

Gender disparity in academic orthopedic programs in Canada: a cross-sectional study

Jennifer Hunter, MD
 Ruby Grewal, MSc, MD
 Diane Nam, MSc, MD
 Kelly A. Lefavre, MSc, MD

Presented at the Resident Research Day, 2019 Orthopaedic Update and BC Orthopaedic Association Annual Meeting, May 1, 2019, Vancouver, BC

Accepted Mar. 5, 2021

Correspondence to:

J. Hunter
 3rd Floor, 2775 Laurel St
 Vancouver BC V5Z 1M9
 jennifer.hunter@alumni.ubc.ca

Cite as: *Can J Surg* 2022 March 9; 65(2).
 doi: 10.1503/cjs.008920

Background: The majority of the literature on gender disparity in orthopedic surgery is from the United States; the Canadian perspective is lacking. The objective of this study was to determine the representation of women faculty members and the proportion of women faculty in published leadership positions in academic orthopedic divisions and departments across Canada.

Methods: In this cross-sectional study, we used a Web-based search strategy to identify faculty listings for all 17 academic orthopedic programs affiliated with the Association of Faculties of Medicine of Canada for the 2018/19 academic year. For each faculty member identified, we determined gender (man or woman), professorial rank and leadership positions. We compared regional gender differences among 3 groups: schools in eastern Canada and Quebec (6), Ontario (6) and western Canada (5). Gender comparisons were made for all variables of interest.

Results: We identified 809 orthopedic surgeons at the 17 Canadian academic institutions, of whom 96 (11.9%) were women. In eastern Canada and Quebec, 16.2% of the faculty were women, significantly above the national average ($p = 0.03$). The corresponding values for Ontario and western Canada were 8.9% ($p = 0.1$) and 11.4% ($p = 0.7$). There were no significant differences in the proportions of women and men at lower levels of promotion, but significantly more men than women had attained full professorship (65 [9%] v. 1 [1%], $p = 0.002$). Women surgeons were not represented in leadership roles or within faculty roles of distinction.

Conclusion: In 2018/19, women orthopedic surgeons were underrepresented in faculty positions across academic orthopedic training programs in Canada, and were disproportionately underrepresented in promoted academic faculty roles and leadership positions. These data can be used to review and educate on equity in hiring and promotion, as well as to foster mentorship and transition planning.

Contexte : La majeure partie de la littérature sur la disparité entre les sexes en chirurgie orthopédique provient des États-Unis; la perspective canadienne fait défaut. L'objectif de cette étude était d'établir la représentation des femmes au sein du corps professoral universitaire et la proportion de ces femmes occupant des postes de direction (affichés publiquement) dans les divisions et départements orthopédiques des universités canadiennes.

Méthodes : Dans cette étude transversale, nous avons utilisé une stratégie de recherche sur le Web pour dresser la liste des professeurs des 17 programmes orthopédiques universitaires affiliés à l'Association des facultés de médecine du Canada pour l'année universitaire 2018/19. Nous avons établi le sexe (homme ou femme) et le rang professoral de chaque personne, et déterminé si elle occupait un poste de direction. Nous avons comparé des différences régionales entre 3 groupes : les établissements de l'Est du Canada et du Québec (6), de l'Ontario (6) et de l'Ouest du Canada (5). Les comparaisons entre les sexes ont été effectuées pour toutes les variables d'intérêt.

Résultats : Nous avons recensé 809 chirurgiens et chirurgiennes orthopédistes dans les 17 établissements universitaires canadiens, dont 96 (11,9 %) étaient des femmes. Cette proportion passait à 16,2 % dans l'Est du Canada et au Québec — nettement au-dessus de la moyenne nationale ($p = 0,03$). Les valeurs correspondantes pour l'Ontario et l'Ouest canadien étaient de 8,9 % ($p = 0,1$) et de 11,4 % ($p = 0,7$), respectivement. Il n'y avait pas de différences importantes dans les proportions de femmes et d'hommes aux échelons de promotion inférieurs, mais beaucoup plus d'hommes que de femmes avaient obtenu un poste de professeur titulaire (65 [9 %] c. 1 [1 %], $p = 0,002$). Aucune chirurgienne n'occupait un poste de direction ou ne détenait de titre de distinction professoral.

Conclusion : En 2018/19, les chirurgiennes orthopédistes étaient sous-représentées au sein du corps professoral dans l'ensemble des programmes de formation orthopédique universitaires au Canada, et étaient sous-représentées de manière disproportionnée aux échelons de promotion supérieurs et dans les postes de direction. Ces données peuvent être utilisées pour évaluer l'équité en matière d'embauche et de promotion, promouvoir l'éducation à ce chapitre et favoriser le mentorat et la planification de la transition.

The Canadian government creates and promotes policies that aim to eliminate workplace discrimination through the *Employment Equity Act*.¹ Canadian women hold 53% of postsecondary degrees.² However, women represent only 45% of the new-entry workforce.³ In the corporate world, women are increasingly funnelled out of the workforce at higher levels of promotion, to a low of 15% of all chief executive officer positions,³ a trend that is mirrored in the public sector.⁴ This disparity continues to occur despite decades of corporate,⁵ provincial⁶ and federal^{7,8} policies designed to further gender equity. Although there is ample evidence that increasing diversity improves organizational success and the financial bottom line across disciplines, disparity continues to exist.^{3,9-11} It has been suggested that continuing to advance gender equity in the workplace could add an additional 4%–9% to the Canadian gross domestic product.³

The field of medicine differs from other corporate workplaces. Its workforce has a larger proportion of highly educated and highly qualified women.¹² As women represented 79.7% of the 2019 Canadian health care workforce,¹³ medicine could be poised to be a leader in gender equity in the workplace. This sentiment has been expressed previously by women physician leaders.¹⁴ As in the business world, there is evidence in clinical care to suggest that gender diversity benefits patients and, in turn, organizations. A 2017 study showed lower mortality rates among Medicare patients treated by female physicians than among those treated by male physicians.¹⁵ Another 2017 article showed lower 30-day postoperative mortality for patients treated by female surgeons compared to those treated by male surgeons.¹⁶ Yet, there are multiple reports that women are underrepresented in academic faculty positions and leadership roles, as exemplified in Alberta,¹⁷ the United States,¹⁸ the European Union¹⁹ and Australia.²⁰ This trend occurs across specialties²¹ and is reflected in national medical societies.^{22,23}

There is also ample evidence of gender disparity in factors commonly associated with scholarly success and professional advancement. Witteman and colleagues²⁴ found that grant applications to the Canadian Institutes of Health Research are less successful when women as opposed to men are assessed as the principal investigator. Men speak at grand rounds presentations up to 30% more often than women,²⁵ and the proportional representation of women presenting at grand rounds lectures falls below the representation of women in medical school, residency and faculty in general.²⁶ Women in medical societies are under-recognized as award recipients, with zero or near-zero results for women award winners across multiple specialties despite varying representation in their fields.²⁷ In addition, a review of 60 major medical journals showed that only 10 of 63 editors-in-chief were women, and only 17.5% of all editorial board members were women, substantially less than men in every category.²⁸ In her article

on implicit bias, Cooke²⁹ described collective bias against female gender in academic medicine. Thus, it is unclear which factors contribute to ongoing gender disparities in higher leadership positions, especially when women physicians represent 42% of all Canadian physicians.³⁰

The proportion of women surgical residents increased from 32% to 43% between 2006 and 2016.³¹ In 2018, 30% of all Canadian surgeons were women,³⁰ and there has been increasing interest in research related to gender inequities that exist in surgical careers.³²⁻³⁴ In particular, it has been shown that women surgeons are less likely than men surgeons to ascend to leadership or academic positions.^{35,36} A 2021 Canadian study showed that this underrepresentation of women at the highest levels of leadership and promotion holds across surgical disciplines.³⁷ In orthopedic surgery, the majority of the literature is from the US; the Canadian perspective is lacking. Among US orthopedic surgeons, women are underrepresented in faculty roles, at leadership levels and in academic positions when compared to other surgical specialties.³⁸

The objective of this study was to determine the representation of women faculty members across the departmental appointment hierarchy and the proportion of women faculty in published leadership positions in academic orthopedic divisions and departments across Canada. Our hypothesis was that women are underrepresented in academic and leadership positions within orthopedic surgery in Canada.

METHODS

We performed a cross-sectional review of all 17 academic orthopedic programs affiliated with the Association of Faculties of Medicine of Canada. All 17 Canadian medical schools have a postgraduate training program in orthopedic surgery that exists as a division of orthopedic surgery in the department of surgery or as a stand-alone department of orthopedic surgery. Data for this study were collected in February 2019 by a single evaluator (J.H.) for consistency. A secured Excel database was created for storage of the study data. All faculty listed on publicly available university-affiliated websites were included in the study. The gender of residents enrolled in the 17 university-affiliated academic orthopedic programs was also recorded in the database. Orthopedic surgeons not affiliated with an academic university-affiliated hospital or training program were not included in this review.

Search procedure

We identified faculty members for each program on university faculty websites or university-affiliated hospital websites. For each faculty member identified, we determined gender, academic or clinical rank, and leadership positions held. We determined gender by name and

faculty photograph, if available, and confirmed it with the person's self-reported provincial college registration. We recognize that gender identity is a fluid construct, but for the purposes of data classification in this study, we classified people as either a man or a woman based on self-reporting. Possible academic and clinical ranks were inclusive of all titles encountered (Box 1). If there was a question regarding any of these data points, we reconfirmed the data by means of secondary searches on other relevant websites (i.e., provincial college registration, university faculty listings, personal websites, public curriculum vitae if available). French-language faculty appointment listings and leadership position titles were translated into the English equivalents for coding by a bilingual surgeon. This Web-based search methodology and data classification are consistent with other published studies in this field.^{26,28,36}

We also reviewed the 2018/19 orthopedic residency cohort data from individual program websites in the same manner as described above. If these data were not immediately available, we requested the gender breakdown of the resident cohort from the residency program administrator.

Statistical analysis

We initially analyzed the data using descriptive statistics. We first considered the faculty and resident groups as a whole. We compared regional gender differences between 3 groups of near-equivalent size: eastern Canada and Quebec (Dalhousie University, McGill University, Memorial University, Université de Montréal, Université de Sherbrooke and Université Laval), Ontario (McMaster University, Northern Ontario School of Medicine, Queen's University, University of Ottawa, University of Toronto and Western University) and western Canada (University of Alberta, University of British Columbia, University of

Calgary, University of Manitoba and University of Saskatchewan). We then analyzed faculty appointments for the same categories across gender.

The leadership roles of department head, division head and program director were reported uniformly. Other roles (e.g., residency program committee member, site director, surgical lead, research director, fellowship coordinator) were reported heterogeneously by each school; thus, they were grouped together and labelled "other leadership roles" within the database for the purposes of consistency. Some surgeons had multiple titles or positions listed. We did not consider these iteratively; rather, we used a binary assessment (a surgeon was identified as having a leadership role or not) in analysis.

We tested all comparisons between proportions using the Fisher exact test with statistical significance set at 0.05. We performed statistical analysis using Stata Release 16 (StataCorp.).

RESULTS

Trainees

Data were obtained from all 17 orthopedic training programs representing the 2018/19 academic year. There were 343 orthopedic trainees nationally, of whom 88 (25.7%) were women and 255 (74.3%) were men. The gender distribution by program is shown in Table 1. The proportion of women ranged from 8% (McMaster University) to 50% (Memorial University).

Table 1. Gender distribution of orthopedic surgery residents in Canadian medical schools

School	No. of residents	Gender; no. (%) of residents	
		Men	Women
Dalhousie University	19	15 (79)	4 (21)
McGill University	27	22 (81)	5 (18)
McMaster University	25	23 (92)	2 (8)
Memorial University	14	7 (50)	7 (50)
Northern Ontario School of Medicine	9	5 (56)	4 (44)
Queen's University	15	9 (60)	6 (40)
Université de Montréal	14	10 (71)	4 (29)
Université de Sherbrooke	16	11 (69)	5 (31)
Université Laval	11	10 (91)	1 (9)
University of Alberta	18	12 (67)	6 (33)
University of British Columbia	26	19 (73)	7 (27)
University of Calgary	21	14 (67)	7 (33)
University of Manitoba	12	10 (83)	2 (17)
University of Ottawa	33	25 (76)	8 (24)
University of Saskatchewan	11	7 (64)	4 (36)
University of Toronto	49	40 (82)	9 (18)
Western University	23	16 (70)	7 (30)
Total	343	255 (74)	88 (26)

Box 1. University appointments at Canadian academic institutions

English

- None
- Lecturer
- Clinical instructor
- Clinical assistant professor
- Clinical associate professor
- Clinical professor
- Assistant professor
- Associate professor
- Professor
- Professor emeritus
- Honorary associate professor
- Distinguished professor

French

- Chargé(e) d'enseignement de clinique
- Chargé(e) d'enseignement
- Professeur(e) adjoint(e) clinique
- Professeur(e) adjoint(e) de clinique
- Professeur(e) agrégé(e) clinique
- Professeur(e) agrégé(e) de clinique
- Professeur(e) de clinique
- Professeur(e) titulaire de clinique
- Professeur(e) adjoint(e)
- Professeur(e) agrégé(e)
- Professeur(e) titulaire
- Other

Faculty

We identified 809 orthopedic surgeons as faculty over the 17 Canadian academic orthopedic training programs, of whom 96 (11.9%) were women. The gender distribution by program is shown in Table 2. The proportion of women ranged from 5% (University of Toronto) to 22% (Université Laval). In eastern Canada and Quebec, 16.2% of the faculty were women, significantly above the national average ($p = 0.03$) (Table 3). The corresponding values for Ontario and western Canada were 8.9% ($p = 0.1$) and 11.4% ($p = 0.7$).

Academic appointments

Departments classified their faculty into clinical and academic streams. Some schools (Dalhousie University,

Northern Ontario School of Medicine, Queen’s University, University of Manitoba, University of Ottawa, University of Toronto and Western University) did not have formal distinctions, classifying their entire faculty into academic positions. The remaining universities had clinical and academic distinctions and were recorded as such.

A significantly higher proportion of women than men did not have a faculty listing (12% v. 5%, $p = 0.003$). There was no significant gender difference in being listed as a lecturer/instructor ($p = 0.6$), clinical assistant professor ($p = 0.8$) or clinical associate professor ($p = 0.7$) (Figure 1).

The distribution of clinical faculty is presented in Figure 2. Women were significantly less likely than men to have achieved clinical professorship (1/96 [1%] v. 44/713 [6%], $p = 0.03$).

At the universities that differentiated between assistant professor, associate professor and full professor, there was no significant gender difference in achieving academic promotion to assistant professor ($p = 0.1$) or associate professor ($p = 0.9$) (Figure 3). However, there was a significant difference in achieving promotion to full professor: 65 men (9%) were full professors, compared to 1 woman (1%) ($p = 0.002$).

Seventeen faculty members attained the position of professor emeritus, and 1 attained the position of honorary professor; all 18 were men. They represented 3% of all men surgeons and 2% of all surgeons (men and women).

Regional differences in levels of promotion were apparent. In eastern Canada and Quebec, the absolute number of women decreased at higher levels of promotion. However, when we assessed the proportions of women and men at each level of promotion, women surgeons were more likely than men surgeons to be listed as clinical assistant/assistant professors ($p = 0.003$). The proportional representation of all surgeons in this region is shown in Figure 4. Faculty listings in Ontario did not statistically deviate from the national trends. The proportional representation of all surgeons in Ontario by faculty listing is shown in Figure 5. However, in western Canada, compared to the rest of the country, more women surgeons were listed as faculty without a rank ($p = 0.002$), and none achieved the rank of clinical or full professor ($p = 0.006$). The proportional faculty distribution is shown in Figure 6.

Leadership

There were no women representing their department as department or division head of orthopedics. There was 1 woman among the group of postgraduate residency program directors. Of other leadership roles, 94% were held by men and 6% by women. Consequently, this means that 26% of all men surgeons listed held some kind of leadership position, compared to 11% of their women counterparts. The difference between genders in leadership positions was statistically significant ($p = 0.001$).

Table 2. Gender distribution of orthopedic surgery faculty

School	No. of faculty	Gender; no. (%) of faculty	
		Men	Women
Dalhousie University	25	23 (92)	2 (8)
McGill University	42	36 (86)	6 (14)
McMaster University	58	54 (93)	4 (7)
Memorial University	36	32 (89)	4 (11)
Northern Ontario School of Medicine	23	20 (87)	3 (13)
Queen’s University	13	11 (85)	2 (15)
Université de Montréal	39	31 (79)	8 (20)
Université de Sherbrooke	25	20 (80)	5 (20)
Université Laval	37	29 (78)	8 (22)
University of Alberta	54	49 (91)	5 (9)
University of British Columbia	171	151 (88)	20 (12)
University of Calgary	67	58 (87)	9 (13)
University of Manitoba	27	24 (89)	3 (11)
University of Ottawa	42	38 (90)	4 (10)
University of Saskatchewan	40	36 (90)	4 (10)
University of Toronto	74	70 (95)	4 (5)
Western University	36	31 (86)	5 (14)
Total	809	713 (88)	96 (12)

Table 3. Regional distribution of men and women orthopedic surgery faculty

Region	No. (%) of faculty		
	Men <i>n</i> = 713	Women <i>n</i> = 96	<i>p</i> value*
Eastern Canada and Quebec†	171 (83.8)	33 (16.2)	0.03
Ontario‡	224 (91.1)	22 (8.9)	0.1
Western Canada§	318 (88.6)	41 (11.4)	0.7

*For comparison with national average.
 †Dalhousie University, McGill University, Memorial University, Université de Montréal, Université de Sherbrooke and Université Laval.
 ‡McMaster University, Northern Ontario School of Medicine, Queen’s University, University of Ottawa, University of Toronto and Western University.
 §University of Alberta, University of British Columbia, University of Calgary, University of Manitoba and University of Saskatchewan.

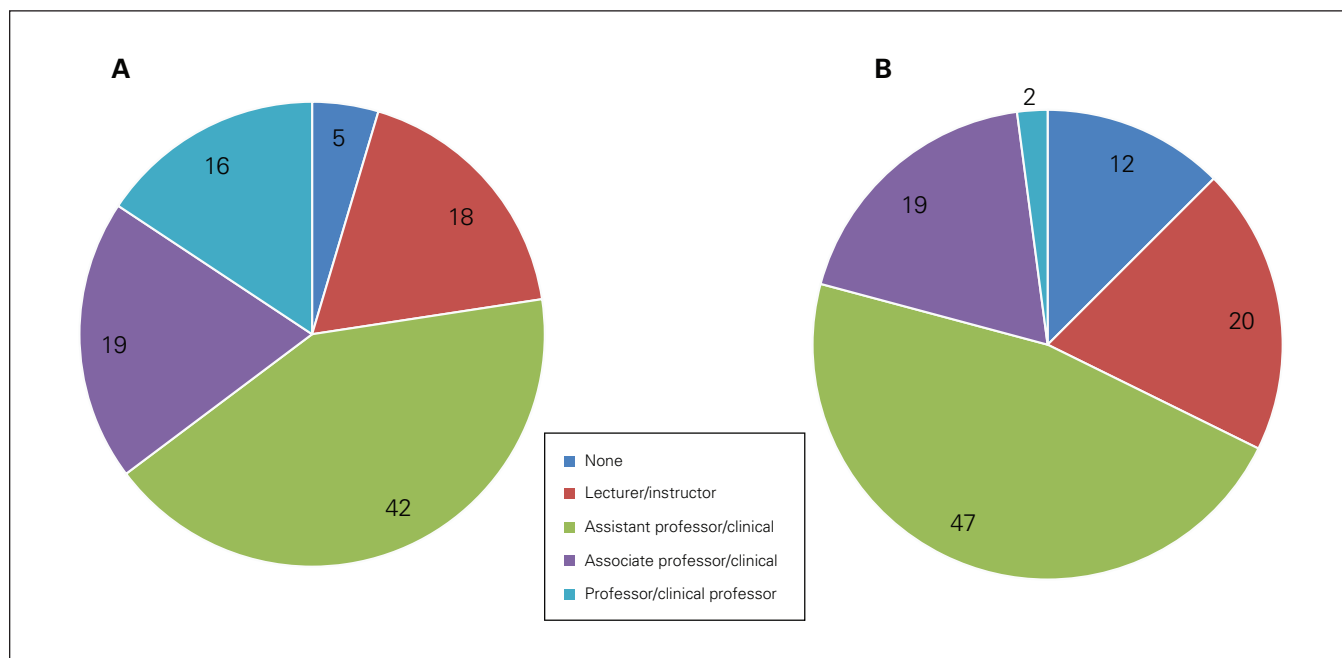


Fig. 1. Proportion of men surgeons (A) and women surgeons (B) at each faculty rank.

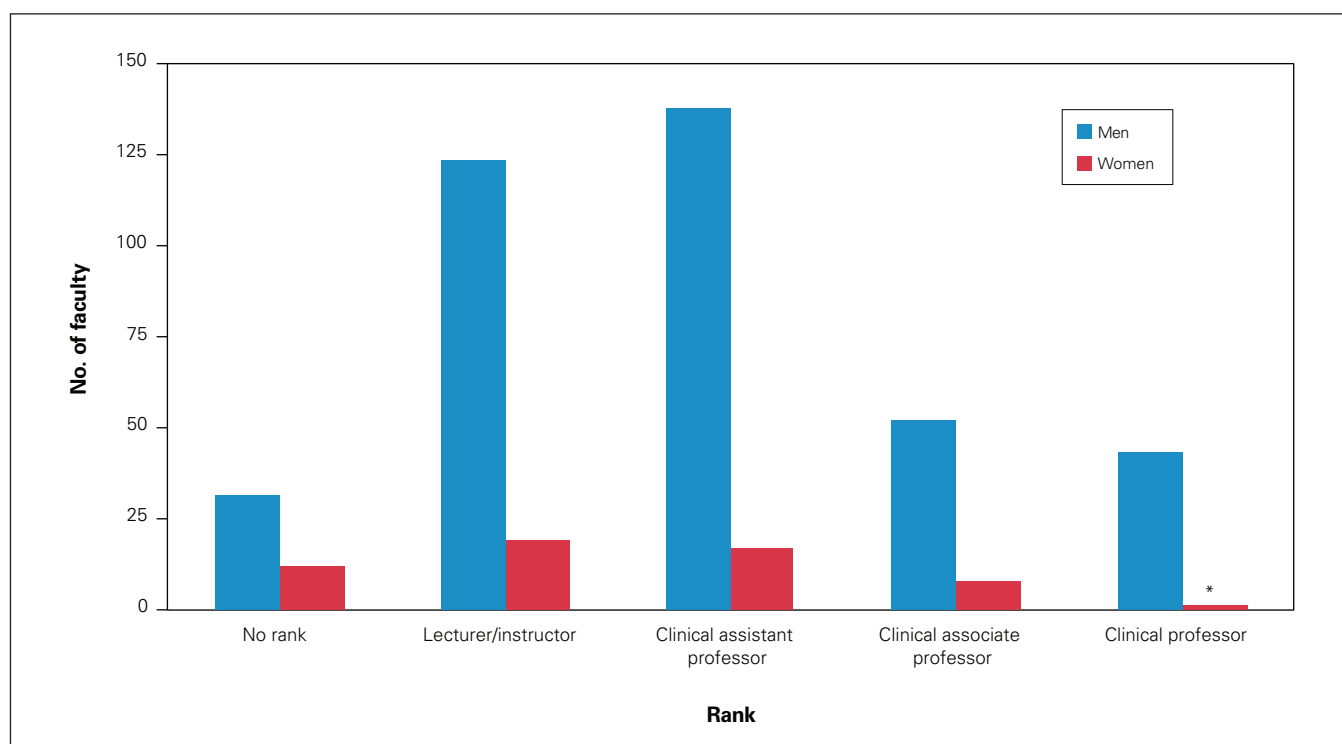


Fig. 2. Gender distribution of orthopedic surgeons by clinical faculty rank. * $p = 0.03$ for difference between men and women.

DISCUSSION

In 2018/19, there were more than 800 orthopedic surgeons listed as faculty by the 17 Canadian medical schools that have a postgraduate training program in orthopedic surgery. Although just over one-quarter of the trainees were

women, only 12% of the faculty that teaches these young surgeons were women. Women orthopedic surgeons were disproportionately overrepresented among faculty members listed but not given a rank. They were disproportionately underrepresented in faculty positions across academic orthopedic training programs. Women were less likely than

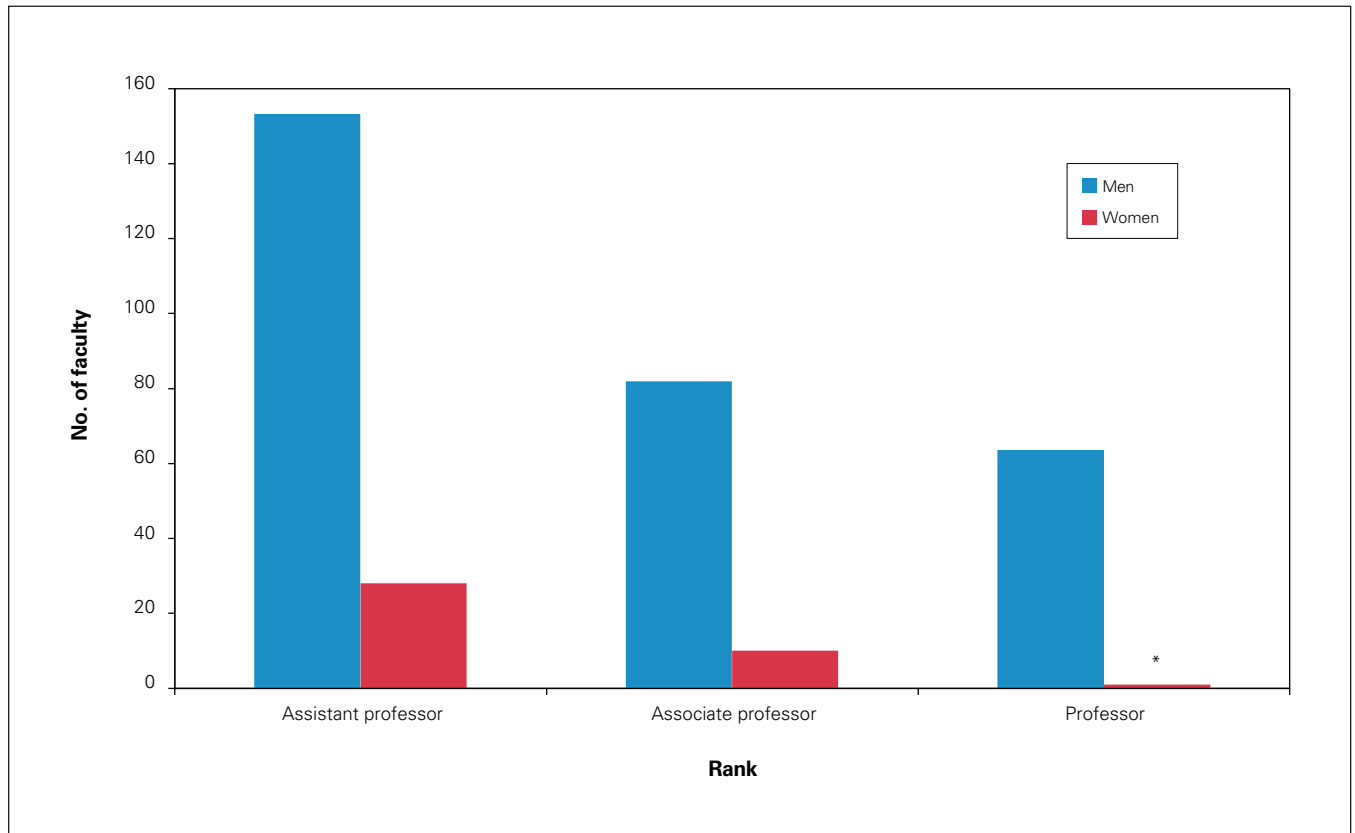


Fig. 3. Gender distribution of orthopedic surgeons by academic faculty rank. * $p = 0.002$ for difference between men and women.

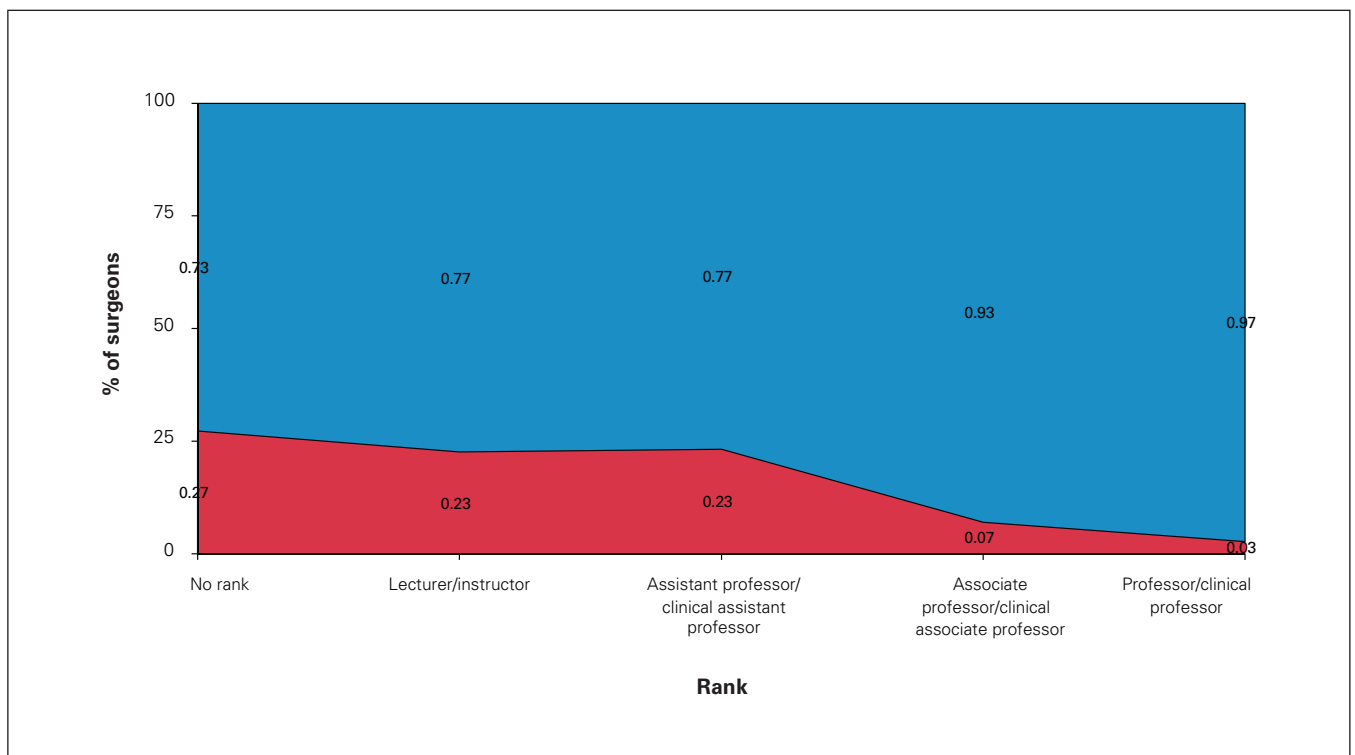


Fig. 4. Proportions of men (blue) and women (red) surgeons across academic and clinical faculty ranks in eastern Canada and Quebec (Dalhousie University, McGill University, Memorial University, Université de Montréal, Université de Sherbrooke and Université Laval).

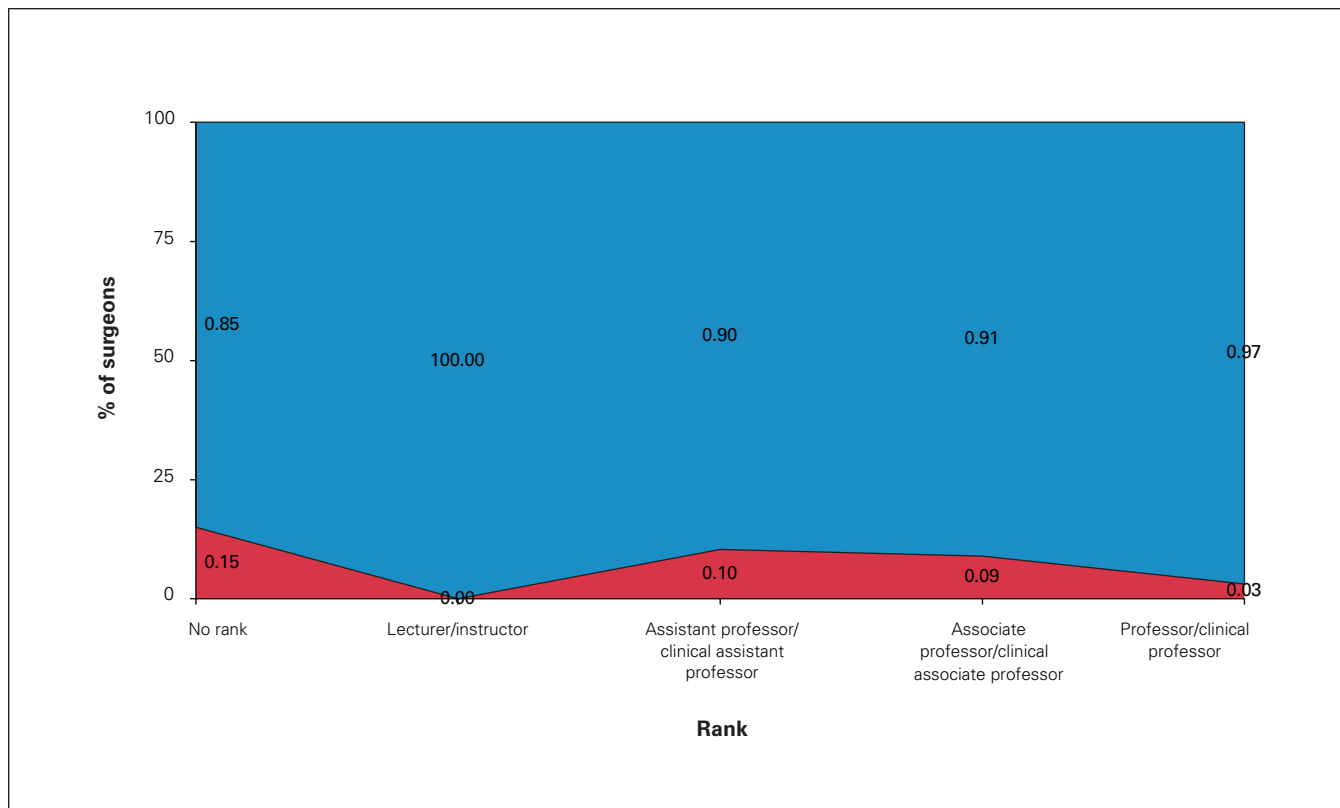


Fig. 5. Proportions of men (blue) and women (red) surgeons across academic and clinical faculty ranks in Ontario (McMaster University, Northern Ontario School of Medicine, Queen’s University, University of Ottawa, University of Toronto and Western University).

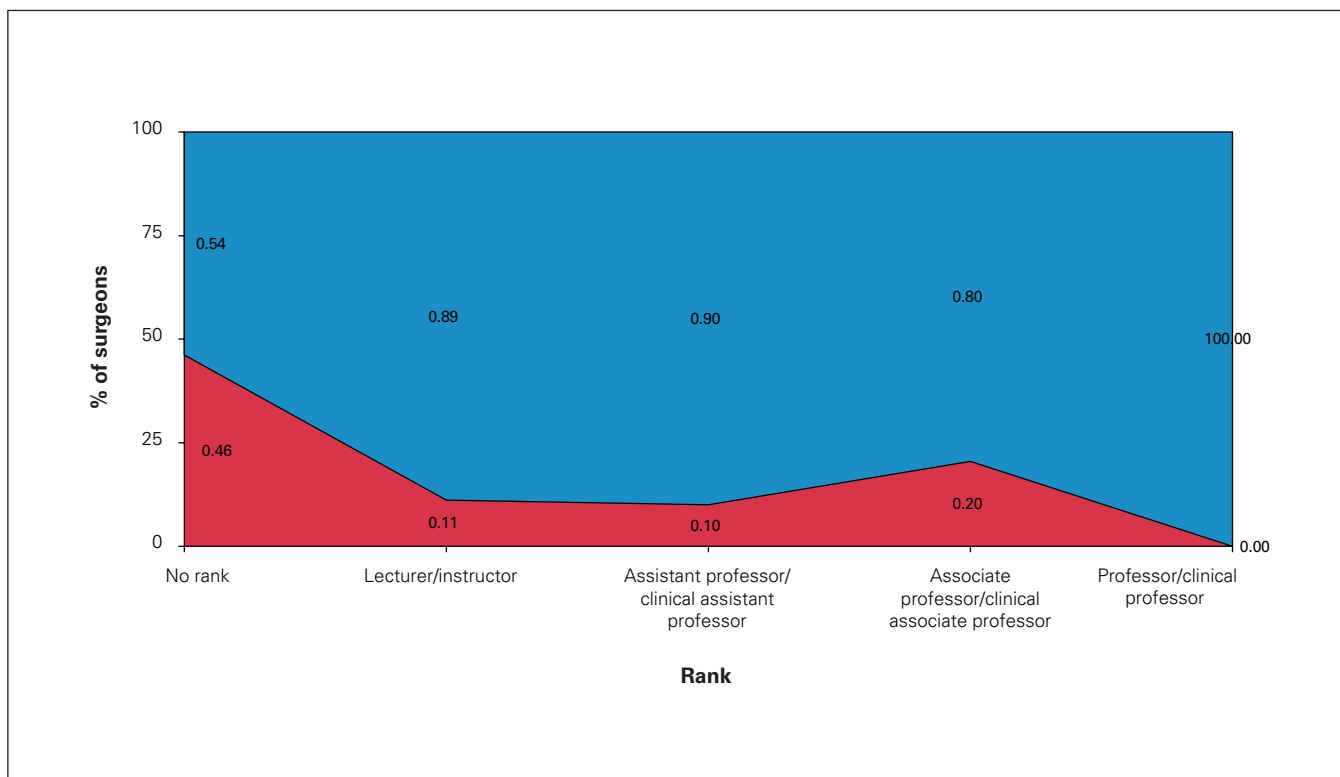


Fig. 6. Proportions of men (blue) and women (red) surgeons across academic and clinical faculty ranks in western Canada (University of Alberta, University of British Columbia, University of Calgary, University of Manitoba and University of Saskatchewan).

men to have achieved promotion to clinical or full professorship. There were regional differences: eastern Canada and Quebec had a higher proportion of women surgeons than Ontario or western Canada, and women in eastern Canada and Quebec were proportionately more likely than men to be clinical assistant/assistant professors. Western Canada contributed to the high proportion of unranked women faculty, and no woman surgeon in that region had been promoted beyond clinical associate or associate professor. Women were significantly underrepresented in leadership roles within academic and clinical faculty.

The closest comparative research is from the US. According to the 2018 American Association of Orthopaedic Surgeons census, 5.8% of all orthopedic surgeons in that country were women,³⁹ and women represented nearly 18% of orthopedic faculty in US medical schools.³⁸ A total of 8.7% of professors of orthopedic surgery were women, far higher than the proportion in Canada, 1%. There was 1 woman department chair nationwide.³⁸ These numbers are increasing, but very slowly.^{39,40} Our US colleagues have also studied trends in the gender distribution of orthopedic residency applicants in order to identify barriers to attracting the best and brightest medical students to this specialty.^{41–43} In 2014–2016, women accounted for only 14% of orthopedic trainees in US residency programs.⁴¹ In comparison, we found that, in the 2018/19 academic year, nearly 26% of all Canadian orthopedic residents were women.

The fact that these numbers are slowly increasing is encouraging, but further efforts are needed, as a glass ceiling effect still exists. Between 1997 and 2017, representation of women increased on editorial boards and in paper authorship, perhaps reflecting the increase of women surgeons in academic medicine.⁴⁴ However, there were no women holding an editor-in-chief role^{28,44} for major orthopedic journals or at higher levels of academic promotion.

When we consider the reasons for wider gender disparities at advanced academic faculty positions, we should assess the metrics that are used to assess promotion at that level. These metrics often include number of publications, impact factor of journals, citations, successful grant applications, and national and international recognition. However, there is evidence that these metrics continue to display gender biases.^{24–28,44}

Women surgeons who wish to progress in their careers also have fewer opportunities for gender-specific mentorship given the small number of women at advanced rank or leadership levels.^{18,19,22,23,34,36} As well, many women surgeons may assume other types of leadership or administrative roles within their academic, clinical or teaching practices. Valuable time is spent in these positions that may not be directly reflected in their curriculum vitae, posted on faculty websites or revealed in more formal assessments during promotion reviews.

Gender differences in application patterns identified by leaders in the business world show that men will apply for a

position if they have satisfied 60% of the application criteria, but women will limit their application until they fulfill 100% of the criteria.⁴⁵ In so doing, women self-screen themselves out of 20% fewer job applications than men.⁴⁵ Women are promoted or hired based on their track record or previous experience, whereas men are considered for their future potential, which makes it difficult for women to break in to leadership roles.⁴⁶ To be considered as a qualified applicant for faculty promotion or to a leadership position, one must often have already attained promotion or success in many other spheres. This bias ties into the work culture of orthopedic surgery, where not only does a woman have to achieve competency, she also has to be permitted or accepted as a leader by others within her work sphere. As in many industries, promotion and leadership opportunities are often informally discussed and colleagues considered before formal candidate searches occur. Thus, it is not unexpected to see a lack of women at the leadership level within orthopedic surgery, because of the cumulative effect of these factors.

Despite numerous publications and calls to action on the topic, orthopedic surgeons as a profession still remain relatively unaware of the existence of intentional and unintentional gender bias and, consequently, of the strategies that can be implemented to rectify the problem.^{14,18,22,47,48} Surgeons, members of promotion and faculty review committees, and those in leadership positions need to be cognizant of their own biases, particularly those that are implicit. There are many accessible tools, such as Project Implicit (<https://implicit.harvard.edu>), to assess one's biases. Such resources and self-learning modules on managing existing biases against gender, diversity and inclusion and their influence on decision-making processes may be helpful to educate and increase awareness. This is applicable to review committees and panels including surgeons to provide direction on how to best evaluate candidates in areas where evidence shows that bias exists. These committees should also strive to have a balanced gender representation of reviewers. Leadership and promotion committees should also consider alternative metrics that relate to leadership and success in the workplace, such as emotional quotient, or emotional intelligence. There is support for such metrics to be used formally in resident training and evaluation of leadership skills.^{49,50} Adoption of metrics such as emotional quotient could advance women in orthopedics, as they often report high scores on these scales.^{51,52}

At the individual institutional level, our data can be used to initiate internal evaluation of policies for equity in hiring and promotion procedures, as well as the collection of meaningful metrics on diversity over time to measure change. In the business world, knowing your current workforce status, focusing on the performance objectives of the role instead of on lists of criteria when publishing opportunities, and anonymizing applicant reviews where possible are all strategies that companies have used to combat gender bias in their recruitment and promotion processes.⁴⁵ These can be adopted in orthopedic surgery.

Mentorship is recognized to be important to the development of trainees and for the career development of academic physicians.^{53,54} A 2019 article highlighted the value of mentorship in orthopedic surgery specifically because it improves retention, job satisfaction, clinical volume, professional networking, career progression and research productivity.⁵⁵ For women orthopedic surgeons, who may have fewer opportunities for gender-specific mentorship, individual departments can strive to implement mentorship programs and aim to ensure everyone receives equal opportunity for participation in academic and leadership activities. A related but distinct avenue to target change within orthopedics is advocacy. Mentors often become advocates for their mentee, whether professionally or academically, but advocacy can come from other sources. The importance of surgical faculty as advocates for trainees, especially as training regimens evolve over time, has been studied.⁵⁶ Advocacy for peer advancement or career development remains important even after training and may be particularly important for women surgeons, who face implicit and systematic biases.

Nationally, orthopedic associations may find our data additive to the information they currently collect and can use it to follow trends over time. National organizations can also participate in informing appropriate mentorship and transition planning for orthopedic surgery in Canada. Future research on gender in surgery in Canada should consider broader assessment of systemic barriers and evaluation of the effectiveness of interventions that support women in surgery.⁴⁸

Some have argued that gender is only 1 of many variables contributing to the disparities between men and women in the workplace and that to focus on gender diversity may be fruitless.⁵⁷ In addition, there may be biologic differences in behaviours between sexes that are unchangeable. In an ideal world, each person would be evaluated purely on the same unbiased metrics. However, our systems have layers of complexity and bias intertwined, and, as gender is constantly intersecting with all these other variables, we cannot ignore it. The fact that there have been federal, provincial and local policies implemented to close the gaps between men and women in the workplace shows the importance gender diversity plays in the Canadian culture broadly.^{1,6-8}

Why should orthopedic surgeons care about the status of gender diversity in our profession? Our profession should strive to continually grow and collectively improve the impact we have on patients' health. Greater gender diversity in the business world has been shown to improve outcome metrics and increase profitability.^{3,9-11} In medicine, gender diversity has been shown to improve patient outcomes.^{15,16} Our profession should reflect the community of patients we care for, including such characteristics as gender, age, nationality, ethnicity and religious affiliation. Most important, diversity within our profession is critical as we aim to continue to recruit and train the best and brightest students, no matter their background.

Studies such as this one are important to the collective orthopedic community. Unless issues with our current state of affairs are identified and measured, there is no benchmark from which we can measure change. It is only in recognizing that inequities exist between men and women that we can explore the reasons behind this inequity and seek to effect change. Future work could investigate factors or institutional barriers to gender equity across orthopedic surgery in Canada.

Limitations

These cross-sectional data represent a snapshot in time in Canadian orthopedic surgery and cannot answer whether there are temporal associations between gender and promotion or whether the faculty gender distribution is changing over time. The study is also limited by its inability to determine causality. The capture of age or data surrounding matriculation regarding any further advanced degrees for each faculty member would have strengthened our data set, but this information was not readily available within our search methodology. Other limitations of this study are inherent in the data collected. We classified gender into a binary variable (man or woman) for each faculty member; however, we acknowledge that gender is more of a fluid construct. The assumptions we made may have led to misclassification errors but are equally likely to have affected women and men.

We could not determine how often published faculty lists are audited or updated by each institution. We took all the collected data at face value and treated institutional data equally, which minimized any collection bias between programs. There are also differences between academic institutions in how faculty are appointed, to which stream they are appointed (clinical or academic) and who meets site-specific qualifications for faculty appointment, which may have led to a differential misclassification bias. Owing to this variability within each program, the number of appointed faculty members may not always reflect the size of the institution. Movement of surgeons between universities is not frequent but does occur. Given the small absolute numbers of women surgeons, geographic movement between institutions may have affected the trends observed. As the data were hand-searched, other misclassification biases may have occurred. However, this was minimized by triangulation of data from multiple sites and is equally likely to have affected women and men. This limitation is unlikely to have affected the analysis.

CONCLUSION

In 2018/19, women orthopedic surgeons were underrepresented in faculty positions across Canadian academic orthopedic training programs, specifically in promoted academic faculty roles and leadership positions. This finding

highlights the need for mandatory diversity education in hiring and promotion procedures, collection of diversity metrics over time at the university and national level so we can measure change within the profession, and diversity-sensitive mentorship and department transition planning. The key stakeholders who will be integral in implementing these changes include the national orthopedic organizations, each individual academic institution, and the orthopedic departments and divisions and their leadership. In addition, orthopedic surgeons must evaluate their own individual biases and their contribution to diversity within the profession. The orthopedic community will be collectively strengthened as a profession if we work toward limiting gender bias in our workplace and effecting positive change.

Affiliations: From the University of British Columbia (Hunter), Vancouver, BC; the Division of Orthopaedics (Grewal), Department of Surgery, University of Western Ontario, London, Ont.; the Division of Orthopaedics (Nam), Department of Surgery, University of Toronto, Toronto, Ont.; and the Department of Orthopaedics (Lefavre), University of British Columbia, Vancouver, BC.

Competing interests: None declared.

Contributors: J. Hunter and K. Lefavre designed the study. J. Hunter acquired the data, which all authors analyzed. J. Hunter and K. Lefavre wrote the manuscript, which all authors critically revised. All authors gave final approval of the article to be published.

Content licence: This is an Open Access article distributed in accordance with the terms of the Creative Commons Attribution (CC BY-NC-ND 4.0) licence, which permits use, distribution and reproduction in any medium, provided that the original publication is properly cited, the use is noncommercial (i.e., research or educational use), and no modifications or adaptations are made. See: <https://creativecommons.org/licenses/by-nc-nd/4.0/>.

References

1. *Employment Equity Act* (S.C. 1995, c. 44). Available: <https://laws-lois.justice.gc.ca/eng/acts/e-5.401/FullText.html> (accessed 2020 Feb. 17).
2. *Table 14-10-0020-01: Unemployment rate, participation rate and employment rate by educational attainment, annual*. Ottawa: Statistics Canada; 2021. Available: <https://www150.statcan.gc.ca/t1/tb11/en/tv.action?pid=1410002001> (accessed 2020 Feb. 17).
3. Devillard S, Vogel T, Pickersgill A, et al. The power of parity: advancing women's equality in Canada. McKinsey & Company; 2017.
4. Culbert L, Griffiths N. Public sector salaries: Where are the women? In B.C., not many are near the top of the pay scale. *Vancouver Sun* 2020 Jan. 31, updated 2020 Feb. 3. Available: <https://vancouversun.com/news/local-news/public-sector-salaries-where-are-the-women-in-b-c-not-many-are-near-the-top-of-the-pay-scale> (accessed 2020 Feb. 17).
5. Women board directors of Canada. New York: Catalyst; 1999. Available: https://catalyst.org/wp-content/uploads/2019/02/1998_catalyst_census-women_board_directors_of_canada.pdf (accessed 2020 Feb. 17).
6. *Act respecting the governance of state-owned enterprises*, CQLR c G-1.02 (CanLII). Available: <https://www.canlii.org/en/qc/laws/stat/cqlr-c-g-1.02/latest/cqlr-c-g-1.02.html> (accessed 2020 Feb. 17).
7. Increasing the representation of women on Canadian boards. Status of Women Canada; modified 2016 Nov. 28. Available: https://publications.gc.ca/collections/collection_2015/cfc-swc/SW21-162-2014-eng.pdf (accessed 2020 Feb. 17).
8. Lord F, Capstick B. Legislative summary of Bill C-25: an Act to amend the Canada Business Corporations Act, the Canada Cooperatives Act, the Canada Not-for-profit Corporations Act, and the Competition Act. Ottawa: Parliament of Canada; 2018. Available: https://lop.parl.ca/sites/PublicWebsite/default/en_CA/ResearchPublications/LegislativeSummaries/ (accessed 2020 Feb. 17).
9. Unlocking female talent in your organization: Women in Work Index 2018 — Canadian insights. Toronto: PwC Canada; 2018. Available: <https://www.pwc.com/ca/en/services/consulting/people-and-organization/women-in-work-canadian-insights.html> (accessed 2020 Feb. 2).
10. Hewlett S, Marshall M, Sherbin L. How diversity can drive innovation. *Harvard Business Review* 2013 December. Available: <https://hbr.org/2013/12/how-diversity-can-drive-innovation> (accessed 2020 Feb. 2).
11. Gompers P, Kovvali S. The other diversity dividend. *Harvard Business Review* 2018 July–August. Available: <https://hbr.org/2018/07/the-other-diversity-dividend> (accessed 2020 Feb. 2).
12. Labor force statistics from the current population survey: employed persons by detailed occupation, sex, race, and Hispanic or Latino ethnicity. Washington: US Bureau of Labor Statistics; modified 2021 Jan. 22. Available: <https://www.bls.gov/cps/cpsaat11.htm> (accessed 2020 Feb. 17).
13. *Table 14-10-0335-02: Proportion of women and men employed in occupations, annual*. Ottawa: Statistics Canada. Available: <https://www150.statcan.gc.ca/t1/tb11/en/tv.action?pid=1410033502> (accessed 2020 Feb. 17).
14. Silver JK. #BeEthical: a call to healthcare leaders — ending gender workforce disparities is an ethical imperative. 2018. Available: https://sheleadshcare.com/wp-content/uploads/2018/10/Be_Ethical_Campaign_101418.pdf (accessed 2020 Feb. 17).
15. Tsugawa Y, Jena AB, Figueroa JF, et al. Comparison of hospital mortality and readmission rates for Medicare patients treated by male vs. female physicians. *JAMA Intern Med* 2017;177:206-13.
16. Wallis CJ, Ravi B, Coburn N, et al. Comparison of postoperative outcomes among patients treated by male and female surgeons: a population based matched cohort study. *BMJ* 2017;359:j4366.
17. Female physician leaders in Alberta Health Services. Edmonton: Alberta Health Services; 2018.
18. The state of women in academic medicine: the pipeline and pathways to leadership 2013–2014. Washington: Association of American Medical Colleges; 2014.
19. Kuhlmann E, Ovseiko PV, Kurmeyer C, et al. Closing the gender leadership gap: a multi-centre cross-country comparison of women in management and leadership in academic health centres in the European Union. *Hum Resour Health* 2017;15:2.
20. Bismark M, Morris J, Thomas L, et al. Reasons and remedies for underrepresentation of women in medical leadership roles: a qualitative study from Australia. *BMJ Open* 2015;5:e009384.
21. Burden M, Frank MG, Keniston A, et al. Gender disparities of leadership and scholarly productivity of academic hospitalists. *J Hosp Med* 2015;10:481-5.
22. Carr PL, Raj A, Kaplan SE, et al. Gender differences in academic medicine: retention, rank, and leadership comparisons from the National Faculty Survey. *Acad Med* 2018;93:1694-9.
23. Silver JK, Ghalib R, Poorman JA, et al. Analysis of gender equity in leadership of physician focused medical specialty societies, 2008–2017. *JAMA Intern Med* 2019;179:433-5.
24. Witteman HO, Hendricks M, Straus S, et al. Are gender gaps due to evaluations of the applicant or the science? A natural experiment at a national funding agency. *Lancet* 2019;393:531-40.

25. Boiko JR, Anderson AJM, Gordon RA. Representation of women among academic grand rounds speakers. *JAMA Intern Med* 2017;177:722-4.
26. Buell D, Hemmelgram BR, Straus SE. Proportion of women presenters at medical grand rounds at major academic centres in Canada: a retrospective observational study. *BMJ Open* 2018;8:e019796.
27. Silver JK, Slocum C, Bank A, et al. Where are the women? The underrepresentation of women physicians among recognition award recipients from medical specialty societies. *PMR* 2017;9:804-15.
28. Amrein K, Langmann A, Fahrleitner-Pammer A, et al. Women underrepresented on editorial boards of 60 major medical journals 2011. *Gen Med* 2011;8:378-87.
29. Cooke M. Implicit bias in academic medicine: #WhatADoctorLooksLike. *JAMA Intern Med* 2017;177:657-8.
30. Physicians in Canada, 2018. Ottawa: Canadian Institute for Health Information; 2019.
31. Fact sheet: gender trends in Canadian postgraduate medical training. Ottawa: Canadian Post-M.D. Education Registry (CAPER). Available: https://caper.ca/sites/default/files/pdf/fact-sheets/FactSheet_Gender_trends_in_Canadian_post-MD_training_en.pdf (accessed 2020 Feb. 17).
32. Phillips NA, Tannan SC, Kalliainen LK. Understanding and overcoming implicit gender bias in plastic surgery. *Plast Reconstr Surg* 2016;138:1111-6.
33. Pattani R, Marquez C, Dinyarian C, et al. The perceived organizational impact of gender gap across a Canadian department of medicine and proposed strategies to combat it: a qualitative study. *BMC Med* 2018;16:48.
34. Greenberg CC. Association for Academic Surgery presidential address: sticky floors and glass ceilings. *J Surg Res* 2017;219:ix-xviii.
35. Epstein NE. Discrimination against female surgeons is still alive: Where are the full professorships and chairs of departments? *Surg Neurol Int* 2017;8:93.
36. Gawad N, Tran A, Martel A, et al. Gender and academic promotion of Canadian general surgeons: a cross-sectional study. *CMAJ Open* 2020;8:E34-40.
37. Hunter J, Crofts H, Keehn A, et al. Gender imbalance amongst promotion and leadership in academic surgical programs in Canada: a cross-sectional investigation. *PLoS One* 2021;16: e0256742.
38. Chambers CC, Ihnow SB, Monroe EJ, et al. Women in orthopaedic surgery: population trends in trainees and practicing surgeons. *J Bone Joint Surg Am* 2018;100:e116.
39. Orthopaedic practice in the U.S.: 2018. Rosemont (IL): American Academy of Orthopaedic Surgeons; 2019.
40. Orthopaedic practice in the U.S.: 2012. Rosemont (IL): American Academy of Orthopaedic Surgeons; 2013.
41. Okike K, Phillips DP, Swart E, et al. Orthopaedic faculty and resident sex diversity are associated with the orthopaedic residency application rate of female medical students. *J Bone Joint Surg Am* 2019;101:e56.
42. Rohde RS, Wolf JM, Adams JE. Where are the women in orthopaedic surgery? *Clin Orthop Relat Res* 2016;474:1950-6.
43. Lewis VO, Scherl S, O'Connor M. Women in orthopaedics: way behind the number curve. *J Bone Joint Surg Am* 2012;94:e30.
44. Rynecki ND, Krell ES, Potter JS, et al. How well represented are women orthopaedic surgeons and residents on major orthopaedic editorial boards and publications? *Clin Orthop Relat Res* 2020;478:1563-8.
45. Tockey D, Ignatova M. Gender insights report: how women find jobs differently. LinkedIn Talent Solutions. Available: <https://business.linkedin.com/content/dam/me/business/en-us/talent-solutions-lodestone/body/pdf/Gender-Insights-Report.pdf> (accessed 2020 Feb. 17).
46. Barsh J, Yee L. Unlocking the full potential of women in the US economy. McKinsey & Company; 2011. Available: <https://www.mckinsey.com/business-functions/organization/our-insights/unlocking-the-full-potential-of-women> (accessed 2020 Feb. 17).
47. West MA, Hwang S, Maier RV, et al. Ensuring equity, diversity, and inclusion in academic surgery: an American Surgical Association white paper. *Ann Surg* 2018;268:403-7.
48. Laver KE, Prichard IJ, Cations M, et al. A systematic review of interventions to support the careers of women in academic medicine and other disciplines. *BMJ Open* 2018;8:e020380.
49. Jensen AR, Wright AS, Lance AR, et al. The emotional intelligence of surgical residents: a descriptive study. *Am J Surg* 2008;195:5-10.
50. Sharp G, Bourke L, Rickard MJFX. Review of emotional intelligence in health care: an introduction to emotional intelligence for surgeons. *ANZ J Surg* 2020;90:433-40.
51. Stami T, Ritin F, Dominique P. Demographic predictors of emotional intelligence among radiation therapists. *J Med Radiat Sci* 2018;65:114-22.
52. Fischer AH, Kret ME, Broekens J. Gender differences in emotion perception and self-reported emotional intelligence: a test of emotion sensitivity hypothesis. *PLoS One* 2018;13:e0190712.
53. Amonoo HL, Barreto EA, Stern TA, et al. Residents' experiences with mentorship in academic medicine. *Acad Psychiatry* 2019;43:71-5.
54. Flexman AM, Gelb AW. Mentorship in anesthesia. *Curr Opin Anaesthesiol* 2011;24:676-81.
55. Salazar DH, Schiff AP, Light TR. The value of senior mentorship among orthopaedic surgeons. *J Am Acad Orthop Surg* 2019;27:861-7.
56. Doherty GM. Surgery resident education 1989-2008: effort, respect, and advocacy. *World J Surg* 2009;33:378-85.
57. Farrell W. Exploiting the gender gap. *New York Times* 2005 Sept. 5;A21.