Influence of undergraduate medical education exposure to cadaveric dissection on choice of surgical specialty: a national survey of Canadian surgical residents

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Background: The number of Canadian Residency Matching Service (CaRMS) applicants ranking surgical specialties as their first choice has declined over the past 20 years; concurrently, there has been a reduction in the number of hours spent teaching undergraduate medical education (UGME) anatomy, particularly with cadaveric dissection. The aim of this study was to determine the factors that most influence selection of a surgical specialty, with specific focus on the impact of UGME anatomy training.

Methods: A 36-item cross-sectional survey was designed by experts in medical education and distributed to all current surgical residents in Canada in October 2018. Responses were recorded on a 5-point Likert scale or by means of list ranking. We analyzed univariable outcomes with a *t* test for continuous outcomes and the χ^2 test for dichotomous outcomes.

Results: Of 1493 surgical residents, 228 responded to the survey (response rate 15.3%). Respondents reported experiences on core rotations and elective rotations, and access to a mentor as the most important factors in deciding to pursue a surgical residency. Anatomy training with or without cadaveric dissection was moderately influential in respondents' first-choice CaRMS discipline (mean Likert scale score 2.97 [standard deviation (SD) 1.34] and 2.87 [SD 1.26], respectively). General surgery residents' CaRMS applications were more likely to have been influenced by UGME anatomy training than the applications by residents in other surgical specialties ($p < 0.001$). The impact of UGME anatomy training did not vary between postgraduate years or between male and female residents.

Conclusion: Canadian surgical residents' decision to apply to a surgical specialty did not seem to be strongly influenced by their UGME anatomy training, with or without cadaveric dissection, but, rather, by factors such as clinical experience and surgical mentorship. Further evaluation of groups that were more positively affected by their UGME anatomy training is warranted.

Contexte : Le nombre de candidats inscrits au Service de jumelage canadien des résidents (SJCR) qui classent les spécialités chirurgicales parmi leurs premiers choix a diminué ces 20 dernières années. Simultanément, dans les programmes d'études médicales prédoctorales, on a noté une baisse du nombre d'heures consacrées à l'enseignement de l'anatomie, particulièrement à la dissection de cadavres. Le but de cette étude était d'identifier les principaux facteurs qui influent sur le choix d'une spécialité chirurgicale, en portant une attention particulière à l'impact de la formation prédoctorale en anatomie.

Méthodes : Des experts en formation médicale ont préparé un sondage de 36 questions qui a été distribué à tous les résidents en chirurgie au Canada en date d'octobre 2018. Les réponses ont été reportées sur une échelle de Likert en 5 points ou sous forme de liste de classement. Nous avons analysé les résultats univariés au moyen d'un test *t* pour les résultats continus et d'un test du χ^2 pour les variables dichotomiques.

Résultats : Sur 1493 résidents en chirurgie, 228 ont répondu au sondage (taux de réponse, 15,3 %). Parmi les plus importants facteurs pour décider de poursuivre leur résidence, les répondants ont mentionné leurs expériences de stages obligatoires et électifs et l'accès à un mentor. La formation en anatomie, avec ou sans dissection de cadavres, a eu une influence modérée sur le premier choix d'une discipline du SJCR (score moyen à l'échelle de Likert 2,97 [écart-type (É.-T.) 1,34] et 2,87 [É.-T. 1,26],

respectivement). Les demandes d'admission des résidents en chirurgie générale étaient plus susceptibles de dépendre de la formation prédoctorale en anatomie que les demandes d'admission dans d'autres spécialités chirurgicales ($p < 0,001$). L'impact de la formation prédoctorale en anatomie n'a pas varié en fonction de l'année de résidence ni selon le sexe des résidents.

Conclusion : La décision des résidents de chirurgie canadiens de s'inscrire dans une spécialité chirurgicale n'a pas semblé fortement influencée par la formation prédoctorale en anatomie, avec ou sans dissection de cadavres, mais plutôt par des facteurs tels que l'expérience clinique et le mentorat en chirurgie. Il faudrait étudier plus en profondeur les groupes pour qui la formation prédoctorale en anatomie a été positive.

The number of Canadian Residency Matching Service (CaRMS) applicants ranking surgical specialties as their first choice has declined over the past 20 years.[1–5] Specifically, there was a reduction in the proportion of applications listing a surgical specialty as first choice from 20.7% in 1998 to 13.3% in 2019.[1] During this same time, there has been a dramatic shift in Canadian undergraduate medical education (UGME) anatomy training programs, such that the number of hours spent teaching anatomy has been reduced.[2,6,7] As a result, some medical schools have reduced exposure to anatomy training with cadaveric dissection.[8,9] Currently, only half of medical schools across Canada have mandatory cadaveric-dissection–based anatomy training.[2]

Programs with mandatory cadaveric dissection produce more Canadian medical graduates who rank a surgical specialty as their first choice CaRMS discipline than programs without mandatory cadaveric dissection.[2] Furthermore, all 3 medical schools most likely to have medical students ranking general surgery as their first choice CaRMS discipline have mandatory cadaveric dissection.[2] Nonetheless, the relation between UGME anatomy training and the decision to pursue a surgical career, and specifically subspecialties within surgery, remains unclear. To our knowledge, there are no studies evaluating the relation between student-perceived influence of UGME anatomy training with cadaveric dissection and applications to surgical residency programs. With the recent heightened attention to unmatched medical students, reduced residency positions and increased interest in non–primary-care specialties, further research is required to identify the factors that influence residents' CaRMS application decisions to help inform and guide future CaRMS decisions by medical students.

The aim of the present study was to further characterize and identify how influential UGME anatomy training is on the first-choice CaRMS discipline among surgical residents across Canada by means of a quantitative cross-sectional survey. The survey was also aimed at identifying other factors that affect surgical specialty selection. The findings may inform how best to encourage UGME students to develop an interest in surgical specialties, as well as aid in the construction of an evidence-based proposal that can be used to guide UGME curriculum development in order to encourage interest in surgical specialties.

Methods

Study population

The eligible group of survey recipients included all surgical residents across all specialties registered in a Canadian postgraduate surgical program who had a medical doctorate degree obtained from a Canadian medical school. Residents were included regardless of age, postgraduate year (PGY), or the primary language of their medical school and residency program. Surgical programs were identified according to those listed by CaRMS and included cardiac surgery, general surgery, neurosurgery, ophthalmology, orthopedic surgery, otolaryngology, plastic surgery, vascular surgery and urology.

Predictors of surgical specialty selection

The primary predictor of surgical specialty selection assessed was the influence of UGME anatomy training, specifically with the use of cadaveric dissection. We measured influence using a 5-point Likert scale ranging from 1 (strongly disagree) to 5 (strongly agree), as well as a list-ranking format.

Secondary predictors assessed included personal factors (i.e., family members in surgery, family members in medicine, children, prospect of having children, significant other(s), mentor(s), free time), professional factors (i.e., future financial compensation, future employment prospects) and educational factors (i.e., anatomy training before medical school, research projects, preclerkship exposure, clerkship exposure). We measured these factors using a 5-point Likert scale and a list-ranking format.

Survey design

We designed an electronic survey with input from 5 physicians with prior experience in conducting cross-sectional surveys and 2 physicians with a focus on medical education research. Following multiple rounds of revision in which primary literature pertaining to each survey item

was presented and analyzed, the survey was reviewed extensively by one of the authors (T.S.), who has experience in conducting survey research in UGME cadaver-based anatomy training.[2] The survey was then piloted with a group of third-year general surgery residents at McMaster University.

The final version included 36 questions divided into 6 sections: demographic information, UGME information, information on UGME anatomy training, factors influencing surgical residency application, factors influencing first-choice CaRMS discipline and comments (Appendix 1, available at canjsurg.ca/018019-a1). The first page of the survey contained survey instructions and covered the informed consent process. The survey was translated into French by a fluently French-speaking physician from Montréal. The English- and French-language versions of the survey were uploaded onto the Web-based platform SurveyMonkey for distribution and subsequent data acquisition.

The survey was distributed electronically in October 2018 to all surgery department chairs across Canada, with an invitation to participate and instructions for dissemination of the survey to current surgical residents in their programs. Two subsequent rounds of distribution to program directors of all surgical departments were done 4 and 8 weeks after the first distribution. Responses were collected for 20 weeks after the first distribution. We anonymized the survey responses according to the chronologic response number. We calculated the response rate based on data from the CaRMS registry indicating that 1493 surgical residency positions were filled by Canadian medical graduates between 2013 and 2017.[1]

As an incentive, respondents were entered into a draw for a $1000 travel voucher to a Canadian medical conference of their choice after they had completed the survey. Informed consent and agreement to participate in the study were implied by submission of a survey response. The study was approved by the Hamilton Integrated Research Ethics Board.

Statistical analysis

After the response deadline, we transferred all survey responses from SurveyMonkey to a Microsoft Excel database. We categorized comments into common categories. We used descriptive statistics to characterize the survey responses where applicable.[10] We analyzed univariable outcomes with a t test for continuous outcomes and the χ^2 test for dichotomous outcomes. Statistical significance was set a priori at $p < 0.05$. All statistical analysis was performed with Stata version 14 (StataCorp).

Results

The survey was distributed to 1493 Canadian surgical residents who had graduated from a Canadian medical school. The overall response rate was 15.3%. Of the 228 survey responses received, 202 (88.6%) were fully completed. The respondents' characteristics are presented in Table 1. The mean age was 28.8 years, 105 respondents (46.0%) were female, and 36 (15.8%) responded in French. The greatest number of responses were submitted by first-year residents (55 [24.1%]), followed by fourth-year residents (50 [21.9%]) and second-year residents (46 [20.2%]). All surgical specialties were represented, with general surgery (97 [42.5%]) and orthopedic surgery (50 [21.9%]) residents accounting for the majority of responses. All Canadian medical schools were represented in the survey responses. McGill University residents accounted for the largest proportion of survey respondents (32 [14.0%]), and the Northern Ontario School of Medicine for the least (2 [0.9%]).

Table 1. Respondent characteristics

Characteristic	No. (%) of respondents* n = 228
Age, mean ± SD, yr	28.83 ± 3.13
Female sex	105 (46.0)
French-speaking	36 (15.8)
Postgraduate year	
1–2	101 (44.3)
3–7	127 (55.7)
Surgical specialty	
Cardiac surgery	6 (2.6)
General surgery	97 (42.5)
Neurosurgery	6 (2.6)
Ophthalmology	13 (5.7)
Orthopedic surgery	50 (21.9)
Otolaryngology	15 (6.6)
Plastic surgery	15 (6.6)
Urology	21 (9.2)
Vascular surgery	5 (2.2)
UGME institution (n = 217)	
Dalhousie University	12 (5.5)
McGill University	32 (14.7)
McMaster University	13 (6.0)
Memorial University	5 (2.3)
Northern Ontario School of Medicine	2 (0.9)
Queen's University	17 (7.8)
Université de Montréal	8 (3.7)
Université de Sherbrooke	19 (8.8)
Université Laval	9 (4.1)
University of Alberta	7 (3.2)
University of British Columbia	18 (8.3)
University of Calgary	14 (6.4)
University of Manitoba	9 (4.1)
University of Ottawa	9 (4.1)
University of Saskatchewan	4 (1.8)
University of Toronto	26 (12.0)
Western University	13 (6.0)

SD = standard deviation; UGME = undergraduate medical education.
*Except where noted otherwise.

Anatomy training

The modalities of UGME anatomy training experienced by the respondents are described in Table 2. Nearly all respondents (189/202 [93.6%]) reported taking part in mandatory UGME anatomy training. Anatomy faculty and staff were present for all anatomy training sessions according to 158 respondents (78.2%). The most common anatomy teaching modality experienced by respondents was didactic teaching sessions (179 [88.6%]), followed by teaching with prosected specimens (175 [86.6%]); 145 respondents (71.8%) reported that they had had dissection-based anatomy training. Respondents identified dissection-based anatomy training as having the greatest number of hours of dedicated teaching (89 respondents [44.1%]) as well as having the greatest positive impact on learning (114 [56.4%]).

Effectiveness of undergraduate medical education anatomy training

Respondents did not express strong agreement or disagreement as to whether UGME anatomy training effectively prepared them for residency (mean Likert score 3.33 [standard deviation (SD) 1.26]) (Table 3). The mean score for the statement that UGME anatomy training with cadaveric dissection changed respondents' original inclination for their first-choice discipline was 2.84 (SD 1.32). Similar results were found for UGME anatomy training as a whole (mean score 2.77 [SD 1.30]). The majority of respondents strongly agreed that UGME anatomy training is an ineffective component of UGME (mean score 4.02 [SD 1.40]). Respondents who spent the majority of their UGME anatomy training hours in prosection- and dissection-based anatomy sessions were significantly more likely to agree that UGME anatomy training is ineffective than those who learned anatomy primarily through small-group tutorials and didactic lectures ($p = 0.03$).

Table 2. Undergraduate medical education anatomy teaching modalities and respondent experience within modalities

Anatomy teaching modality	No (%) of respondents $n = 202$	No (%) of respondents	
		Most time spent	Greatest impact on learning
Dissection	145 (71.8)	89 (44.1)	114 (56.4)
Prosection	175 (86.6)	38 (18.8)	59 (29.2)
Didactic	179 (88.6)	60 (29.7)	19 (9.4)
Tutorial	122 (60.4)	15 (7.4)	10 (5.0)

Factors influencing first-choice residency application

The impact of various influential factors on first-choice residency application is reported in Table 4. The mean Likert scale score for the statement that respondents' first-choice discipline for CaRMS was influenced by UGME anatomy training was 2.87 (SD 1.26), and for the statement that respondents' first-choice discipline for CaRMS was influenced by UGME anatomy training with cadaveric dissection, 2.97 (SD 1.34). The most influential factor was exposure to surgical specialties during clerkship elective rotations (mean score 4.31 [SD 1.16]), followed by exposure to surgical specialties during clerkship core rotations (mean score 4.30 [SD 1.02]) and access to mentorship (mean score 4.06 [SD 1.10]). The influencing factors that scored the lowest were having children at the time of residency application (mean score 1.41 [SD 0.94]), having family members working in a surgical specialty (mean score 1.63 [SD 1.13]), having family members working in medicine (mean score 1.91 [SD 1.28]) and significant other(s) (mean score 2.01 [SD 1.20]).

Male residents were more likely than female residents to have been influenced by anatomy training before UGME ($p = 0.04$), significant other(s) ($p = 0.04$), the potential for free time outside of work ($p = 0.02$) and potential financial compensation associated with a career in surgery ($p = 0.02$). There were no factors that were significantly more influential for female residents than for male residents. The responses of junior residents (PGY 1–2) were not significantly different from those of senior residents (PGY 3–7). The influence of UGME anatomy training with cadaveric dissection was significantly greater for general surgery residents than for residents in other surgical specialties ($p < 0.001$). The first-choice application

Table 3. Likert scale responses regarding effectiveness of undergraduate medical education anatomy training

Statement	Response*; no. of respondents†					Mean score ± SD
	1	2	3	4	5	
UGME anatomy effectively prepared me for residency	19	42	32	68	39	3.33 ± 1.26
UGME anatomy changed my original inclination for my first-choice discipline	47	31	56	41	20	2.77 ± 1.30
UGME anatomy with cadaveric dissection changed my original inclination for my first-choice discipline	37	33	47	34	23	2.84 ± 1.32
UGME anatomy is an ineffective component of undergraduate medical learning	25	9	12	40	109	4.02 ± 1.40

SD = standard deviation; UGME = undergraduate medical education.
*1 = strongly disagree, 2 = disagree, 3 = neutral, 4 = agree, 5 = strongly agree.
†Not all respondents indicated their level of agreement with all statements.

Table 4. Mean Likert scale scores for factors influencing first-choice residency application

	Overall	Male	Female		PGY 1–2	PGY 3–7		General surgery $n = 97$	Orthopedic surgery $n = 50$	Other $n = 81$	
Factor	Mean ± SD	Mean ± SD	Mean ± SD	*p* value	Mean ± SD	Mean ± SD	*p* value	Mean ± SD	Mean ± SD	Mean ± SD	*p* value
UGME anatomy training	2.87 ± 1.26	2.97 ± 1.22	2.85 ± 1.29	0.2	2.90 ± 1.25	2.83 ± 1.25	0.7	3.13 ± 1.28	3.13 ± 1.28	2.71 ± 1.18	0.04
UGME anatomy training with cadaveric dissection	2.97 ± 1.34	2.94 ± 1.32	3.00 ± 1.37	0.8	2.90 ± 1.34	3.05 ± 1.35	0.47	3.40 ± 1.27	2.44 ± 1.21	2.73 ± 1.35	< 0.001
Anatomy training before UGME	2.68 ± 1.29	2.86 ± 1.27	2.45 ± 1.29	0.04	2.55 ± 1.25	2.84 ± 1.34	0.1	2.68 ± 1.39	2.74 ± 1.20	2.66 ± 1.25	0.96
Research projects	3.03 ± 1.35	3.19 ± 1.29	2.84 ± 1.41	0.08	3.02 ± 1.29	3.05 ± 1.44	0.9	2.91 ± 1.29	2.95 ± 1.33	3.23 ± 1.43	0.3
Exposure in preclerkship	3.90 ± 1.36	3.97 ± 1.24	3.83 ± 1.28	0.4	3.93 ± 1.23	3.88 ± 1.30	0.8	3.92 ± 1.27	3.95 ± 1.25	3.87 ± 1.27	0.9
Exposure in surgery core rotation	4.30 ± 1.02	4.28 ± 0.99	4.33 ± 1.06	0.7	4.36 ± 0.87	4.23 ± 1.20	0.4	4.51 ± 0.87	4.40 ± 0.76	4.00 ± 1.25	0.007
Exposure in surgery elective rotation	4.31 ± 1.16	4.28 ± 1.21	4.35 ± 1.10	0.7	4.29 ± 1.15	4.35 ± 1.18	0.8	4.32 ± 1.18	4.32 ± 1.04	4.31 ± 1.22	1.00
Family member in surgery	1.63 ± 1.13	1.72 ± 1.22	1.53 ± 1.03	0.4	1.65 ± 1.15	1.62 ± 1.13	0.9	1.43 ± 0.83	1.89 ± 1.29	1.69 ± 1.27	0.2
Family member in medicine	1.91 ± 1.28	1.99 ± 1.34	1.83 ± 1.23	0.49	1.84 ± 1.24	2.00 ± 1.34	0.47	1.57 ± 0.92	2.10 ± 1.42	2.17 ± 1.46	0.045
Children at time of residency application	1.41 ± 0.94	1.51 ± 1.06	1.29 ± 0.78	0.2	1.38 ± 0.93	1.44 ± 0.96	0.8	1.26 ± 0.62	1.32 ± 0.90	1.62 ± 1.19	0.2
Prospect of having children	2.11 ± 1.24	2.23 ± 1.22	1.98 ± 1.26	0.2	2.04 ± 1.15	2.20 ± 1.34	0.4	1.80 ± 1.05	1.79 ± 1.06	2.66 ± 1.37	< 0.001
Significant other(s)	2.01 ± 1.20	2.18 ± 1.23	1.79 ± 1.13	0.04	2.00 ± 1.20	2.03 ± 1.20	0.9	1.99 ± 1.13	1.91 ± 1.07	2.11 ± 1.36	0.7
Mentor(s)	4.06 ± 1.10	4.11 ± 1.11	4.00 ± 1.10	0.48	4.12 ± 0.96	3.99 ± 1.26	0.4	4.12 ± 1.05	3.66 ± 1.20	4.23 ± 1.07	0.02
Time outside of work	2.60 ± 1.29	2.79 ± 1.26	2.37 ± 1.30	0.02	2.66 ± 1.31	2.52 ± 1.27	0.4	2.31 ± 1.26	2.31 ± 1.16	3.13 ± 1.25	< 0.001
Future potential financial compensation	2.52 ± 1.27	2.71 ± 1.25	2.30 ± 1.26	0.02	2.50 ± 1.23	2.56 ± 1.33	0.7	2.24 ± 1.16	2.58 ± 1.26	2.84 ± 1.34	0.01
Future job prospects	2.41 ± 1.15	2.51 ± 1.18	2.30 ± 1.12	0.2	2.30 ± 1.02	2.56 ± 1.29	0.1	2.18 ± 1.07	2.07 ± 1.00	2.93 ± 1.18	< 0.001

PGY = postgraduate year; SD = standard deviation; UGME = undergraduate medical education.

decision of respondents in surgical specialties other than general surgery and orthopedic surgery was more likely to be influenced by factors extrinsic to UGME, such as the prospect of having children, the potential for free time outside of work in the future and future employment prospects ($p < 0.001$ for all).

Illustrative comments

Illustrative comments are displayed in Table 5. Comments with regard to UGME anatomy training programs in general focused on areas of potential improvement. Comments regarding cadaveric dissection in particular were positive overall, with 3 respondents highlighting its importance in encouraging pursuit of a surgical specialty. A common theme was the importance of clinical exposure, in particular preclerkship exposure, to surgical specialties.

Discussion

The present survey failed to show that UGME anatomy training with cadaveric dissection significantly influenced the decision of current surgical residents to pursue a surgical residency position. Their mean response when asked whether such training influenced their first-choice CaRMS discipline was neutral on a Likert scale, and, from a list of 16 factors, UGME anatomy training with cadaveric dissection was the sixth most influential factor regarding the decision to apply to a surgical residency program. The most impactful factors on selecting a surgical specialty were exposure to surgical specialties during clerkship elective rotations, clerkship core rotations and preclerkship rotations, and strong surgical mentorship. As such, clinical experience before residency application appears to be far more important than UGME anatomy training with or without cadaveric dissection when choosing to apply to a surgical residency program. Furthermore, UGME anatomy training appears to have little impact on Canadian medical students' first-choice CaRMS discipline.

Although the survey results were fairly similar among subgroups, such as gender and PGY, there were important differences between surgical specialties. In particular, the CaRMS decisions of general surgery and orthopedic surgery residents were more influenced by their experience with UGME anatomy training than by other factors. General surgery residents were more heavily influenced than other surgical residents by UGME anatomy training with cadaveric dissection. A previous survey showed that

Table 5. Illustrative comments on the factors that influenced residents to pursue a surgical residency

Category	Comment
UGME anatomy training: general	I think that more surgeon involvement in anatomy training would have been more encouraging of my pursuing this specialty.
	Anatomy labs occurred too early in the medical education as it would be more beneficial right before clerkship.
	Of all reasons to be anxious during first year, my anatomy knowledge was the biggest contributor.
	Anatomy classes only reinforced my primary idea.
UGME anatomy training: cadaveric dissection	I believe cadaveric dissection was important. I think it should be more available and have more dedicated time for students interested in surgery.
	Having access to a teacher only some of the time during cadaveric dissection can often make it frustrating and a less useful learning experience.
	Cadaveric dissection is an essential part of learning medicine and understanding one's interest and passion for a surgical specialty.
	I wouldn't say this was the principal factor that made me decide to pursue a career in surgery, but it was definitely a piece of the puzzle that all pointed in the direction of choosing to pursue a surgical career.
Preclerkship surgical exposure	My first exposure to surgery came in the form of several self-arranged observerships in my preclerkship years. This is what caused me to pursue surgery. I think that my enjoyment of UGME anatomy certainly helped cement this decision, and I can't imagine anatomy without cadaveric dissection.
	Preclerkship experiences in many fields helped me narrow down my elective choices in combination with advice and guidance from my mentor, which led me to surgery.
	Hands-on shadowing experience made a difference in my choice of surgical discipline.
Other	Experiences prior to medical school influenced me the most.
	I like the content of my surgical specialty, and that's really the only factor that drew me to it.

UGME = undergraduate medical education.

medical students associate anatomy training with general surgery more than any other medical specialty.[11] Therefore, perhaps our results are due to the possibility that an increased interest in anatomy contributes to more profound learning and a more impactful overall experience. Although there is no evidence to suggest that medical students who go on to apply to a general surgery residency program have different experiences with cadaveric dissection than medical students who apply to other programs, it has been reported that they are less likely to feel intimidated during mandatory UGME cadaveric dissection.[12] Therefore, taking measures to improve medical students' comfort level during cadaveric dissection may indirectly affect the influence of UGME anatomy training on decisions regarding surgical residency application.

In the present study, clinical experience, both in preclerkship and clerkship, affected the decision to apply to a surgical specialty for residents across all surgical specialties. Surgical experiences in preclerkship ranked as the fourth most impactful factor. This is in keeping with previous reports. In a recent systematic review, Peel and colleagues[5] identified 10 studies in which preclerkship surgical exposure was associated with a positive experience and was important in dispelling the notion that a career in surgery did not allow for adequate work–life balance. Similarly, exposure to surgical specialties in clerkship has been found to significantly increase medical students' interest in pursuing a surgical specialty.[5,13,14] Clerkship surgical exposure can change medical students' perceptions of surgery from negative to positive.[5,15] In the present study, clerkship surgical exposure during elective rotations and core rotations were the first and second most impactful factors, respectively, on application to a surgical residency program. The third most impactful factor was surgical mentorship, which is generally seen as having a positive influence on the decision to pursue a career in surgery.[13,14] Furthermore, the lack of surgical mentorship is associated with a decreased likelihood of pursuing a career in surgery.[5] It has been suggested that surgical mentorship for women is less available and less influential;[14] however, this was not observed in the present survey. Regardless, increasing the availability of surgical staff and residents to act as mentors for medical students could contribute to increased Canadian medical student interest in surgical residency programs.

Medical schools have attempted to enhance these previously mentioned factors through programs such as preclerkship electives and mentorship programs.[14,16–19] Similar initiatives to enhance student experience in UGME anatomy have been less common.[18]

Our findings highlight potential cost-effective areas for improvement. First, changing the timing of UGME anatomy training with cadaveric dissection may increase the impact that UGME anatomy training has on the CaRMS decision-making process for medical students. Having cadaveric-dissection–based anatomy occur after preclerkship may enhance student learning and confirm medical students' interest in pursuing either a surgical or a nonsurgical specialty.[20] However, UGME anatomy training has also been shown to influence up to 32% of first-year medical students to consider a career in surgery and 17% of first-year medical students to decide against a surgical specialty.[21] Although there is conflicting evidence regarding the optimal timing for UGME anatomy training, the general agreement in the present study with the statement "UGME anatomy training is ineffective" highlights the need for change.

Second, although 78% of respondents stated that anatomy faculty and medical staff were present during their UGME anatomy training sessions, 1 respondent mentioned that it would be valuable for staff surgeons to be present during anatomy training. This has been shown to have a positive impact on medical students' perception of a surgical career: students participating in an anatomy training session with cadaveric dissection led by a staff surgeon had favourable perceptions of surgeons and a career in surgery after a single session.[22] In the present study, the 3 medical schools most likely to have medical students ranking general surgery as their first-choice CaRMS discipline were among the 5 schools most likely to always have teaching staff present during UGME anatomy sessions. As such, having more surgeon or surgical resident involvement during UGME anatomy training, specifically through demonstrating technical skills during cadaveric-based anatomy training, can be an important factor in at least ensuring that medical students feel more informed as to whether they are interested in pursuing a career in surgery.

Third, further investigation of the perceptions of general surgery and orthopedic surgery residents of UGME anatomy training with or without cadaveric dissection may elucidate other potential areas for improvement.

Limitations

Given the cross-sectional nature of our study, there are a number of possible confounding factors, such as surgical inclination before medical school and evolving lifestyle factors between medical school and residency, that were not controlled for. Moreover, our study failed to show causative relations between personal, professional or educational variables and the decrease in surgical residency applications. As such, it is possible that the variables most responsible for the decreasing number of CaRMS applicants ranking surgical specialties highly are not included in this survey.

Second, recall bias is inherent to most survey research. Concern regarding overestimation or underestimation of effects is reduced in the present study, as health care professionals have shown less recall bias in survey studies than the general population.[23] Furthermore, the greatest number of survey responses was from first-year residents, which minimized the recall period.[24]

Third, the response rate was only 15.3%, substantially lower than what has been reported previously for health care survey data.[25,26] The low response rate raises the possibility of selection bias. However, every Canadian medical school was represented, and the demographic characteristics of the respondents were in keeping with the national averages for surgical residents.[1,12] Furthermore, the response rate was based on an estimation of the number of current Canadian surgical residents from readily available CaRMS data; therefore, the population size may have been overestimated given the high attrition rate of residents in surgical programs.[27]

Fourth, the relatively large financial incentive for participation in the survey may have increased the risk of response bias. Respondents may have been less inclined to respond truthfully and thoughtfully than to simply respond rapidly. Nonetheless, financial incentive is an important method to increase survey response rates.[28] Socially desirable responding, an important factor in response bias, is also known to be decreased with the use of online surveys.[29]

Last, 2 medical schools in Canada have 3-year curricula, and the remainder have 4-year curricula. We did not control for this variability in UGME length, and it may have influenced the observed results. However, a similar proportion of students from these schools apply to surgical residency positions, and, thus, influencing factors are likely similar between the 2 groups.[1]

Conclusion

The results of this national cross-sectional survey show that current Canadian surgical residents' decision to apply to a surgical specialty did not seem to be strongly influenced by their UGME anatomy training, with or without cadaveric dissection, but, rather, by factors such as clinical experience and surgical mentorship. Further evaluation of groups that were more positively affected by their UGME anatomy training, such as general surgery and orthopedic surgery residents, may elicit strategies to enhance medical students' interest in surgery through UGME anatomy training.

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References

1. R-1 data and reports. Canadian Resident Matching Service; 2019. Available: https://www.carms.ca/data-reports/r1-data-reports/ (accessed 2018 Aug. 9).
2. Schroeder T, Elkheir S, Farrokhyar F, et al. Does medical school anatomy exposure affect surgical residency applications? An analysis of the Canadian residency match data. *Can J Surg* 2019;63: E129-34.
3. O'Herrin JK, Lewis BJ, Rikkers LF, et al. Why do students choose careers in surgery? *J Surg Res* 2004;119:124-9.
4. Austin RE, Wanzel KR. Supply versus demand: a review of application trends to Canadian surgical training programs. *Can J Surg* 2015; 58:143-4.
5. Peel JK, Schlachta CM, Alkhamesi NA. A systematic review of the factors affecting choice of surgery as a career. *Can J Surg* 2018;61: 58-67.
6. Drake RL, McBride JM, Lachman N, et al. Medical education in the anatomical sciences: the winds of change continue to blow. *Anat Sci Educ* 2009;2:253-9.
7. Heylings DJA. Anatomy 1999–2000: The curriculum, who teaches it and how? *Med Educ* 2002;36:702-10.
8. Kovacs G, Levitan R, Sandeski R. Clinical cadavers as a simulation resource for procedural learning. *AEM Educ Train* 2018;2:239-47.
9. Habbal O. The state of human anatomy teaching in the medical schools of Gulf Cooperation Council countries: present and future perspectives. *Sultan Qaboos Univ Med J* 2009;9:24-31.
10. Norman G. Likert scales, levels of measurement and the "laws" of statistics. *Adv Health Sci Educ Theory Pract* 2010;15:625-32.
11. Dawson AG, Bruce SAM, Heys SD, et al. Student views on the introduction of anatomy teaching packages into clinical attachments. *Clin Anat* 2009;22:267-72.
12. Tomlinson C, LaBossière J, Rommens K, et al. The Canadian general surgery resident: defining current challenges for surgical leadership. *Can J Surg* 2012;55(Suppl 2):S184-90.
13. Scott IM, Matejcek AN, Gowans MC, et al. Choosing a career in surgery: factors that influence Canadian medical students' interest in pursuing a surgical career. *Can J Surg* 2008;51:371-7.
14. Ko HH, Lee TK, Leung Y, et al. Factors influencing career choices made by medical students, residents, and practising physicians. *BC Med J* 2007;49:482-9.
15. Bhangu A, Boutefnouchet T, Yong X, et al. A three-year prospective longitudinal cohort study of medical students' attitudes toward anatomy teaching and their career aspirations. *Anat Sci Educ* 2010;3: 184-90.
16. Patel VM, Warren O, Ahmed K, et al. How can we build mentorship in surgeons of the future? *ANZ J Surg* 2011;81:418-24.
17. Kibbe MR, Pellegrini CA, Townsend CM, et al. Characterization of mentorship programs in departments of surgery in the United States. *JAMA Surg* 2016;151:900-6.
18. Gawad N, Moussa F, Christakis GT, et al. Planting the "SEAD": early comprehensive exposure to surgery for medical students. *J Surg Educ* 2013;70:487-94.
19. Cloyd J, Holtzman D, O'Sullivan P, et al. Operating room assist: surgical mentorship and operating room experience for preclerkship medical students. *J Surg Educ* 2008;65:275-82.
20. Cotter JR, Cohan CS. The timing, format, and role of anatomical sciences in medical education. *Int Assoc Med Sci Educ* 2010; 20:276-9.
21. Pulcrano ME, Malekzadeh S, Kumar A. The impact of gross anatomy laboratory on first year medical students' interest in a surgical career. *Clin Anat* 2016;29:691-5.
22. Are C, Stoddard HA, Thompson JS, et al. The influence of surgical demonstrations during an anatomy course on the perceptions of first-year medical students toward surgeons and a surgical career. *J Surg Educ* 2010;67:320-4.
23. Kellerman SE, Herold J. Physician response to surveys: a review of the literature. *Am J Prev Med* 2001;20:61-7.
24. Althubaiti A. Information bias in health research: definition, pitfalls, and adjustment methods. *J Multidiscip Healthc* 2016;9:211-7.
25. Cho YI, Johnson TP, VanGeest JB. Enhancing surveys of healthcare professionals: a meta-analysis of techniques to improve response. *Eval Health Prof* 2013;36:382-407.
26. Cunningham CT, Quan H, Hemmelgarn B, et al. Exploring physician specialist response rates to web-based surveys. *BMC Med Res Methodol* 2015;15:32.
27. Khoushkal Z, Hussain M, Greco E, et al. Prevalence and causes of attrition among surgical residents: a systematic review and meta-analysis. *JAMA Surg* 2017;152:265-72.
28. Edwards P, Roberts I, Clarke M, et al. Increasing response rates to postal questionnaires: systematic review. *BMJ* 2002;324:1183.
29. Tuten TL, Urban DJ, Bosnjak M. Internet surveys and data quality: a review. In: Batinic B, Reips UD, Bosnjak M, editors. *Online social sciences*. Seattle: Hogrefe and Huber Publishers; 2002:7-26.