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Research

Applicant gender and matching to first-choice discipline: a cross-sectional analysis of data from the Canadian Resident Matching Service (2013–2019)

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Abstract

Background: Previous studies examining potential sex and gender bias in the Canadian Resident Matching Service (CaRMS) match have had conflicting results. We examined the results of the CaRMS match over the period 2013–2019 to determine the potential association between applicants' gender and the outcome of matching to their first-choice discipline.

Methods: In this cross-sectional analysis, we determined the risk of matching to one's first-choice discipline in CaRMS by applicant gender and year, for all Canadian medical students who participated in the first iteration of the R-1 match for the years 2013 to 2019. We analyzed data in 3 categories of disciplines according to CaRMS classifications: family medicine, nonsurgical disciplines and surgical disciplines. We excluded disciplines with fewer than 10 applicants.

Results: Match results were available for 20 033 participants, of whom 11 078 (55.3%) were female. Overall, female applicants were significantly more likely to match to their first-choice discipline (relative risk [RR] 1.03, 95% confidence interval [CI] 1.02–1.04). After adjustment for match year and stratification by discipline categories, we found that female applicants were more likely to match to family medicine as their first choice (RR 1.04, 95% CI 1.03–1.05) and less likely to match to a first-choice surgical discipline (RR 0.95, 95% CI 0.91–1.00) than their male peers. There was no significant difference between the genders in matching to one's first-choice nonsurgical discipline (RR 1.01, 95% CI 0.99–1.03).

Interpretation: These results suggest an association between an applicant's gender and the probability of matching to one's first-choice discipline. The possibility of gender bias in the application process for residency programs should be further evaluated and monitored.

Each year, the Canadian Resident Matching Service (CaRMS) administers a matching process whereby eligible applicants apply for and are assigned to Canadian residency positions.[1] The CaRMS match is intended to be a "fair, transparent, and equitable" process that favours the applicant.[2,3] Published best practices in residency application recommend that resident selection should promote diversity and "be free of inappropriate bias."[4] Despite these recommendations, the CaRMS match has recently been criticized for its subjectivity and possible bias.[4,5] These concerns are compounded by recent increases in the number of unmatched applicants; as the match becomes more competitive, potential biases may affect larger numbers of medical students.[1,4,5]

Previous attempts to monitor North American resident matches for gender bias have had disparate results. Several observational studies of small programs have not found evidence of gender or sex bias,[6,7] whereas others have reported an advantage for female applicants.[8,9] A series of articles evaluating CaRMS match data from 1995 to 2004 found no advantage for either male or female applicants when applying to various surgical specialties, an overall disadvantage for male applicants when all specialties were combined, and an advantage for female applicants when the first-choice specialty was psychiatry, family medicine or emergency medicine.[9–12] However, a recent letter to the editor concerning the 2018 CaRMS match suggested that a lower proportion of women than men matched to their first-choice discipline in the surgical specialties.[5]

Detailed analysis of the association between matching to one's top-ranked discipline in CaRMS and the applicant's gender has not been reported since 2004. An up-to-date

Competing interests: None declared.

This article has been peer reviewed.

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***CMAJ Open* 2020. DOI:10.9778/cmajo.20190029**

analysis of the CaRMS match results is needed to better understand whether gender bias may be present in more recent matches. We therefore assessed variability in first-choice match rates between male and female applicants from Canadian medical schools in the 2013 through 2019 CaRMS match.

Methods

Setting and design

For this cross-sectional analysis, we used results from the CaRMS first-iteration R-1 match for the years 2013 to 2019. We excluded disciplines with fewer than 10 applicants over the study period because of small numbers, and we also excluded family medicine integrated specialties because it was unclear how these disciplines should be categorized.

Data source

We obtained data from CaRMS for the first iteration of the R-1 match for the years 2013 to 2019, regardless of match status. In the CaRMS match, medical students submit applications to training programs, ranking their programs in order of preference, and the training programs similarly rank the applicants (a detailed description of the CaRMS match algorithm is available in video format[3]). The residency training programs have access to a photograph of the applicant, the applicant's name and gender identity (binary options only), and supporting documents, such as medical school transcripts and student performance records, citizenship documents, reference letters, personal letters, and examination results and assessments. The CaRMS algorithm then matches each applicant to the highest-ranked program for which spots are still available, moving down the applicant's list until the applicant has a position or is left unmatched. Unmatched candidates may then participate in the second iteration of CaRMS, during which they may apply for any unfilled residency positions.[3] We obtained data for Canadian medical graduates concerning their first-choice discipline and matched discipline, as well as the number of applicants who matched to their first-choice discipline, segregated by gender. Data on geographic location of matches, including first-choice geographic location, were not available because of privacy standards.

CaRMS has defined the following discipline groupings: family medicine, nonsurgical and surgical. The surgical disciplines were cardiac surgery, general surgery, neurosurgery, obstetrics and gynecology, ophthalmology, orthopedic surgery, otolaryngology, plastic surgery, urology and vascular surgery. The nonsurgical disciplines were anatomic pathology, anesthesiology, dermatology, diagnostic radiology, emergency medicine, general pathology, hematologic pathology, internal medicine, laboratory medicine, medical genetics, medical microbiology, neurology, neurology – pediatric, neuropathology, nuclear medicine, pediatrics, physical medicine and rehabilitation, psychiatry, public health and preventive medicine, and radiation oncology.[13] Gender was self-reported, and the only options offered on the CaRMS application are "male" and "female."

Statistical analysis

We assessed univariable associations with χ^2 statistics. We analyzed associations between matching to one's first-choice discipline and gender, discipline and match year using multivariable log-binomial regression. We grouped the disciplines according to the CaRMS-defined groupings: family medicine, nonsurgical and surgical. We report the relative risk (RR) of matching to one's first-choice specialty using male gender as the reference gender, 2013 as the reference year and family medicine as the reference discipline. We assessed effect modification by including interaction terms for each of the variables and assessing their significance (defined as $p < 0.05$) in the model.

We conducted secondary analyses on 31 individual CaRMS disciplines, and analyzed the relative risk of matching in each individual discipline by gender using bivariable analysis, pooling data across years. For this analysis, we report the fixed-effects (Mantel–Haenszel) summary RR. All statistical analyses were conducted using R version 3.6.0.

Ethics approval

This study was approved by the University of Calgary's institutional ethics review board.

Results

Study cohort

Applicant gender, first-choice discipline and match results were available for 20 058 participants for the match years from 2013 to 2019 (n = 11 090 women [55.3%]). Two disciplines with a total of 25 participants (0.1% of the total cohort; n = 12 women [48%]) were excluded from analysis. Excluded disciplines are listed in Appendix 1 (available at www.cmajopen.ca/content/8/2/E346/suppl/DC1).

Table 1 presents cohort characteristics stratified by the 3 discipline categories. There were 7144 applicants who ranked family medicine as their first choice (n = 4455 women [62.4%]), 9298 applicants who ranked nonsurgical disciplines as their first choice (n = 4775 women [51.4%]) and 3591 applicants who ranked surgical disciplines as their first choice (n = 1848 women [51.5%]). A greater proportion of female than male applicants ranked family medicine as their first-choice discipline (40.2% v. 30.0%) and a lower proportion of female than male applicants ranked a surgical discipline as their first choice (16.7% v. 19.5%).

Matching to first-choice discipline

Overall, 16 766 (83.7%) of applicants matched to their first-choice discipline during the study period (Table 2). The proportion of applicants matching to their first-choice discipline was lowest for surgical disciplines (69.1%, n = 2481) and highest for family medicine (96.3%, n = 6881) ($p <$ 0.001). Overall, a greater proportion of female than male applicants matched to their first-choice discipline (84.9% v. 82.2%; absolute difference +2.7%; $p < 0.001$). With stratification by discipline category, a significantly greater proportion of female than male applicants matched to family medicine as a first choice (97.6% v. 94.2%; absolute difference

Table 1: Characteristics of the overall cohort and stratified by discipline category

Factor	Discipline category; no. (%) of applicants, by column and row*			
	All disciplines	Family medicine	Nonsurgical disciplines†	Surgical disciplines‡
Overall	20 033 (100.0)	7144 (35.7)	9298 (46.4)	3591 (17.9)
Gender				
Female	11 078 (55.3)	4455 (62.4, 40.2)	4775 (51.4, 43.1)	1848 (51.5, 16.7)
Male	8955 (44.7)	2689 (37.6, 30.0)	4523 (48.6, 50.5)	1743 (48.5, 19.5)
Match year				
2013	2695	979 (36.3)	1167 (43.3)	549 (20.4)
2014	2847	1087 (38.2)	1275 (44.8)	485 (17.0)
2015	2862	1101 (38.5)	1290 (45.1)	471 (16.4)
2016	2904	1050 (36.2)	1359 (46.8)	495 (17.0)
2017	2893	983 (34.0)	1399 (48.4)	511 (17.7)
2018	2913	970 (33.3)	1372 (47.1)	571 (19.6)
2019	2919	974 (33.4)	1436 (49.2)	509 (17.4)

*For overall data (first row) and data according to match year, the percentages are calculated by row only.
†Anatomic pathology, anesthesiology, dermatology, diagnostic radiology, emergency medicine, general pathology, hematologic pathology, internal medicine, laboratory medicine, medical genetics, medical microbiology, neurology, neurology – pediatric, neuropathology, nuclear medicine, pediatrics, physical medicine and rehabilitation, psychiatry, public health and preventive medicine, and radiation oncology.
‡Cardiac surgery, general surgery, neurosurgery, obstetrics and gynecology, ophthalmology, orthopedic surgery, otolaryngology, plastic surgery, urology and vascular surgery.

Table 2: Number and proportion of applicants who matched to their first-choice discipline according to study factors, for the overall cohort and stratified by 3-category discipline

Factor	Discipline category; no. (%) of applicants*				
	All disciplines	Family medicine	Nonsurgical disciplines†	Surgical disciplines‡	*p* value§
Applicants matched to first-choice discipline	16 766 (83.7)	6881 (96.3)	7404 (79.6)	2481 (69.1)	
Gender					Overall: $p < 0.001$
Female	9406 (84.9)	4349 (97.6)	3813 (79.9)	1244 (67.3)	Female v. male: $p_{Family} < 0.001$ $p_{Nonsurgical} = 0.6$ $p_{Surgical} = 0.02$
Male	7360 (82.2)	2532 (94.2)	3591 (79.4)	1237 (71.0)	
Year					Overall: $p < 0.001$
2013	2333 (86.6)	948 (96.8)	994 (85.2)	391 (71.2)	2013–2019: $p_{Family} = 0.8$ $p_{Nonsurgical} < 0.001$ $p_{Surgical} < 0.001$
2014	2461 (86.4)	1038 (95.5)	1059 (83.1)	364 (75.1)	
2015	2454 (85.7)	1060 (96.3)	1040 (80.6)	354 (75.2)	
2016	2428 (83.6)	1013 (96.5)	1066 (78.4)	349 (70.5)	
2017	2364 (81.7)	950 (96.6)	1073 (76.7)	341 (66.7)	
2018	2341 (80.4)	935 (96.4)	1070 (78.0)	336 (58.8)	
2019	2385 (81.7)	937 (96.2)	1102 (76.7)	346 (68.0)	

*The denominators for calculating percentages in this table are the values in the corresponding cells of Table 1.
†Anatomic pathology, anesthesiology, dermatology, diagnostic radiology, emergency medicine, general pathology, hematologic pathology, internal medicine, laboratory medicine, medical genetics, medical microbiology, neurology, neurology – pediatric, neuropathology, nuclear medicine, pediatrics, physical medicine and rehabilitation, psychiatry, public health and preventive medicine, and radiation oncology.
‡Cardiac surgery, general surgery, neurosurgery, obstetrics and gynecology, ophthalmology, orthopedic surgery, otolaryngology, plastic surgery, urology and vascular surgery.
§The *p* values are based on the χ^2 test.

+3.4%; $p < 0.001$), but a significantly lower proportion matched to a first-choice surgical discipline (67.3% v. 71.0%; absolute difference –3.7%; $p = 0.02$).

After adjustment for match year and discipline, female gender was associated with matching to one's first-choice discipline (RR 1.03, 95% confidence interval [CI] 1.02–1.04; Table 3). Relative to 2013, matching to one's first-choice discipline was less likely in 2018 and 2019; this finding was primarily driven by greater risk of not matching to one's first choice in nonsurgical disciplines. Compared with applicants who ranked family medicine as their first choice, applicants who ranked nonsurgical and surgical disciplines as their first choice were 17% and 28% less likely to match, respectively (RR for nonsurgical disciplines 0.83, 95% CI 0.82–0.84; RR for surgical disciplines 0.72, 95% CI 0.70–0.74).

Interaction of gender and matching to first-choice discipline

Discipline and gender were the only statistically significant interaction terms. Therefore, we performed log-binomial regression analyses stratified by discipline (Table 3). In the stratified analyses, gender was significantly associated with matching to one's first-choice discipline (Table 3). Female applicants were significantly less likely than male applicants to match to a first-choice surgical discipline (RR 0.95, 95% CI 0.91–1.00). In contrast, female applicants were significantly more likely to match to family medicine as a first choice (RR 1.04, 95% CI 1.03–1.05). There was no association of gender with matching to a first-choice nonsurgical specialty (RR 1.01, 95% CI 0.99–1.03).

We assessed the relative risk of matching to one's first choice in 31 individual disciplines by gender using bivariable analysis (i.e., pooling data across years; Table 4). We did not perform multivariable regression for the 31 disciplines because of small sample size for many of the individual disciplines. Female applicants were significantly less likely to match to urology than their male peers (RR for urology 0.80, 95% CI 0.66–0.97) and significantly more likely to match to psychiatry and family medicine as their first choice (RR for psychiatry 1.06, 95% CI 1.01–1.11; RR for family medicine 1.04, 95% CI 1.03–1.05).

Interpretation

Our study provides an assessment of the association between applicant gender and matching to one's first-choice

Table 3: Relative risk of matching to one's first-choice discipline from log-binomial regression, including results stratified by 3-category discipline

Variable	RR (95% CI) for unstratified adjusted model*	Discipline category; RR (95% CI) for stratified adjusted model†		
		Family medicine	Nonsurgical disciplines‡	Surgical disciplines§
Total no. of applicants	20 033	7144	9298	3591
Gender				
Male	1.0 (Ref.)	1.0 (Ref.)	1.0 (Ref.)	1.0 (Ref.)
Female	1.03 (1.02–1.04)	1.04 (1.03–1.05)	1.01 (0.99–1.03)	0.95 (0.91–1.00)
Year				
2013	1.0 (Ref.)	1.0 (Ref.)	1.0 (Ref.)	1.0 (Ref.)
2014	0.99 (0.98–1.00)	0.99 (0.97–1.00)	0.98 (0.94–1.01)	1.05 (0.98–1.13)
2015	0.99 (0.98–1.00)	1.00 (0.98–1.01)	0.95 (0.91–0.98)	1.06 (0.98–1.14)
2016	0.99 (0.97–1.00)	1.00 (0.98–1.01)	0.92 (0.89–0.96)	0.99 (0.92–1.07)
2017	0.98 (0.97–1.00)	1.00 (0.98–1.01)	0.90 (0.87–0.94)	0.94 (0.87–1.02)
2018	0.98 (0.96–0.99)	1.00 (0.98–1.01)	0.92 (0.88–0.95)	0.83 (0.76–0.90)
2019	0.98 (0.96–0.99)	0.99 (0.98–1.00)	0.90 (0.87–0.94)	0.96 (0.88–1.04)
Discipline				
Family medicine	1.0 (Ref.)	–	–	–
Nonsurgical‡	0.83 (0.82–0.84)	–	–	–
Surgical§	0.72 (0.70–0.74)	–	–	–

Note: CI = confidence interval, Ref. = reference category, RR = relative risk.
*Controlled for gender, year (categorical) and 3-category discipline, with no interaction terms.
†Controlled for gender and year (categorical).
‡Anatomic pathology, anesthesiology, dermatology, diagnostic radiology, emergency medicine, general pathology, hematologic pathology, internal medicine, laboratory medicine, medical genetics, medical microbiology, neurology, neurology – pediatric, neuropathology, nuclear medicine, pediatrics, physical medicine and rehabilitation, psychiatry, public health and preventive medicine, and radiation oncology.
§Cardiac surgery, general surgery, neurosurgery, obstetrics and gynecology, ophthalmology, orthopedic surgery, otolaryngology, plastic surgery, urology and vascular surgery.

Table 4: Relative risk of matching to first-choice discipline for each individual discipline (female v. male applicants)

Discipline	RR (95% CI)*
Family medicine	1.04 (1.03–1.05)
Nonsurgical disciplines†	
Anatomic pathology	1.08 (0.99–1.17)
Anesthesiology	1.00 (0.93–1.09)
Dermatology	0.96 (0.79–1.18)
Diagnostic radiology	1.00 (0.93–1.09)
Emergency medicine	1.04 (0.92–1.17)
General pathology	1.02 (0.68–1.52)
Hematologic pathology	0.86 (0.63–1.16)
Internal medicine	1.01 (0.98–1.03)
Laboratory medicine	1.22 (0.93–1.61)
Medical genetics (and genomics)	1.09 (0.92–1.29)
Medical microbiology	1.00 (0.68–1.46)
Neurology	1.08 (0.97–1.20)
Neurology – pediatric	0.99 (0.65–1.49)
Neuropathology	1.00 (1.00–1.00)
Nuclear medicine	1.22 (1.00–1.49)
Pediatrics	1.02 (0.94–1.11)
Physical medicine and rehabilitation	1.03 (0.89–1.19)
Psychiatry	1.06 (1.01–1.11)
Public health and preventive medicine	1.11 (0.88–1.38)
Radiation oncology	0.98 (0.86–1.12)
Surgical disciplines†	
Cardiac surgery	0.82 (0.61–1.11)
General surgery	0.99 (0.91–1.08)
Neurosurgery	0.97 (0.76–1.24)
Obstetrics and gynecology	0.98 (0.86–1.11)
Ophthalmology	1.04 (0.90–1.20)
Orthopedic surgery	0.96 (0.87–1.06)
Otolaryngology	0.89 (0.75–1.06)
Plastic surgery	0.94 (0.75–1.17)
Urology	0.80 (0.66–0.97)
Vascular surgery	0.83 (0.59–1.15)
Summary‡	1.02 (1.01–1.03)

Note: CI = confidence interval, RR = relative risk.
*Data are pooled across years.
†As defined by the Canadian Resident Matching Service.
‡Fixed effects (Mantel–Haenszel) meta-analysis.

discipline in the CaRMS matches over the period 2013 to 2019. In our study, female applicants were more likely overall to match to their first-choice discipline than male applicants. However, we also found that male applicants were significantly more likely to match to their first-choice surgical discipline than female applicants and, conversely, that female applicants were significantly more likely to match to family medicine as a first choice.

Previous examinations of the effect of sex or gender on successful matching to residency training program have had conflicting results. In an audit of a single anesthesiology training program in the United States, female applicants were more likely to match than male applicants (odds ratio [OR] 1.2, 95% CI 1.1–1.3).[8] Similarly, in the combined CaRMS matches for 1995 to 2004, male applicants had 1.6 greater odds of being unmatched than female applicants.[9] The latter authors did not find a significant association of sex or gender with odds of matching to radiology, ophthalmology or the surgical specialties.[10–12] A study of a single US radiology training program determined that female applicants were more likely to receive an interview than male candidates, but female applicants were no more likely to match than male applicants.[7] Worryingly, a recently published study of neurosurgery applicants in the US National Resident Matching Program between 1990 and 2007 showed that female candidates were less likely to match than their male counterparts (OR 0.59, 95% CI 0.48–0.72), even after adjustment for confounders such as United States Medical Licensing Examination scores and medical school class rank.[14] In contrast, a well-designed single-centre study that used randomly assigned names for orthopedic surgery applications did not detect implicit gender bias.[15] Importantly, although multiple studies have been performed to examine factors that may influence match results, many have not reported on the impact of applicant sex or gender.[16,17]

Limitations

An important limitation of our study is that CaRMS data do not provide information on the strength of individual applications, according to aspects such as an applicant's performance records[18] and the quality of reference letters.[6] In addition, CaRMS does not collect data on other potential confounders that might influence an applicant's success, such as age, race or ethnicity, indigeneity, sexual orientation,[8,19] personality characteristics[20] or a parent's career.[21] The absence of these data types limited our ability to address intersectionality, that is, the overlap of social categories that combine to increase or alter how disadvantage or discrimination is experienced by specific groups. For example, systemic disadvantages experienced by women from racial minorities in medicine are expected to be greater than and different from those faced by white women or men from racial minorities. In addition, CaRMS collects data on applicant gender only in binary categories, which prevented us from assessing the impact of applicant gender on match results, in particular for applicants who are gender diverse or gender nonconforming.

Our selected outcome — matching to one's first-choice discipline — might miss other outcomes considered important by candidates. For example, applicants might consider their first-choice city for training to be more important than their discipline or might consider their second-choice discipline to be highly acceptable.

Our study analyzed data only for Canadian medical graduates undergoing the first iteration of the CaRMS match. Our results may not be generalizable beyond this population.

Given the number of statistical analyses that we performed, such as those reported in Table 4, our results are subject to risks from multiple comparisons and type 1 errors. Therefore, these results should be interpreted with caution.

Our results also do not account for specific program efforts that may have been undertaken during the study period, such as implicit-bias training. Such efforts may affect gender bias.[22,23]

Conclusion

Our findings have important implications. The CaRMS match is a career branch point for Canadian physicians. Residency training programs therefore have a responsibility to ensure that their application processes are objective and fair, and it is of ethical and legal importance to monitor the matching process for bias and to implement effective systemic methods to reduce or eliminate bias. The potential presence of bias in the CaRMS match warrants greater attention and additional evaluation. Failure to guard residency selection from bias invites legal and ethical scrutiny.

References

1. Wilson CR, Bordman ZN. What to do about the Canadian Resident Matching Service. *CMAJ* 2017;189:E1436-47.
2. Canadian Resident Matching Service [homepage]. Ottawa: Canadian Resident Matching Service. Available: www.carms.ca (accessed 2020 Feb. 24).
3. How does the match algorithm work? [video]. Ottawa: Canadian Resident Matching Service. Available: www.carms.ca/the-match/how-it-works/ (accessed 2020 Feb. 24).
4. Bandiera G, Abrahams C, Ruetalo M, et al. Identifying and promoting best practices in residency application and selection in a complex academic health network. *Acad Med* 2015;90:1594-601.
5. Ryan T. Addressing bias and lack of objectivity in the Canadian resident matching process [letter]. *CMAJ* 2018;190:E1211-2.
6. Fraser JD, Aguayo P, St Peter S, et al. Analysis of the pediatric surgery match: factors predicting outcome. *Pediatr Surg Int* 2011;27:1239-44.
7. Hewett L, Lewis M, Collins H, et al. Gender bias in diagnostic radiology resident selection, does it exist? *Acad Radiol* 2016;23:101-7.
8. de Oliveira GS Jr, Akikwala T, Kendall MC, et al. Factors affecting admission to anesthesiology residency in the United States: choosing the future of our specialty. *Anesthesiology* 2012;117:243-51.
9. Baerlocher MO, Detsky AS. Are applicants to Canadian residency programs rejected because of their sex? *CMAJ* 2005;173:1439-40.
10. Baerlocher MO. Does sex affect residency application to surgery? *Can J Surg* 2007;50:434-6.
11. Baerlocher MO, Noble J. Does sex affect the success rate of Canadian ophthalmology residency applicants? *Can J Ophthalmol* 2006;41:163-8.
12. Baerlocher MO, Walker M. Does gender impact upon application rejection rate among Canadian radiology residency applicants? *Can Assoc Radiol J* 2005;56:232-7.
13. R-1 data and reports. Ottawa: Canadian Resident Matching Service; 2019. Available: www.carms.ca/data-reports/r1-data-reports/ (accessed 2020 Feb. 24).
14. Durham SR, Donaldson K, Grady MS, et al. Analysis of the 1990–2007 neurosurgery residency match: Does applicant gender affect neurosurgery match outcome? *J Neurosurg* 2018;129:282-9.
15. Scherl SA, Lively N, Simon MA. Initial review of Electronic Residency Application Service charts by orthopaedic residency faculty members. Does applicant gender matter? *J Bone Joint Surg Am* 2001;83:65-70.
16. Collins M, Curtis A, Artis K, et al. Comparison of two methods for ranking applicants for residency. *J Am Coll Radiol* 2010;7:961-6.
17. Stratman EJ, Ness RM. Factors associated with successful matching to dermatology residency programs by reapplicants and other applicants who previously graduated from medical school. *Arch Dermatol* 2011;147:196-202.
18. Mueller AS, Jenkins TM, Osborne M, et al. Gender differences in attending physicians' feedback to residents: a qualitative analysis. *J Grad Med Educ* 2017;9:577-85.
19. *Criminal Code*, R.S.C. 1985, c. C-46.
20. Frantsve LM, Laskin DM, Auerbach SM. Personality and gender influences on faculty ratings and rankings of oral and maxillofacial surgery residency applicants. *J Dent Educ* 2003;67:1252-9.
21. Weissbart SJ, Stock JA, Wein AJ. Program directors' criteria for selection into urology residency. *Urology* 2015;85:731-6.
22. Devine PG, Forscher PS, Cox WTL, et al. A gender bias habit-breaking intervention led to increased hiring of female faculty in STEMM departments. *J Exp Soc Psychol* 2017;73:211-5.
23. Girod S, Fassiotto M, Grewal D, et al. Reducing implicit gender leadership bias in academic medicine with an educational intervention. *Acad Med* 2016;91:1143-50.

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Contributors: Shannon Ruzycki conceived and designed the project, contributed to data acquisition and analysis, wrote the first draft of the manuscript and edited all versions of the manuscript. Madalene Earp performed the data analysis, contributed to the methods, results and tables, and edited the revised manuscript. Irene Ma supervised this work, provided administrative and funding support, contributed to the study design and data analysis, and edited the first draft and revised versions of the manuscript. All authors gave final approval of the version to be published and agreed to act as guarantors of the work.

Funding: This study was funded by the John A. Buchanan Chair of General Internal Medicine at the University of Calgary.

Data sharing: The data used in this study are publicly available at the website of the Canadian Resident Matching Service (www.carms.ca/), under the "Data & Reports" tab.

Acknowledgements: The authors thank Sara Rattanasithy and the data services team of the Canadian Resident Matching Service for providing and preparing the data used in this study.

Supplemental information: For reviewer comments and the original submission of this manuscript, please see www.cmajopen.ca/content/8/2/E346/suppl/DC1.