

Research productivity among Canadian urology residents: A national, cross-sectional analysis

Ihtisham Ahmad¹, Anna-Lisa V. Nguyen², Zizo Al-Daqqaq³, Sanchit Kaushal¹, Adree Khondker⁴, Mohamad Baker Berjaoui⁴, Naeem Bhojani⁵, Monica A. Farcas⁴, Christopher J.D. Wallis⁴, David-Dan Nguyen^{4,6}, Jason Y. Lee⁴

¹Temerty Faculty of Medicine, University of Toronto, Toronto, ON, Canada; ²Schulich School of Medicine and Dentistry, Western University, London, ON, Canada; ³Division of Urology, University of Ottawa, Ottawa, ON, Canada; ⁴Division of Urology, University of Toronto, Toronto, ON, Canada; ⁵Division of Urology, Centre hospitalier de l'Université de Montréal (CHUM), Université de Montréal, Montréal, QC, Canada; ⁶Institute of Health Policy, Management and Evaluation, Dalla Lana School of Public Health, University of Toronto, Toronto, ON, Canada

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Corresponding author: Dr. Jason Y. Lee, Division of Urology, University of Toronto, Toronto, ON, Canada; Jason.Lee2@uhn.ca

ABSTRACT

Introduction: We aimed to characterize and identify factors associated with research productivity of Canadian urology residents.

Methods: This cross-sectional study used publicly available data to evaluate the research productivity of all active Canadian urology residents as of November 2023, regardless of start date. Trainee names and demographic data were collected using residency program websites and a systematic web search. Publication metrics were obtained from Scopus.

KEY MESSAGES

- Protected research time in a clinician-investigator program (CIP) is the strongest associated factor of academic productivity but is rarely used.
- Pre-residency publications were associated with future productivity and suggest a gender gap favoring male applicants.
- We found that a program's research-active environment matters more than mandatory short projects. Larger faculty size correlated with higher resident output, while simply requiring a research project or block did not.
- These publication-based benchmarks may inform trainee counseling and program policies aimed at supporting resident scholarship.

Linear regression was used to model the associations between individual and program-level factors with publications per postgraduate year (PGY).

Results: We included 182 Canadian urology residents. The median total publications was four (interquartile range [IQR] 1, 8). The median publication-per-PGY was 0.25 (IQR 0.0, 0.8). The median h-index was 2 (IQR 1, 3). The male median pre-residency publications was two (IQR 1, 5) compared to female median pre-residency publications of one (IQR 0, 4, $p=0.04$). Pre-residency publications were associated with publications-per-PGY ($\beta=0.10$, 95% confidence interval [CI] 0.08–0.12, $p<0.001$). Clinician-investigator program participation was associated with publications-per-PGY ($\beta=5.27$, 95% CI 3.60–6.94, $p<0.001$). No gender differences in productivity were observed during residency.

Conclusions: Pre-residency publications and participation in a clinician-investigator program were the strongest factors associated with productivity. These findings highlight the need for equitable early research mentorship and access to protected research time, alongside the influence of a research-active program environment. These publication-based benchmarks may inform trainee counseling and program policies aimed at supporting resident scholarship; however, publication counts do not capture research quality, impact, or resident competence.

INTRODUCTION

Scholarly activity is a core component of medical training and an essential element of the Scholar role within the CanMEDS framework (1). In urology, research is not only integral to residency education but also a factor in the residency selection process (2). While the emphasis and expectations placed on resident research activity likely vary across programs, the extent of this variability and its impact on scholarly output remain unclear.

Previous cross-sectional analyses from different specialties have investigated research productivity and associated factors among resident cohorts (3–5). Factors such as graduate degrees, previous research experience, or program size have been implicated as predictors of greater productivity. In urology, research productivity has been evaluated at all levels of training in the United States, from medical school applicants to staff urologists (6–8). Among other factors, gender-based differences and dedicated research time have been found to be associated with higher publication rates (9,10). To date, no Canadian analysis has characterized the state of research productivity in our domestic context.

In this study, we aimed to quantify scholarly output during residency and identify individual- and program-level factors associated with greater research productivity among Canadian urology residents. These insights may help guide medical students considering urology as a specialty and provide residency programs with information on resident research productivity.

METHODS

Study design and cohort

Using publicly available data, we conducted a cross-sectional study to evaluate the research productivity of all active Canadian urology residents as of November 2023. We included all active urology residents at this time regardless of start date. Residency program characteristics, including Program Directors (PDs), were also collected. Research ethics board approval was not required under the University of Toronto policy, considering the use of publicly available data. We identified active urology residents' names using program websites and by inquiring with program administrators.

Data extraction

Demographic data of trainees were collected using residency program websites and a systematic web search. Two reviewers independently collected data for each resident, and any discrepancies were resolved by consensus. Gender was determined using reported pronouns where available or inferred using Gender-API. Information on trainees' education and research background was also collected, including anticipated residency graduation year, medical school attended, previous completion of a graduate degree, highest graduate degree obtained, and enrolment in a clinician-investigator program (CIP). A CIP describes a structured element during residency that is dedicated to at least 2 full-time years of research training. Program research requirements (e.g. required projects or blocks) were collected from program websites and the Canadian Resident Matching Service (CaRMS) website. PD research metrics were collected on Scopus, including total publications, h-index, total citations, and the number of last-author publications.

Study outcomes

Trainee names were searched on Scopus to obtain information on publication metrics such as total publications, total citations, h-index, authorship position, and number of articles. For trainees who were not available on Scopus, an advanced search was performed on PubMed. This data was used to determine the total number of pre-residency publications, publications during residency, and publications per post-graduate year (PGY).

The residency start year was used to define residency and pre-residency periods. To account for the lag time of publications among active residents, publications during the first 6 months of the PGY-1 year were classified as pre-residency publications. Similarly, publications until six months after graduation for PGY-5 residents were classified as residency publications, as these were assumed to have originated during residency.

Statistical analysis

Descriptive statistics were used to characterize resident demographics. Graphs of correlations for key variables were generated while omitting outliers (top 95th percentile for the dependent variable) for clear interpretation. For our primary analysis, we employed ordinary least-squares linear regression to model the association between variables of interest and publications-per-

PGY rate. This outcome was selected as it controls for a resident's time in training and mitigates bias from pre-residency publications more effectively than publication counts alone. As a sensitivity analysis, negative binomial regression was used to model total publication counts during residency, incorporating an offset for years in training and adjusting for anticipated graduation year to account for differences in exposure time and stage of training. Given the relatively small sample size and inclusion of multiple correlated trainee- and program-level variables, a parsimonious model was specified to mitigate multicollinearity and ensure model stability; we expected to exclude sparse or highly collinear variables. For both models, coefficients or incidence rate ratios were reported, as appropriate, with 95% confidence intervals. Analyses were performed using Stata MP14 (Stata Corp LLC, TX, USA) with statistical significance set at a two-sided $p < 0.05$.

RESULTS

Resident demographics

Overall, 182 Canadian urology residents across 13 residency programs were identified and reviewed (Table 1). The majority (67%) of residents were male and most (57%) had not completed a graduate degree before entering residency. Twenty-four percent held a graduate degree, including 6 (14%) with a doctorate. Information on graduate degree status was unavailable for 19% of residents. At the time of data collection, only four residents (2%) were enrolled in a CIP, 3 from Toronto (75%) and 1 from Alberta (25%). No residents of this cohort were identified who had previously completed CIP and were now continuing training.

Research productivity

The median total publications for residents (Table 2) were 4 (IQR 1, 8) and median overall publications-per-PGY was 0.25 (IQR 0.0, 0.8). Median h-index was 2 (IQR 1, 3). Residents had a median of 1 (IQR 0, 3) first author papers and a median of 1 (IQR 0, 3) second or third authorship papers. Excluding case reports and literature reviews, residents had a median of 2 (IQR 1, 5) original research articles published. Total publications across residents (Figure 1A) shows a right-skewed distribution as publication counts increase ($r^2 = 0.66$, $p < 0.001$). Additional granularity stratified by each PGY shows that senior residents tend to have higher bibliometric outcomes than their juniors (Supplementary Table 1).

The median number of pre-residency publications (Table 2) was 2 (IQR 1, 5). Forty-five residents (25%) had no pre-residency publications. Male residents had significantly more ($p = 0.04$) pre-residency publications than their female counterparts at 2 (IQR 1, 5) versus 1 (IQR 0, 4).

The median number of publications during residency (Table 2) was 1 (IQR 0, 3). Adjusting for training level, the median publication-per-PGY was 0.25 (IQR 0, 0.8). The distribution of publication-per-PGY across residents (Figure 1B) shows a weak negative correlation ($r^2 = 0.18$, $p = 0.03$). The correlation between pre-residency publications and residency

publications (Figure 2A) or publications-per-PGY (Figure 2B) both show a weak positive correlation as pre-residency publications increase ($r^2=0.08$, $p<0.001$; and $r^2=0.13$, $p<0.001$ respectively). Similar trends are observed when outliers are included in correlation analyses analysis (Supplementary Figures 1 & 2).

Program descriptions and program directors

Only three of the 13 residency programs (23%) required a research project, and only one had a mandatory research rotation block (8%). Ten programs (77%) reported having a CIP available. Only two (15%) programs in the country had residents enrolled in a CIP at the time of this study, which was Toronto ($n=3$) and Alberta ($n=1$).

PDs were predominantly male at 11 (85%) and only 6 (46%) held a graduate degree. Only one PD held a doctorate degree (8%). PDs had a median of 31 (IQR 27, 85) total publications and a median of 384 (IQR 271, 1567) citations. Their median h-index was 12 (IQR 9, 22).

Regression modeling for publications

In our linear regression model predicting publications-per-PGY, three factors were independently associated with a greater publications-per-PGY during residency (Supplementary Table 2). Enrollment in a CIP was the strongest factor ($\beta=5.27$, 95% CI 3.60-6.94, $p<0.001$). However, this finding should be interpreted cautiously given the small size of the CIP cohort ($n=4$) and the potential for overfitting. A higher number of pre-residency publications was also significantly associated with greater publications-per-PGY ($\beta=0.10$, 95% CI 0.08-0.12, $p<0.001$). At the program level, the total number of faculty members was a significant, though modest, factor ($\beta=0.02$, 95% CI 0.003-0.04, $p=0.02$). Amongst specific programs, only a single program ($\beta=2.26$, 95% CI 1.16-3.35, $p<0.001$) was associated with greater publications-per-PGY for its residents. Several factors, including male gender ($\beta=0.49$, $p=0.09$), possession of a graduate degree ($\beta=0.61$, $p=0.09$), and a higher PD h-index ($\beta=0.03$, $p=0.09$), had positive coefficients but did not reach statistical significance. All other trainee demographics, medical school, program director metrics, and program characteristics were not significantly associated with the publications-per-PGY.

In our sensitivity analysis using a negative binomial regression model predicting total during-residency publication counts, while accounting for differences in duration of training, several factors were independently associated with greater publication counts (Supplementary Table 3). Enrollment in a CIP was a strong factor (IRR=3.40, 95% CI 1.42-8.16, $p=0.008$), although similarly this should be interpreted cautiously given the CIP sample size and potential instability of estimates. A higher number of pre-residency publications was also significantly associated with greater publication counts during residency (IRR=1.03, 95% CI 1.01-1.04, $p<0.001$). At the program level, a higher PD h-index was significantly associated with greater resident publication counts (IRR=1.08, 95% CI 1.02-1.14, $p=0.006$). PDs with a master's degree were also associated with higher resident publication counts (IRR=3.33, 95% CI 1.76-6.28,

$p < 0.001$). In contrast, male gender (IRR=1.24, $p=0.36$), highest graduate degree, no mandatory research block, and total faculty members in program were not significantly associated with publication counts during residency. Earlier anticipated graduation years were associated with greater publication counts relative to the reference group, while all other program characteristics were not significantly associated with the outcome.

DISCUSSION

This is the first study to characterize research productivity among Canadian urology residents. Cross-sectional data from active residents as of November 2023 revealed a median of 4 total publications, 0.25 publications-per-PGY, and 2 pre-residency publications. Pre-residency publications and enrollment in CIP were significant factors associated with higher publications-per-PGY. While male residents had higher pre-residency publication counts, this difference did not persist during residency training, suggesting that training environments may mitigate early disparities.

Our results reinforce and add new insights to existing ideas about during- and pre-residency academic output for urology trainees. Consistent with previous American analyses over 2 decades, we demonstrate that pre-residency publications are associated with future productivity (11,12). During residency, our results contrast with those of an earlier, limited survey by Andrews et al. (2013), who found that level of PGY significantly affected scholarly activity. Rather, our multivariate model showed that when productivity is examined as a rate, PGY level was not predictive of output. Our most strongly associated factor, aligning with a 2011 American analysis (6), was dedicated research time during residency. This finding is most clearly demonstrated by the effectiveness of a CIP in our cohort. Shorter, less formal research initiatives like mandated projects or single blocks did not correlate with productivity. This is also supported by recent systematic reviews that synthesized reports across multiple disciplines, concluding that short-term research time allocations were not effective at increasing residency publication output (13,14).

This work examined factors beyond the trainee and into the role of program and leadership characteristics for resident productivity. While previous studies have established the importance of dedicated research time (6,11), we build on this to suggest that the environment in which that time is spent deserves consideration. Although not all program director metrics reached significance, the trend between a PD's higher h-index and greater resident productivity, coupled with the significant effect of total faculty size, adds further nuance to existing literature. We suggest that academic output may be fostered not just by allocating time for research, but by embedding residents within a research-active faculty led by an academically supportive PD.

Collectively, these findings point to several actionable opportunities to enhance the scholarly activity of Canadian urology trainees. First, the influence of pre-residency publications, and the identified gender disparity therein, reveal a possible point of intervention at the medical school level. The observed difference in pre-residency publications by gender may relate, in part, to differences in exposure to urology or mentorship during medical school. In a national survey

of Canadian medical students, Siron et al. found that female students were less likely than male students to report adequate exposure to urology or participation in urology research projects (15). The authors highlighted early exposure through research, role models, and shadowing as factors supporting interest in urology among female medical students. Two large national studies support these results, similarly reporting lower publication output among female medical students (16,17). Although these findings provide relevant context, ours and similar works cannot determine when students developed an interest in a specialty or the mechanisms underlying the observed difference in pre-residency publications. Second, CIP enrollment was associated with greater publication productivity, consistent with the dedicated research time these programs provide. This pathway may be particularly valuable for residents seeking intensive research training; however, the small number of enrolled residents should not be interpreted as evidence of unmet demand, as we did not assess residents' interest in CIP participation. Programs may consider ensuring that interested residents have access to information and mentorship regarding available clinician-investigator pathways. Finally, the influence of program-level factors, namely faculty size and the academic profile of program leadership, suggests that strategic investment in building a pervasive research culture would be beneficial for resident productivity. The opportunity for inter-program collaboration in this context, especially beneficial to smaller programs, would be a valuable and unique addition. Overall, future initiatives may focus on structured research training, equitable early mentorship, and building sustainable program infrastructure across all Canadian urology programs.

Our study has limitations that are important to consider. First, our analysis is confined to a cross-sectional view of a single point in time based on curated bibliographic databases for an evolving trainee landscape. Current and future trainees may not reflect the demographics and trends observed in this cohort, especially for smaller identified groups like residents in CIPs or with graduate degrees before residency. Next, despite controlling for training duration, the accrual of academic experience over time for senior residents may have provided an advantage for faster publications compared to their less experienced juniors. Lag time from project conception to publication may also have confounded the number of pre-residency and late-residency publications for residents. We did attempt to mitigate this concern by including all articles published during the first residency year and final year, regardless of starting/graduation dates. Particularly for senior residents, some projects may not be published until more than one year after completion and therefore were not captured in our analysis. As well, internal program factors, like mentorship opportunities, mentorship quality, and research support outside of mandatory blocks, could not be assessed. We were similarly unable to capture the productivity of applicants who did not match to urology; therefore, our findings for early residents reflect only matched applicants, and it remains unclear whether unmatched applicants differ in this context. Finally, publication counts represent only one dimension of resident activity. They do not capture methodological rigor, clinical relevance, educational value, nor the resident's contribution to a project. These findings should be interpreted as national bibliometric

benchmarks and not as evidence that greater publication volume necessarily represents higher-quality scholarship. Future work incorporating resident and faculty perspectives could further clarify which research opportunities and supports are most valued during training and how they contribute to residents' longer-term career development.

Importantly, high research productivity is neither a universal goal for urology residents nor an expectation implied by our findings. Publication output should not be interpreted as a measure of clinical skill, competence, or overall performance as a urologist. Rather, these benchmarks and associated factors are most relevant to residents who wish to pursue substantial research involvement or an academic career, and to programs seeking to support those individual goals.

CONCLUSIONS

This cross-sectional study reveals variability in publication-based research productivity among Canadian urology residents and highlights several associated individual- and program-level factors. Male residents had higher pre-residency publication counts, but there were no gender differences during urology residency training in Canada. Prior engagement in research, protected research time, and structured academic programming were associated with greater productivity during residency. Importantly, bibliometric output should not be interpreted as a comprehensive measure of research quality or scholarly success.

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FIGURES AND TABLES

Figure 1. Distribution of (A) total publications and (B) publications per postgraduate year (PGY) among all active residents with outliers (top 95th percentile) removed.

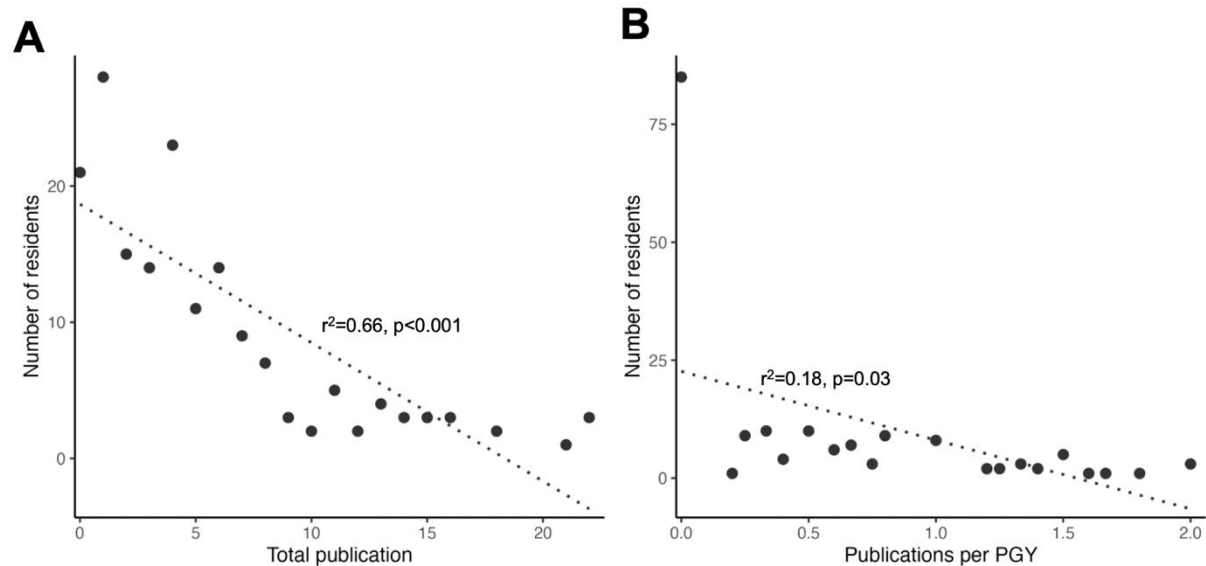


Figure 2. Association between (A) pre-residency publications and residency publications or (B) publications-per postgraduate year among all active residents with outliers (top 95th percentile) removed.

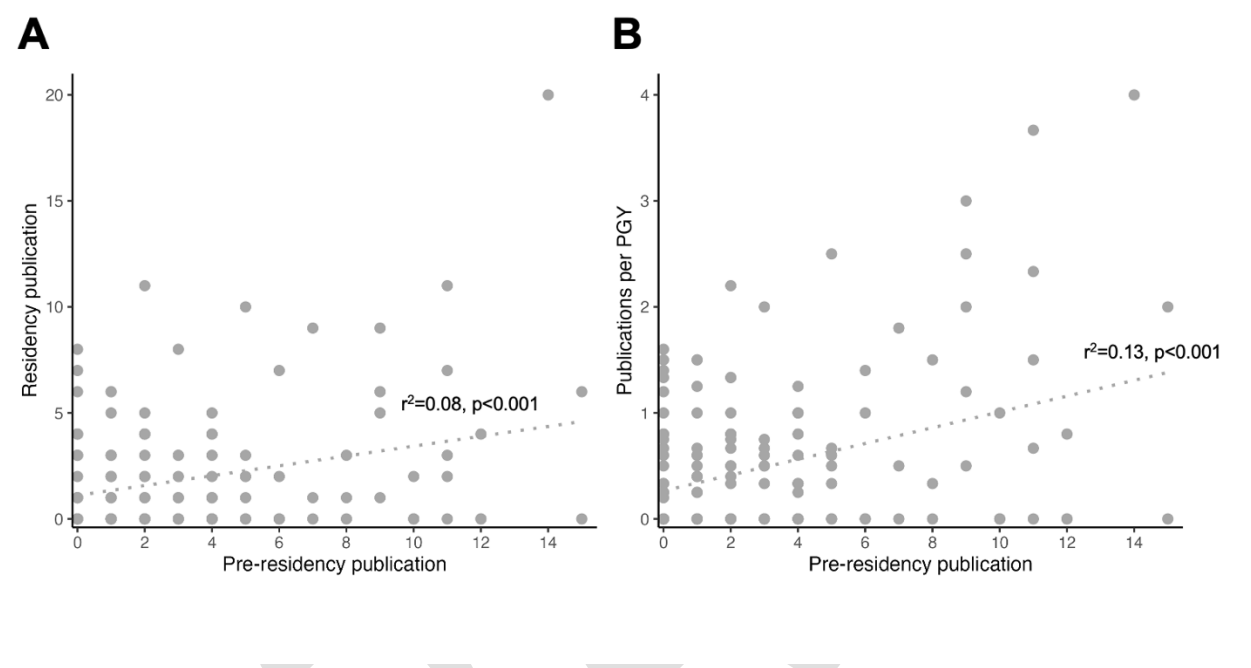


Table 1. Summary of urology residents’ characteristics as of November 2023	
Variable	Number of residents n (%)
Gender	
Male	123 (67%)
Female	58 (32%)
Non-binary	1 (1%)
Graduate degree status	
No graduate degree	104 (57%)

Yes	43 (24%)
Unknown	35 (19%)
Highest graduate degree	
No graduate degree	85 (47%)
Masters	35 (19%)
PhD	6 (3%)
Professional degree (non-MD)	1 (1%)
Graduate certificate or diploma	1 (1%)
Unknown	54 (29%)
Enrolled in CIP	
No	108 (59%)
Yes	4 (2%)
Unknown	70 (39%)

CIP: clinician-investigator program.

Table 2. Summary of urology residents' research metrics as of November 2023		
	Median (IQR)	Mean (SD)
Total publications	4 (1–8)	7.4 (13)
h-index	2 (1–3)	2.7 (4.6)
Publications per year	1.4 (0.5–3.25)	3.2 (6.5)
Pre-residency publications	2 (1–5)	4.7 (9.9)
During residency publications	1 (0–3)	2.2 (3.9)

Publications-per-PGY	0.25 (0.0–0.8)	0.6 (1.4)
Total original research articles	2 (1–5)	4.8 (8.9)
Total first-author publications	1 (0–3)	2.5 (4.7)
Total top 3 author publications	1 (0–3)	3.5 (8.8)
Total citations	16 (3–64)	78 (249)

IQR: interquartile range; PGY: postgraduate year; SD: standard deviation.

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