Trends in types of graduate degrees and research output for academic general surgeons in Canada

Kevin Verhoeff, MD, BMSc
Kieran Purich, MD, MSc
Alexander Miles, MD
Janice Y. Kung, MLIS
A.M. James Shapiro, MD, PhD
David L. Bigam, MD, MSc

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Correspondence to:
K. Verhoeff
c/o Dvorkin Lounge Mailroom 2G2
Walter C. Mackenzie Health Sciences Centre
8440-112 ST NW
Edmonton AB T6G 2B7
verhoeff@ualberta.ca

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Summary

The proportion of general surgeons with graduate degrees in Canada is increasing. We sought to evaluate the types of graduate degree held by surgeons in Canada, and whether differences in publication capacity exist. We evaluated all general surgeons working at English-speaking Canadian academic hospitals to determine the types of degrees achieved, changes over time and research output associated with each degree. We identified 357 surgeons, of whom 163 (45.7%) had master's degrees and 49 (13.7%) had PhDs. Achievement of graduate degrees increased over time, with more surgeons earning master's degrees in public health (MPH), clinical epidemiology and education (MEd), and fewer master's degrees in science (MSc) or PhDs. Most publication metrics were similar by degree type, but surgeons with PhDs published more basic science research than those with clinical epidemiology, MEd or MPH degrees (2.0 v. 0.0, $p < 0.05$); surgeons with clinical epidemiology degrees published more first-author articles than surgeons with MSc degrees (2.0 v. 0.0, $p = 0.007$). An increasing number of general surgeons hold graduate degrees, with fewer pursuing MSc and PhD degrees, and more holding MPH or clinical epidemiology degrees. Research productivity is similar for all groups. Support to pursue diverse graduate degrees could enable a greater breadth of research.

The employment and research landscape for general surgeons in Canada continues to evolve, with increasing focus placed on graduate training and research productivity, but it is unclear what degrees general surgeons achieve and whether this has changed over time.[1,2] It also remains unclear whether any specific degree type is associated with increased research productivity. Characterizing trends and current graduate degree types held by Canadian surgeons may help programs ensure the success of their residents by offering degrees that are relevant, of interest and beneficial to surgical practice.

We evaluated this question by investigating general surgeons from all English-speaking Canadian academic institutions, with data collected as previously described by Purich and colleagues.[2] We obtained type of graduate degree and timing of degree achievement using Theses Canada, current publications and university websites, and by directly contacting surgeon's offices. We categorized each surgeon's degree by 2-author consensus as a master's degree in science (MSc), public health (MPH), clinical epidemiology (MClinEpi) focus, education (MEd); a PhD (focusing on basic science research); other graduate degree; or no graduate degree. We evaluated graduate degree achievement and type over time according to the surgeon's graduation year for their doctor of medicine (MD) degree. We collected publications between 2013 and 2018, and research impact for all surgeons, as reported by Purich and colleagues.[2] We compared research productivity, publication characteristics (basic science v. clinical study, as categorized by 2-author consensus) and study type (review v. primary study v. book chapter) by type of graduate degree.[2] We determined statistical significance using the Kruskal–Wallis test with the Dunn multiple comparison test. We also evaluated the types of graduate degrees and research output for surgeons hired

since 2013 to characterize differences between recent and older hires. Given significant outliers, we completed a post hoc analysis of the research output from the top 10% (i.e., hyperperformers) of included surgeons based on number of publications.

We included 357 surgeons from 31 institutions (listed in Appendix 1, available at canjsurg.ca/lookup/doi/10.1503/cjs.020721/tab-related-content). Of these surgeons, 145 (40.6%) did not have graduate degrees and 212 (59.4%) did. The proportion of surgeons with graduate degrees increased substantially over time, with changes in the types of degrees achieved (Figure 1). Over time, more surgeons have pursued MPH and MClinEpi degrees, and fewer have pursued MSc and PhD degrees. With regard to degree timing, the number of surgeons who pursued graduate training both during and after residency has increased (Figure 2).

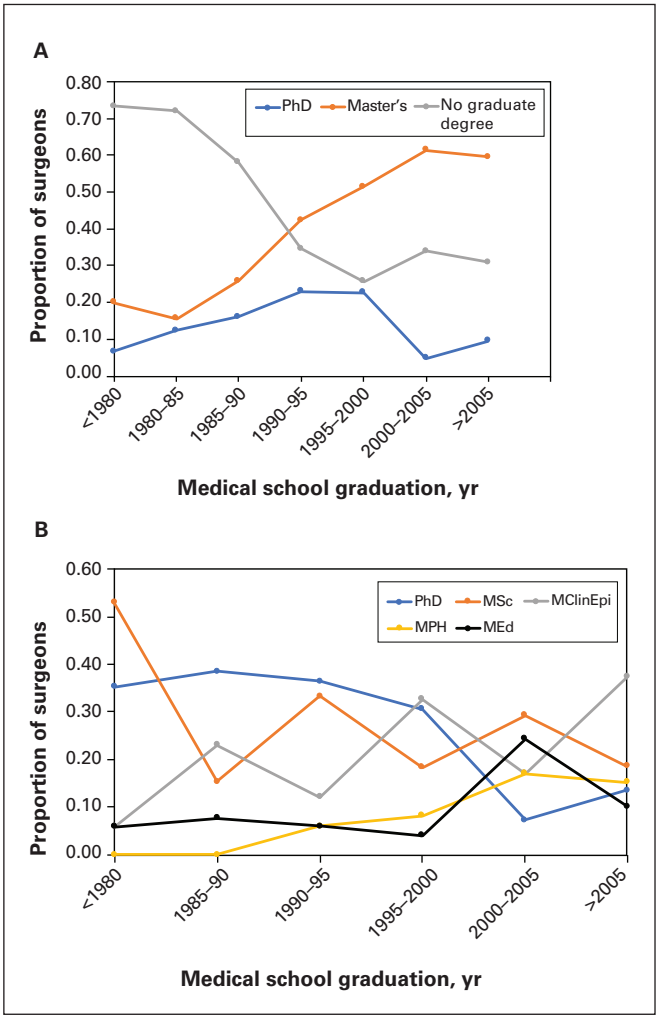

Fig. 1. Graduate degree achievement for academic surgeons in Canada over time. (A) Rate of graduate degree achievement over time. (B) Type of graduate degrees held by surgeons over time (excluding surgeons with graduate degrees categorized as "other" as they represented < 10% of population at all time points).

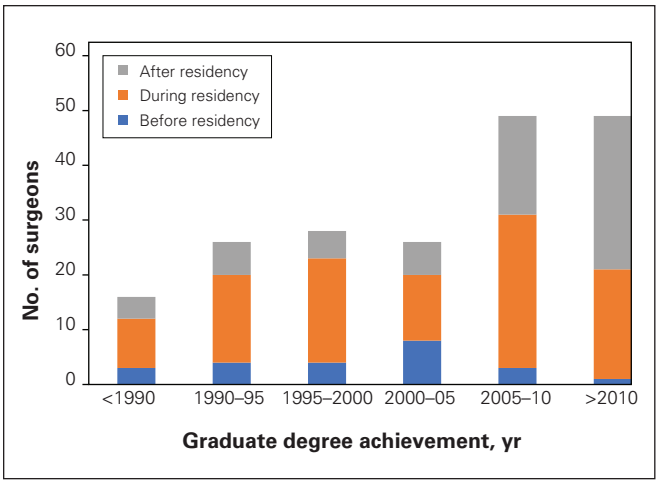

Fig. 2. Timing of graduate degree achievement for academic surgeons in Canada over time. We cluded 18 surgeons owing to uncertainty regarding timing of their graduate degree training (n = 5) or because they held dual graduate degrees (n = 13).

When comparing research of the 212 surgeons with a graduate degree, those with PhDs had higher metrics than those with other graduate degrees (Table 1). Otherwise, we observed only small differences in research metrics by degree type (Table 1). Surgeons with an MSc published more basic science manuscripts in the 6-year study period than surgeons with MClinEpi degrees (Figure 3). On the other hand, those with MClinEpi degrees published more manuscripts as first authors than surgeons with MSc degrees (Figure 3). No other statistically significant differences were found when comparing surgeons with different master's degrees. Of surgeons hired since 2013 (n = 80), only 27.5% did not have graduate degrees with substantial variability in degree subtypes (Appendix 1, Table 1S). However, analysis of the research output for surgeons hired since 2013 showed overall lower research metrics, including fewer publications per year during the study period, than surgeons hired before 2013 (Appendix 1, Table 2S). Among the 36 hyperperformers in the top 10% in terms of research output, graduate degree types varied, yet their research output made up a substantial proportion of the total research in Canada (Table 2).

For surgeons and residents directed toward a practice in academic general surgery, a graduate degree is becoming a common requirement. Among surgeons with graduate degrees, the proportion with MPH and MClinEpi degrees has increased substantially over time, with a decrease in the proportion with PhD and MSc degrees. We observed only minimal differences in research productivity based on degree type. This increasing breadth with sustained productivity can be seen as a sign of success for current training programs and hiring committees. Equally valuing this broad armamentarium of skills is likely to encourage interest

Table 1. Research productivity of general surgeons in Canada with graduate degree training, stratified by type of degree

Metric	Median (IQR)* PhD *n* = 49	MSc *n* = 54	MClinEpi *n* = 53	MPH *n* = 24	MEd *n* = 22	Other *n* = 10	*p* value
No. of years worked between 2013–2018, mean (median, IQR)	5.4 (6.0, 6.0–6.0)	5.3 (6.0, 6.0–6.0)	4.9 (6.0, 4.0–6.0)	4.7 (6.0, 3.0–6.0)	5.4 (6.0, 6.0–6.0)	4.7 (6.0, 3.0–6.0)	MClinEpi v. PhD 0.759 All others > 0.999
No. of papers in 6 years	22.0 (8.0–34.5)	8.5 (4.0–27.3)	16.0 (6.0–29.0)	9.0 (4.0–33.8)	10.5 (2.8–25.3)	10.0 (5.0–18.8)	MSc v. PhD 0.584 All others > 0.999
No. of papers per year	3.8 (1.7–6.9)	1.8 (1.0–4.5)	2.8 (1.4–6.4)	3.1 (1.3–6.0)	1.8 (0.6–5.2)	2.3 (1.0–5.1)	MSc v. PhD 0.315 MEd v. PhD 0.723 All others > 0.999
CiteScore	5.1 (3.5–6.3)	4.6 (3.6–5.8)	4.5 (3.4–5.0)	3.7 (2.3–4.7)	3.7 (2.0–4.7)	3.6 (2.6–4.4)	MClinEpi v. PhD 0.936 MPH v. PhD 0.040 MEd v. PhD 0.027 Other v. PhD 0.533 MPH v. MSc 0.304 MEd v. MSc 0.209 All others > 0.999
No. of first authorships in 6 years	1.0 (0–3.0)	0 (0–1.3)	2.0 (0–4.0)	1.0 (0–2.8)	1.0 (0–2.3)	2.0 (0–4.5)	MSc v. PhD 0.076 MClinEpi v. MSc 0.007 Other v. MSc 0.641 MPH v. MClinEpi 0.978 All others > 0.999
No. of last authorships in 6 years	5.0 (1.0–8.0)	2.0 (0.8–6.3)	2.0 (0.5–6.5)	1.5 (0–8.8)	1.5 (0–7.3)	2.0 (0–6.3)	MSc v. PhD 0.965 All others > 0.999
No. of middle authorships in 6 years	14.0 (4.5–24.5)	6.0 (2.8–18.5)	9.0 (2.0–19.5)	5.5 (2.3–20.5)	7.0 (0.8–18.0)	4.0 (1.8–10.3)	Other v. PhD 0.804 All others > 0.999
No. of citations per paper	10.5 (6.0–15.0)	10.5 (3.9–16.3)	9.0 (6.0–11.8)	6.8 (3.0–12.1)	6.5 (3.0–11.5)	6.8 (2.9–13.9)	MPH v. PhD 0.538 MEd v. PhD 0.185 MEd v. MSc 0.550 All others > 0.999
6-year *h*-index	11.0 (5.5–15.5)	7.0 (3.0–12.0)	9.0 (4.5–12.5)	6.5 (2.3–12.8)	6.0 (2.8–14.0)	6.5 (2.5–10.0)	MSc v. PhD 0.287 MEd v. PhD 0.540 All others > 0.999
No. of basic science papers	2.0 (0–9.0)	0 (0–3.3)	0 (0–0)	0 (0–0)	0 (0–0)	0 (0–0)	MClinEpi v. PhD < 0.001 MPH v. PhD < 0.001 MEd v. PhD 0.001 Other v. PhD 0.007 MClinEpi v. MSc 0.0117 MPH v. MSc 0.054 MEd v. MSc 0.109 Other v. MSc 0.174 All others > 0.999
No. of clinical papers	15.0 (5.5–33.0)	7.5 (3.5–21.3)	15.0 (6.0–28.5)	9.0 (3.3–33.8)	10.0 (2.8–25.3)	10.0 (5.0–18.0)	MSc v. PhD 0.513 MClinEpi v. MSc 0.701 All others > 0.999
No. (%) of surgeons with < 1 publication per year	8 (16.3)	11 (20.4)	8 (15.1)	5 (20.8)	7 (31.8)	2 (20)	
No. of review articles	2.0 (1.0–4.0)	1.0 (0–4.0)	2.0 (0–4.5)	1.5 (1.0–4.5)	1.0 (0–5.0)	1.5 (0–4.3)	All > 0.999
No. of book chapters	0 (0–1.0)	0 (0–1.0)	0 (0–0)	0 (0–1.0)	0 (0–0.3)	0 (0–0)	All > 0.999
No. of primary literature or general articles	19.0 (5.5–28.0)	7.5 (2.8–22.5)	11.0 (4.5–22.0)	7.5 (2.3–25.5)	7.5 (1.0–18.5)	8.5 (1.8–13.8)	MSc v. PhD 0.368 MPH v. PhD 0.924 MEd v. PhD 0.457 All others > 0.999
No. of narrative papers	0 (0–2.5)	0 (0–1.3)	0 (0–1.0)	0 (0–1.8)	1.0 (0–2.3)	0 (0–1.3)	MSc v. PhD 0.856 All others > 0.999

IQR = interquartile range; MClinEpi = master's of clinical epidemiology; MEd = master's of education; MPH = master's of public health; MSc = master's of science.
*Unless indicated otherwise.

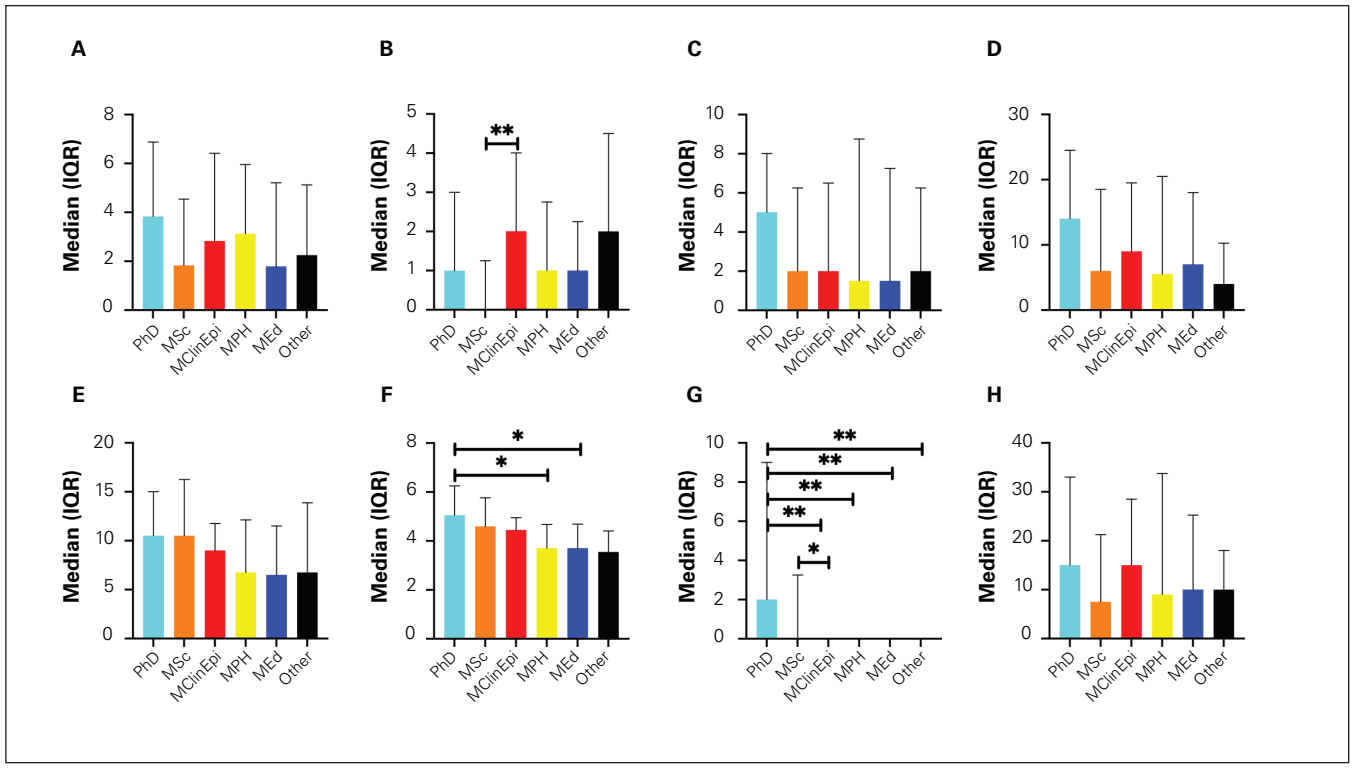

Fig. 3. Research productivity of general surgeons in Canada with graduate degrees, stratified by degree type, including (A) number of publications per year, (B) number of first authorships, (C) number of last authorships, (D) number of middle authorships, (E) citations, (F) CiteScore (G) number of basic science manuscripts and (H) number of clinical manuscripts. Statistical significance indicated by *($p < 0.05$) and **($p < 0.01$). IQR = interquartile range; MClinEpi = master's of clinical epidemiology; MEd = master's of education; MPH = master's of public health; MSc = master's of science.

Table 2 (part 1 of 2). Descriptive statistics of hyperperformers (top 10% as defined by the total number of manuscripts between 2013 and 2018)

Variable	Median* *n* = 36	Total *n* = 36
No. of years worked 2013–2018, mean	6.0	
Total no. of papers in 6 years	66.5	2920†
No. of papers per year	10.2	473.5
No. of first authorships in 6 years	2.0	193
No. of last authorships in 6 years	20.0	855
No. of middle authors in 6 years	44.5	1872
Total no. of citations	1732.5	88893‡
No. of citations per paper	13.0	
6-year *h*-index	22.0	
No. of basic science papers	2.0	431
No. of clinical papers	56.5	2484
No. of review articles	8.0	427
No. of book chapters	1.0	68
No. of primary literature or general articles	53.5	2227
No. of narrative articles	3.0	193
City of work		
Toronto		18
Montréal		5
Edmonton		4
Calgary		4
London		2
Vancouver		1
Winnipeg		1
Ottawa		1

Table 2 (part 2 of 2). Descriptive statistics of hyperperformers (top 10% as defined by the total number of manuscripts between 2013 and 2018)

Variable	Median* *n* = 36	Total *n* = 36
Types of graduate degree		
PhD		9
MSc		7
None		7
MPH		5
MEd		4
MClinEpi		3
Other		1

MClinEpi = master's of clinical epidemiology; MEd = master's of education; MPH = master's of public health; MSc = master's of science.
*Unless indicated otherwise.
†46.1% of initial cohort's 6333 publications.
‡57.0% of initial cohort's 155929 citations

and lifelong research pursuit to continue moving the field forward. Newly hired surgeons appear to have less research productivity, suggesting that more than 10 years is needed to develop research infrastructure, collaborations and teams, which should be considered by institutional review committees and for resource allocation.

As a final point, it is astonishing that 36 hyperperformers are responsible for about half of the publications and citations among all 357 general surgeons in Canada. Clearly, factors other than graduate degree subtype lead surgeons such as these to be this academically productive. Analysis of personal characteristics that motivate these individuals, similar to what has been evaluated in highly successful orthopedic surgeons, would be of interest for academic recruitment and to foster future success of similar people.[3] In addition, the effect of employment contracts, research mandates, time commitment to research and financial support likely play a role in both graduate degree achievement and research productivity.

The proportion of academic surgeons with graduate degrees continues to increase in Canada, and the types of degrees pursued has changed over time, with more surgeons pursuing MPH and MClinEpi degrees. Overall, the research productivity remains similar for academic general surgeons, regardless of their graduate degree type, although it appears to take several years to become established. Finally, outliers in this study outline the need for future research evaluating hyperperformers in general surgery.

Affiliations: From the Department of Surgery, University of Alberta, Edmonton, Alta. (Verhoeff); the Department of Surgery, University of Alberta, Edmonton, Alta. (Purich); the Department of Surgery, University of Alberta, Edmonton, Alta. (Miles); the John W. Scott Health Sciences Library, University of Alberta, Edmonton, Alta. (Kung); the Clinical Islet Transplant Program, Alberta Diabetes Institute, University of Alberta, Department of Surgery, Canadian National Transplant Research Program, Edmonton, Alta. (Shapiro); the Department of Surgery, University of Alberta, Edmonton, Alta. (Bigam).

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