Total	1.0 (4.0)	1.0 (3.0)	1.0 (4.3)
Men			
First author	0.0 (1.3)	0.0 (1.5)	0.0 (2.0)
Last author	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)
Total	0.5 (4.0)	1.0 (3.0)	1.0 (5.0)
Women			
First author	0.0 (2.0)	0.5 (2.0)	1.0 (2.0)
Last author	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)
Total	1.0 (4.0)	1.0 (3.0)	2.0 (3.0)
All publications			
All surgeons			
First author	2.0 (6.0)	5.0 (9.0)	17.0 (24.5)
Last author	0.0 (3.0)	5.0 (8.0)	22.5 (35.3)
Total	9.0 (17.3)	29.0 (33.0)	98.5 (125.3)
Men			
First author	2.0 (6.0)	4.0 (9.0)	17.0 (25.0)
Last author	0.0 (3.0)	5.0 (8.0)	21.0 (35.5)
Total	8.5 (17.5)	28.0 (32.0)	102.0 (123.0)
Women			
First author	3.0 (5.3)	6.0 (8.5)	16.0 (12.0)
Last author	0.5 (2.3)	5.0 (10.0)	24.0 (48.0)
Total	9.0 (14.8)	32.0 (34.0)	95.0 (128.0)
h-index			
All surgeons	4.0 (6.3)	11.0 (9.0)	28.0 (23.5)
Men	4.0 (7.3)	11.0 (10.0)	28.0 (25.0)
Women	4.5 (6.3)	12.5 (8.8)	29.0 (18.0)

Note: FRCSC = Fellow of Royal College of Physicians and Surgeons of Canada, IQR = interquartile range.

women (11.0 [14.0] v. 7.5 [11.0]). However, the mean number of publications per year of practice (i.e., after attaining FRCSC) was similar between men and women (3.12 [SD 9.09] v. 2.09 [SD 2.48], $p = 0.2$).

After adjustment for graduate degree, fellowship training, total publications, h-index and years in practice, women were less likely than men to be full professors (odds ratio [OR] 2.79, 95% CI 1.13 to 6.92) (Table 3). Years in practice was independently positively associated with full professorship (OR 1.61, 95% CI 1.13 to 2.30). Total number of publications was also positively associated with full professorship, but did not reach significance (OR 1.18, 95% CI 1.00 to 1.39). The concordance statistic (C-statistic) for the model was 0.88, which suggests excellent predictive performance.

In the secondary analysis to evaluate a composite outcome of promotion to associate or full professor, after adjustment for the same variables as in the first multivariable analysis, women were less likely than men to be associate or full professors (OR 1.93, 95% CI 1.10 to 3.38) (Table 4). Years in practice was also independently positively associated with promotion to associate or full professorship (OR 2.35, 95% CI 1.72 to 3.19) as was h-index (OR 1.09, 95% CI 1.00 to 1.19). The C-statistic for this model was 0.87, which also suggests excellent predictive performance.

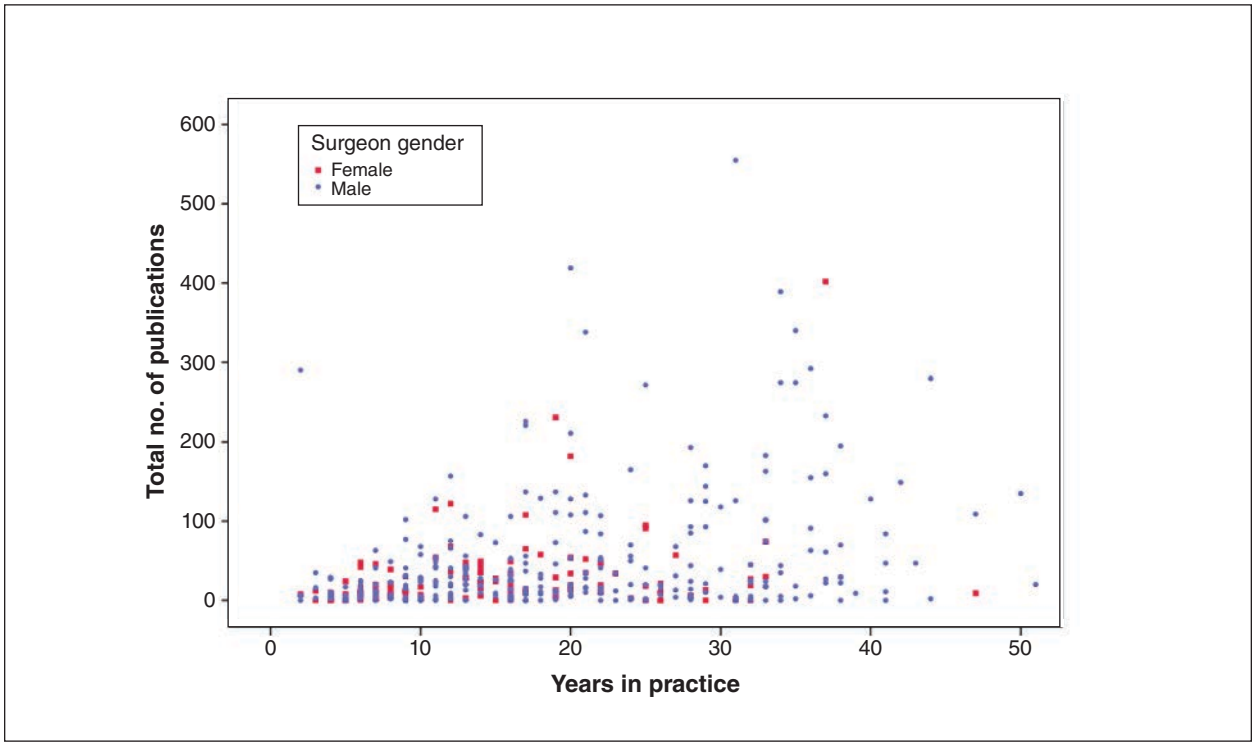

Figure 1: Scatterplot of number of publications by male and female surgeons based on number of years in practice.

Table 3: Multivariable analysis of variables associated with full professorship

Variable	OR (95% CI)
Degree	
None	Reference
Master's	0.87 (0.39 to 1.95)
PhD	0.70 (0.22 to 2.29)
Total publications	
Per 10 publications	1.18 (1.00 to 1.39)
h-index	1.05 (0.97 to 1.13)
Fellowships	
0	Reference
≥ 1	0.52 (0.24 to 1.13)
Practice years, per decade of practice	1.61 (1.13 to 2.30)
Gender	
Female	Reference
Male	2.79 (1.13 to 6.92)

Note: CI = confidence interval, OR = odds ratio.

Table 4: Multivariable analysis of variables associated with combined outcome of associate or full professorship

Variable	OR (95% CI)
Degree	
None	Reference
Master's	1.47 (0.79 to 2.76)
PhD	0.85 (0.32 to 2.21)
Total publications	
Per 10 publications	1.15 (0.91 to 1.46)
h-index	1.09 (1.0 to 1.19)
Fellowships	
0	Reference
≥ 1	1.00 (0.54 to 1.87)
Practice years, per decade of practice	2.35 (1.72 to 3.19)
Gender	
Female	Reference
Male	1.93 (1.10 to 3.38)

Note: CI = confidence interval, OR = odds ratio.

Interpretation

In this study exploring the factors associated with academic promotion among Canadian general surgeons, we found that, after years in residency, graduate and fellowship training, and research productivity were controlled for, men were more likely to be promoted in professorship status than women. Given the long-standing substantial proportion of female general surgeons in Canada, this study serves as a natural experiment to determine whether the pipeline effect explains the

gender disparity in promotion. Our model shows good overall predictive ability and expected relations between promotion and other variables, such as years in practice. Our findings highlight ongoing gender inequity in academia, suggest that the pipeline cannot be sufficiently relied on to correct gender inequity, and underscore the need to identify and eliminate existing barriers.

The gender inequity shown in this study is consistent with a recent US study of 91 000 physicians that showed that women were less likely to be full professors after age, experience, specialty and research productivity were accounted for.[2] Among the 4455 general surgeons included, the absolute adjusted gender difference in professorship was significant, at –4.6% (95% CI –7.6% to –1.6%). Variables controlled for included age, years since residency, publications, number of National Institutes of Health grants, whether a physician had conducted a clinical trial and whether a physician was a faculty member at a top-20 US medical school in research ranking.

Reasons for gender disparities in promotion are likely multifactorial. Gender discrimination has been shown to exist in academic medicine,[21,25–27] and, thus, gender bias, however unintentional, may contribute to the inequitable promotion given the inherent subjectivity of the promotion process. Institutional barriers, such as difficulty finding mentorship, sponsorship and female role models, lack of accommodation for differential family responsibilities and underrepresentation of women in leadership positions have been studied to explain the gender inequity.[22,28,29]

Multiple approaches to mitigate the barriers that result in the promotion inequity have been studied and are likely necessary. To date, the success of most programs is undermined by their "bottom-up" approach, which requires additional investment of those they intend to support, as opposed to a "top-down" approach, which begins with change from the higher management within academic institutions.[30]

A system of academic promotion is common to all Canadian faculties of medicine, with similar criteria that revolve around acknowledgement of contributions to specific aspects of the academic mission.[31–35] Although there are some institutional variations, the main themes guiding promotion are relatively universal across faculties of medicine internationally.[36–39] Promotion to full professor generally requires international recognition, which may serve as a barrier owing to less acceptance and fewer speaker invitations to female surgeons in many countries.[37,39,40]

Limitations

Promotion criteria are often described as multifaceted and generally include demonstration of excellence in 3 major spheres: education, scholarship and service to the university. The lack of specificity within these guidelines introduces the potential for subjectivity, which may enable subtle implicit biases to become influential. This subjectivity may be further exacerbated with the currently broadening definition of scholarly output compared to the traditional definition represented by grants and publications. Although publication is a common theme across all promotion processes, the inability to capture nonresearch factors (i.e., teaching, invited talks) that are not publicly available but may also support promotion represents a limitation to our study. Capturing the specific promotion track (i.e., education, scholarship, service to the university) would allow direct comparison between surgeons within each track.

There are several other limitations to this study, including the reliance on hand-searched data, which introduces potential misclassification bias, although minimized by triangulation of sources and standardized auditing. However, as any misclassification errors are equally likely to occur for data gathered for male and female surgeons, this limitation is likely nondifferential. Demographic data were also limited by maiden names, common names, movement between institutions and heterogeneity of professorship definitions across universities. Finally, we were unable to capture leaves of absence, such as parental leave, which may influence variables that take years into account. Although these demographic limitations may be affected by gender differences in a small subset of academic surgeons, they are unlikely to affect the results in a substantive way. Failure to identify publications owing to maiden names is more likely to undercredit women than men, thus creating bias to the null. The effect of common names and heterogeneity in professor titles between institutions is unlikely to affect gender differentially. The effect of movement between institutions is unknown, although it is thought to be uncommon among Canadian surgeons and may not affect professorship status. Although parental leave may represent an unmeasured confounder, the impact of parental leave on the promotion of female surgeons may instead represent 1 causal barrier contributing to the inequity observed.[41]

Other limitations include that 1 institution did not confirm the information gathered in the database, the within-directory accuracy of information gathered from physician directories is unknown, and we are unaware of internal audit processes for these directories. In addition, use of the h-index has limitations with respect to self-citation, time dependency, differences among research fields and that it does not take into account all citations.[42] These limitations are unlikely to affect gender differentially or, in the case of the h-index, may even create bias to the null because of time dependency. Finally, we treated missing data (5%) with case deletion under the assumption of missing at random. In the absence of an obviously plausible mechanism to suggest otherwise, this has been shown to be a reasonable assumption in practical situations[43] but nonetheless has the potential to introduce some degree of selection bias.

Conclusion

Among Canadian general surgeons with faculty appointments, women are significantly less likely than men to receive promotion to full professor when years in practice, clinical and graduate training, and measures of research productivity are controlled for. With increasing awareness of the pervasive gender inequity in systems of promotion, we must employ effort in identifying and eliminating the existing equity barriers.

Future studies should assess the effects of top-down approaches on equity in systems of promotion. Acknowledgement of the inequity in our own population, followed by its purposeful elimination, is integral to allowing our patients and the medical profession as a whole to benefit from the full potential of a diverse and inclusive physician workforce.

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Affiliations: Division of General Surgery, Department of Surgery, Faculty of Medicine (Gawad, Tran, Martel, Allen, Manhas, Balaa), The Ottawa Hospital, University of Ottawa, Ottawa, Ont.; Department of Surgery (Baxter), Li Ka Shing Knowledge Institute, St. Michael's Hospital, University of Toronto, Toronto, Ont.

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