



## Trends in female applicants to Canadian ophthalmology residency programs from 1998-2020 Tendances dans les candidatures féminines aux programmes de résidence en ophtalmologie au Canada de 1998 à 2020

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Résumé de l'article

**Contexte :** L'ophtalmologie a toujours été une spécialité dominée par les hommes. Malgré une proportion plus élevée de femmes dans les facultés de médecine canadiennes depuis le début des années 2000, on ignore si les tendances en matière de candidatures féminines et d'admission en ophtalmologie ont suivi la même évolution. Cette étude vise à évaluer les tendances en matière de représentation des sexes parmi les postulants aux programmes de résidence en ophtalmologie au Canada de 1998 à 2020 et à comparer ces tendances à celles observées dans d'autres spécialités chirurgicales.

**Méthodes :** Nous avons obtenu des données agrégées sur le nombre annuel de postulants masculins et féminins ayant classé l'ophtalmologie comme spécialité de premier choix et y ayant été jumelés avec succès à partir de la base de données du Service canadien de jumelage des résidents (CaRMS). Nous avons ensuite effectué une analyse transversale rétrospective des données publiques disponibles. Par la suite, nous avons comparé les tendances des postulantes en ophtalmologie, ainsi parmi les femmes ophtalmologues en exercice, à celles observées dans d'autres disciplines chirurgicales.

**Résultats :** La proportion de candidatures féminines a augmenté de 24,3 % en 1998 à 33,3 % en 2020 ( $p = 0,001$ ), et celle des candidates jumelées a augmenté de 28,6 % en 1998 à 40,5 % en 2020 ( $p = 0,023$ ). Cependant, la variation incrémentale de cette proportion n'a pas augmenté de manière statistiquement significative en 2008-2012, 2013-2016 et 2017-2020. Une comparaison des taux de jumelage des hommes et des femmes n'a pas révélé de différence significative ( $p = 0,45$ ). Les tendances parmi les femmes postulantes en ophtalmologie et les femmes ophtalmologues en exercice étaient similaires à celles des autres spécialités chirurgicales.

**Conclusions :** Bien que la proportion de femmes qui postulent en ophtalmologie augmente, il y a un plateau récent en-deçà d'une parité hommes-femmes. D'autres études sont nécessaires pour identifier les obstacles potentiels et atténuer d'éventuels préjugés sexistes résiduels.



# Trends in female applicants to Canadian ophthalmology residency programs from 1998-2020

## Tendances dans les candidatures féminines aux programmes de résidence en ophtalmologie au Canada de 1998 à 2020

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### Abstract

**Background:** Ophthalmology has historically been a male-dominated specialty. Despite there being a higher proportion of females in Canadian medical schools since the early 2000s, it is unknown if trends in female applicants and those accepted to ophthalmology have followed suit. This study aims to evaluate trends in gender representation of ophthalmology applicants to Canadian residency programs from 1998 to 2020 and to compare those trends to other surgical specialties.

**Methods:** We obtained aggregate data of the annual number of male and female applicants ranking and successfully matching to ophthalmology as their first-choice specialty from the Canadian Residency Matching Service (CaRMS) database. We then carried out a retrospective cross-sectional analysis on the publicly available data. Subsequently, we compared trends in female applicants to ophthalmology, as well as female practicing ophthalmologists, to other surgical disciplines.

**Results:** The proportion of female applicants increased from 24.3% in 1998 to 33.3% in 2020 ( $p = 0.001$ ), and matched female applicants increased from 28.6% in 1998 to 40.5% in 2020 ( $p = 0.023$ ). However, the incremental change in proportion did not statistically significantly increase in 2008-2012, 2013-2016, and 2017-2020. Comparison of male and female matching success rates did not reveal a significant difference ( $p = 0.45$ ). Trends in female applicants to ophthalmology and female practicing ophthalmologists were similar to other surgical specialties.

**Conclusions:** Although the proportion of female applicants is increasing, there is a recent plateau and an inability to equalize the female-to-male ratio in ophthalmology. Further studies are needed to identify potential barriers and mitigate possible residual gender biases.

### Résumé

**Contexte :** L'ophtalmologie a toujours été une spécialité dominée par les hommes. Malgré une proportion plus élevée de femmes dans les facultés de médecine canadiennes depuis le début des années 2000, on ignore si les tendances en matière de candidatures féminines et d'admission en ophtalmologie ont suivi la même évolution. Cette étude vise à évaluer les tendances en matière de représentation des sexes parmi les postulants aux programmes de résidence en ophtalmologie au Canada de 1998 à 2020 et à comparer ces tendances à celles observées dans d'autres spécialités chirurgicales.

**Méthodes :** Nous avons obtenu des données agrégées sur le nombre annuel de postulants masculins et féminins ayant classé l'ophtalmologie comme spécialité de premier choix et y ayant été jumelés avec succès à partir de la base de données du Service canadien de jumelage des résidents (CaRMS). Nous avons ensuite effectué une analyse transversale rétrospective des données publiques disponibles. Par la suite, nous avons comparé les tendances des postulantes en ophtalmologie, ainsi parmi les femmes ophtalmologues en exercice, à celles observées dans d'autres disciplines chirurgicales.

**Résultats :** La proportion de candidatures féminines a augmenté de 24,3 % en 1998 à 33,3 % en 2020 ( $p = 0,001$ ), et celle des candidates jumelées a augmenté de 28,6 % en 1998 à 40,5 % en 2020 ( $p = 0,023$ ). Cependant, la variation incrémentale de cette proportion n'a pas augmenté de manière statistiquement significative en 2008-2012, 2013-2016 et 2017-2020. Une comparaison des taux de jumelage des hommes et des femmes n'a pas révélé de différence significative ( $p = 0,45$ ). Les tendances parmi les femmes postulantes en ophtalmologie et les femmes ophtalmologues en exercice étaient similaires à celles des autres spécialités chirurgicales.

**Conclusions :** Bien que la proportion de femmes qui postulent en ophtalmologie augmente, il y a un plateau récent en-deçà d'une parité hommes-femmes. D'autres études sont nécessaires pour identifier les obstacles potentiels et atténuer d'éventuels préjugés sexistes résiduels.

medical students were female.<sup>1</sup> By 1989, approximately 44% of medical students were female. During the mid 1990s and early 2000s, the proportion of female and male medical students equalized and has subsequently skewed towards a higher number of females ever since.<sup>2</sup> While this statistic is recognized and celebrated in both the medical and non-medical communities, more studies are needed to identify disparities in gender representation within specific medical specialties. This information may inform possible steps for achieving gender equality in various medical specialties, which may in turn increase access of care and health outcomes for female patients.<sup>3</sup>

Despite the increasing number of female students entering medical school over the past few decades, surgical specialties, on average, attract fewer female applicants.<sup>4</sup> This gender disparity is particularly evident within the field of ophthalmology, where each year between 2010-2020, just 33.3-46.5% of Canadian Resident Matching Service (CaRMS) applicants ranking ophthalmology as their first choice were female.<sup>5</sup> In other surgical fields where historical gender disparities exist, such as cardiac surgery or otolaryngology-head and neck surgery, recent studies have been published examining and discussing applicant trends based on gender.<sup>6,7</sup> A study by Lorello et al. in 2020 evaluated trends in female CaRMS applicants to all specialties;<sup>4</sup> however, a study specific to the trends of female students applying to ophthalmology has not been published since 2006.<sup>8</sup> More specifically, recent comparisons between trends seen in ophthalmology and other surgical specialties, statistical examination of how those trends have developed and changed over time, examination of matching success rates by gender in ophthalmology, and a review of the proportion of practicing female ophthalmologists were identified as gaps in the literature. As such, a more recent review of the data is warranted to contribute to the growing knowledge base on gender representation in medicine, and in ophthalmology specifically. These data may allow for future research into reasons behind these trends, as well as prompt discussion and change regarding any potential gender biases seen.

To address these gaps in the literature, we conducted a retrospective analysis. The primary aim was to examine female representation in ophthalmology applicants and those successfully matching to the specialty from 1998 to 2020. The secondary aims of this study were 1) to compare trends in female representation to other surgical specialties, 2) to compare the success rate of female applicants to the success rate of male applicants in

ophthalmology residency programs, and 3) to examine trends in practicing female ophthalmologists.

## Methods

### Study design

This was a retrospective cross-sectional analysis of gender-stratified match data results for surgical specialties from the publicly available CaRMS database between 1998-2020.<sup>5</sup> We obtained data for Canadian medical graduate (CMG) applicants in the first iteration of the match. We then carried out a second analysis on publicly available data from the Canadian Medical Association (CMA) Physician Census from 2000 to 2019 regarding trends in practicing female ophthalmologists.<sup>9</sup> In addition, we examined data from the CMA regarding practicing female surgeons in other surgical specialties. The local research ethics board waived the need for ethics approval as this study analyzed publicly available data.

### Sampling methods

We collected aggregate data for the annual number of male and female applicants ranking ophthalmology as their first-choice specialty, as well as those that subsequently matched, for each year. Gender was self-reported on the CaRMS application with the only available options of “male” and “female.” We then obtained cumulative data of the total number of females among all CaRMS applicants, as well as the number of females applying and matching to any surgical program, for each year. The surgical disciplines grouped together included cardiac surgery, general surgery, neurosurgery, ophthalmology, orthopedic surgery, otolaryngology, plastic surgery, urology and vascular surgery. These programs were included as they are listed under surgical specialties on the CaRMS website dating back to 1998.

We extracted additional data from the CMA Physician Census from 2000 to 2019.<sup>9</sup> This data included the number and percentage of male and female ophthalmologists currently practicing in Canada. We also obtained these same data points for other surgical subspecialties.

### Statistical analysis

To account for the increase in the total number of medical students and the increase in size of residency training programs over time, we used the proportion of females to analyze trends instead of absolute number of females. We first examined the proportion of females-to-males ranking ophthalmology as their first-choice specialty, as well as the proportion of females-to-males matching to ophthalmology as their first-choice specialty. We applied

the same method for the analysis of female applicants in other surgical specialties.

To compare the success rate of female to male applicants in ophthalmology residency programs, we calculated the success rate for each gender for each year. This represents the proportion of successfully matched applicants out of all the applicants that ranked ophthalmology as their first choice. We also used proportions when comparing female and male practicing ophthalmologists and other surgical specialists.

We used a fractional regression model with logit link, a type of regression model used when the dependent variable has upper and lower limits (such as with proportions), to analyze the proportion of female ophthalmology applicants over the study period.<sup>10</sup> This type of analysis shows whether the change in a dependent variable (i.e., proportion) is correlated with the change in another variable (i.e., time) in a statistically significant way. We carried out the analysis of trend first by treating time as a continuous variable for each year, and then by treating it as a categorical variable across distinct 4- or 5-year time periods (1998–2002, 2003–2007, 2008–2012, 2013–2016, and 2017–2020). We used a categorical variable for surgical discipline in the fractional logit model to evaluate other surgical specialties' trends over time, and an interaction term (which essentially describes how similar one trend is to another) to assess if the change in trend over time was different than the reference category of ophthalmology. We performed a Bonferroni correction when multiple comparisons were made.

We analyzed and compared the change in trend of the matching success rate for each gender over the study period using a fractional logistic regression with an interaction term to assess for effect modification. We conducted further sub-analysis at the yearly level using a Fisher's exact test to determine if being male or female was associated with an increased rate of matching in that particular year.

We compiled descriptive statistics and graphical trends over time for each residency training program across all years, as well as for practicing female physicians across different surgical disciplines. We performed all data analyses using Stata software (version 15.1; Stata Corp, College Station, Texas).

## Results

### Gender representation in ophthalmology applicants

The proportion of female medical students ranking and matching to ophthalmology as their first choice in the annual CaRMS match have both shown an overall increase. From 1998 to 2020, the proportion of female applicants compared to male applicants ranking ophthalmology rose from 24.3% ( $n = 37$ ) to 33.3% ( $n = 75$ ) ( $p = 0.001$ ) and the proportion of female applicants matching to ophthalmology rose from 28.6% ( $n = 14$ ) to 40.5% ( $n = 37$ ) ( $p = 0.023$ ) (Figure 1; Table 1).

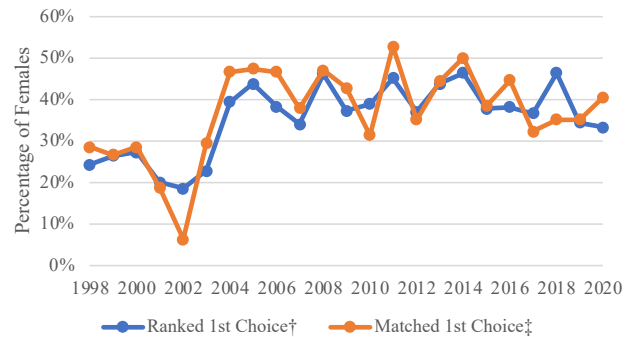


Figure 1. Proportion of female applicants ranking and matching to ophthalmology as their first-choice specialty from 1998 to 2020.

†Proportion of females ranking ophthalmology as first choice out of all the applicants ranking ophthalmology first choice. ‡Proportion of females who matched to ophthalmology as first choice out of all the applicants who matched to ophthalmology

Similarly, when comparing the change in proportion using the 4- or 5-year time periods, female applicants ranking ophthalmology increased from 23.5% ( $n = 166$ ) between 1998-2002 to 37.9% ( $n = 253$ ) between 2017-2020 ( $p < 0.001$ ) and female applicants matching to ophthalmology increased from 21.3% ( $n = 75$ ) between 1998-2002 to 35.9% ( $n = 145$ ) between 2017-2020 ( $p = 0.006$ ) (Figure 2; Table 2).

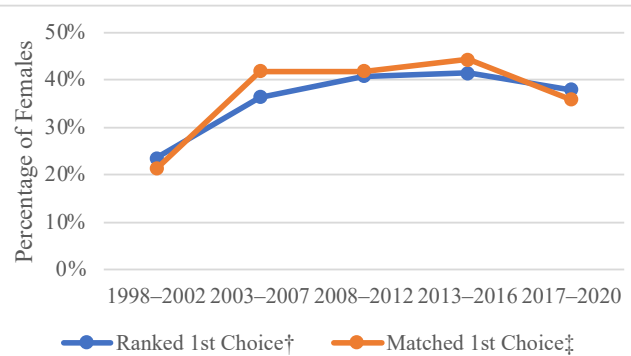


Figure 2. Proportion of female applicants ranking and matching to ophthalmology as their first-choice specialty averaged over 4- or 5-year time periods.

†Proportion of females ranking ophthalmology as first choice out of all the applicants ranking ophthalmology first choice. ‡Proportion of females who matched to ophthalmology as first choice out of all the applicants who matched to ophthalmology

However, comparing incremental change in proportion throughout the intermediate 4- to 5-year time periods did not reveal the same trend, and most of the increase from

1998 to 2020 actually occurred in the early 2000s. Lastly, the proportion of females matching to ophthalmology statistically significantly decreased in 2017-2020 to 35.9%

( $n = 145$ ) compared to 44.4% ( $n = 151$ ) in the previous time period ( $p = 0.002$ ).

Table 1. First-choice applicants to Ophthalmology programs from 1998 to 2020

Year	Ranked 1st Choice		Matched 1st Choice		Proportion Female Ranked (%) <sup>†</sup>	Proportion Female Matched (%) <sup>‡</sup>
	Female (n)	Male (n)	Female (n)	Male (n)		
1998	9	28	4	10	24.3	28.6
1999	9	25	4	11	26.5	26.7
2000	9	24	4	10	27.3	28.6
2001	7	28	3	13	20.0	18.8
2002	5	22	1	15	18.5	6.3
2003	5	17	5	12	22.7	29.4
2004	13	20	7	8	39.4	46.7
2005	14	18	9	10	43.8	47.4
2006	18	29	14	16	38.3	46.7
2007	16	31	11	18	34.0	37.9
2008	24	28	16	18	46.2	47.1
2009	22	37	15	20	37.3	42.9
2010	21	33	11	24	38.9	31.4
2011	28	34	19	17	45.2	52.8
2012	23	39	13	24	37.1	35.1
2013	21	27	16	20	43.8	44.4
2014	26	30	19	19	46.4	50.0
2015	20	33	15	24	37.7	38.5
2016	21	34	17	21	38.2	44.7
2017	18	31	11	23	36.7	32.4
2018	33	38	13	24	46.5	35.1
2019	20	38	13	24	34.5	35.1
2020	25	50	15	22	33.3	40.5

<sup>†</sup>Proportion of females ranking ophthalmology as first choice out of all the applicants ranking ophthalmology first choice; <sup>‡</sup>Proportion of females who matched to ophthalmology as first choice out of all the applicants who matched to ophthalmology

Table 2. Proportion of female first-choice applicants to Ophthalmology programs averaged over 4- or 5- year time periods.

Year Cohort	Proportion Female Ranked % (n) <sup>†</sup>	p-value (compared to previous year cohort)	Proportion Female Matched % (n) <sup>‡</sup>	p-value (compared to previous year cohort)
1998–2002	23.5 (166)	---	21.3 (75)	---
2003–2007	36.5 (181)	0.001	41.8 (110)	0.001
2008–2012	40.8 (289)	0.166	41.8 (177)	0.968
2013–2016	41.5 (212)	0.784	44.4 (151)	0.566
2017–2020	37.9 (253)	0.214	35.9 (145)	0.002

<sup>†</sup>Proportion of females ranking ophthalmology as first choice out of all the applicants ranking ophthalmology first choice; <sup>‡</sup>Proportion of females who matched to ophthalmology as first choice out of all the applicants who matched to ophthalmology

### Gender representation compared to other surgical disciplines

The proportion of female applicants ranking (Figure 3) and the proportion of female applicants matching (Figure 4) to each surgical subspecialty as their first choice has increased significantly from 1998 to 2020 ( $p < 0.05$  for each specialty individually). The change in this increasing proportion over time for both ranking and matching was not significantly different when each program was compared to ophthalmology, except for cardiac surgery and otolaryngology. For these two specialties, the rate of change in the proportion of female applicants ranking it as first choice was greater than the rate of change of females ranking ophthalmology ( $p = 0.041$  and  $p = 0.016$  for cardiac surgery and otolaryngology, respectively, when compared to ophthalmology). This change in tendency was not seen in the proportion of females matching to cardiac surgery

and otolaryngology when compared to ophthalmology. We also ran the same analyses from 2003-2020, as it may appear that the rate of change of females ranking and matching to ophthalmology decreased compared to other surgical specialties. In terms of females ranking surgical specialties, only cardiac surgery had a significantly higher rate of change ( $p = 0.044$ ). However, general surgery, orthopedic surgery, and otolaryngology had significantly higher rates of change compared to ophthalmology when it came to females matching ( $p = 0.008$ ,  $p = 0.010$ , and  $p = 0.021$ , respectively).

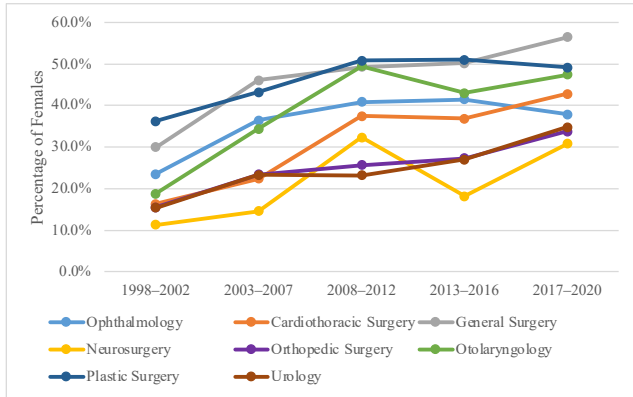


Figure 3. Proportion of female applicants ranking each surgical discipline as their first choice from 1998 to 2020.

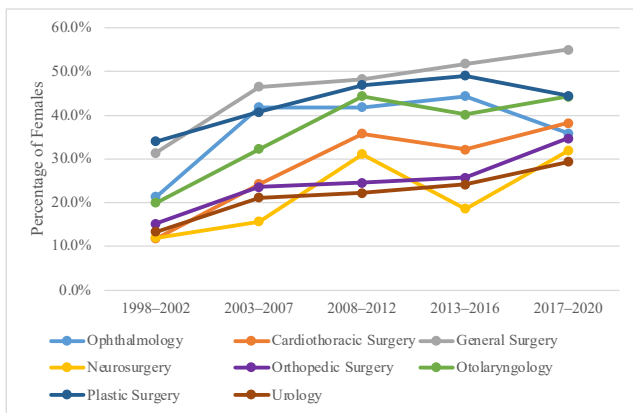


Figure 4. Proportion of female applicants matching to each surgical discipline as their first choice from 1998 to 2020.

We analyzed the overall proportion of females applying and matching to any surgical program over the 4- or 5-year time periods (Table 3). The proportion of female applicants ranking any surgical discipline increased from 22.8% ( $n = 1,114$ ) between 1998-2002 to 44.0% ( $n = 1,619$ ) between 2017-2020 ( $p < 0.001$ ) and the female applicants matching to any surgical discipline increased from 21.8% ( $n = 749$ ) between 1998-2002 to 42.5% ( $n = 1,062$ ) between 2017-2020 ( $p < 0.001$ ). However, this change in proportion was not significant when comparing the time periods 2017-2020 to 2013-2016, and 2013-2016 to 2008-2012 ( $p > 0.05$  for each).

Comparison of the success rate between the genders

The acceptance rate of female applicants that ranked ophthalmology as their first choice and successfully matched did not significantly change throughout the years studied ( $p = 0.120$ ). The matching success rates of female and male applicants throughout the years studied were also not significantly different ( $p = 0.45$ ). Between 1998 and 2020, the average success rate of female applicants was 61.0% and the average success rate of male applicants was 58.0%. When looking at each year individually, the

likelihood of successfully matching among those that ranked ophthalmology as their first choice did not depend on gender (Table 4).

Table 3. Proportion of female applicants to CaRMS and surgical specialties

Year Cohort	All CaRMS Applicants	Surgical CaRMS Applicants <sup>§</sup>	
	Total Females % (n)	Ranked 1st Choice, Females % (n) <sup>†</sup>	Matched 1st Choice, Females % (n) <sup>‡</sup>
1998–2002	46.3 (5,724)	22.8 (1,114)	21.8 (749)
2003–2007	54.6 (7,857)	33.2 (1,432)	33.2 (1,053)
2008–2012	57.4 (12,085)	39.7 (2,012)	37.7 (1,507)
2013–2016	55.6 (11,308)	40.1 (1,542)	38.9 (1,118)
2017–2020	55.2 (11,655)	44.0 (1,619)	42.5 (1,062)

<sup>†</sup>Proportion of females ranking surgical programs as first choice of all the applicants ranking surgical programs as first choice. <sup>‡</sup>Proportion of females who matched to a surgical program as first choice out of all the applicants that matched to a surgical program as first choice. <sup>§</sup>Surgical disciplines include cardiac surgery, general surgery, neurosurgery, ophthalmology, orthopedic surgery, otolaryngology, plastic surgery, urology and vascular surgery.

Table 4. Success rates to Ophthalmology programs among first-choice applicants

Year	Success Rate Females % (n)	Success Rate Males % (n)	p-value
1998	44.4 (9)	35.7 (28)	0.70
1999	44.4 (9)	44.0 (25)	1.00
2000	44.4 (9)	41.7 (24)	1.00
2001	42.9 (7)	46.4 (28)	1.00
2002	20.0 (5)	68.2 (22)	0.13
2003	100.0 (5)	70.6 (17)	0.29
2004	53.8 (13)	40.0 (20)	0.49
2005	64.3 (14)	55.6 (18)	0.72
2006	77.8 (18)	55.2 (29)	0.14
2007	68.8 (16)	58.1 (31)	0.54
2008	66.7 (24)	64.3 (28)	1.00
2009	68.2 (22)	54.1 (37)	0.41
2010	52.4 (21)	72.7 (33)	0.15
2011	67.9 (28)	50.0 (34)	0.20
2012	56.5 (23)	61.5 (39)	0.79
2013	76.2 (21)	74.1 (27)	1.00
2014	73.1 (26)	63.3 (30)	0.57
2015	75.0 (20)	72.7 (33)	1.00
2016	81.0 (21)	61.8 (34)	0.23
2017	61.1 (18)	74.2 (31)	0.36
2018	39.4 (33)	63.2 (38)	0.06
2019	65.0 (20)	63.2 (38)	1.00
2020	60.0 (25)	44.0 (50)	0.23

Gender representation in practicing physicians

The proportion of female practicing ophthalmologists out of total number of practicing ophthalmologists has significantly increased over the past two decades from 16.3% ( $n = 1,072$ ) in 2000 to 28.3% ( $n = 1,246$ ) in 2019. We also observed an increase in female representation in the trends of female practicing physicians found in other surgical specialties, (Figure 5) but this pattern was highest in ophthalmology compared to the other surgical subspecialties measured in this study.

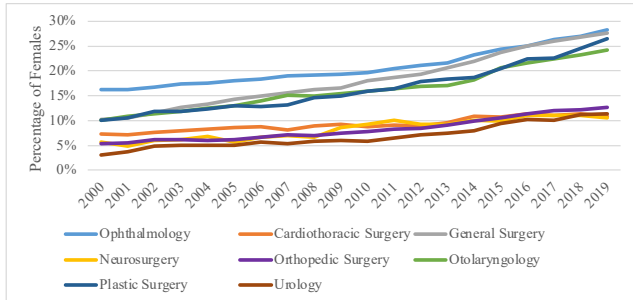


Figure 5. Proportion of female practicing physicians by specialty from 2000 to 2019

## Discussion

Our study demonstrates that there was a statistically significant increase in the proportion of total female applicants to ophthalmology, and in the proportion of female applicants accepted from 1998 to 2020. The proportion of female applicants increased from 24.3% in 1998 to as high as 46.5% in 2018, and matched female applicants increased from 28.6% in 1998 to as high as 52.8% in 2011 (Table 1). However, this change occurred early on as the incremental change between 1998-2002 and 2003-2007 was statistically significant (Table 2), but between each subsequent 4- to 5-year period, there was no significant increase. In fact, in the 2017-2020 period there was a significant decrease in proportion of matched females compared to the previous period. Based on Figure 1, we can see that the increase primarily occurred from 2002-2004, and a relative plateau begins afterward. The increase in female applicants and matches within ophthalmology in the early 2000s may be partially accounted for by the overall increase in female medical students in Canada. The stagnation seen in the following years could be due to a variety of factors that discourage women from pursuing a career in ophthalmology; however, further investigation is needed to elicit what these factors could be. Further investigation into the decrease in proportion of females matching to ophthalmology is also needed.

The percentage of total female applicants to CaRMS increased from 45.4% in 1998 to 56.1% in 2020.<sup>5</sup> Although the number of females exceeds males in Canadian medical schools,<sup>2</sup> there is a persistent gap in the female-to-male ratio in ophthalmology ranking and matching. Between 2017 and 2020, the average proportion of females applying and matching to ophthalmology was still only 37.9% and 35.9%, respectively (Table 2). In comparison to other surgical specialties, we found that the rates of change for females ranking and matching were statistically

significantly higher than ophthalmology in certain specialties (e.g., cardiac surgery for ranking, general surgery for matching), but not significantly different in most others. The reasons for these disparities are still unclear, but it appears as though the overall trends in females ranking and matching are mostly similar across surgical specialties. This raises the question of why this could be occurring; due to the higher number of females than males in medical schools, it may seem that a lesser percentage of females are applying to ophthalmology and other surgical specialties compared to males. For the instances that there are differences, further monitoring, and research as to why these differences are present and what institutions can do to change that may be warranted so that potential strategies to equalize gender representation can be well-informed.

In 2006, Baerlocher & Noble concluded that there was no discrimination against female ophthalmology CaRMS applicants based on gender.<sup>8</sup> Other studies on potential gender-based favouritism in for specific surgical specialties have found similar results.<sup>11,12</sup> However, a 2020 study by Ruzycki et al. found that females were less likely to match to a first-choice surgical subspecialty than males, so results are variable.<sup>13</sup> According to our study, a comparison of the success rates between males and females in ophthalmology, both overall and for each individual year, did not reveal a statistically significant difference (Table 4). The success rate of female applicants has also not statistically changed from 1998-2020, suggesting that any increases seen in female ophthalmology resident numbers is not based on a change in their ability to match, but rather an increase in the proportion applying. Again, this finding may suggest that the difference in proportion between males and females is due to a lack of female applicants; why this is still occurring may be an important topic for further research.

Many theories have been put forth regarding why rates of female applications are lower in surgical specialties, including ophthalmology. Lack of mentorship in male-dominated specialties and societal expectations or personal family goals are commonly cited.<sup>8,11,14,15</sup> Our study shows that there are fewer female practicing ophthalmologists than males to act as mentors. No specific data or studies could be identified on rates of female leadership in ophthalmology in Canada, but statistics from the American Academy of Ophthalmology in the United States show that female ophthalmologists continue to be underrepresented, often comprising approximately 30% of

leadership positions.<sup>16</sup> However, a study published by Kletke et al. in 2020 noted that most recently practicing (finished residency within the last 20 years) female ophthalmologists in Canada felt like they had adequate female mentors within the specialty.<sup>17</sup> This would suggest that a lack of female mentorship in ophthalmology may not play a large role in the gender disparity of applicants, and that there are probably other factors affecting these rates.

Several personal factors may also influence specialty choice; lifestyle implications of surgical specialties is one such factor. A recent systematic review by Trinh et al. in 2021 showed that female medical students across the globe were statistically significantly more influenced by lifestyle factors such as maternity leave and possibility of part-time work than their male counterparts when considering a career in surgery; however, ophthalmology was not included in this review and thus results may not apply.<sup>18</sup> Another systematic review corroborated these findings by demonstrating that specialties with a higher ratio of females to males were linked with a better work-life balance.<sup>19</sup> However, ophthalmology is broadly seen as a lifestyle-positive specialty, and as such the aforementioned lifestyle factors may not apply to ophthalmology as much as other surgical specialties. As such, more investigation is needed to pinpoint exact causes and to explain why some surgical specialties have seen increases in female first choice ranking/matching in the years since 2003-2007 that ophthalmology has not.

In terms of trends observed in the proportion of practicing female ophthalmologists, the proportion has increased from 16.3% in 2000 to 28.3% in 2019 (Figure 5). The proportion of practicing female ophthalmologists in 2019 does not reflect the number of females accepted into and graduating from residency programs since 1998 (Table 1) since the proportion of practicing female ophthalmologists is much lower than the proportion applying and matching into the specialty. This may be a result of several factors, such as part-time employment, maternity leave situations, or a historical male dominance in ophthalmology. More specifically, if ophthalmologists practice until the age of retirement, the population of ophthalmologists that began practicing in the mid to late 20<sup>th</sup> century will have much more male representation than the population of ophthalmologists that began practicing recently based on historical match data. As such, the imbalance of genders practicing in the profession will likely take multiple generations to equalize, but the increase in proportion from 2000-2019 does suggest that this equalization process

is underway. In addition, it is important to note that ophthalmology does hold a higher female representation in practicing physicians compared to other surgical specialties, although the rate of increase in proportion is not significantly different compared to other specialties. Potential reasons for this could be examined in future research.

The main limitations of this study arise from the nature of the data available from the CaRMS database, and the fact that this is a retrospective study. The specialty-specific data on the number of students applying and matching was only reported for those that applied to said specialty as their first choice. Data on applicants who applied to or matched to a surgical specialty as their second choice or lower are unknown and thus we are potentially missing the totality of applicants. However, given that the success rate is not significantly different between males and females, it is unlikely that this would create any bias in the analysis of proportions. Finally, CaRMS data up to 2020 only provided options of “male” and “female” for students to select, and therefore may be unable to adequately represent all medical students applying for residency positions.

## Conclusion

Overall, there is a positive pattern of females applying to and being accepted into an ophthalmology residency program in Canada. However, there is an obvious plateauing of the numbers over the years since 2003-2004. Despite the increased proportion of female-to-male medical students, there still exists a modest but definite disparity in candidates applying to ophthalmology, which then translates to a lower proportion of females matching to the specialty. Further studies are needed to identify residual gender disparities and the factors that encourage or deter females from applying to ophthalmology and other surgical specialties so that we may address these.

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