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Research

Characteristics and outcomes of Canadian MD/PhD program graduates: a cross-sectional survey

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Abstract

Background: Combined MD/PhD programs provide a structured path for physician-scientist training, but assessment of their success within Canada is limited by a lack of quantitative data. We collected outcomes data for graduates of Canadian MD/PhD programs.

Methods: We developed and implemented a Web-based survey consisting of 41 questions designed to collect outcomes data for Canadian MD/PhD program alumni from 8 Canadian universities who had graduated before September 2015. Respondents were categorized into 2 groups according to whether they had or had not completed all training.

Results: Of the 186 eligible alumni of MD/PhD programs, 139 (74.7%) completed the survey. A total of 136/138 respondents (98.6%) had completed or were currently completing residency training, and 66/80 (82%) had completed at least 1 postgraduate fellowship. Most (58 [83%]) of the 70 respondents who had completed all training were appointed as faculty at academic institutions, and 37 (53%) had been principal investigators on at least 1 recent funded project. Among the 58 respondents appointed at academic institutions, 44/57 (77%) dedicated at least 20% of their time to research, and 25/57 (44%) dedicated at least 50% to research. During their combined degree, 102/136 respondents (75.0%) published 3 or more first-author papers, and 133/136 (97.8%) matched with their first choice of specialty. The median length of physician-scientist training was 13.5 years. Most respondents graduated with debt despite having been supported by Canadian Institutes of Health Research MD/PhD studentships.

Interpretation: Most Canadian MD/PhD program alumni pursued careers consistent with their physician-scientist training, which indicates that these programs are meeting their primary objective. Nevertheless, our findings highlight that a minority of these positions are research intensive; this finding warrants further study. Our data provide a baseline for future monitoring of the output of Canadian MD/PhD programs.

Physician-scientists receive research training in addition to medical education, and they pursue careers applying both. Combined MD/PhD programs, which integrate medical undergraduate and doctoral research training, provide a structured path for trainees to earn both MD and PhD degrees. Although combined MD/PhD programs are not the sole path to a career as a physician-scientist, they are among the most prominent.[1,2] Despite compelling evidence that physician-scientists, and MD/PhDs in particular, make significant research contributions, there is a decline in the number of physician-scientists being trained.[3–8] Several factors have been proposed to explain the perceived endangerment of the physician-scientist workforce, including the financial disincentives to pursuing a career as a physician-scientist.[6,9,10]

In the United States, a significant body of research substantiates the value of the Medical Scientist Training Program, both at individual schools[2,11–13] and in national analyses.[1,14–16] However, little parallel evidence is available concerning Canadian MD/PhD programs.[3,17,18] The paucity of outcomes data limits assessment of whether MD/PhD programs are meeting their

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goal of training leaders in clinical and translational research. The lack of quantitative data regarding MD/PhD program graduates is particularly relevant in light of the recent decision by the Canadian Institutes of Health Research (CIHR) to terminate funding for MD/PhD programs. We therefore sought to collect quantitative data concerning the demographic characteristics, education, career trajectory, publication and funding records, debt, and career and lifestyle satisfaction of Canadian MD/PhD program graduates.

Methods

Survey design and administration

We developed and implemented a Web-based survey consisting of 41 questions designed to collect outcomes data for Canadian MD/PhD program graduates. We excluded 1 MD/PhD program (at the University of Calgary) from the survey, as this program includes people who have completed, or nearly completed, a PhD degree before entering medical school, and therefore only a small fraction of graduates have completed an integrated MD/PhD as delivered across the rest of Canada. We also excluded Canadian MD/PhD programs without alumni having graduated before September 2015.

A pilot survey was distributed to graduates of the University of British Columbia MD/PhD program. Based on their feedback, the survey was revised for clarity and was distributed in 2015–2016 to all alumni who had graduated from Canadian MD/PhD programs before September 2015. The MD/PhD programs provided contact information for graduates or contacted graduates directly. Graduates were provided with definitions of translational, clinical and basic science research from Rubio and colleagues[19] and the definition of health services research used by the CIHR[20] in order to complete survey items designed to rate involvement in these domains of research. Questions evaluating graduates' satisfaction with their training were rated on a 5-point Likert scale, from "strongly disagree" to "strongly agree." Graduates were contacted up to 6 times by email, twice by phone and once by mail. We conducted the survey using survey tools in Google Forms. The complete survey is provided as Appendix 1 (available at www.cmajopen.ca/content/5/2/E308/suppl/DC1).

Analysis

Initially, responses were not anonymous in order to ensure that respondents did not inadvertently complete the survey twice; responses were subsequently anonymized before data analysis. Respondents were required to complete 17 of the 41 questions, but responses were not required for the remaining 24 questions. We therefore calculated proportions relative to the number of respondents who answered each question. Respondents were categorized into 2 groups according to whether they had or had not completed all training. Respondents were considered to have completed all training if they reported they had completed residency training, or did not intend to complete residency training and did not list the title of their current appointment as "clinical fellow/research fellow."

Ethics approval

Approval was obtained to distribute the survey to Canadian MD/PhD program graduates from the University of British Columbia Behavioural Research Ethics Board (H15–02871).

Results

Demographic characteristics

Of the 186 eligible alumni of MD/PhD programs at the 8 participating institutions, 139 completed the survey, for an overall response rate of 74.7%. Five respondents completed the survey twice; we retained only their second response. Contact information could not be identified for 5 graduates; the response rate among contacted alumni was 76.8%. The median age of the respondents was 37 years. Of the 139 respondents, 68 (48.9%) (24 women; mean age 33.4 [standard deviation (SD) 2.58] yr; mean time since graduation 3.5 [SD 2.18] yr) were still completing residency or clinical or research fellowships, and 70 (50.4%) (13 women; mean age 42.2 [SD 5.04] yr; mean time since graduation 12.3 [SD 4.98] yr) had completed all training; 1 respondent did not provide information about training. Response rates at individual schools ranged from 50% to 100% (median 81%) (Table 1).

Education

A total of 132 respondents provided information about their degrees. The median time from MD/PhD program entry to graduation was 7.7 years. Thirty-four respondents (25.8%) took 8 or more years to graduate, with 13 (9.8%) spending 9 or more years in a combined program. Before entering an MD/PhD program, 110 respondents (83.3%) completed a Bachelor of Science degree, 14 (10.6%) completed a Bachelor of Health Sciences degree, and 10 (7.6%) completed another bachelor's degree. Thirty-one respondents (23.5%) entered MD/PhD programs holding master's degrees.

Respondents who felt their physician-scientist training was complete were asked to state the total length of their training, including residency, fellowships and all other training they felt had contributed to their career as a physician-scientist since entering a MD/PhD program. The median total length of physician-scientist training from MD/PhD program entry to completion of all training was 13.5 years. Most of the respondents had completed (80 [58.0%]) or were currently completing (55 [39.9%]) a residency; only 2 respondents (1.4%) did not plan to complete residency training. One respondent did not provide information about residency training. Most of the respondents who had completed a residency also pursued clinical (54 [68%]) or research (30 [38%]) fellowships, with 18 (22%) completing both clinical and research fellowships; 14 respondents (18%) reported no postdoctoral training. Of the 136 respondents who had completed or were currently completing residency training, 133 (97.8%) matched with their first choice of specialty, and 122 (89.7%) matched at their first choice of location. The most common specialties were internal medicine (31/132 respondents [23.5%]), pediatrics (10 [7.8%]), anatomic pathology (9 [6.8%]), diagnostic radiology (9 [6.8%]) and neurology (8 [6.1%]) (Table 2);

124/132 respondents (93.9%) indicated that they pursued an identifiable medical specialty.

In general, respondents expressed satisfaction with the quality of both their medical education (129/138 [93.5%] agreeing or strongly agreeing) and their physician-scientist training (115/136 [84.6%] agreeing or strongly agreeing) (Table 3). Moreover, respondents generally agreed or strongly agreed that they would complete an MD program (125/138 [90.6%], a PhD program (106/136 [77.9%]) or a combined MD/PhD program (100/137 [73.0%]) again if they could revisit their choices.

Career trajectory

One respondent did not provide information about career stage. Most of the 70 respondents who had completed all training reported that their current appointment was at an academic institution (58 [83%]) and/or in private or hospital clinical practice (17 [24%]). Three (4%) of those who had completed all training reported that their current appointment was at a government or private research institute or in industry. None of those who had completed all training were unemployed. All but 4 respondents who had completed all training were appointed within Canada (52 [74%]) or in the US (14 [20%]). Fifty-nine (84%) of those who had completed all training were appointed at the level of assistant professor or higher, and 44 (63%) had protected research time (Table 4). After completion of all training, on average, respondents reported dedicating 34% of their time to research, 51% to clinical practice, 10% to teaching, 7% to administration and 1% to other duties. Among respondents who had finished all training, 43/69 (62%) dedicated at least 20% of their time to research and also at least 20% of their time to clinical practice; 25 (36%) dedicated 50% or more of their time to research, and 10 (14%) reported they were not involved in research at all.

Respondents primarily reported involvement in clinical research (84/135 [62.2%] agreed or strongly agreed) or translational research (78 [57.8%] agreed or strongly agreed). Fifty-one (37.8%) agreed or strongly agreed that they were involved in basic science research, and 23/134 (17.2%) agreed or strongly agreed that they were involved in health services research. A total of 117/138 respondents (84.8%) agreed or strongly agreed that the combined MD/PhD degree helped their career, and 99 (71.7%) agreed or strongly agreed that they would be substantially involved in research in the future.

Publications, funding and debt

Information about publications, funding and debt was available for 138 respondents. Among the 138, 126/137 (92.0%) had authored a peer-reviewed manuscript within the previous 36 months, and 99 (72.3%) had authored a peer-reviewed manuscript within the previous 12 months. The corresponding proportions for respondents who had completed all training were similar (93% and 77%). Moreover, 37 (53%) of those who had completed all training had been the principal investigator on a funded project within the previous 36 months, and 31 (44%) had been the principal investigator on a funded project within the previous 12 months (Table 4). The corresponding proportions for respondents employed

Table 1: Institution and graduation year of respondents, nonrespondents and graduates not contacted

School/graduation year	No. (%) of graduates		
	Responded *n* =139	Did not respond *n* = 42	Not contacted *n* = 5
School			
McGill University	29 (72.5)	8 (20.0)	3 (7.5)
McMaster University	3 (75.0)	1 (25.0)	0 (0)
Université de Sherbrooke	1 (100.0)	0 (0)	0 (0)
University of Alberta	13 (50.0)	12 (46.2)	1 (3.8)
University of British Columbia	23 (95.8)	1 (4.2)	0 (0)
University of Manitoba	3 (100.0)	0 (0)	0 (0)
University of Toronto	54 (74.0)	18 (24.6)	1 (1.4)
Western University	13 (86.7)	2 (13.3)	0 (0)
Graduation year			
1990–1994	3 (75.0)	1 (25.0)	0 (0)
1995–1999	14 (73.7)	5 (26.3)	0 (0)
2000–2004	16 (59.2)	10 (37.0)	1 (3.7)
2005–2009	38 (77.6)	8 (16.3)	3 (6.1)
2010–2015	68 (78.2)	18 (20.7)	1 (1.1)

within academic institutions were higher (62% and 52%). Among the 58 respondents who had completed all training and were employed in an academic institution, the most common sources of funding were private or extramural funding organizations (25 [43%]), charitable foundations (25 [43%]) and the CIHR (22 [38%]); 27 (47%) reported receiving funding from the CIHR, Natural Sciences and Engineering Research Council or another federal granting agency (Table 4).

During the course of their combined degree, 45/136 respondents (33.1%) published 5 or more first-author papers, and 102 (75.0%) published 3 or more; 6 (4.4%) were not first authors on a peer-reviewed manuscript. With respect to coauthorship, which often reflects additional collaborative research work beyond the thesis itself, 87/134 respondents (64.9%) coauthored 4 or more peer-reviewed manuscripts during their combined degree, and 7 (5.2%) did not coauthor a peer-reviewed manuscript.

Almost all respondents reported receiving at least 1 source of funding during the course of their MD/PhD degree, the most common being CIHR MD/PhD program funding (99/137 respondents [72.3%]). Other sources were other CIHR funding (31 respondents [22.6%]), charitable foundations (26 [19.0%]), and other federal (20 [14.6%]) or provincial (18 [13.1%]) funding agencies; 1 respondent reported not receiving any funding during physician-scientist training. Nevertheless, over half of respondents (83 [60.1%]) carried debt after completing their physician-scientist training, with 70 (50.7%) graduating with more than $20 000 in debt and 52 (37.7%) graduating with more than $50 000 in debt.

Table 2: Residency choices of Canadian MD/PhD program graduates

Specialty	No. (%) of respondents *n* = 132*
Internal medicine	31 (23.5)
Pediatrics	10 (7.8)
Anatomic pathology	9 (6.8)
Diagnostic radiology	9 (6.8)
Neurology	8 (6.1)
Anesthesiology	7 (5.3)
Dermatology	6 (4.5)
Neurosurgery	6 (4.5)
Ophthalmology	6 (4.5)
Psychiatry	6 (4.5)
General surgery	4 (3.0)
Obstetrics and gynecology	4 (3.0)
Hematological pathology	3 (2.3)
Radiation oncology	3 (2.3)
Emergency medicine	2 (1.5)
Medical genetics	2 (1.5)
Medical microbiology	2 (1.5)
Neuropathology	2 (1.5)
Otolaryngology — head and neck surgery	2 (1.5)
Plastic surgery	2 (1.5)
Other	8 (6.1)

*Seven respondents did not provide information about specialty.

Interpretation

A primary goal of combined MD/PhD programs is to produce graduates who leverage their training in both research and clinical practice in careers as physician-scientists. Most of the Canadian MD/PhD program graduates that we surveyed pursued further training consistent with such careers, entering residency programs and completing postgraduate clinical or research fellowships. Likewise, most remained significantly involved in research after completing their training, secured appointments with protected research time at academic institutions and obtained competitive research funding. These findings suggest that Canadian MD/PhD programs are effective in training graduates to pursue careers integrating research and clinical practice. However, the median time of 13.5 years spent by Canadian MD/PhDs pursuing all physician-scientist training supports the notion that considerable financial disincentives exist to pursuing this career path. This may account for the relatively low proportion of MD/PhD program graduates (38%) who completed postdoctoral research fellowships.

Concerns expressed by a 2011 CIHR International Review Panel about clinician-scientists' having 50% or less time for research[7] are borne out in our data. Only 36% of graduates reported dedicating 50% or more of their time to research. Although the proportion was slightly higher in academia (44%), it remained considerably lower than in a survey of American MD/PhD program graduates (64%).[1] It is noteworthy in this respect that most graduates who had completed all training entered academia and were appointed at the level of assistant professor or higher. The fact that Canadian MD/PhD graduates typically pursue careers in academia yet dedicate less time to research than American MD/PhDs suggests that academic health sciences centres in Canada may not be structured to support physician-scientists in positions with the majority of time dedicated to research, particularly given the decline of federal funding programs to support the salary of both clinician-scientist and PhD-only investigators. This may underlie the difference between Canadian and American graduates in the proportion who reported significant involvement in basic science research (38% v. 57%), as clinical research is likely easier to integrate into a predominantly clinical appointment than an independent basic research program. This proportion is similar to the proportion of University of Toronto Clinician-Investigator Program or Surgeon-Scientist Program trainees who completed basic research projects between 2011–2016, 37%.[21] However, other outcomes of research activity suggest that Canadian graduates maintain substantive involvement in research despite having less protected research time than their American counterparts: similar

proportions of Canadian and American MD/PhDs appointed in academia held identifiable research funding (62% and 61%, respectively).[1] This suggests that Canadian graduates are able to secure funding and lead projects even while dedicating less than half of their time to research.

Despite the general tendency for MD/PhD program graduates to pursue careers as physician-scientists, 14% of respondents who had completed all training reported that they dedicated no time at all to research at their current appointment, and 14% disagreed or strongly disagreed that they would be substantially involved in research in the future. These figures are similar to the 16% of American alumni who eventually enter private practice and the 13% of American alumni who indicated they were not involved in research.[1] However, it is noteworthy that only 23% of our respondents who dedicated less than 50% of their time to research disagreed or strongly disagreed that they would be substantially involved in research in the future, which again suggests a lack of opportunities for physician-scientists to effectively integrate research and clinical practice in Canada.

Limitations

A quarter of alumni of the 8 participating MD/PhD programs were not included. Given the exclusion of 1 Canadian program from the survey, it is possible that survey respondents were not representative of the entire population of Canadian MD/PhD program alumni, although the relatively high response rate mitigates the impact of nonresponse bias on the results. The low median respondent age, 37 years, may have biased results concerning the career trajectories of MD/PhDs, since early-career investigators may be less likely to hold identifiable funding or have protected research time. Finally, the difficulty identifying current contact information and, in some cases, even the names of Canadian MD/PhD program graduates suggests a need for coordinated tracking of alumni, as is required by American Medical Scientist Training Programs receiving National Institute of General Medical Sciences funding.[1]

Conclusion

We present a comprehensive characterization of Canadian MD/PhD program graduates. Our study provides evidence that most graduates pursue careers as physician-scientists and that many assume leadership roles in clinical and translational research. However, our data raise concerns about the career opportunities available within Canada for graduates to integrate research with clinical practice, and identify financial constraints and lack of protected research time as key factors.

Table 3: Responses to survey items evaluating respondents' satisfaction with their training

Survey item	Response; no. (%) of respondents *n* = 139*				
	Strongly disagree	Disagree	Neutral	Agree	Strongly agree
Overall, I am satisfied with the quality of my medical education	1 (0.7)	1 (0.7)	7 (5.1)	53 (38.4)	76 (55.1)
Overall, I am satisfied with the quality of my clinician-scientist training	1 (0.7)	3 (2.2)	17 (12.5)	54 (39.7)	61 (44.9)
If I could revisit my choice, I would choose to attend medical school again	3 (2.2)	0 (0)	10 (7.2)	39 (28.3)	86 (62.3)
If I could revisit my choice, I would choose to attend a PhD or combined PhD program again	6 (4.4)	8 (5.9)	16 (11.8)	47 (34.6)	59 (43.4)
If I could revisit my choice, I would choose to attend an MD/PhD program again	9 (6.6)	6 (4.4)	22 (16.1)	43 (31.4)	57 (41.6)
I am engaged in translational research	29 (21.5)	9 (6.7)	19 (14.1)	32 (23.7)	46 (34.1)
I am engaged in clinical research	17 (12.6)	14 (10.4)	20 (14.8)	48 (35.6)	36 (26.7)
I am engaged in basic science research	44 (32.6)	23 (17.0)	17 (12.6)	18 (13.3)	33 (24.4)
I am engaged in health services research	80 (59.7)	10 (7.5)	21 (15.7)	17 (12.7)	6 (4.5)
I will be substantially involved in research in the future	8 (5.8)	7 (5.1)	24 (17.4)	38 (27.5)	61 (44.2)
The combined MD/PhD degree has helped my career	1 (0.7)	7 (5.1)	13 (9.4)	40 (29.0)	77 (55.8)
I am satisfied with my work–life balance	4 (3.0)	23 (17.0)	39 (28.9)	56 (41.5)	13 (9.6)
I believe that Canada should train more clinician-scientists	3 (2.2)	5 (3.6)	14 (10.1)	40 (29.0)	76 (55.1)
I believe the CIHR should fund Canadian MD/PhD programs	3 (2.2)	4 (2.9)	11 (8.0)	21 (15.2)	99 (71.7)

Note: CIHR = Canadian Institutes of Health Research.
*Responses may not sum to the number indicated in the columns when a response to the relevant question was not required to complete the survey.

Table 4: Outcomes related to research activity for respondents still completing training, respondents who had completed all training and the subset of respondents in the latter group appointed in academic institutions

Outcome	No. (%) of respondents*		
	In training *n* = 68	Completed all training *n* = 70	Academics *n* = 58
Title at current appointment			
Resident	54 (79.4)	0 (0)	0 (0)
Clinical fellow/research fellow	14 (20.6)	0 (0)	0 (0)
Instructor/adjunct professor	0 (0)	7 (10.0)	4 (6.9)
Assistant professor/staff scientist	0 (0)	38 (54.3)	35 (60.3)
Associate professor/senior scientist	0 (0)	14 (20.0)	12 (20.7)
Professor/section chief	0 (0)	7 (10.0)	6 (10.3)
Clinician	0 (0)	4 (5.7)	1 (1.7)
Protected research time at current appointment	33 (48.5)	44 (62.8)	42 (72.4)
Time dedicated to research at current appointment, %			
0	12 (18.2)	10 (14.5)	5 (8.8)
10	33 (50.0)	13 (18.8)	8 (14.0)
20	11 (16.7)	10 (14.5)	9 (15.8)
30	3 (4.5)	6 (8.7)	6 (10.5)
40	0 (0)	5 (7.2)	4 (7.0)
50	0 (0)	5 (7.2)	5 (8.8)
60	1 (1.5)	6 (8.7)	6 (10.5)
70	3 (4.5)	10 (14.5)	10 (17.5)
80	1 (1.5)	4 (5.8)	4 (7.0)
90	2 (3.0)	0 (0)	0 (0)
I will be substantially involved in research in the future			
Strongly disagree	3 (4.4)	5 (7.1)	3 (5.2)
Disagree	2 (2.9)	5 (7.1)	2 (3.4)
Neutral	12 (17.6)	12 (17.1)	8 (13.8)
Agree	21 (30.9)	17 (24.3)	15 (25.9)
Strongly agree	30 (44.1)	31 (44.3)	30 (51.7)
Recent coauthored peer-reviewed manuscript			
No	6 (9.0)	5 (7.1)	2 (3.4)
Yes, within last 12 mo	45 (67.2)	54 (77.1)	50 (86.2)
Yes, within last 36 mo	16 (23.9)	11 (15.7)	6 (10.3)
Principal investigator on recent funded project			
No	NA	33 (47.1)	22 (37.9)
Yes, within last 12 mo	NA	31 (44.3)	30 (51.7)
Yes, within last 36 mo	NA	6 (8.6)	6 (10.3)
Funding since completing clinician-scientist training			
CIHR	NA	22 (31.4)	22 (37.9)
NSERC	NA	7 (10.0)	7 (12.1)
Other federal granting agency	NA	13 (18.6)	11 (19.0)
National/international charitable foundation	NA	25 (35.7)	25 (43.1)
Private/extramural	NA	27 (38.6)	25 (43.1)
Intramural	NA	3 (4.3)	3 (5.2)
Other	NA	7 (10.0)	6 (10.3)
None	NA	41 (58.6)	25 (43.1)

Note: CIHR = Canadian Institutes of Health Research, NA = not applicable, NSERC = Natural Sciences and Engineering Research Council.
*Responses may not sum to the number indicated in the columns when a response to the relevant question was not required to complete the survey.

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