Opening the “Black Box” for Canadian Cardiac Surgery Residency Applicants*

Klaudiusz Stoklosa, MD,a Amine Mazine, MD,a Keir A. Forgie, MD,b Amy Brown, MD, MSc,c Ali Hage, MD, MPH,d Khalid Ridwan, MD, MSc,e Charles Laurin, MD, MSc,f Jessica G.Y. Luc, MD,g Bobby Yanagawa, MD, PhD,h and Terrence M. Yau, MD, MSc.i

a Division of Cardiac Surgery, University of Toronto, Toronto, Ontario, Canada
b Division of Cardiac Surgery, University of Alberta, Edmonton, Alberta, Canada
c Division of Cardiac Surgery, University of Calgary, Calgary, Alberta, Canada
d Division of Cardiac Surgery, Department of Surgery, Western University, London Health Sciences Centre, London, Ontario, Canada
e Division of Cardiac Surgery, McGill University, Montreal, Quebec, Canada
f Division of Cardiac Surgery, Université Laval, Quebec City, Quebec, Canada
g Division of Cardiovascular Surgery, University of British Columbia, Vancouver, British Columbia, Canada
h Division of Cardiac Surgery, St. Michael’s Hospital, University of Toronto, Toronto, Ontario, Canada
i Division of Cardiac Surgery, University Health Network—Toronto General Hospital, University of Toronto, Toronto, Ontario, Canada

ABSTRACT

Background: This study reports on the main criteria used by Canadian cardiac surgery residency program committees (RPCs) to select residency program committee members found most and least important and medical students’ perceptions for these factors to identify and dispel myths*

CONCLUSION:

Canadian cardiac surgery residency programs seek applicants demonstrating clinical excellence - as assessed by surgical rotations and reference letters from colleagues - and strong interview performance.

*66 Residency program committee members from all 12 Canadian cardiac surgery programs and 41 Canadian medical students interested in cardiac surgery residency participated*

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applicants and the perceptions of Canadian medical students interested in cardiac surgery.

Methods: A 50-question online survey was sent to all 12 Canadian cardiac surgery RPCs. A similar 52-question online survey targeted at Canadian medical students interested in applying to cardiac surgery residency programs was distributed. Data from both surveys were analyzed using descriptive statistics.

Results: A total of 62% of all cardiac surgery RPC members (66 of 106) participated, including committee members from all 12 programs (range: 1-12 members per program; 9%-100% response rate per program) and 67% of program directors (8 of 12). Forty-one Canadian medical students (22 pre-clerks [54%], 2 MD/PhD students [5%], and 17 clinical clerks [41%]) participated. Committee members considered the following criteria to be most important when selecting candidates: on-service clinical performance, the interview, quality of reference letters from cardiac surgeons, and completing a rotation at the target program’s institution. In contrast, the following criteria relating to the candidate were considered to be less important: wanting to practice in the city or province of training, having a connection to the program location, and personally knowing committee members. Medical students’ perceptions were concordant regarding what factors are the most important but they overestimated the influence of non-clinical factors and research productivity in increasing their competitiveness.

Conclusion: Canadian cardiac surgery residency programs seek applicants who demonstrate clinical excellence, as assessed by surgical rotations and reference letters from colleagues, and strong interview performance.

Canadian medical students submit their residency program application through the Canadian Residency Matching Service (CaRMS). Residency program committees (RPCs), often consisting of the program director (PD), staff members, and resident representatives, deliberate on the CaRMS applications to allocate interviews and rank students after the interview process. Since 2013, Canadian residency programs have had to publicly share their selection process goals to increase application transparency. Although details about the Canadian residency application process can be viewed on the CaRMS website (www.carms.ca), becoming a “strong” or competitive candidate for any residency program remains a constant source of stress for students. Cardiac surgery residency, a Canadian surgical program parallel to the American Integrated Cardiothoracic Surgical Training Program, has become an increasingly popular and competitive option in Canada over the past 10 years. The number of applicants has nearly doubled from 13, 7 of whom ranked cardiac surgery as their first choice, for 11 total residency positions in 2013, to 24, with 16 ranking cardiac surgery as their first choice, for 11 total positions in 2022. Prospective students can apply to 12 accredited Canadian cardiac surgery programs—3 programs in Quebec and 9 programs outside Quebec—although some programs do not offer a residency position each year, and programs accept only up to 1 or 2 trainees.

The volume of research exploring the relative importance of various aspects of the residency application package is limited. To our knowledge, no studies have been performed on prospective Canadian cardiac surgery trainees, before or during the COVID-19 pandemic. We sought to survey all members from each of the 12 cardiac surgery RPCs with respect to the factors considered most and least important when deliberating on and selecting prospective residents. Moreover, we sought to survey Canadian medical students

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Corresponding author: Dr Terrence Yau, Chair, Division of Cardiovascular Surgery, University of Toronto; Professor, Division of Cardiac Surgery, University Health Network—Toronto General Hospital, 200 Elizabeth St, 4N, Toronto, Ontario M5G 2C4; Canada. Tel.: +1-416-340-4074; fax: +1-416-340-4385.

E-mail: terry.yau@uhn.ca

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See page 987 for disclosure information.
who were considering or exploring the field of cardiac surgery, to dispel myths around the application process. By doing so, our objective was to decipher the “black box” of applying to this specialty. We hypothesized that clinical performance would be considered most important among RPCs whereas students would overemphasize the importance of research experience.

Methods
Survey design
A working group (K.S., A.M., and T.M.Y.) developed a survey for Canadian cardiac surgery RPCs, adapted from Nguyen DD et al. (2020) (Supplemental Appendix S1).9 Participants were asked demographic questions, to rank 40 items on a 5-point Likert scale with 1 being “unimportant” and 5 being “most important,” and to list the minimum number of publications required to be viewed as a strong applicant for their program (Supplemental Fig. S1 and Supplemental Tables S1-S3). The survey was written in English and distributed to all 12 Canadian cardiac surgery RPCs through a Web-based platform (Google Forms, Google, Mountain View, CA). Only members of each 2020-2021 RPC could participate; if a program did not offer a residency position during this cycle, members of their 2019-2020 RPC were recruited.

A similar 52-question online survey targeted at students interested in applying to cardiac surgery residency programs was designed (Supplemental Appendix S2). The survey was written in English and asked participants to assess the same items using the same 5-point Likert scale based on the students’ perceptions of which aspects would define a strong applicant for a Canadian cardiac surgery residency program. The survey was distributed widely across Canadian medical school cardiac surgery interest groups, via organized events and social media platforms. The survey was open to only Canadian medical students for a period of 3 weeks in March 2021. Institutional ethics approval was obtained from the University of Toronto Health Sciences Research Ethics Board.

Statistical analysis
Data were analyzed using descriptive statistics. All statistical analyses were performed using Microsoft Excel (Microsoft, Redmond, WA). Statistical significance was set at $P < 0.05$. Data are presented as mean ± standard deviation. A response to every question was mandatory for survey submission.

RPC member survey responses were analyzed cumulatively and divided categorically based on demographic factors (experience and location). We defined “relatively inexperienced” as ≤ 2 years on the committee, and “very experienced” as ≥ 7 years on the committee. These criteria were selected in an attempt to balance proportional representation of relatively inexperienced and relatively experienced participants. Quebec and non-Quebec RPC results were compared to examine differences between predominantly Francophone and Anglophone programs. Quebec RPCs consisted of responses from McGill University, the University of Laval, and the University of Montreal. Non-Quebec RPC data consisted of all other RPC responses.

Survey answers of $\geq 7$ were treated as 7 for calculations, where applicable. The PD’s answer choice was selected for the question “Does your institution have a working ranking of students (ranked first to last) prior to conducting interviews?” to resolve discrepancies in RPC answers. Pre-clinical and MD/PhD responses were grouped together for data analysis. All authors have reviewed and approved the final manuscript.

Results
Respondent demographics
Of 106 Canadian RPC members surveyed, 66 (62%) participated, with representation from all 12 Canadian cardiac surgery programs (Table 1). Participant numbers ranged from 1-12 members per program, representing a 9%-100% response rate per program. A total of 8 PDs (67%) participated. The average experience level for RPC members was 3.9 ± 2.5 years, with 35% being relatively inexperienced and 30% being very experienced. Among PDs, the average experience level was 3.9 ± 1.8 years, with 25% being relatively inexperienced and 12.5% being very experienced. A total of 41 Canadian medical students participated—22 pre-clerks (54%), 2 MD/PhD students in their research years (5%), and 17 clerks (41%).

RPC responses
Perceptions regarding what factors are most and least important were similar between programs and among RPC categories (Figs. 1 and 2; Supplemental Tables S1 and S2). For all groups, performance during rotation(s) at program institution, quality of performance at interview, stress management during interview, and quality of reference letters from cardiac surgeons were among the 5 most important factors. Desire to practice in the city or province of the program, connection to the program location, having a higher degree, having reference letters from non-cardiac surgeons, and desire to work in a community setting were among the least important factors. Among Quebec RPC members, English proficiency was seen as being more important than French proficiency, with Likert scores of 4.00 ± 0.95 and 3.58 ± 1.44, respectively (Supplemental Table S2).

Despite the similarities, several statistically significant differences exist between very experienced and relatively inexperienced RPC members and between Quebec and non-Quebec RPC members (Supplemental Table S3). Compared to relatively inexperienced RPC members, very experienced RPC members placed a greater importance on completing a rotation with an RPC member ($P = 0.047$), clerkship academic performance ($P = 0.04$), and minimum number of overall authored publications ($P = 0.02$). Compared to non-Quebec RPC members, Quebec RPC members placed a greater importance on preclinical academic awards ($P = 0.01$), entrepreneurial endeavors ($P = 0.02$), having a higher degree ($P = 0.04$), French proficiency ($P < 0.001$), and having reference letters from non-cardiac surgeons ($P = 0.03$).

Medical student responses
All medical student respondents expressed interest in cardiac surgery. Medical students’ perceptions of most and least
important factors in a candidate’s application were similar for clerkship vs pre-clerkship students (Figs. 1 and 2). In both groups, performance during rotation(s) at the program institution, quality of reference letters from cardiac surgeons, and quality of/performance at the interview were among the 5 most important factors, and French proficiency and entrepreneurial endeavors were among the 5 least important factors. The overall patterns were similar for the 2 groups, with slight differences in relative ordering.

Despite the similarities, statistically significant differences were found in the relative weight of various factors (Supplemental Table S3). Pre-clerkship students perceived cardiac surgery as being a more difficult program to match into, compared to other CaRMS direct-entry specialties ($P < 0.001$) and other CaRMS surgical specialties ($P = 0.03$), compared to clerkship students. Pre-clerkship students believed candidates needed more total authored research publications related to cardiac surgery ($P < 0.01$), 1.05 more first-author publications related to cardiac surgery ($P < 0.001$), 2.13 more overall authored publications ($P < 0.001$), and 1.33 more overall first-author publications ($P < 0.001$) to be a strong applicant. Of note, RPC members placed higher emphasis than did medical students on pre-clinical academic performance ($P = 0.02$).

Moreover, although 33 medical students (80%) believed institutions have pre-interview student rankings, 11 programs (92%) indicated that they do not have such rankings (Table 2).

### Discussion

This survey focused on the perceived importance of various aspects of the CaRMS application and interview process among Canadian cardiac surgery RPCs and Canadian medical students interested in this specialty. We report a high degree of homogeneity in RPC member answers with respect to what factors are the most and least important to be considered a strong applicant. We also report that medical students’ perceptions were concordant regarding what the most important factors are but they also revealed several misconceptions. The study results confirmed our research hypothesis.

Unlike cardiothoracic residency and fellowship streams in the US, Canadian cardiac surgery programs do not place weight on standardized examinations such as the USMLE Step 1 and Step 2 CK scores. Canadian cardiac surgery programs appear to place the greatest value on the clinical excellence of their prospective applicants. This factor was assessed by performance during institutional rotations, reference letters from colleagues, interview performance, and to a lesser degree, clerkship academic performance and efficient management of patients on the ward. The finding that medical students viewed these factors as the most important is reassuring. Variability in these overall patterns within RPC categories was minimal. This finding highlights the uniformly high standards upheld across all Canadian cardiac surgery programs.

### Misconceptions

This study identified several misconceptions held by Canadian medical students. First, the importance of research productivity is overvalued by medical students. A statistically significant difference was found in the perceptions of medical students vs RPC members regarding the minimum total number of first-author and overall research publications, both related and unrelated to cardiac surgery, required to help define a strong applicant. Previous studies have highlighted the finding that although medical students allocate substantial time to research productivity in hopes of increasing their competitiveness, no added benefit seems to be accrued from reporting more research activities. Surveys of program directors across various medical and surgical disciplines have demonstrated that research has low to moderate importance in applicant rankings.

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**Table 1. Demographic composition of survey responses**

| Program               | Participation, n (%) | Size of RPC | RPC completion, % |
|-----------------------|----------------------|------------|-------------------|
| Dalhousie University  | 4 (6)                | 5          | 80                |
| McGill University     | 6 (9)                | 9          | 67                |
| McMaster University   | 8 (9)                | 9          | 67                |
| University of Alberta | 12 (18)              | 12         | 100               |
| University of British Columbia | 12 (18) | 11         | 45                |
| University of Calgary | 8 (12)               | 11         | 73                |
| University of Laval   | 3 (5)                | 6          | 50                |
| University of Manitoba| 3 (5)                | 8          | 40                |
| University of Montreal| 3 (5)                | 5          | 60                |
| University of Ottawa  | 1 (2)                | 11         | 9                 |
| University of Toronto | 10 (15)              | 11         | 91                |
| Western University    | 5 (8)                | 8          | 63                |
| Total                 | 66                   | 106        | 62                |

**Experience on RPC, n (%)**

| Experience on RPC, y | Participation, n (%) | PD experience on RPC, n (%) |
|---------------------|----------------------|-----------------------------|
| RPC, y              | RPC, n (%)           |
| 0 (First year on RPC) | 6 (9)                | 0 (0)                       |
| 2                   | 10 (15)              | 2 (25)                      |
| 3                   | 10 (15)              | 3 (37.5)                    |
| 4                   | 4 (6)                | 0 (0)                       |
| 5                   | 8 (12)               | 1 (12.5)                    |
| 6                   | 1 (2)                | 1 (12.5)                    |
| 7+                  | 20 (30)              | 1 (12.5)                    |
| Total               | 66                   | 8                           |
| Mean ± SD, y        | 3.9 ± 2.5            | 3.9 ± 1.8                   |

**Medical school training level**

| Medical school training level | Participation, n (%) |
|------------------------------|----------------------|
| Preclinical (first/second year) | 22 (54)             |
| PhD portion of MD/PhD        | 2 (5)                |
| Clinical clerk (third/fourth year) | 17 (41)             |
| Total                        | 41                   |

PD, program director; RPC, residency program committee; SD, standard deviation; y, years.

* Percentage of total.
Figure 1. The 5 most-important aspects of the application across residency program committee (RPC) and medical student categories (mean ± standard deviation).
Cardiac surgery is, however, a largely academic specialty. In the American Integrated Cardiothoracic Surgery Training Program, the average applicant had a total academic profile of 16.5 abstracts, presentations, and publications in the 2021 Association of American Medical Colleges (AAMC) Table B1 report. Not surprisingly, most Canadian cardiac surgery programs cited having several authored papers as important in being considered a competitive applicant, with some programs placing more emphasis than others on academia (Supplemental Table S1). Although this study provides

| RPC Cumulative | Having reference letters from non-cardiac surgeons | 2.71±1.12 |
|----------------|---------------------------------------------------|------------|
|                | Pre-clinical academic performance                  | 2.63±1.24  |
|                | Desire to work in a non-academic setting           | 2.63±1.11  |
|                | Entrepreneurial endeavors                          | 2.59±1.00  |
|                | French proficiency                                 | 2.10±1.14  |
| Very experienced | Participation in ranked/competitive team sports    | 2.54±1.10  |
|                | Entrepreneurial endeavors                          | 2.50±1.06  |
|                | Per-clinical academic performance                  | 2.38±1.17  |
|                | Participation in team sports (competitive/recreational) | 2.29±0.91 |
|                | French proficiency                                 | 1.75±0.79  |
| Relatively inexperienced | Having reference letters from non-cardiac surgeons | 2.25±1.04 |
|                | Pre-clinical academic performance                  | 2.00±1.60  |
|                | Desire to practice in the province of the program  | 2.00±0.93  |
|                | Desire to practice in the city of the program      | 1.63±0.92  |
| Program Directors | Connection to the program location                | 2.26±1.22  |
|                | Having reference letters from non-cardiac surgeons | 2.15±1.12  |
|                | Desire to practice in the province of the program  | 1.70±1.02  |
|                | Desire to practice in the city of the program      | 1.67±0.99  |
|                | French proficiency                                 | 1.41±0.74  |
| Quebec RPC | Desire to work in a non-academic setting           | 2.33±0.98  |
|                | Connection to the program location                 | 2.08±0.67  |
|                | Personally knowing one of the RPC members          | 2.00±0.95  |
|                | Desire to practice in the province of the program  | 1.92±0.90  |
|                | Desire to practice in the city of the program      | 1.92±0.90  |
| Cumulative medical students | Having reference letters from non-cardiac surgeons | 1.5±1.12 |
|                | Pre-clinical academic performance                  | 1.63±1.11  |
|                | Desire to work in a non-academic setting           | 1.67±1.09  |
|                | Entrepreneurial endeavors                          | 1.59±1.00  |
|                | French proficiency                                 | 1.10±1.14  |
| Pre-graduate and MD/PhD students | Participation in ranked/competitive team sports   | 2.54±1.10  |
|                | Entrepreneurial endeavors                          | 2.50±1.06  |
|                | Per-clinical academic performance                  | 2.38±1.17  |
|                | Participation in team sports (competitive/recreational) | 2.29±0.91 |
|                | French proficiency                                 | 1.75±0.79  |
| Pre-graduate and MD/PhD students | Artistic and musical endeavors                     | 2.68±1.06  |
|                | Entrepreneurial endeavors                          | 2.63±1.09  |
|                | Desire to work in a non-academic setting           | 2.63±1.30  |
|                | French proficiency                                 | 2.47±1.35  |

Figure 2. The 5 least-important aspects of the application across residency program committee (RPC) and medical student categories (mean ± standard deviation).
general information on a national level, applicants should know what the idiosyncrasies are of each program to which they apply. An interesting finding is that research was regarded as more important among very experienced RPC members, compared to relatively inexperienced RPC members, particularly the number of total first-authored publications, either related or unrelated to cardiac surgery. This finding may reflect a cultural evolution, with research productivity being more highly valued among older surgeons. Some more senior surgeons may feel that research productivity during medical school is a harbinger of academic success during residency and as a staff surgeon. Previous studies have demonstrated a positive correlation between medical school research productivity and future academic success.\textsuperscript{16-21} Relatively inexperienced committee members are often residents or junior staff surgeons who may prioritize recruiting a teammate who has a strong work ethic and personal skills rather than high research productivity. Canadian students can be reassured by the balance of experience, and thus perceptions, among members of RPCs, and by the low threshold for authorship on research publications required for applicants to be considered competitive.

![Figure 3. Statistically significant differences between cumulative medical students and cumulative residency program committee (RPC) members; $t$-value calculated as Average 1—Average 2, with values > 0 indicating that medical students place more weight on the relative importance. *Minimum number of publications to be considered a strong applicant.](image-url)
We also report several non-clinical misconceptions held by medical students. Medical students placed significantly more importance on the candidate’s connection to the program, desire to practice in the city and/or province of the program, and having and/or expressing desire to attain a higher degree. Medical students can be encouraged by the relative unimportance of these factors in candidate selection. One may postulate that the prevalence of fellowship training among cardiac surgery trainees and job recruiting during and after such fellowships account for the relative unimportance of these factors.22-24

Furthermore, cardiac surgery programs in Quebec provide instruction either primarily in French or by immersing trainees within predominantly Francophone communities, which is a barrier to entry for some applicants. However, high proficiency in French is not critical to Quebec RPC members in deciding on candidate competitiveness. Rather, conversational speaking ability, writing ability, and French reading comprehension serve as mandatory benchmarks to ensure that trainees can communicate with patients and interdisciplinary hospital staff.

Of note, most Canadian cardiac surgery programs do not conduct pre-interview candidate ranking. This approach provides an equal playing field wherein applicants can best connect with RPC members and differentiate themselves during the interview stage. Applicants must understand that being given an interview indicates a program’s interest in the candidate. Candidates are encouraged to use the interview as an opportunity to showcase their suitability for a specific program and the unique aspects they would bring to it. In particular, candidates may consider highlighting how they could improve the program for other residents and the institution if they are matched into it.

Although all medical students were interested in applying to a Canadian cardiac surgery position, pre-clerkship students were more likely to view cardiac surgery programs as being more difficult to match into than other CaRMS direct-entry and surgical specialties and were less confident that they would apply when the time came. Pre-clerkship students’ relative unfamiliarity with other specialties, in part owing to their being at an early stage in their career exploration, may account for these results. However, one must wonder whether these statistically significant observations are due to applicants’ misconceptions and how much they are a function of applicants being from medical school programs that provide less exposure to cardiac surgery mentors, research, and operative experiences.

Implications

Canadian medical schools are heterogeneous in the clinical exposure and preclinical cardiac surgery course content they provide.23-25 Access to cardiac surgeons for career exposure and mentorship guidance, particularly relating to cardiac surgery residency applications, can therefore be limited for some students. Our study findings may therefore provide increased transparency in the selection process and serve as a comprehensive, informal guide for prospective students who are confused about how to become competitive candidates. This guidance is particularly helpful for students who would otherwise rely on online forums, such as Premed 101 Forums (forums.premed101.com), classmates, family, and their own assumptions when determining what factors are sought out by those reviewing cardiac surgery residency applications.26 Our study findings also may help prospective American candidates applying to integrated cardiothoracic residency programs. Highlighting Canadian medical student misconceptions may also motivate pre-clerkship students to give stronger consideration to a career in cardiac surgery. Notably, historically underrepresented medical students may no longer consider misconceptions as being barriers to entry, such as there being a need for either extensive research authorship, connections to a program location, or a desire to practice in the city or province of the program. Moreover, outlining these misconceptions also provides PDs with critical information to better tailor their informal, open-house events, and informs cardiac surgeons in mentorship roles.

Our study also lends itself to follow-up data collection. One must wonder what impact current COVID-19 pandemic restrictions, such as interviews conducted through Web-based platforms and no Canadian away electives, have on resident recruitment. Current restrictions save students money on travelling fees but prevent them from interacting with the culture, residents, and staff at each program. Future research should examine the evolution of resident ranking throughout and after the COVID-19 pandemic. This current study may also inspire similar research within and between other CaRMS direct-entry specialties for increased transparency and reassurance for students. Future research also should examine reasons for statistically significant differences between pre-clerkship and clerkship students with respect to the perceived likelihood of applying to cardiac surgery and the perceived difficulty of matching into this specialty.

Limitations

The study has limitations at the RPC respondent level. Notably, 4 PDs did not participate, representing one-third of the programs. Although this lack of participation likely did not substantially affect the results, the PDs have an impactful voice and make the final decision on their program’s ranking list. Additionally, the small sample size (n = 62 RPC members) across only one RPC cohort year may limit the long-term applicability of the results. However, the heterogeneity in RPC experience and the overall agreement among RPC

### Table 2. Pre-interview student rankings

| Question                                      | Response | Cumulative RPC | Cumulative medical students |
|-----------------------------------------------|----------|----------------|-----------------------------|
| Does your institution have a working ranking of students prior to conducting interviews? | Yes | 1 (8) | 33 (80) |
|                                               | No       | 11 (92)        | 8 (20)                     |

Values are n (%).  
RPC, residency program committee.
members regarding what factors are most and least important suggest that results would be similar if participation had been increased across many RPC cohorts. Future investigations should repeat this study every 5-10 years to determine if perceptions have changed.

Survey-specific limitations include the subjective interpretation of questions and use of a nonvalidated survey. Additionally, future investigations should examine the impact of demographic diversity (sex, age, socioeconomic status, race, and belonging to a group that is traditionally underrepresented in medicine) on resident selection and include a short-answer portion to capture factors not listed as answer choices. Furthermore, assessment of the individual importance of one factor is difficult when factors are considered in combination.

Finally, the study has limitations at the medical student respondent level. The survey link was distributed electronically across Canadian medical schools for only 3 weeks. It is difficult to assess whether students at every Canadian medical school saw the link or had sufficient time to go through it. Given that no directory of medical students contemplating a career in cardiac surgery is currently available, assessing study participation as a response rate is not possible. Our efforts to maintain student anonymity in such a small specialty only further augmented this limitation. Without knowing which medical school program respondents attend, the reach of this survey cannot be assessed, although a lack of representation from one medical school could also indicate a lack of interest from that school’s students.

**Conclusion**

Canadian cardiac surgery residency programs pursue applicants who exhibit clinical excellence at the medical school level. Medical students are aware of the importance of these factors, particularly excellence demonstrated during clerkship rotations, reference letters, and interview performance. However, students overemphasize the necessity of non-clinical factors for application competitiveness. Ideally, future studies will provide information about the evolution of factor importance in applicant selection throughout and after the COVID-19 pandemic. Overall, this comprehensive study will likely prove beneficial in alleviating medical student stress related to applying to Canadian cardiac surgery residency programs and encouraging more students to consider this career path.

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**References**

1. Bandiera G, Abrahams C, Cipolla A, et al. Best practices in applications & selection: final report. Available at: https://pgme.utoronto.ca/wp-content/uploads/2016/06/BPASDraftFinalReportPGMEACMay2013.pdf. Accessed March 20, 2022.

2. Clark M, Shah S, Kolla I, et al. Post-CaRMS match survey for fourth year medical students. Can Med Educ J 2020;11:e101-10.

3. Blissert S, Law C, Morra D, Ginsburg S. The relative influence of available resources during the residency match: a national survey of Canadian medical students. J Grad Med Educ 2011;3:497-502.

4. Kulasegaram K, D’Eon M. Postgraduate medical education selection in Canada: opening the black box. Can Med Educ J 2020;11:e1-3.

5. CaRMS. R-1 match interactive data, https://www.carms.ca/data-reports/r1-data-reports/r1-match-interactive-data/. Accessed June 30, 2022.

6. CaRMS. Program descriptions—first iteration, https://www.carms.ca/match/r-1-main-residency-match/program-descriptions/. Accessed October 28, 2021.

7. Obafemi OO, Mullis DM, Rogers AB, Lee AM. Characteristics of integrated thoracic surgery residency matriculants: a survey of program directors. Ann Thorac Surg 2022;114:1035-42.

8. Smoold B, Nguyen SN, Kelly JJ, Han JJ. Integrated cardiothoracic surgery: developing a successful residency application. J Thorac Cardiovasc Surg 2020;160:167-74.

9. Nguyen DD, Lee JY, Domes T, et al. Survey of Canadian urology programs: Which aspects of the Canadian Residency Matching Service (CaRMS) application are the most important? Can Urol Assoc J 2020;14:169-73.

10. Green M, Jones P, Thomas JX. Selection criteria for residency: results of a national program directors survey. Acad Med 2009;84:362-7.

11. Lakoff J, Howse K, Cofie N, Heeneman S, Dalgarno N. Analysis of factors affecting Canadian medical students’ success in the residency match. Can Med Educ J 2020;11:e43-55.

12. Hill MR, Goicochea S, Merlo LF. In their own words: stressors facing medical students in the millennial generation. Med Educ Online 2018;23:1530558.

13. Melendez MM, Xu X, Sexton TR, Shapiro MJ, Mohan EP. The importance of basic science and clinical research as a selection criterion for general surgery residency programs. J Surg Educ 2008;65:151-4.

14. Negard M, Assimacopoulos E, Harland K, Van Heukelom J. Emergency medicine residency selection criteria: an update and comparison. AEM Educ Train 2018;2:146-53.

15. American Association of Medical Colleges. Table B1. Test scores and experiences of first-year residents, by specialty. Available at: https://www.aamc.org/data-reports/students-residents/interactive-data/report-residents/2021/table-b1-test-scores-and-experiences-first-year-residents-specialty. Accessed March 1, 2022.

16. Dorsey ER, Raphael BA, Balcer LJ, Galetta SL. Predictors of future publication record and academic rank in a cohort of neurology residents. Neurology 2006;67:1535-7.

17. Rezek I, McDonald RJ, Kallmes DF. Pre-residency publication rate strongly predicts future academic radiology potential. Acad Radiol 2012;19:632-4.

18. Yang G, Zaid UB, Erickson BA, et al. Urology resident publication output and its relationship to future academic achievement. J Urol 2011;185:642-6.
19. Grimm LJ, Shapiro LM, Singhapricha T, et al. Predictors of an academic career on radiology residency applications. Acad Radiol 2014;21:685-90.

20. Kohlert S, Zuccaro L, McLean L, Macdonald K. Does medical school research productivity predict a resident’s research productivity during residency? J Otolaryngol Head Neck Surg 2017;46:34.

21. Wang H, Bajaj SS, Williams KM, et al. Early engagement in cardiothoracic surgery research enhances future academic productivity. Ann Thorac Surg 2021;112:1664-71.

22. Shah AA, Aftab M, Tchantchaleishvili V, et al. Characterising the operative experience of cardiac surgical trainees: What are residents really doing in the operating room? Ann Thorac Surg 2016;101:2341-9.

23. Tchantchaleishvili V, LePar DJ, Odell DD, et al. Predictors of career choice among cardiothoracic surgery trainees. Ann Thorac Surg 2015;100:1849-54.

24. Bergquist CS, Brescia AA, Watt TMF, Pienta MJ, Bolling SF. Super fellowships among cardiothoracic trainees: prevalence and motivations. Ann Thorac Surg 2021;111:1724-9.

25. Noly PE, Rubens FD, Ouzounian M, et al. Cardiac surgery training in Canada: current state and future perspectives. J Thorac Cardiovasc Surg 2017;154:998-1005.

**Supplementary Material**

To access the supplementary material accompanying this article, visit *CJC Open* at https://www.cjcopen.ca/ and at https://doi.org/10.1016/j.cjco.2022.07.017.