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The changing landscape of orthopaedic surgery in Ontario: Where we are, where we have been, and where we are going.

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Abstract

Orthopedic surgery is a field which has often been talked about with regards to surgeon underemployment. This is particularly important given the paradoxical increasing demand for orthopedic care. There has not been well studied literature understanding the state of orthopedic surgery training in Ontario, Canada. Using a combination of various databases and surveying surgeons trained in Ontario we sought to provide some insight.

We demonstrated multiple important findings. More recent graduates are feeling less ready to enter practice and almost all graduates do at least 1 fellowship, with equal amount of 1 versus 2 fellowships. We showed an effect of school of graduation on likelihood of emigrating out of Ontario. More recent graduates are more likely to emigrate out of necessity, and less likely to pursue a graduate degree out of interest. Despite all the challenges, however, orthopedic surgeons remain satisfied with their work.

Keywords

Orthopedic surgery, Health Human Resource planning, fellowship training, surgical education.

Summary for Lay audience

Despite having received a significant level of training, orthopedic surgeons trained in Ontario do not feel ready to enter practice and are spending an extra two years in further training: whether it be waiting for a job or expanding their skills—significantly more than surgeons trained in the United States. More recent graduates are going to the United States out of necessity, getting graduate degrees not out of interest, and are feeling less ready to enter practice. All of which are outcomes which necessitate a re-evaluation of how surgeons are being trained in Ontario, Canada. We also showed that graduates from the University of Ottawa are more likely to work in the USA and settle farthest from their school of training, suggesting a regional mismatch of needs and resources to maintain the number of surgeons trained and raises questions worth looking into.

Co-authorship statement

Dr. Brent Lanting: Contributed to project design, reviewed, and revised manuscript.

Dr. Emil Schemitsch: Contributed to project design, reviewed, and revised manuscript.

Dr. Steve Papp: Contributed to project design, reviewed, and revised manuscript in chapter 3.

Dr. Sophia Frost: Contributed to data analysis, manuscript review, and revision in chapter 3.

Dr. Amirti Vivekandan: Contributed to data analysis, manuscript review, and revision in chapter 3.

Dr. Lyn Sibley: Contributed to manuscript review, and revision in chapter 3.

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Glossary of terms

Abbreviation	Meaning
HHR	Health Human Resource
UofT	University of Toronto
Std. dev	standard deviation
SE	standard error
MOH	Ministry of Health
MOHLTC	Ministry of Health and Long Term Care
CaRMS	Canadian Residency Matching Service
CAPER	Canadian Post-MD education Registry
UWES	Utrecht Work Engagement Scale
Std. R	Standard residual

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Chapter 1 : Introduction

This chapter provides an overview of orthopaedic training in Canada, health human resource (HHR) planning, and factors influencing orthopaedic care.

1.1 Overview of surgical training in Canada.

Becoming an orthopaedic surgeon is a long and arduous journey. It involves a 3–4-year undergraduate degree, followed by completion of a 3-4 year medical school degree. After medical school, those aspiring for a career in orthopaedic surgery, apply to a 5-year training program. After completing this 5-year surgical program, an independent licence is obtained. In theory, after obtaining an independent licence new grads can start their practice. However, much more commonly new graduates seek further subspecialty training in the form of fellowships.

1.2 Orthopaedic surgery training in Canada

In Canada there are 16 accredited programs for orthopaedic surgery. These are: University of British Columbia, University of Alberta, University of Calgary, University of Manitoba, University of Saskatchewan, University of Ottawa, University of Toronto, Northern Ontario School of Medicine, McMaster University, Queens University, Western University, Dalhousie University, Memorial University of Newfound Land, McGill University, University of Montreal, University of Laval, University of Sherbrooke [1].

These programs are certified by the Royal College of Physicians and Surgeons of Canada (RCPSC) which sets the standards for postgraduate training[2]. Once applicants have matched then they must go through the 5-year journey to become a competent surgeon. A year of training is typically divided into 13 blocks which are each 4 weeks long. Trainees then rotate through 1-4 block rotations. These are within the field of orthopaedics, but also related non-orthopaedic rotations.

Within the field of orthopaedics trainees rotate through the various subspecialty rotations. The subspecialty rotations include paediatrics, spine, trauma, foot and ankle, upper extremity, sports, arthroplasty, and tumour. Trainees will rotate through each subspecialty multiple times in order to gain competency[3]. Trainees typically do a junior and senior rotation with graduated responsibility. Off service rotations can include, but are not limited to, internal medicine, plastic surgery, emergency medicine, general surgery, traumatology, vascular surgery, intensive care, and geriatrics. These are meant to give a broad understanding of medicine required of any physician, and on a practical level help trainees pass the surgical foundations exam[4].

1.3 The structure of residency education

Residency education in Canada is currently undergoing a seismic shift[5]. Surgical education is shifting from an apprenticeship time-based model to a competency based one. The previous status-quo was one of a time-based one where residents spend 5 years in training and after this standard training period, provided they passed the written exam, were deemed to be competent. While surgeons were trained in this model for decades, just like with any model there were inherent problems with it.

Feedback was often informal and while faculty may have felt that they were giving feedback, the unstandardized nature of it often left residents not perceiving that they were receiving feedback[6]. The unstandardized nature of the informal feedback was challenging to formally assess technical skills. This has led to research foci in ways of evaluating technical skills.

1.4 Proposed tools of surgical skills

Unlike conceptual knowledge which can be assessed by asking theoretical questions during a written assessment, technical skills pose a challenge. There have been evaluation tools looking at technical skills[7]. One solution to this has been the objective standardized clinical examination (OSCE)[7]. The OSCE is set up as multiple stations with a standardized scenarios requiring a technical intervention. Each station then has a standardized assessment tool which has, typically, has shown reliability, and construct validity. While OSCEs are supported in terms of their assessment abilities, they have their associated challenges.

Some of the challenges associated OSCEs are that they can be cost prohibitive due to the nature of their design. There are costs associated with the clinical scenarios, which can use cadavers or high-fidelity simulators. There have been proposed alternatives, such as work-based assessments.

1.5 Evaluating surgeons on the job

One of the tenants of competency based education (CBME) are Entrustable Professional Activities (EPAs)[8]. EPAs are the foundational skills of a specialty and serve as the basis of evaluations in a CBME curriculum. The theory behind EPAs is that by having multiple EPAs, evaluations can become more frequent allowing for more feedback. Frequent assessments have a benefit in terms of increased feedback, but also have been used to enhance learning. This is known as the testing effect.

1.6 Test enhanced learning: the testing effect

In their seminal work, Roediger and Karpicke showed that there is an additive effect of testing on long-term retention[9]. This paper has changed the way that the learning fields views tests. Tests have shifted from being used as an assessment of learning, to one *for* learning. The theory behind the testing effect is that each *test* engages memory routes. Each time participants use these routes, then these memory routes are strengthened and memory is enhanced—the retrieval practice hypothesis[10].

Some of the criticism of the testing effect is that this is simply a matter of repeated exposure. However, the testing effect has been shown to enhance learning in related material that was not in the repeated tests[11]. This shows a transferable benefit of testing which can be seen in material outside of the controlled environment.

The testing effect is often done in episodic type of scenarios. Episodic memory refers to a type of memory in which involves recollection of previous information in the past. However, the testing effect has also been studied in skills based environments[12]. The testing effect has been shown in the orthopaedic literature. Studies looking at the testing effect in an open reduction internal fixation (ORIF) situation show a benefit [13]. Once a resident has gained the required level of competency, they must be evaluated prior to being given independence.

1.7 Evaluation of independence.

Progression of independence is determined by the Competency Committee, which is part of all programs. The Competency Committee assess the trainee's progress holistically and makes decisions if they progress throughout their training and eventually progress to the final milestone: the *Royal College Examination.* The Royal College of Physicians and Surgeons of Canada (RCPSC) exam is a multi-part exam involving a written and an oral examination, which are done at different time points. Once they have passed both the written and oral component, then they are deemed to be competent to practice independently in Canada. Overall the pathway to independence is long, without a clear, objective, way of truly assessing independence.

1.8 Routes after residency

While these new graduates are licenced to practice independently, trainees often do not enter practice directly. Rather, graduates typically seek further training in the terms of fellowships to gain mastery in a subspecialty area.

1.9 Motivations for fellowships

Fellowship training can serve multiple purposes. These can include: filling in gaps from residency training, increasing employment desirability, allowing for networking opportunities, and increasing potential income. The motivations for graduates to seek fellowships is not well understood and is a topic which would be of interest. Investigating graduate's motivations in fellowship choices can help guide both HHR planning and career guidance at a local level.

Establishing a career is challenging and stressful for many new surgeons after training. Challenges may include seeking employment, relocating, and setting up a new practice. Underemployment is a reality for many recent graduates, who accept locum or part-time work as an alternative to unemployment due to lack of opportunities[14]. In Canada, those in neurosurgery, radiation oncology, and orthopaedic surgery have faced the most difficulty finding employment[15]. From 2011-2018, 37% of orthopaedic surgeons had not found stable employment at the time of certification. Given this delay, many have turned to other forms of work as a temporary solution. In 2012, almost 22% of new graduates reported multiple locum or part-time positions, implying delayed time to reach full employment—that is employment that is not episodic[14].

One potential factor contributing to this difficulty for early-career surgeons is a mismatch between physician supply and capacity. Recently, the physician workforce has been growing more quickly than the general population, with a 3.8% increase in the number of physicians between 2017-2018 compared to a population growth rate of just over double that in four times as many years (2014-2018)[16]. Despite this recent growth, Canada ranks 25th, with an average of 2.8 physicians per 1,000 inhabitants, when compared to 34 other OECD countries[17]. The average number of physicians per 1,000 inhabitants for the 35 OECD countries was 3.2. The juxtaposition of underemployed graduates with a low physician-per-capita is due to severe underfunding of the system rather than an oversupply of physicians. This juxtaposition leaves patients suffering while waiting for orthopaedic care.

A recent study showed that patients who wait more than 6 months for hip and knee arthroplasty experience a significant decrease in quality of life and increase in frailty[18]. Ontario, the largest province in Canada, has set a quality-based procedure (QBP) target of 6 months for hip and knee replacements. Ontario's own targets are only met 60% of the time for knee replacements, with an average wait time of 189 days, with hips meeting the targets 64% of the time with an average wait time of 156 days. Performance varies significantly within the province with our institution, University Hospital London Health Sciences, meeting knee replacement targets 32% of the time,

with an average wait of 402 days, and hip replacement targets 25% of the time with an average wait of 390 days[19]. This is a large academic centre in a major urban centre. From these data it is clear that patients are not getting the care they need when they need it.

In order to have meaningful discussion, accurate data on physician billing patterns from early to mid-career may give us insight into the current stresses for physicians starting to practise. At an approximate public cost of $780,000 to train a specialist it may also offer insight into the millions of dollars spent training these specialists and whether they are being utilized effectively after their training is completed[20].

1.10 Human resource planning in Canada

Healthcare is typically federally funded but provincially administered. Within the province healthcare human resource (HHR) planning is complex. While training from medical school to independent practice is a linear path for the individual, with regards to government planning it is complex.

Medical school is often under the responsibility of the Ministry of Education, while residency allocations are under the responsibility of the Ministry of Health (MOH)[21]. This can lead to situations of incongruous policies, as seen in Ontario where decisions made by the Ministry of Health led to negative effects.

In 2015, the Ministry of Health made an announcement that 50 residency spots would be cut which in hindsight was not well thought out[1]. Despite this, the number of medical students applying to residency positions would have stayed the same. As such, there were the same number of applicants for less positions. This led to a significant amount of unmatched medical students in the subsequent years[22]. In response to this, there was a onetime increase of $23 million for extra residency positions to help clear the backlog of unmatched medical students.

1.11 Orthopaedic surgery residency allocations

The number of orthopaedic surgery residency positions has declined from 2012 to 2020 to the point where we are training half the number of residents we used to. This change was in response to an increased number of unemployed/underemployed orthopaedic surgeons[15]. Despite the apparent static funding, the demand for orthopaedic care is high as noted by the ever-increasing waiting time for orthopaedic care.

1.12 The demand for orthopaedic care is increasing

The demand for orthopaedic care is expected to increase[23]. With an increasingly aging population, the demand for orthopaedic care, especially arthroplasties, is expected to increase as such, proactive HHR planning is needed to better serve the population.

1.13 Surgeon practice patterns are not well understood

Recent analysis of changes in surgical practice patterns is lacking. Chan et al. (1998) examined practice profiles of older Ontario physicians based on OHIP billings, with an identified cohort of 2,055 aged 65+ followed from 1989-1996[24]. Older physicians were overrepresented in surgical specialties, paediatrics, diagnostic imaging, and among specialists in rural areas. Many older physicians had reduced workloads, with 60% working part time. Older family physicians were less likely to work in obstetrics and emergency medicine, participated in more operations as surgical assists, and treated an older patient population. This demonstrated the areas of practice their younger colleagues needed to absorb over time in order to provide comprehensive patient care.

Practice patterns of orthopaedic surgeons are not ones that are well understood and are an area of focus.

1.14 References

1. Zeng A, Brenna C, Ndoja S. Fundamental trends within falling match rates: insights from the past decade of Canadian residency matching data. *Can Med Educ J*. 2020. doi:10.36834/cmej.69289
2. Royal College of Physicians and Surgeons of Canada. Competence by Design (CBD) Cohort Roll Out Plan. website. http://www.royalcollege.ca/rcsite/documents/icre/2018-07-16-cohort-roll-out-revised-e.pdf. Published 2018. Accessed February 11, 2020.
3. Gofton WT, Dudek NL, Wood TJ, Balaa F, Hamstra SJ. The Ottawa Surgical Competency Operating Room Evaluation (O-SCORE). *Acad Med*. 2012;87(10):1401-1407. doi:10.1097/ACM.0b013e3182677805
4. Kouzmina E, Mann S, Chaplin T, Zevin B. An evaluation of the surgical foundations curriculum: a national study. *J Surg Educ*. 2021;78(3):914-926.
5. Frank JR, Snell LS, Cate O Ten, et al. Competency-based medical education: theory to practice. *Med Teach*. 2010;32(8):638-645. doi:10.3109/0142159X.2010.501190
6. Blankush JM, Shah BJ, Barnett SH, et al. What are the associations between the quantity of faculty evaluations and residents' perception of quality feedback? *Ann Med Surg*. 2017;16:40-43.
7. Richard K.Reznick HM. Changes in the wind. *N Engl J Med*. 2006;355:2664-2669. doi:10.1021/jf052913o
8. Ten Cate O. Nuts and bolts of entrustable professional activities. *J Grad Med Educ*. 2013;5(1):157-158.
9. Roediger HL, Karpicke JD, Roediger III HL, Karpicke JD. Test-enhanced learning: Taking memory tests improves long-term retention. *Psychol Sci*. 2006;17(3):249-255. doi:10.1111/j.1467-9280.2006.01693.x
10. Koh AWL, Lee SC, Lim SWH. The learning benefits of teaching: A retrieval practice hypothesis. *Appl Cogn Psychol*. 2018;32(3):401-410. doi:10.1002/acp.3410
11. Roediger HL, Butler AC. The critical role of retrieval practice in long-term retention. *Trends Cogn Sci*. 2011;15(1):20-27. doi:10.1016/j.tics.2010.09.003
12. Kromann CB, Bohnstedt C, Jensen ML, Ringsted C. The testing effect on skills learning might last 6 months. *Adv Heal Sci Educ*. 2010;15(3):395-401.
13. Ndoja S, Dion C-A, Pirshahid AA, et al. Active Retrieval Improves Procedural Learning in Orthopedic Surgery. *J Surg Educ*. 2022.

14. Fréchette D, Datta I, Jacob C, Shrichand A, Hollenberg DB. *What's Really Behind Canada's Unemployed Specialists?: Too Many, Too Few Doctors? Findings from the Royal College's Employment Study-2013*. Royal College of Physicians and Surgeons of Canada; 2014.
15. Frechette D, Shrichand A, Manogaran M, Jacob C, Dimillo S. Employment patterns of Canada's newly certified medical specialists: findings from the Royal College Employment Study. *Ottawa R Coll Physicians Surg Canada*. 2019.
16. CIHI. *Physicians in Canada, 2018*. Ottawa; 2019. doi:978-1-77109-848-9
17. OECD. Doctors (indicator). doi:10.1787/4355e1ec-en
18. Clement ND, Wickramasinghe NR, Bayram JM, et al. Significant deterioration in quality of life and increased frailty in patients waiting more than six months for total hip or knee arthroplasty. *Bone Joint J*. 2022;104-B(11):1215-1224. doi:10.1302/0301-620X.104B11.BJJ-2022-0470.R2
19. Health Quality Ontario. Measuring wait times. King's Printer. https://www.ontariohealth.ca/public-reporting/wait-times. Published 2022. Accessed December 6, 2022.
20. Ontario G of. *2013 Annual Report.*; 2013. https://www.auditor.on.ca/en/content/annualreports/arreports/en13/2013ar_en_web.pdf.
21. Tang B, Zhou LL, Koushan K. Physician workforce planning in Ontario must move from short-term reactivity to long-term proactivity. *Can Med Educ J*. 2018;9(2):e84-e88.
22. Markovic S, Ndoja S, Zhong A, et al. *Physician Services Planning and The Unmatched Medical Graduate*. Toronto Ontario; 2019. https://omsa.ca/sites/default/files/page/12/lobby_day_2019_-_backgrounder.pdf.
23. Shipton D, Badley EM, Mahomed NN. Critical Shortage of Orthopaedic Services in Ontario, Canada. *JBJS*. 2003;85(9). https://journals.lww.com/jbjsjournal/Fulltext/2003/09000/Critical_Shortage_of_Orthopaedic_Services_in.9.aspx.
24. Chan B, Anderson GM, Theriault M-E. Patterns of practice among older physicians in Ontario. *CMAJ*. 1998;159(9):1101-1106.
25. Government of Ontario. Ontario population projections. King's Printer. https://www.ontario.ca/page/ontario-population-projections. Published 2021. Accessed December 6, 2022.

26. Ludwig J, Jakobsen RB, Charles YP, et al. What it takes to become an orthopaedic surgeon: A comparison of orthopaedic surgical training programmes in 10 countries focusing on structure and fellowship requirements. *Int J Surg*. 2021;95:106150.
27. Holmboe ES, Sherbino J, Long DM, Swing SR, Frank JR. The role of assessment in competency-based medical education. *Med Teach*. 2010;32(8):676-682. doi:10.3109/0142159X.2010.500704
28. Frank JR, Snell L, Englander R, Holmboe ES, Collaborators I. Implementing competency-based medical education: moving forward. *Med Teach*. 2017;39(6):568-573.
29. Daniels AH, DiGiovanni CW. Is subspecialty fellowship training emerging as a necessary component of contemporary orthopaedic surgery education? *J Grad Med Educ*. 2014;6(2):218-221.
30. Hariri S, York SC, O'Connor MI, Parsley BS, McCarthy JC. Career plans of current orthopaedic residents with a focus on sex-based and generational differences. *JBJS*. 2011;93(5):e16.
31. Herndon JH. Orthopaedic surgery fellowships: a ten-year assessment. Subspecialty training during residency and the ideal academic fellowship. *J Bone Joint Surg Am*. 1998;80(12):1836-1838.
32. Theelen L, Bischoff C, Grimm B, Heyligers IC. Current practice of orthopaedic surgical skills training raises performance of supervised residents in total knee arthroplasty to levels equal to those of orthopaedic surgeons. *Perspect Med Educ*. 2018;7:126-132.
33. Mitchell PM, Gavrilova SA, Dodd AC, Attum B, Obremskey WT, Sethi MK. The impact of resident involvement on outcomes in orthopedic trauma: An analysis of 20,090 cases. *J Clin Orthop Trauma*. 2016;7(4):229-233.
34. Giordano L, Oliviero A, Peretti GM, Maffulli N. The presence of residents during orthopedic operation exerts no negative influence on outcome. *Br Med Bull*. 2019;130(1):65-80.
35. Nousiainen MT, Latter DA, Backstein D, Webster F, Harris KA. Surgical fellowship training in Canada: what is its current status and is improvement required? *Can J Surg*. 2012;55(1):58-65. doi:10.1503/cjs.043809
36. Chowdhury MM, Dagash H, Pierro A. A systematic review of the impact of volume of surgery and specialization on patient outcome. *Br J Surg*. 2007;94(2):145-161. doi:10.1002/bjs.5714

37. Shervin N, Rubash HE, Katz JN. Orthopaedic procedure volume and patient outcomes: a systematic literature review. *Clin Orthop Relat Res*. 2007;457:35-41.
38. Cooper RR. Impact of fellowships on orthopaedic surgery residencies, patient care, and orthopaedic practice. Part I. *J Bone Joint Surg Am*. 1998;80(12):1829-1830.
39. Mead M, Atkinson T, Srivastava A, Walter N. The Return on Investment of Orthopaedic Fellowship Training: A Ten-year Update. *JAAOS - J Am Acad Orthop Surg*. 2020;28(12). https://journals.lww.com/jaaos/Fulltext/2020/06150/The_Return_on_Investment_of_Orthopaedic_Fellowship.10.aspx.
40. Almansoori KA, Clark M. Increasing trends in orthopedic fellowships are not due to inadequate residency training. *Educ Res Int*. 2015;2015.
41. Ontario C of P and S of. No Title. https://doctors.cpso.on.ca/. Accessed July 20, 2023.
42. IBM. SPSS Statistics for Windows. 2017.
43. DePasse JM, Daniels AH, Durand W, Kingrey B, Prodromo J, Mulcahey MK. Completion of Multiple Fellowships by Orthopedic Surgeons: Analysis of the American Board of Orthopaedic Surgery Certification Database. *Orthopedics*. 2018;41(1):e33-e37. doi:10.3928/01477447-20171106-05
44. Friedell ML, VanderMeer TJ, Cheatham ML, et al. Perceptions of graduating general surgery chief residents: are they confident in their training? *J Am Coll Surg*. 2014;218(4):695-703.
45. Badley EM, Canizares M, Mahomed N, Veinot P, Davis AM. Provision of Orthopaedic Workforce and Implications for Access to Orthopaedic Services in Ontario. *JBJS*. 2011;93(9). https://journals.lww.com/jbjsjournal/Fulltext/2011/05040/Provision_of_Orthopaedic_Workforce_and.8.aspx.
46. Salsberg ES, Grover A, Simon MA, Frick SL, Kuremsky MA, Goodman DC. An AOA critical issue: Future physician workforce requirements: Implications for orthopaedic surgery education. *J Bone Jt Surgery Am Vol*. 2008;90(5):1143.
47. Comeau P. Crisis in orthopedic care: surgeon and resource shortage. *CMAJ*. 2004;171(3):223.
48. Rullán PJ, Deren ME, Zhou G, et al. The Arthroplasty Surgeon Growth Indicator: A Tool for Monitoring Supply and Demand Trends in the Orthopaedic Surgeon Workforce from 2020 to 2050. *JBJS*. 2023;105(13).

https://journals.lww.com/jbjsjournal/Fulltext/2023/07050/The_Arthroplasty_Surgeon_Growth_Indicator__A_Tool.9.aspx.

49. Sielatycki JA, Sawyer JR, Mir HR. Supply and Demand Analysis of the Orthopaedic Trauma Surgeon Workforce in the United States. *J Orthop Trauma*. 2016;30(5). https://journals.lww.com/jorthotrauma/Fulltext/2016/05000/Supply_and_Demand_Analysis_of_the_Orthopaedic.12.aspx.
50. Horst PK, Choo K, Bharucha N, Vail TP. Graduates of Orthopaedic Residency Training Are Increasingly Subspecialized: A Review of the American Board of Orthopaedic Surgery Part II Database. *JBJS*. 2015;97(10). https://journals.lww.com/jbjsjournal/Fulltext/2015/05200/Graduates_of_Orthopaedic_Residency_Training_Are.14.aspx.
51. Manser R. US and Canada GeoCoordinates. US and Canada GeoCoordinates. https://www.serviceobjects.com/blog/free-zip-code-and-postal-code-database-with-geocoordinates/. Published 2020. Accessed July 16, 2023.
52. Marsh JL. Avoiding burnout in an orthopaedic trauma practice. *J Orthop Trauma*. 2012;26:S34-S36.
53. Simons BS, Foltz PA, Chalupa RL, Hylden CM, Dowd TC, Johnson AE. Burnout in US military orthopaedic residents and staff physicians. *Mil Med*. 2016;181(8):835-839.
54. Foran IM. A Perspective on the Effect of the 80-hour Work Week: Has it Changed the Graduating Orthopaedic Resident? *J Am Acad Orthop Surg*. 2020;28(10):e418-e419.
55. Hui RWH, Leung KC, Ge S, et al. Burnout in orthopaedic surgeons: A systematic review. *J Clin Orthop Trauma*. 2019;10:S47-S52. doi:https://doi.org/10.1016/j.jcot.2019.01.028
56. Kakiashvili T, Leszek J, Rutkowski K. The medical perspective on burnout. *Int J Occup Med Environ Health*. 2013;26:401-412.
57. Shanafelt TD, Bradley KA, Wipf JE, Back AL. Burnout and self-reported patient care in an internal medicine residency program. *Ann Intern Med*. 2002;136(5):358-367.
58. West CP, Huschka MM, Novotny PJ, et al. Association of perceived medical errors with resident distress and empathy: a prospective longitudinal study. *Jama*. 2006;296(9):1071-1078.
59. Kwah J, Weintraub J, Fallar R, Ripp J. The effect of burnout on medical errors and professionalism in first-year internal medicine residents. *J Grad Med Educ*. 2016;8(4):597-600.

60. Campbell Jr DA, Sonnad SS, Eckhauser FE, Campbell KK, Greenfield LJ. Burnout among American surgeons. *Surgery*. 2001;130(4):696-705.
61. Torp S, Grimsmo A, Hagen S, Duran A, Gudbergsson SB. Work engagement: a practical measure for workplace health promotion? *Health Promot Int*. 2013;28(3):387-396.
62. Schaufeli WB, Salanova M, González-Romá V, Bakker AB. The measurement of engagement and burnout: A two sample confirmatory factor analytic approach. *J Happiness Stud*. 2002;3:71-92.
63. Schaufeli WB, Bakker AB, Salanova M. Utrecht work engagement scale-9. *Educ Psychol Meas*. 2003.
64. Schaufeli WB, Bakker AB, Salanova M. The measurement of work engagement with a short questionnaire: A cross-national study. *Educ Psychol Meas*. 2006;66(4):701-716.
65. Hernández Vargas CI, Llorens Gumbau S, Rodríguez Sánchez AM, Dickinson Bannack ME. Validation of the UWES-9 Scale in Mexican Health Professionals. *Pensam Psicológico*. 2016;14(2):89-100.
66. Arora M, Diwan AD, Harris IA. Burnout in orthopaedic surgeons: a review. *ANZ J Surg*. 2013;83(7-8):512-515.

Chapter 2 : Thesis rationale and questions

2.1 Overview

The purpose of this project is to gain an understanding of orthopaedic surgeons trained in Ontario, Canada. Where are they? What are they doing? Do they feel adequately trained? How many fellowships are they doing? Why are they doing fellowships? Are they struggling to find jobs after training? When they get a job, do they get full resources or are they underemployed in their first few years, compared to their earlier counterparts. Are they engaged in their work and satisfied?

While there are many factors at play in understanding proper HHR planning in orthopaedic surgery. We believe that these questions collectively will inform leaders both involved in education (residency and fellowship) and those in policy positions. These questions may help optimize orthopedic HHR planning in Ontario.

2.2 Hypotheses

Hypothesis 1: Economic impact of recent graduates

We hypothesize that more recent graduates would have lower billings than their counterparts earlier in time. This would be due to a possible delay in obtaining full time employment.

Hypothesis 2: Period of bottle neck

We hypothesize there to be a significant divergence between number of surgeons trained and number retained in Ontario within the last 5 to 10 years, which has led to a significant under-employment/ unemployment of graduates during that time.

Hypothesis 3: Comfort in entering practice independently

We hypothesize that graduates do not feel comfortable entering practice out of residency, with more recent graduates feeling less comfortable.

Hypothesis 4: Motivations for further training

We hypothesize that more recent graduates are doing more fellowship and are doing them more out of necessity rather than interest.

Hypothesis 5: Pursuit of graduate degrees

We hypothesize that more recent graduates are acquiring more graduate degrees during or after residency and are doing it out of necessity rather than interest.

Hypothesis 6: Emigration out of Canada and Ontario

We hypothesize that more recent graduates are more likely to be employed outside of Ontario and Canada.

Hypothesis 7: Job satisfaction

We hypothesize that more recent graduates, those who have done more fellowships, and those in the USA are less engaged in their work and will score lower on the UWES-9.

Chapter 3 : Has the transition into full-time practice changed over the last 20 years for Orthopaedic Surgeons? An analysis using Ministry of Health billing data.

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Manuscript submitted for publication

3.2 Abstract

Background: Underemployment is a reality for many new graduates, who accept locum or part-time work as an alternative to unemployment due to lack of opportunities. We analysed orthopaedic surgeons' Ontario Health Insurance Program (OHIP) billing data over a 20-year period as a proxy of practice patterns. We hypothesized that billing, in the first 6 years of practise, would be affected due to underemployment and locum practises during this time.

Methods: The annual average billing totals of orthopaedic surgeons were analysed. This was broken down into: year of graduation, year of billings, and number of surgeons billing in that year. Public census data of the Ontario population size were analysed as a proxy of orthopaedic demand.

Results: A cross sectional analysis in 2019 showed that there were approximately 15 surgeons per graduating year billing in Ontario from the 1995 to 2016 cohorts. 2017 and 2018 had an increase to 30 and 36 actively billing surgeons respectively. The number of new actively billing surgeons returned to historical numbers in 2019 with 20 actively billing surgeons.

For those surgeons billing in Ontario, billing trends have been roughly stable with average billings increasing each year for the first 6 years in practice ($p<0.05$). There was not an effect of year of graduation on the first 6 years of billings ($p>0.05$). Billings were stable after 6 years in practice ($p>0.05$).

Discussion and Conclusion: Our healthcare system has not expanded to support more orthopaedic surgeons despite the aging and growing population. There was an attempt to increase the number of orthopaedic surgeons in Ontario. However, this led to a mismatch between the number of surgeons trained and the number of surgeons retained. Despite our growing

population, the number of surgeons being trained has not reflected this. Further research needs to be done to guide optimal health human resource decision making.

Level of evidence: IV

Funding sources/Disclosures: Individual-level data were obtained from the Ontario Ministry of Health and Long-Term Care (MOHLTC) under an agreement with the Ontario Medical Association (OMA), who provided aggregated data for this study.

3.2 Introduction

Establishing a career is challenging and stressful for many new surgeons after training. Challenges may include seeking employment, relocating, and setting up a new practice. Underemployment is a reality for many recent graduates, who accept locum or part-time work as an alternative to unemployment due to lack of opportunities[14]. In Canada, those in neurosurgery, radiation oncology, and orthopaedic surgery have faced the most difficulty finding employment[15]. From 2011-2018, 37% of orthopaedic surgeons had not found stable employment at the time of certification. Given this delay, many have turned to other forms of work as a temporary solution. In 2012, almost 22% of new graduates reported multiple locum or part-time positions, implying delayed time to reach full employment—that is in their own practice, full-time[14].

One potential factor contributing to this difficulty for early-career surgeons is a mismatch between physician supply and capacity. Recently, the physician workforce has been growing more quickly than the general population, with a 3.8% increase in the number of physicians between 2017-2018 compared to a population growth rate of just over double that in four times as many years (2014-2018)[16]. Despite this recent growth, Canada ranks 25th, with an average of 2.8 physicians per 1,000 inhabitants, when compared to 34 other OECD countries[17]. The average number of physicians per 1,000 inhabitants for the 35 OECD countries was 3.2. The juxtaposition of underemployed graduates with a low physician-per-capita is due to severe underfunding of the system rather than an oversupply of physicians. This juxtaposition leaves patients suffering while waiting for orthopaedic care.

A recent study showed that patients who wait more than 6 months for hip and knee arthroplasty experience a significant decrease in quality of life and increase in frailty[18]. Ontario, the largest province in Canada, has set a quality-based procedure (QBP) target of 6 months for hip and knee replacements. Ontario's own targets are only met 60% of the time for knee replacements, with an average wait time of 189 days, with hip replacements meeting the targets 64% of the time with an average wait time of 156 days. Performance varies significantly within the province with our institution, University Hospital London Health Sciences, meeting knee targets 32% of the time, with an average wait of 402 days, and hip targets 25% of the time with an average wait of 390 days[19]. This is a large academic centre in a major urban centre. From these data it is clear that patients are not getting the care they need when they need it.

In order to have meaningful discussion, accurate data on physician billing patterns from early to mid-career may give us insight into the current stresses for physicians starting to practise. At an approximate public cost of $780,000 to train a specialist it may also offer insight into the millions of dollars spent training these specialists and whether they are being utilized effectively after their training is completed[20].

Recent analysis of changes in surgical practice patterns is lacking. Chan et al. (1998) examined practice profiles of older Ontario physicians based on OHIP billings, with an identified cohort of 2,055 aged 65+ followed from 1989-1996[24]. Older physicians were overrepresented in surgical specialties, paediatrics, diagnostic imaging, and among specialists in rural areas. Many older physicians had reduced workloads, with 60% working part time. Older family physicians were less likely to work in obstetrics and emergency medicine, participated in more operations as surgical assists, and treated an older patient population. This demonstrated the areas of practice their younger colleagues needed to absorb over time to provide comprehensive patient care.

While HHR planning is a complex process involving multiple factors where one solution may not work for everyone, objective data may be an important tool to understand the evolution of surgical practice patterns. An analysis of practice patterns showing how these patterns have changed over the last 20 years will help surgical trainees prepare for their careers, and guide health care policy and planning.

The primary objective of this study was to determine how the first 6 years of orthopaedic surgeons' billings have changed in the last 20 years. Secondary objectives were to determine whether the billing changed after 6 years of practice and how the number of physicians in practice has changed over time.

3.3 Methods

Average yearly orthopaedic surgery fee-for-service billings, to the Ontario Ministry of Health (MOH) from 1989 to 2019 was analysed. These billings were adjusted to the consumer price index of 2018 and was provided to us already adjusted by the MOH. We analysed the number of surgeons billing each year and the average fees billed per year were filtered by year of graduation. A linear regression model was used to analyse average yearly fees billed as a function of year of residency graduation. Data was split into early career (first 6 years in practice) and 6+ years.

The Canadian Post-MD Education Registry (CAPER) was used to analyse the number of orthopaedic surgeons finishing training from orthopaedic institutions each year from 1989 to 2017.

Residency positions on the Canadian Residency Application Service (CaRMS) from 2013 to 2021 were analysed as a rough proxy of future surgeon output. Data was analysed using SPSS.

3.4 Results

From 1989 to approximately 2011, the number of orthopaedic surgeons completing their training in Ontario ranged from 15-30 per year. From 2012 to 2016 there was a steady increase in the number of surgeons graduating from Ontario institutions, with a peak of 55 residents graduating in 2016 (Figure 3-1). There appears to have been a sharp reduction in the number of residency spots available after 2016 with 27 orthopaedic residency spots being available in Ontario in 2021, projecting a maximum of 27 graduates in 2026 from Ontario institutions. (Figure 3-1). CAPER reports completion of medical training (residency and fellowship(s)).

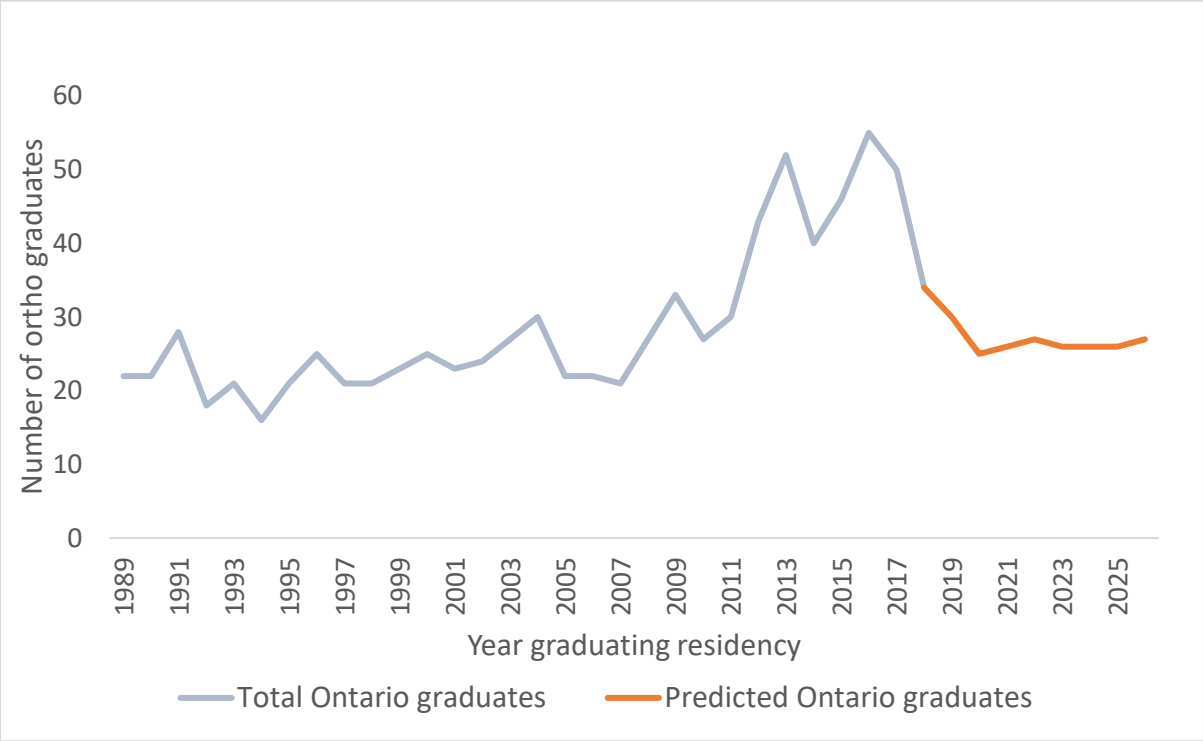

Figure 3-1 Total number of Ontario orthopaedic surgery graduates (blue line) from CAPER data set, predicted number of graduates (red line) over time, this was calculated looking at the number of filled orthopaedic surgery spots at a given year, and adding 5 years

When looking at actively billing surgeons in Ontario, a cross sectional analysis in 2019 showed that there was an average of 15 (+/- 5) surgeons billing the MOH per year of residency graduation from 1995 to 2016. There was an increase in 2017 to 2018 with a peak of 36 surgeons working in

2019 who finished residency in 2018 (Figure 3-2). Figure 2 shows the number of actively billing surgeons in Ontario as a function of year of residency graduation.

Figure 3-2 The number of orthopaedic surgeons billing in Ontario in 2019 as a function of year of residency graduation.

The mismatch between actively billing surgeons and number of trained surgeons diverged from 2007 to 2018. This can be seen by comparing Figure 1 and Figure 2 (Figure 3-3).

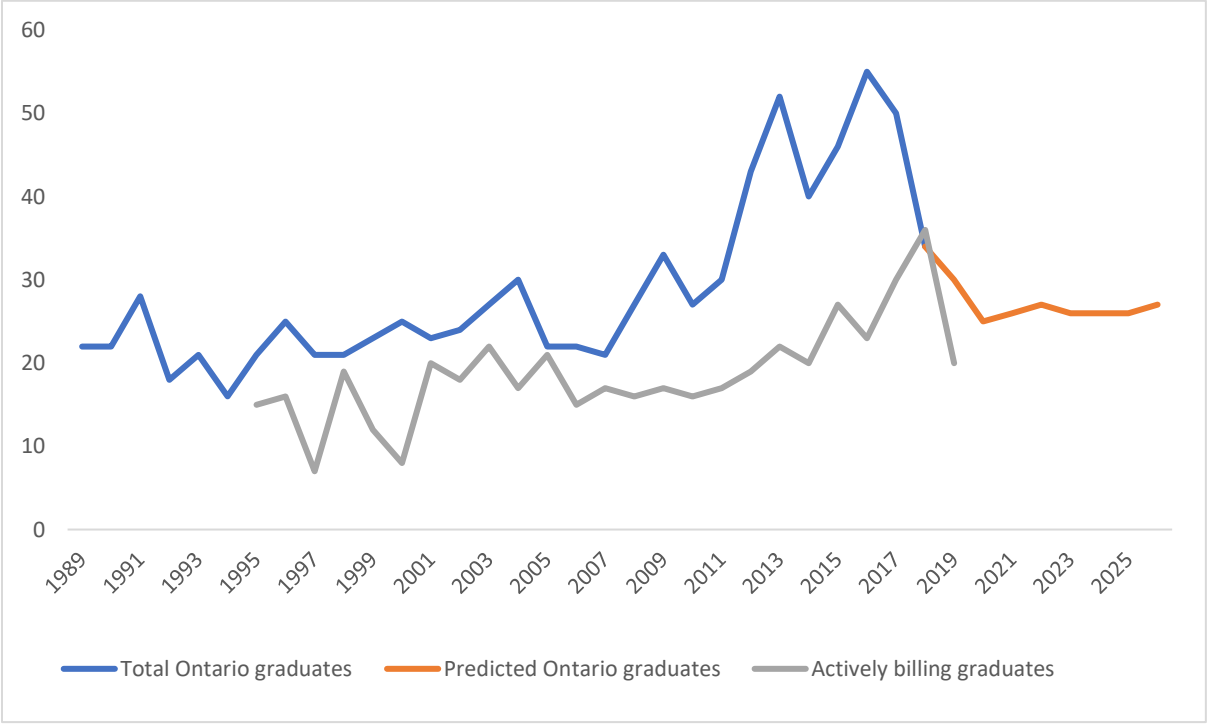

Figure 3-3 Figure 1 and 2 superimposed on each other. We see from 2007 to 2018 a divergence between the number of actively billing surgeons and the number of trained surgeons in Ontario. X axis is year, Y axis is number of graduates

In the first 6 years of practice there is a statistically significant increase in income, adjusted for inflation, for each year in practice ($p<0.05$). There was no effect of year of graduation ($p>0.05$) (Figure 3-4).

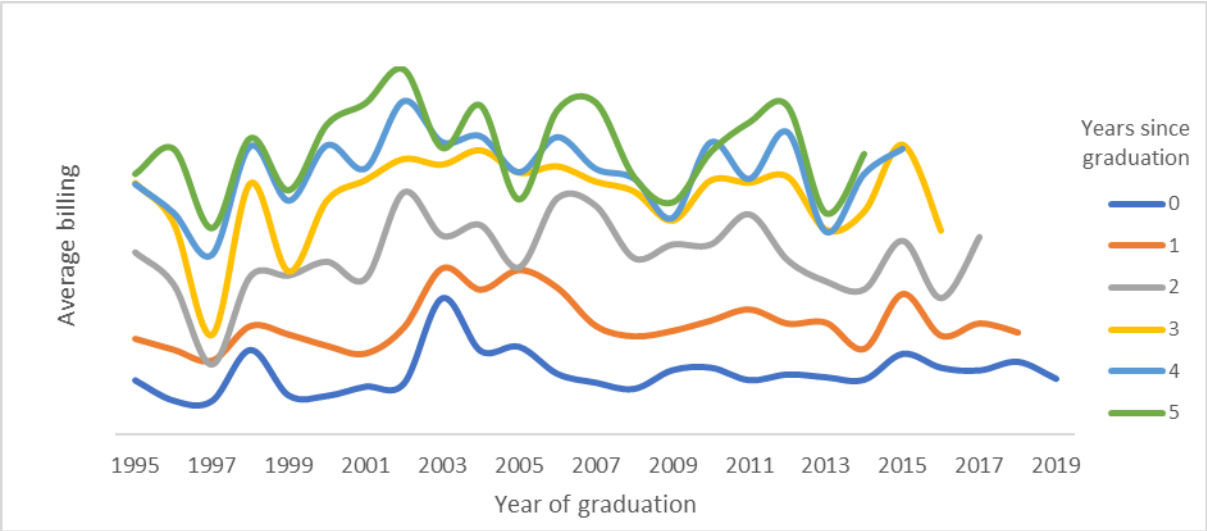

Figure 3-4 Average yearly billing in the first 6 years of practice grouped by 5-year intervals of graduation. Y is average FFS billing. We opted to not display it as to not shift the focus of the paper on the amount billed.

While we analysed average amount billed per year, we opted to not display it in the figure as to not shift the focus of the paper to the amount billed. There was no increase in income after 6 years of practice ($p>0.05$).

3.5 Discussion

The most striking finding in this study was the significant asynchrony in orthopaedic surgeon supply and new surgeons starting to bill in Ontario. There appeared to have been an attempt to increase supply between 2012 to 2016 without a synchronized match in new surgeons' billings (Figure 3-3). This can understandably lead to significant stressors in new graduates due to the scarcity of opportunities. We can assume that graduates at that time may have made decisions that they would not have otherwise made. Some of these graduates would have possibly had to have emigrated: either to another province or another country. For those that were able to secure employment in Ontario, they may have accepted a position in a subspecialty or location that they would not have otherwise chosen—these are areas ripe for further research. Certainly, we can appreciate a lag in surgeon output as the increase in new surgeons graduating from 2012 to 2016

would reflect decisions made around 2007 to 2011 given orthopaedic surgery is a 5-year program. As such, it would be interesting to understand the rationale that led to these initial decisions to increasing training spots for more surgeons and then the reason to cut back so quickly; a decision which would have an acute effect on medical school to residency transition [1,21,22].

We demonstrated the average billings in the first 6 years of orthopaedic practice have not changed in the last 20 years which was an unexpected finding. Given the reports of underemployment, we expected a decrease in productivity in more recent years as new graduates do further subspecialisation[2]. Younger graduates seem to have similar billing patterns to older graduates. With that being said, it is important to acknowledge that billings only tell part of the story. More recent graduates may have similar billings compared to their predecessors, but they may be accomplishing this with more over-night and weekend work which pays after-hours premiums, fellowships in which they can bill as surgical assistants, or by doing unscheduled surgeries during locums—billing histories do not equate to insight on full time employment. Regardless, we demonstrated that those who were billing in Ontario, whether they had secured or not secured permanent employment, whichever they may be, did not come at a financial cost in terms of fee for service billings.

Our data suggests that on average, 15 (+/- 5) new orthopaedic surgeons are added to the work-force each year; a number which has been relatively stable in the last 20 years with the exception of a slight peak in 2018 with 36 surgeons. The increased aging population implies increased orthopaedic demand. Our data suggests that, for a brief period of time, the number of training spots was increased to support this need. However, there was not a reciprocal increase in active number of surgeons in Ontario. This lack of matching funding led to wasting public resources for training, increased stressors for graduating surgeons and lack of retention of these highly trained and valuable resources to the province.

3.6 Limitations

One major limitation to this study is that it is looking at average population billing data. As such, it is not possible to extrapolate the degree of employment of individual surgeons. A more recent graduate could be billing in a similar manner in their first 5 years after graduating residency as their predecessors, but doing so through locums, surgical assisting, and after-hours cases. This requires working more difficult hours, a more unstable job and reflects not using graduates in a

way that the training was intended. Therefore, using billing in this case as a proxy to a "real job" may be, in fact, overstating the successes of recent graduates in finding meaningful employment. Another limitation is with CAPER data. CAPER data only shows the year a trainee finished their training. There may be fluctuations due to fellowship(s), delaying graduation for personal leave, graduate work, or repeating a year for a multitude of reasons. The use of CaRMS data to assess the number of trainees has similar limitations. CaRMS only shows how many residency spots there are upon matching and the number of graduates can fluctuate for the reasons stated with CaPER data but also people switching in and out of orthopaedic surgery.

3.7 Conclusion

While there was an initial attempt to increase the number of surgeons in Ontario to serve the population, this was not met with an increase in new surgeons entering the system. As such, it appears that the asynchrony between new surgeons and capacity led to an underemployment crisis. This appears to have been improved by a reduction in the number of graduating surgeons, rather than an increase in resources to serve the patients of Ontario. Given the increasing age of the population, there will likely be a significant increase in demand for orthopaedic care over the coming years;[25] while the increasing age of surgeons, and related increase in retirement will lead to a decrease in the supply. Decreasing trainees rather that increasing health care funding will not help with this problem.

An interesting area of future study would be to analyse Orthopaedic graduates during the time period of 2009 to 2016. This was a time where there was significant asynchrony between the number of surgeons being trained and those retained and practising in Ontario. It would be interesting to understand the career decisions they made, and the motivations behind these decisions in this time of significant asynchrony. There likely were significant stressors in newly minted surgeons leading to career decisions that were not ideal. Future research should focus on matching the needs of the population to the number of trainees and the funding required for fruitful employment upon graduation.

3.8 References

1. Fréchette D, Datta I, Jacob C, Shrichand A, Hollenberg DB. What's Really Behind Canada's Unemployed Specialists?: Too Many, Too Few Doctors? Findings from the Royal College's Employment Study-2013. Royal College of Physicians and Surgeons of Canada; 2014.
2. Frechette D, Shrichand A, Manogaran M, Jacob C, Dimillo S. Employment patterns of Canada's newly certified medical specialists: findings from the Royal College Employment Study. Ottawa R Coll Physicians Surg Canada. 2019.
3. CIHI. Physicians in Canada, 2018. Ottawa; 2019. doi:978-1-77109-848-9
4. OECD. Doctors (indicator). doi:10.1787/4355e1ec-en
5. Clement ND, Wickramasinghe NR, Bayram JM, et al. Significant deterioration in quality of life and increased frailty in patients waiting more than six months for total hip or knee arthroplasty. Bone Joint J. 2022;104-B(11):1215-1224. doi:10.1302/0301-620X.104B11.BJJ-2022-0470.R2
6. Health Quality Ontario. Measuring wait times. King's Printer. https://www.ontariohealth.ca/public-reporting/wait-times. Published 2022. Accessed December 6, 2022.
7. Ontario G of. 2013 Annual Report.; 2013. https://www.auditor.on.ca/en/content/annualreports/arreports/en13/2013ar_en_web.pdf.
8. Chan B, Anderson GM, Theriault M-E. Patterns of practice among older physicians in Ontario. CMAJ. 1998;159(9):1101-1106.
9. Tang B, Zhou LL, Koushan K. Physician workforce planning in Ontario must move from short-term reactivity to long-term proactivity. Can Med Educ J. 2018;9(2):e84-e88.
10. Markovic S, Ndoja S, Zhong A, et al. Physician Services Planning and The Unmatched Medical Graduate. Toronto Ontario; 2019. https://omsa.ca/sites/default/files/page/12/lobby_day_2019_-_backgrounder.pdf.
11. Zeng A, Brenna C, Ndoja S. Fundamental trends within falling match rates: insights from the past decade of Canadian residency matching data. Can Med Educ J. 2020. doi:10.36834/cmej.69289
12. Government of Ontario. Ontario population projections. King's Printer. https://www.ontario.ca/page/ontario-population-projections. Published 2021. Accessed December 6, 2022.

Chapter 4 : What are trainees doing after residency?

This chapter explores what the time immediately after residency looks like for graduates. Do they feel ready to practice? Do they feel obligated to do a fellowship? How long does it take for them to gain full employment, and what those early career decisions look like. Understanding the immediate post residency landscape would help guide decisions made during residency: whether from the program side, or trainee side.

4.1 Abstract

Orthopedic surgery has been a focus of discussion of new graduate underemployment and under resources. However, there is little literature critically appraising the outcome of orthopedic surgery training in Ontario. The purpose of this study was to gain insight on the outcome of graduates of Ontario programs in the last 30 years.

Methods: We invited 618 graduates of Ontario orthopedic surgery programs from 1992 to 2020 to participate in our survey regarding their practice patterns, and career choices.

Results: We received a 36% response rate. Graduates do not feel ready to enter independent practice, with graduates of UofT feeling the least ready, and more recent graduates overall feeling less ready. Almost everyone does one fellowship. The number of people that do 2 fellowships is the same as those that do 1. This has not changed with time and does not appear to help with comfort to practice nor earlier employment. The vast majority of attributed current surgical skills are from fellowship training.

Conclusion: We need to re-examine how we view residency training given that most residents do not feel prepared for practice and are doing 2 fellowships. While the time to employment has not gotten worse, it has not gotten better either and trainees from Ontario programs are incurring a significant opportunity cost doing a second fellowship—something which is not seen in graduates from US programs.

4.2 Introduction

The goal of any residency training program is to produce a graduate that is capable of functioning independently. Surgical training in North America is 5 years in length, but this is not universal around the world[26]. Canada has developed a competency based assessment for evaluation of readiness for practice—a shift away from case number based threshold[27,28] The question that remains at hand is: are graduates ready to practice independently directly out of residency?

Orthopedic surgery has the largest number of trainees pursuing fellowship after training[29,30]. This is a substantial increase from decades ago when only a small sample of graduates pursued further training[31]. Residents are skilled and safe operators. There is an abundance of literature showing that orthopedic surgery residents performing surgeries do not impact patient outcomes, only surgical time[32–34]. As such, this then brings the question of: why? Do trainees not feel adequately trained? Has case volume gone down? Has case complexity gone up? Have techniques advanced where more training is needed? Or is it simply because this is what market forces have demanded now?

A surgical fellowship is typically 1-2 years of focused clinical experience completed after residency. Most fellowships in the United States are accredited through an accrediting body. However, in Canada while they are completed through an academic institution, they are not accredited in that they do not lead to certification in an area of subspecialty training[35]. In orthopedics the potential routes for fellowship include hand, upper extremity, spine, trauma, foot and ankle, sports medicine, arthroplasty, or pediatric surgery.

There is argument to be made for specialty training. Literature has shown better patient outcomes in procedures performed by high volume surgeons[36,37]. This is certainly an argument for subspecialty training; however, there are downsides to unofficial obligatory subspecialty training. The challenges that arise are: if a generalist performs a procedure within the scope of a subspecialist, would they be at a higher risk of litigation[38]? One also needs to consider the economic impact of fellowship training, with hand, pediatrics, and foot and ankle subspecialties result in a net loss in income through the course of a surgeons career as a result of subspecialty training[39].

One of the downsides of continued specialization, is the decrease of general scope. Maintaining subspecialty skills necessitates a high volume—which, by definition, implies less volume in other procedures. Not all centres can offer such high volume, which leaves rural areas underserved due

to a lack of generalist surgeons. Despite the increasing trend of fellowship training, there is literature demonstrating that graduates feel adequately trained in their residency and choose fellowships to expand their skills, or make themselves more marketable[40].

4.3 Study rationale

The purpose of this study was to assess how many fellowships were undertaken by orthopedic graduates, which fellowships, and the motivations for those fellowship(s). We wanted to assess intrinsic motivations (out of desire), and extrinsic motivations (out of necessity). While other studies have surveyed graduating residents on their motivations for fellowship[40], this is the first study to our knowledge looking at a cross-sectional analysis of all practicing orthopedic surgeons. This type of analysis allows us to evaluate trends as a function of year of graduation.

4.4 Hypotheses

Hypothesis 1: Comfort in entering practice independently.

We hypothesize that graduates do not feel comfortable entering practice out of residency, and more recent graduates feeling less comfortable.

Hypothesis 2: Motivations for further training

We hypothesize that more recent graduates are completing more fellowship(s) and are completing them more out of necessity rather than interest.

Hypothesis 3: Pursuit of graduate degrees

We hypothesize that more recent graduates are acquiring more graduate degrees during or after residency and are doing it out of necessity rather than interest.

4.5 Methods

A database of orthopedic surgery graduates from 1992 to 2022 fromOntario residency programs was created. Any physician must register with their regulatory medical body to practice. The regulatory bodies have publicly searchable databases, as such we utilized these to build a database of orthopedic surgeons.

We used the publicly available physician search from the College of Physicians and Surgeons of Ontario (CPSO). All active and inactive members of the CPSO with the designation of "Orthopedic surgery" were searched[41]. Their year Name, year of graduation, school of graduation, and registered practice address were collected. For surgeons no longer practicing in Ontario, or where their address was not available, we searched their location using *Google™ and* confirmed this information using their local medical regulatory body.

Where available, physician e-mail was recorded. This information was typically available for physicians working in academic institutions. The local academic institution public faculty database was searched. Postgraduate offices of Ontario orthopedic programs were contacted with the rationale for our study and asked if they were willing to share their alumni database with us. If unable, or not willing, we focused on physician contact information found through the regulatory bodies.

Residents with foreign funding were excluded as they are attached to a return of service and motivations for fellowship choices are different than those not with a return of service.

Ontario residency programs were limited to: University of Ottawa, Queen's University, University of Toronto, Northern Ontario School of Medicine, McMaster University, and Western University.

Where possible the survey was distributed electronically with one reminder one week after, and a second reminder one month after distribution. A paper copy of the survey was sent through physical mail with return postage to the surgeon's office address (Appendix A: Survey).

This study was approved by our institutional ethics review board (Appendix B: REB approval).

4.6 Survey and analysis

Demographic data was collected: year of graduation, school of graduation.

With regards to fellowship, we collected: number of fellowship (s), location of fellowship (s), and subspecialty of fellowship(s).

Preparedness to practice from residency was assessed by a self-reported 5-point scale.

> "Yes I could have entered practice out of residency yes but fellowship helped, no but could have figured it out with trial and error, no, I would have needed a lot of help from colleagues early on, no I definitely needed to do a fellowship and extra training."

We collected motivations for fellowship: interest, lack of comfort, specific opening requiring the fellowship, need to be more marketable, increase income potential. These were assessed on a 7-point Likert scale ranging from Strongly disagree (1), to strongly agree (7).

We also assessed if trainees got a graduate degree during or after training. We wanted to assess motivations for graduate degree during or after training, if it was intrinsic (interest), necessity for a job (job required it, or the job they took required a lot of research), or if it was to make themselves more marketable. This was also assessed on a 7-point Likert scale.

We assessed if surgeons did a locum during their fellowship (yes/no). We assessed how long after formal training (including fellowship) it took for full-time employment.

Another factor that was assessed was time for comfort in independent practice, and what percentage of skills they perceived they got from fellowship and residency.

The survey was designed by SN and edited by the two co-supervisors BL and ES. Once satisfied the survey was then sent to the entire Division of Orthopedic Surgery at Western for their input. Members were given a rationale for the study and instructed to *not* fill out the survey but simply provide feedback on the type of questions. The survey was then edited based on feedback received for ethics approval before being sent for data collection.

All data was analysed using Statistical Package for the Social Sciences (SPSS)[42]. Year of graduation and Likert item responses were considered continuous data. School of graduation and number of fellowships were considered categorical. Country of practice (Canada, not Canada) was considered binary categorical.

$\chi 2$ test was performed when evaluating two categorical variables. Binary regression analysis was used to analyse the relationship between binary categorical independent variables data with continuous dependent variables. One way ANOVA was used for categorical independent variables with continuous dependent data. Linear regression was used to compare two sets of continuous data (dependent and independent).

4.7 Results

Descriptive results

A total of 618 graduates met the criteria with 439 available e-mails (71%). Distributions of graduates per school and available electronic contact information are shown in Table *4-1*.

Table 4-1. Distribution of orthopedic surgery graduates from Ontario medical schools and availability of e-mail contact.

School of residency graduation	Number of graduates	Number of graduates with e-mail on file	Percentage of graduates with email on file
McMaster	96	23	24.0
NOSM	7	0	0.0
Ottawa	114	110	96.5
Queens	64	10	15.6
University of Toronto (UofT)	225	198	88.0
Western	112	98	87.5
Total	618	439	71.0

Of the 618 identified graduates, 471 (76.21%) are practicing in Canada, 144 (23.30) in the United States, and 3 (0.49%) in other countries. Table *4-2* shows the distributions of graduates around the world. **In-depth geographical analysis will be performed in chapter 5.**

Table 4-2 Distribution of countries where Ontario Orthopedic surgery graduates are currently practicing.

Country	Number of graduates	Percentage of graduates
Bahamas	1	0.16
Canada	471	76.21
New Zealand	1	0.16
United Kingdom	1	0.16
United States	144	23.30
Total	618	100.00

Year of graduation ranged from 1992 to 2020, with the mean being 2008, median 2010, and mode of 36 graduates in 2015. Distributions of number of graduates per year are shown in Figure 4-1.

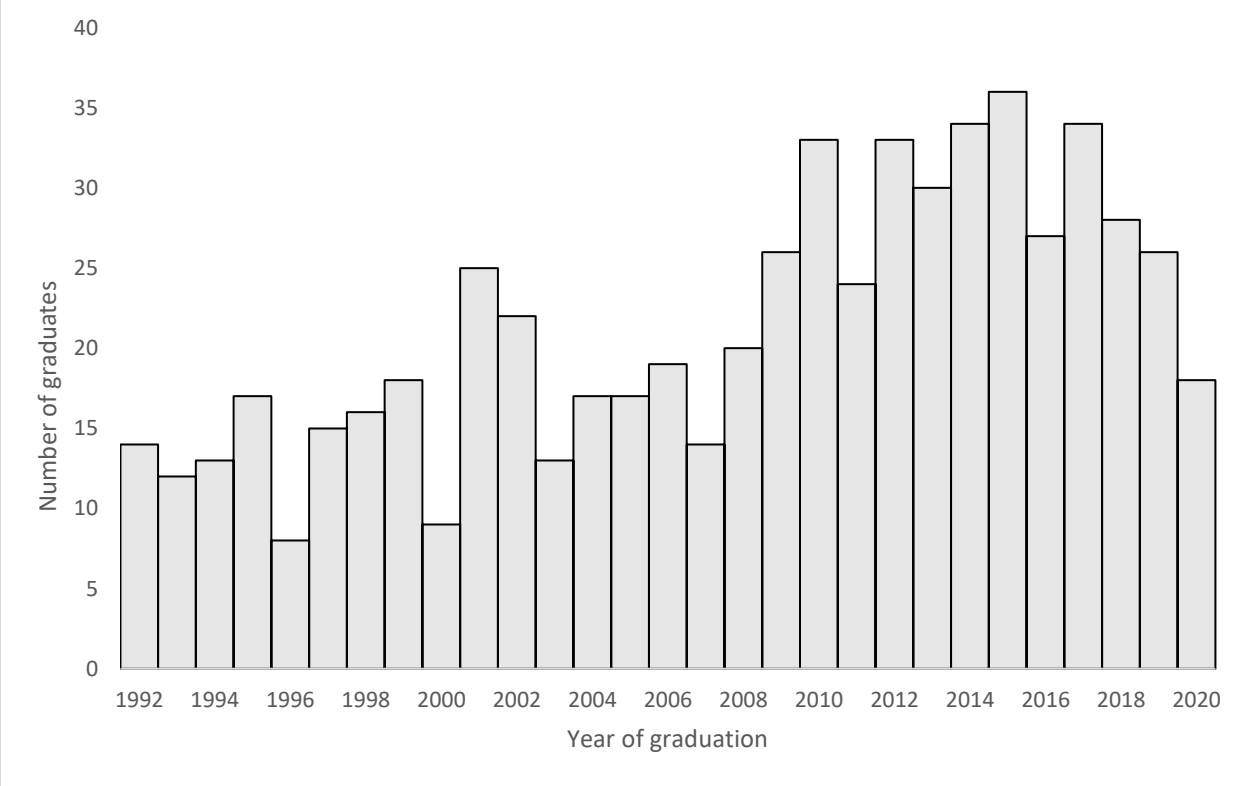

Figure 4-1 Number of orthopedic surgery graduates from Ontario per year

Of the 439 emails, 45 (10%) either bounced back or were filtered, leaving 394 possible respondents. 149 surgeons started the survey with 138 fully competing it (93%). The total response

rate in the e-mail survey was 138 out of a pool of 394, leading to a response rate of 35% for the electronic survey.

Those who did not respond to the survey, or those whom we did not have electronic contact information, were sent the survey over physical mail. Due to complexities of arranging international return mail, and 99% being in either the United States or Canada, physical mail was only sent to US and Canadian surgeons. The 138 who responded to the electronic survey, leaving 477 for physical mail. Of the physical mail sample, 367 (76.9%) were sent to Canadian addresses, and the remaining 113 (23.1%) to US addresses. Of the 477 physical mail invitations, 12 were returned by the post office for various reasons, incorrect address, no longer working there etc, Leaving 465 possible responses. We received 86 (18.0%) responses by physical mail, with 70 from Canada and 16 from the United States. This resulted with an overall completion by 224 respondents out of 618 and an overall response rate of 38.03% and completion rate of 36.25%. Table 4-3 shows the distribution of responses from e-mail, and electronic surveys. Partial responses were analysed when possible.

Table 4-3 Response rate per country of e-mail and physical mail surveys

Country	Number of graduates	Completed e-mail survey	Partially completed e-mail survey	Completed physical mail survey	Total responses (partial and complete)	Total complete responses	Percent response rate (fully completed)
Canada	471	111	8	70	190	181	38.64
United States	144	27	3	16	46	43	29.86
Other	3	0	0	0	0		0
Total	618	138	11	86	235	224	36.25

Number of fellowships

Of the 236 possible 231 responded with how many fellowships they completed. Almost everyone (98%) did at least 1 fellowship. The mode was 2 fellowships (107) with only 4 (1.7%) not completing any fellowships (Figure 4-2). There was **no** difference in the number of surgeons completing one fellowship or two fellowships ($\chi 2(1)=0.31$, $p=0.58$)

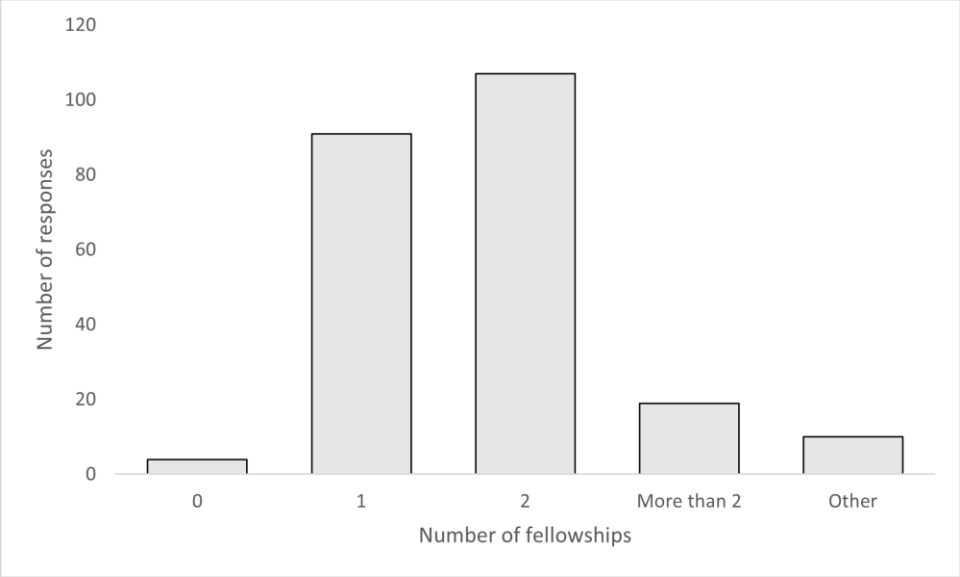

Figure 4-2 Total number of individuals and the number of fellowships completed. The other category includes 1 currently in fellowship, 1 doing 2 half fellowships, and 8 completing a single half fellowship.

People who reported 2 half fellowships were coded as doing 2 and people who did half a fellowship were record as one, so as to focus on the number of fellowships in terms of discreet numbers, as opposed to a time focus. Those currently in fellowship were coded as 1.

There was **no** effect of school on number of fellowships ($\chi 2(15)=18.93$, $p=0.22$), nor country of practice ($\chi 2(3)=1.50$, $p=0.68$) nor year of graduation ($F(3, 221)=0.97$ $p=0.41$), nor gender $\chi 2(3)=0.83$, $p=0.84$.

The most common fellowship was arthroplasty, with 39 out of 235 respondents (16%), followed by trauma 29 (12.3%). Full results are shown in Table *4-4*.

.

Table 4-4: Distribution of reported fellowships

	Frequency	Percent
Arthroplasty	39	16.6
Trauma	30	12.8
Sports	30	12.8
Upper Extremity	29	12.3
Spine	19	8.1
Paediatrics	18	7.7
Trauma and Upper Extremity	10	4.3
Trauma and arthroplasty	8	3.4
Foot & ankle	8	3.4
Trauma foot and ankle	5	2.1
Arthroplasty and Foot & ankle	4	1.7
Hand	4	1.7
Oncology	3	1.3
Sports and trauma	3	1.3
Sports, foot & ankle	2	0.9
Clinical Orthopedics	1	0.4
Arthroplasty,Sports, Foot & ankle	1	0.4
Trauma, Arthroplasty (lower extremity reconstruction),Sports	1	0.4
Sports, upper extremity	1	0.4
Spine and trauma	1	0.4
Pediatrics, trauma, arthoplasty	1	0.4
Trauma,Arthroplasty (lower extremity reconstruction),Foot & ankle	1	0.4
Trauma,Upper extremity,Arthroplasty (lower extremity reconstruction)	1	0.4
Upper extremity,Arthroplasty,Foot & ankle, Trauma	1	0.4
Arthroplasty and Oncology	1	0.4
Trauma and oncology	1	0.4
Sports and upper extremity	1	0.4
No response or no fellowship	11	4.7
Total	235	100.0

Self-reported comfort entering practice independently.

An overall $\chi 2$ confirmed that people responded differently than expected by chance, $\chi 2$ (4) =89.49, $p<0.001$. This is assuming equal distributions across all 5 responses.

More participants than expected by chance (44%) reported "Yes, but I feel like doing a fellowship helped make things easier". Less than expected responded with "No, I would have needed help from collegues early on" (7.1%) and "No, but with trial and error I could have figured things out" (12.8%).

We then proceeded to group "Yes, I could have entered practice directly out of residency" and "Yes, but I feel like doing fellowship helped make things easier" as a "yes" with regards to comfort in entering practice out of residency. The remaining items, "No, but with trial and error I could have figured things out. "No, I would have needed help from colleagues early on" and "I definitely needed to do a fellowship and extra training" were grouped together. These were coded as "no" with regards to comfort in entering practice out of residency.

We set an arbitrary threshold of 80% of graduates feeling ready for independent practice; as such we performed a chi square test against these expectations. Our results showed 62% felt ready for independent practice out of residency; significantly different than the expected 80% $\chi 2$ (1) = 46.04, $p<0.001$. Thus, graduates did *NOT* feel ready to enter practice out of residency.

We performed a binary logistic regression analysis predicting readiness, being yes vs no, from year of graduation. The number of people reporting ready for practice varied as a function of time, with surgeons who graduated more recently feeling **less ready**, B=-0.05, SE=0.02, p=0.01.

There was an effect of school on readiness to practice, with graduates of UofT less likely to feel ready for independent practice $\chi 2$ (5) =13.93, p=0.016 than predicted. As per normal protocol, a standard residual ≥ 2 or ≤ -2 was considered a major contributor to that category (Table *4-5*). Due to the low sample size of NOSM, the analysis was done with and without NOSM. Results were unchanged. As such, data is reported with NOSM for completeness.

Table 4-5: $\chi 2$ analysis of School and readiness to practice out of residency. Std. residual stands for standard residual.

			School of graduation						
			McMaster	NOSM	Ottawa	Queens	UofT	Western	Total
Ready to practice?	No	Count	9	1	23	5	33	15	86
		Std. Residual	0.2	1.0	-0.2	-0.7	**2.0**	-1.7	
	Yes	Count	13	0	40	13	28	46	140
		Std. Residual	-0.2	-0.8	0.2	0.6	-1.6	1.3	
Total		Count	22	1	63	18	61	61	226

Motivation(s) for fellowship(s)

There was not a function of number of fellowships in readiness to practice $\chi 2$ (3) =3.37, p=0.338. Items regarding motivations for fellowship were analysed using factor analysis. Two factors were reported to have an Eigen value greater than 1 (Table *4-6*).

Table 4-6: Rotated factor loadings of survey items regarding motivations for doing fellowship(s)

	Rotated Component factor loading	
Items	1	2
There were more job openings in that specific fellowship than others	0.79	
There was a specific opening that required that fellowship	0.74	
That specific fellowship(s) had better renumeration than others	0.72	
This was not an area I felt I was fully comfortable in being independent in	0.50	
This was an interest of mine		0.97

Factor 1 comprised of "there were more job openings in that specific field, there was a specific opening that required that fellowship, that specific fellowship(s) had better renumerations than others. These 3 items had a factor loading of greater than 0.7 and fit in the theme of extrinsic motivations. The item "this was not an area I felt I was fully comfortable being independent in"

also loaded on factor 1 and a factor loading of 0.50. Factor 2 was comprised of a single item "this was an interest of mine" with a factor loading of 0.97, this was felt to represent intrinsic motivation. Due to the low factor loading of "this was not an area I felt fully comfortable being independent in" as well as being theoretically different, we re-ran our analysis forcing a 3-factor solution.

The 3 factors loaded with factor 1 being "there were more job openings in that specific field, there was a specific opening that required that fellowship, that specific fellowship(s) had better renumerations than others." These were felt to be extrinsic motivators. Factor 2 was a single item "this was not an area I felt fully comfortable being independent in." This was felt to be discomfort in this area of practice. Factor 3 was a single item "this was an interest of mine." This was felt to be interest.

Analysis of motivation(s) for fellowship(s)

We performed three different linear regression analyses using year to predict the 3 factors: extrinsic, discomfort, and interest as motivators for pursuing fellowship. Data are summarized in Table *4-7* .

There was a statistically significant association between year of graduation and discomfort as a motivation for fellowship ($F(1,217)=5.37$, $B=0.04$ $SE=0.02$ $\beta=0.16$, $p=0.02$), indicating more recent graduates showing a stronger propensity to choose fellowship due to lack of comfort. However, $R^2=0.02$ indicated that this model only explained 2% of the variability, showing a weak relationship. There was no relationship between year of graduation and extrinsic motivators, $B=0.01$, $SE=0.01$, $\beta=-0.06$ $p=0.41$, and interest $B=-0.001$, $SE=0.001$, $\beta=-0.03$ $p=0.69$.

Table 4-7 Summary of multiple regressions of motivations of doing a fellowship with year of graduation.

Variables tested	Regression Weights	B	SE	β	p-value	Result
Extrinsic	Extrinsic→time	0.01	0.01	0.06	0.41	No relationship
Interest	Interest→time	0.001	0.001	0.03	0.69	No relationship
Discomfort	Discomfort→time	0.04	0.02	0.16	0.02	Statistically significant relationship
R^{2*}	0.02					
$F(1,217)^{*}$	5.37					

Note. * R^2 and F values only reported for discomfort vs time analysis

We ran a 6 (school: McMaster, NOSM, Ottawa, Queens, UofT, McMaster, Western; between subject) x3 (motivation measure; Extrinsic, discomfort, interest) repeated measures ANOVA. There was a significant effect of motivation, $F(2,436)=50.89$, $p<0.001$. There was no effect of school $F(5,218)=0.52$ $p=0.76$, there was no interaction between school and motivation. $F(10,436)=1.01$ $p=0.43$.

Post hoc analysis showed that participants were primarily motivated by interest (mean=6.38 SD=1.32) more than extrinsic (mean=3.04 SD=1.45), or comfort (mean=3.46 SD=1.94), both p=<0.01. Extrinsic and discomfort did not differ p=1.00.

Job directly out of training

Neither year of graduation (B=-0.03 SE 0.02 p=0.13) nor school of graduation ($\chi2$ (5)=6.98 p=0.22), nor country ($\chi2$ (1)=1.74 p=0.19), nor number of fellowships ($\chi2$ (3)=3.00 p=0.39), nor gender ($\chi2$ (1)=0.45 p=0.50), nor locuming during fellowship $\chi2$ (1)=0.268 p=0.61 predicted likelihood of job directly out of training.

Locuming during fellowship

60.8% stated they did not locum during fellowship. 39.2% did. There was an statistically significant effect of time (B=0.06 SE=0.02 p=0.002) and country ($\chi 2$ (1)=8.08 p=0.004) with more recent graduates more likely to locum, and graduates employed in the US less likely locum. School of graduation did **not** predict likelihood of locuming during fellowship $\chi 2$ (5)=7.62 p=0.18

Time after formal training to feel comfortable operating independently

With regards to time to feel comfortable operating independently, the majority stated it took them 0 to 6 months, with the second most common being 1 to 2 years (Table *4-8*).

Table 4-8 Distribution of time after formal training to feel comfortable operating independently.

Time after formal training	Number of responses	Percentage
No response	10	4.3
0-6 months	118	50.2
6 months to a year	37	15.7
1-2 years	39	16.6
2-3 years	16	6.8
3-4 years	9	3.8
4-5 years	6	2.6
Total	235	100.0

Time for comfort to practice was grouped into 4 groups, 0 to 6 months, 6 months to 1 year, 1-2 years, greater than 2 years. Those who did not respond were excluded from analysis.

Number of fellowships predicted comfort operating independently $\chi 2(9)=17.00$ p=0.049. This was driven with those who did 0 fellowships feeling more comfortable operating independently 1-2 years in practice. However, cell size was less than the minimum 5 required for a valid $\chi 2$ test. This finding is **not** replicated once those doing 0 fellowships were excluded ($\chi 2(6)=6.15$, p=0.41). Neither year of graduation ($F(3,221)=0.23$, p=0.84), nor school of graduation $\chi 2(30)=38.87$, p=0.13 predicted time after formal training to feel comfortable operating independently.

Percentage of current surgical skills based on fellowship or residency

With regards to attribution of current surgical skills based on fellowship or residency there were 224 and 230 responses respectively, with a mean of 65.83% attribution to fellowship and 49.49 attribution to residency (Table *4-9*).

Table 4-9: Percent of current operative techniques are based on skills learned in fellowship or residency (out of 100%)

	Percent of current operative techniques are based on skills learned in fellowship?	Percent of current operative techniques are based on skills learned in residency?
Number of responses	224	230
Mean	65.83	49.49
Median	70.00	50.00
Mode	80	50

Year of graduation predicted neither skills learned from fellowship (B=0.38, SE=0.19, β=0.13 p=0.59) nor skills learned from residency (B=-0.20, SE=0.21 Beta=-0.06, p=0.35. There was an overall effect of school of graduation with percentage of skills learned from fellowship (F(4,218)=2.51, p=0.04)) however, this effect was **not** identified in the post hoc analysis. The closest difference was seen between graduates of McMaster University demonstrating 14.9% higher than Western University from skills attributed to fellowship, with p=0.1. There was no effect of school on percentage of skills attributed to residency (F(F4,224)=1.45, p=0.22).

We ran a 2(% of skills learned from residency, % of skills learned from fellowship;within subject)x2(readiness for practice out of residency (yes/no)) repeated measures ANOVA. We observed a significant effect of skills gained from residency vs fellowship, F(1,218)=89.61, p<0.001. We did not observe a significant effect of readiness for practice out of residency F(1,218)=0.06 p=0.81.

These effects were superseded by a significant interaction F(1, 218)=21.88, p<0.001 between readiness for practice and where you got the majority of your skills from. With those feeling ready to practice out of residency reporting a high percentage of skills learned from residency

(mean=52.43% SD=22.94) compared those that did not feel ready to practice out of residency (mean 43.53% SD=24.42), F(1,218)=7.47, p=0.007. People who reported not feeling ready practicing out of residency attribute a greater percentage of skills learned from fellowship (mean=72.16 SD 19.23) compared to those feeling ready to practice out of residency (mean=62.13 SD 23,27), F(1,218)=10.99, p=0.001. Overall, it appears that surgeons attribute more of their current surgical skills from skills learned in fellowship than residency regardless of whether they felt comfortable practicing out residency without a fellowship (Figure 4-3).

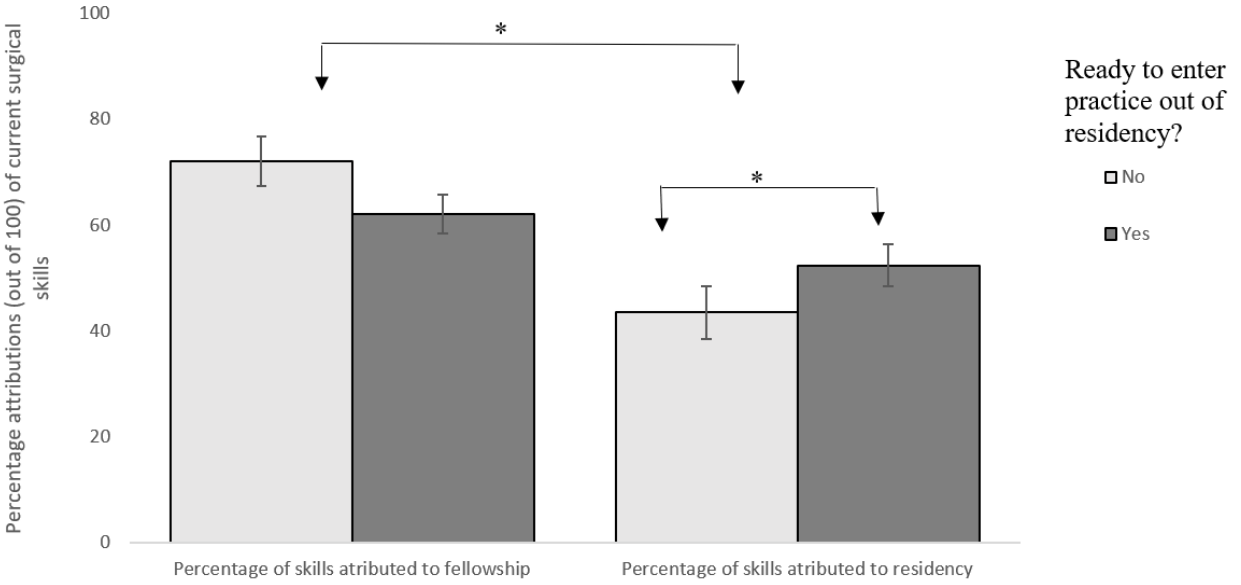

*Figure 4-3 comparing percentage of current surgical skills attributed to fellowship and residency, to if surgeons felt comfortable entering practice directly out of residency. * denotes statistical significance.*

Graduate degrees during or after residency

Approximately 78(34%) of respondents got a graduate degree during or after residency (Table 4-10). Of the 78 respondents, 9 (11%) were PhD, 1(1%) MBA, 1 in epidemiology, 5 (6%) did not specify, and the remaining 62 were Masters degrees. (79%). People were equally split in doing a graduate degree during (60.5%) or after (39.5%) residency X2(1)=3.37 p=0.07.

Table 4-10*: Distribution of graduate degree or not during or after residency*

	Number of responses	Percentage of respondents
No	146	65.2
Yes	78	34.8
Total	224	100.0
No response	11	
Total	235	

Neither Year of graduation (B=0.04 SE 0.02 p=0.06) nor School (χ2(5)=10.48 p=0.06) significantly predicted likelihood of getting a graduate degree during or after residency. There was no significant standard residual.

Factor analysis of motivations for graduate degrees during or after residency showed 2 factors with an Eigen value greater than 1. First factor reflected motivations out of necessity and included items: "My job required a lot of research", "I felt I did not have the skills to do it", and "this was a requirement for my job". Factor 2 reflected intrinsic motivations and included items "I did it to expand my expertise" and "I felt I had to in order to make myself more advantageous for the job market" (reverse coded).

Year of graduation significantly predicted intrinsic motivations for graduate degree (F1,73)=6.42, p=0.01, with more recent graduates **less** likely to do a graduate degree during/after residency out of **interest**, B=-0.06, β=0.025. However, this was a weak relationship, with the model only predicting 8% of the variability, R^2=0.08. Year of graduation did not predict necessity (B=-0.04 SE 0.03 β= -0.14 p=0.25)

4.8 Discussion

Graduates do not feel ready to enter practice directly out of residency.

More recent graduates in general report feeling less ready, and graduates out of UofT specifically feeling less ready than other schools, to enter practice directly out of residency. However, while this is a significant effect, this is a small one. This is a potential area of future investigation. Comfort entering practice directly out of residency does *not* predict the number of fellowships pursued.

Practicing independently once starting practice

Most responded 0 to 6 months as time in practice it took to start feeling comfortable practicing independently. There was no effect of year of graduation or number of fellowships on reports of how long it took to feel comfortable practicing independently.

Those who felt comfortable entering practice directly out of residency attributed more of their current surgical skills to skills learned in residency, than those who did not feel comfortable entering directly out of residency. However, overall graduates report skills from fellowship as a greater contributor to current surgical practice regardless of comfort in entering practice directly out of fellowship.

A significant number of graduates do 2 fellowships.

Almost everyone does a fellowship (98%). The most common fellowship was arthroplasty (16%) followed by trauma (13%). Equal number of people do 1 or 2 fellowships. No effect of time, school, gender, nor country of practice, on the number of fellowships completed.

People did fellowship out of interest more than all factors. However, more recent graduates were most likely to do a fellowship because of discomfort. However, this must be interpreted with significant caution is the model only explained 2% of the variance. There was no change across year of graduation with regards to interest or extrinsic motivators. School of graduation did not affect motivators for pursuing fellowship training.

Locuming

More recently graduates are more likely to locum during fellowship. Those who practice in the US currently were less likely to locum during fellowship.

Difficulty finding a job has not changed substantially

Year of graduation, school, country, number of fellowship, locuming during fellowship, nor gender predicted likelihood of taking a job out of training.

Graduate degrees

Approximately 1/3rd of respondents got a graduate degree during or after residency, with Masters being the most common one. There was no effect of school of graduation on the likelihood of getting a graduate degree. While there was no overall effect of time on likelihood of getting a graduate degree, recent graduates were ***less*** likely to get one out of interest. However, this was a weak effect.

Limitations

The biggest limitation of this study is that it is a cross-sectional self-reported study. It is difficult to accurately evaluate motivations for decisions made years ago and there may be an element of retrospective justification. Our analyses are also limited to correlational, and caution must be taken to *not* interpret these as causational.

Overall discussion

The interesting takeaways from all this data is that our graduates do not feel comfortable entering practice directly out of residency, *especially* newer graduates, and most are doing 2 fellowships. This is quite significant as two fellowships has a significant opportunity cost. While there is a paucity of literature on orthopedic surgery in Canada, when looking at the literature in the United States, the majority (>90%) of graduates do pursue fellowship after residency[29], a small amount (4.5%) of members in a 2018 study had two fellowships[43]. Our results show that the driving motivator for pursuit of fellowship is interest. However, it is unclear why Ontario graduates are "interested" in pursuing two fellowships. Our study was not designed to differentiate motivators for a second fellowship but is a potential future area of study.

The other question that this study raises is: why are our graduates not ready for independent practice? The literature with regards to comfort in entering practice is lacking. Studies in the US on general surgery shows that their graduates feel comfortable entering general practice[44]. However, the question remains: are orthopedic graduates in general not comfortable entering practice, or is this an effect of training in Ontario? Given that most graduates, regardless of number of fellowship(s), reported that they felt comfortable operating independently 0-6 months in practice the result of graduates reporting discomfort entering practice directly out of residency must be

interpreted with caution. The study was not designed to assess the nuances of the *degree* of discomfort such as an impostor syndrome type of discomfort, or a discomfort due to lack of adequate training and potential harm to patient care.

With regards to residency training and fellowships; if everyone is doing 1 or 2 fellowships, then do we need to re-evaluate what residency education means. Can we start residents in a focused practice while in residency, or is orthopedics evolving into a 6-year program? Why are newer graduates feeling less comfortable? Is it because the complexities of our training have increased, or has the quality of our training decreased?

4.9 Limitations

A limitation in this study is the dataset. When searching the CPSO, we used the filter of certification of independent practice in Orthopedic surgery to identify individuals who completed residency in Ontario. As such individuals who did *not* report to the CPSO that they met the requirements for independent practice would not be captured. These would be individuals who after residency left Ontario and never returned. The residency offices of Western, Ottawa, and the UofT were able to share their alumni list with us, we consider our database for those schools to be comprehensive. McMaster stated they were recently starting to build their list and shared what they had. Queens and NOSM did not share their list. As such there is a chance that we did not capture graduates from those 3 schools.

4.10 Conclusion

Based on these results a critical look at orthopedic surgery training in Ontario must be performed. Our graduates are not feeling ready entering practice, especially our new graduates and the average person does 2 fellowships. These findings necessitate an appraisal of our goals in residency education. Residency is a 5-year process, and we need to ensure that our graduates are properly prepared to enter practice.

4.11 References

1. Zeng A, Brenna C, Ndoja S. Fundamental trends within falling match rates: insights from the past decade of Canadian residency matching data. *Can Med Educ J*. 2020. doi:10.36834/cmej.69289
2. Royal College of Physicians and Surgeons of Canada. Competence by Design (CBD) Cohort Roll Out Plan. website. http://www.royalcollege.ca/rcsite/documents/icre/2018-07-16-cohort-roll-out-revised-e.pdf. Published 2018. Accessed February 11, 2020.
3. Gofton WT, Dudek NL, Wood TJ, Balaa F, Hamstra SJ. The Ottawa Surgical Competency Operating Room Evaluation (O-SCORE). *Acad Med*. 2012;87(10):1401-1407. doi:10.1097/ACM.0b013e3182677805
4. Kouzmina E, Mann S, Chaplin T, Zevin B. An evaluation of the surgical foundations curriculum: a national study. *J Surg Educ*. 2021;78(3):914-926.
5. Frank JR, Snell LS, Cate O Ten, et al. Competency-based medical education: theory to practice. *Med Teach*. 2010;32(8):638-645. doi:10.3109/0142159X.2010.501190
6. Blankush JM, Shah BJ, Barnett SH, et al. What are the associations between the quantity of faculty evaluations and residents' perception of quality feedback? *Ann Med Surg*. 2017;16:40-43.
7. Richard K.Reznick HM. Changes in the wind. *N Engl J Med*. 2006;355:2664-2669. doi:10.1021/jf052913o
8. Ten Cate O. Nuts and bolts of entrustable professional activities. *J Grad Med Educ*. 2013;5(1):157-158.
9. Roediger HL, Karpicke JD, Roediger III HL, Karpicke JD. Test-enhanced learning: Taking memory tests improves long-term retention. *Psychol Sci*. 2006;17(3):249-255. doi:10.1111/j.1467-9280.2006.01693.x
10. Koh AWL, Lee SC, Lim SWH. The learning benefits of teaching: A retrieval practice hypothesis. *Appl Cogn Psychol*. 2018;32(3):401-410. doi:10.1002/acp.3410
11. Roediger HL, Butler AC. The critical role of retrieval practice in long-term retention. *Trends Cogn Sci*. 2011;15(1):20-27. doi:10.1016/j.tics.2010.09.003
12. Kromann CB, Bohnstedt C, Jensen ML, Ringsted C. The testing effect on skills learning might last 6 months. *Adv Heal Sci Educ*. 2010;15(3):395-401.
13. Ndoja S, Dion C-A, Pirshahid AA, et al. Active Retrieval Improves Procedural Learning

in Orthopedic Surgery. *J Surg Educ*. 2022.

14. Fréchette D, Datta I, Jacob C, Shrichand A, Hollenberg DB. *What's Really Behind Canada's Unemployed Specialists?: Too Many, Too Few Doctors? Findings from the Royal College's Employment Study-2013*. Royal College of Physicians and Surgeons of Canada; 2014.
15. Frechette D, Shrichand A, Manogaran M, Jacob C, Dimillo S. Employment patterns of Canada's newly certified medical specialists: findings from the Royal College Employment Study. *Ottawa R Coll Physicians Surg Canada*. 2019.
16. CIHI. *Physicians in Canada, 2018*. Ottawa; 2019. doi:978-1-77109-848-9
17. OECD. Doctors (indicator). doi:10.1787/4355e1ec-en
18. Clement ND, Wickramasinghe NR, Bayram JM, et al. Significant deterioration in quality of life and increased frailty in patients waiting more than six months for total hip or knee arthroplasty. *Bone Joint J*. 2022;104-B(11):1215-1224. doi:10.1302/0301-620X.104B11.BJJ-2022-0470.R2
19. Health Quality Ontario. Measuring wait times. King's Printer. https://www.ontariohealth.ca/public-reporting/wait-times. Published 2022. Accessed December 6, 2022.
20. Ontario G of. *2013 Annual Report*.; 2013. https://www.auditor.on.ca/en/content/annualreports/arreports/en13/2013ar_en_web.pdf.
21. Tang B, Zhou LL, Koushan K. Physician workforce planning in Ontario must move from short-term reactivity to long-term proactivity. *Can Med Educ J*. 2018;9(2):e84-e88.
22. Markovic S, Ndoja S, Zhong A, et al. *Physician Services Planning and The Unmatched Medical Graduate*. Toronto Ontario; 2019. https://omsa.ca/sites/default/files/page/12/lobby_day_2019_-_backgrounder.pdf.
23. Shipton D, Badley EM, Mahomed NN. Critical Shortage of Orthopaedic Services in Ontario, Canada. *JBJS*. 2003;85(9). https://journals.lww.com/jbjsjournal/Fulltext/2003/09000/Critical_Shortage_of_Orthopaedic_Services_in.9.aspx.
24. Chan B, Anderson GM, Theriault M-E. Patterns of practice among older physicians in Ontario. *CMAJ*. 1998;159(9):1101-1106.
25. Government of Ontario. Ontario population projections. King's Printer.

https://www.ontario.ca/page/ontario-population-projections. Published 2021. Accessed December 6, 2022.

26. Ludwig J, Jakobsen RB, Charles YP, et al. What it takes to become an orthopaedic surgeon: A comparison of orthopaedic surgical training programmes in 10 countries focusing on structure and fellowship requirements. *Int J Surg*. 2021;95:106150.
27. Holmboe ES, Sherbino J, Long DM, Swing SR, Frank JR. The role of assessment in competency-based medical education. *Med Teach*. 2010;32(8):676-682. doi:10.3109/0142159X.2010.500704
28. Frank JR, Snell L, Englander R, Holmboe ES, Collaborators I. Implementing competency-based medical education: moving forward. *Med Teach*. 2017;39(6):568-573.
29. Daniels AH, DiGiovanni CW. Is subspecialty fellowship training emerging as a necessary component of contemporary orthopaedic surgery education? *J Grad Med Educ*. 2014;6(2):218-221.
30. Hariri S, York SC, O'Connor MI, Parsley BS, McCarthy JC. Career plans of current orthopaedic residents with a focus on sex-based and generational differences. *JBJS*. 2011;93(5):e16.
31. Herndon JH. Orthopaedic surgery fellowships: a ten-year assessment. Subspecialty training during residency and the ideal academic fellowship. *J Bone Joint Surg Am*. 1998;80(12):1836-1838.
32. Theelen L, Bischoff C, Grimm B, Heyligers IC. Current practice of orthopaedic surgical skills training raises performance of supervised residents in total knee arthroplasty to levels equal to those of orthopaedic surgeons. *Perspect Med Educ*. 2018;7:126-132.
33. Mitchell PM, Gavrilova SA, Dodd AC, Attum B, Obremskey WT, Sethi MK. The impact of resident involvement on outcomes in orthopedic trauma: An analysis of 20,090 cases. *J Clin Orthop Trauma*. 2016;7(4):229-233.
34. Giordano L, Oliviero A, Peretti GM, Maffulli N. The presence of residents during orthopedic operation exerts no negative influence on outcome. *Br Med Bull*. 2019;130(1):65-80.
35. Nousiainen MT, Latter DA, Backstein D, Webster F, Harris KA. Surgical fellowship training in Canada: what is its current status and is improvement required? *Can J Surg*. 2012;55(1):58-65. doi:10.1503/cjs.043809

36. Chowdhury MM, Dagash H, Pierro A. A systematic review of the impact of volume of surgery and specialization on patient outcome. *Br J Surg*. 2007;94(2):145-161. doi:10.1002/bjs.5714
37. Shervin N, Rubash HE, Katz JN. Orthopaedic procedure volume and patient outcomes: a systematic literature review. *Clin Orthop Relat Res*. 2007;457:35-41.
38. Cooper RR. Impact of fellowships on orthopaedic surgery residencies, patient care, and orthopaedic practice. Part I. *J Bone Joint Surg Am*. 1998;80(12):1829-1830.
39. Mead M, Atkinson T, Srivastava A, Walter N. The Return on Investment of Orthopaedic Fellowship Training: A Ten-year Update. *JAAOS - J Am Acad Orthop Surg*. 2020;28(12). https://journals.lww.com/jaaos/Fulltext/2020/06150/The_Return_on_Investment_of_Orthopaedic_Fellowship.10.aspx.
40. Almansoori KA, Clark M. Increasing trends in orthopedic fellowships are not due to inadequate residency training. *Educ Res Int*. 2015;2015.
41. Ontario C of P and S of. No Title. https://doctors.cpso.on.ca/. Accessed July 20, 2023.
42. IBM. SPSS Statistics for Windows. 2017.
43. DePasse JM, Daniels AH, Durand W, Kingrey B, Prodromo J, Mulcahey MK. Completion of Multiple Fellowships by Orthopedic Surgeons: Analysis of the American Board of Orthopaedic Surgery Certification Database. *Orthopedics*. 2018;41(1):e33-e37. doi:10.3928/01477447-20171106-05
44. Friedell ML, VanderMeer TJ, Cheatham ML, et al. Perceptions of graduating general surgery chief residents: are they confident in their training? *J Am Coll Surg*. 2014;218(4):695-703.
45. Badley EM, Canizares M, Mahomed N, Veinot P, Davis AM. Provision of Orthopaedic Workforce and Implications for Access to Orthopaedic Services in Ontario. *JBJS*. 2011;93(9). https://journals.lww.com/jbjsjournal/Fulltext/2011/05040/Provision_of_Orthopaedic_Workforce_and.8.aspx.
46. Salsberg ES, Grover A, Simon MA, Frick SL, Kuremsky MA, Goodman DC. An AOA critical issue: Future physician workforce requirements: Implications for orthopaedic surgery education. *J Bone Jt Surgery Am Vol*. 2008;90(5):1143.
47. Comeau P. Crisis in orthopedic care: surgeon and resource shortage. *CMAJ*.

2004;171(3):223.

48. Rullán PJ, Deren ME, Zhou G, et al. The Arthroplasty Surgeon Growth Indicator: A Tool for Monitoring Supply and Demand Trends in the Orthopaedic Surgeon Workforce from 2020 to 2050. *JBJS*. 2023;105(13). https://journals.lww.com/jbjsjournal/Fulltext/2023/07050/The_Arthroplasty_Surgeon_Growth_Indicator__A_Tool.9.aspx.
49. Sielatycki JA, Sawyer JR, Mir HR. Supply and Demand Analysis of the Orthopaedic Trauma Surgeon Workforce in the United States. *J Orthop Trauma*. 2016;30(5). https://journals.lww.com/jorthotrauma/Fulltext/2016/05000/Supply_and_Demand_Analysis_of_the_Orthopaedic.12.aspx.
50. Horst PK, Choo K, Bharucha N, Vail TP. Graduates of Orthopaedic Residency Training Are Increasingly Subspecialized: A Review of the American Board of Orthopaedic Surgery Part II Database. *JBJS*. 2015;97(10). https://journals.lww.com/jbjsjournal/Fulltext/2015/05200/Graduates_of_Orthopaedic_Residency_Training_Are.14.aspx.
51. Manser R. US and Canada GeoCoordinates. US and Canada GeoCoordinates. https://www.serviceobjects.com/blog/free-zip-code-and-postal-code-database-with-geocoordinates/. Published 2020. Accessed July 16, 2023.
52. Marsh JL. Avoiding burnout in an orthopaedic trauma practice. *J Orthop Trauma*. 2012;26:S34-S36.
53. Simons BS, Foltz PA, Chalupa RL, Hylden CM, Dowd TC, Johnson AE. Burnout in US military orthopaedic residents and staff physicians. *Mil Med*. 2016;181(8):835-839.
54. Foran IM. A Perspective on the Effect of the 80-hour Work Week: Has it Changed the Graduating Orthopaedic Resident? *J Am Acad Orthop Surg*. 2020;28(10):e418-e419.
55. Hui RWH, Leung KC, Ge S, et al. Burnout in orthopaedic surgeons: A systematic review. *J Clin Orthop Trauma*. 2019;10:S47-S52. doi:https://doi.org/10.1016/j.jcot.2019.01.028
56. Kakiashvili T, Leszek J, Rutkowski K. The medical perspective on burnout. *Int J Occup Med Environ Health*. 2013;26:401-412.
57. Shanafelt TD, Bradley KA, Wipf JE, Back AL. Burnout and self-reported patient care in an internal medicine residency program. *Ann Intern Med*. 2002;136(5):358-367.
58. West CP, Huschka MM, Novotny PJ, et al. Association of perceived medical errors with

resident distress and empathy: a prospective longitudinal study. *Jama*. 2006;296(9):1071-1078.

59. Kwah J, Weintraub J, Fallar R, Ripp J. The effect of burnout on medical errors and professionalism in first-year internal medicine residents. *J Grad Med Educ*. 2016;8(4):597-600.
60. Campbell Jr DA, Sonnad SS, Eckhauser FE, Campbell KK, Greenfield LJ. Burnout among American surgeons. *Surgery*. 2001;130(4):696-705.
61. Torp S, Grimsmo A, Hagen S, Duran A, Gudbergsson SB. Work engagement: a practical measure for workplace health promotion? *Health Promot Int*. 2013;28(3):387-396.
62. Schaufeli WB, Salanova M, González-Romá V, Bakker AB. The measurement of engagement and burnout: A two sample confirmatory factor analytic approach. *J Happiness Stud*. 2002;3:71-92.
63. Schaufeli WB, Bakker AB, Salanova M. Utrecht work engagement scale-9. *Educ Psychol Meas*. 2003.
64. Schaufeli WB, Bakker AB, Salanova M. The measurement of work engagement with a short questionnaire: A cross-national study. *Educ Psychol Meas*. 2006;66(4):701-716.
65. Hernández Vargas CI, Llorens Gumbau S, Rodríguez Sánchez AM, Dickinson Bannack ME. Validation of the UWES-9 Scale in Mexican Health Professionals. *Pensam Psicológico*. 2016;14(2):89-100.
66. Arora M, Diwan AD, Harris IA. Burnout in orthopaedic surgeons: a review. *ANZ J Surg*. 2013;83(7-8):512-515.

Chapter 5 : Understanding orthopaedic surgery graduates' surgical practice: where and what?

This chapter explores what orthopaedic surgeon's surgical practice looks like. This chapter asks: where are surgeons practicing geographically, how do they describe their practice: specialist or generalist. The other thing we sought to understand is how much resources they have allocated to them, that is, the number of operating room (OR) days, and clinic days in a week.

5.1 Abstract

There has been considerable discussion regarding the demand for orthopedic surgery care and simultaneously the lack of employment opportunities for new graduates. We sought to understand the practice patterns and locations of orthopedic surgeons trained in Ontario.

Methods: 618 surgeons trained from 1992 to 2020 were invited to participate in a survey investigating their current practice location, pattern, available resources, and reasons for emigration if they are practicing outside of Canada.

Results: 235 surgeons responded (36%) with 224 full responses. Emigration out of Canada did not change with time, nor number of fellowships, however more recent graduates are were likely to leave out of necessity rather than interest. Graduates of the University of Ottawa are more likely to work in the United States, and more likely to settle farthest from their school if they stayed in Ontario. Graduates of The University of Toronto are more likely to work within 50km of their training program than other schools. Most surgeons describe themselves as specialists (community/ academic), with very few self-described generalists (10%).

Discussion and conclusion: We have shown an effect of school on the probability of leaving Canada and, more recent graduates leaving out of necessity. This suggests that more recent graduates are not feeling there are enough opportunities, with graduates of Ottawa being the hardest hit. We also show that almost no one views themselves as a generalist, suggesting a re-evaluation of the goals of residency education.

5.2 Introduction

There is a significant shortage of orthopaedic care in Ontario[23,45] and across North America[46,47]. The literature on orthopaedic care shortage focuses primarily on arthroplasty[48] with some studies showing that there may be an oversupply of orthopaedic trauma surgeons[49]. Studies have shown that in the United states, 90% of orthopaedic surgery graduates do a fellowship with the most common being sports (30%), spine (16%), hand (14%)[50]. To our understanding there has not been any published literature investing fellowship choices in a Canadian context.

5.3 Study rationale

The purpose of this study was to gain a better understanding of what an orthopedic surgeon's practice looks like: What fellowship(s) they did, how much OR and clinic time they get. We also sought to assess where their practice is (Canada versus not Canada), and if there was a function of their training location.

5.4 Hypothesis

We hypothesize that more recent graduates are more likely to be employed outside of Ontario and Canada.

5.4 Methods

The methods are discussed in detail in Chapter 4. They are summarized below. Orthopaedic surgery graduates from 1992 to 2020 from Ontario residency programs were surveyed. Residents with foreign funding were excluded as they are attached to a return of service and motivations for fellowship choices are different than those not with a return of service.

Ontario residency programs were limited to: University of Ottawa, Queen's University, University of Toronto, Northern Ontario School of Medicine, McMaster University, and Western University. Where possible the survey was distributed electronically with 1 reminder 1 week after, and a second reminder 1 month after distribution. A paper copy of the survey was sent through physical mail with return postage to the surgeon's office address. This study was approved by our institutional ethics review board.

5.5 Survey and data analysis

Demographics data was collected from publicly available sources. These included the College of Physicians and Surgeons of Ontario (CPSO) for surgeons practicing in Ontario, and the relevant

regulatory body where each surgeon was practicing. The data collected were: gender, school of graduation, year of graduation, and practice address.

We surveyed surgeons' self-description of their practice: academic generalist/ subspecialist. Community generalist/ subspecialist. We asked them to report how many OR and clinic days on average they had a week. For those who emigrated outside of Canada, the motivations for emigration were explored in a 7-point Likert scale ranging from strongly disagree to strongly agree. Data was analysed in SPSS[42]. Year of graduation and Likert item responses were considered continuous data. School of graduation and number of fellowships were considered categorical. Country of practice (Canada, not Canada) was considered binary categorical.

$\chi 2$ test was performed when evaluating two categorical variables. Binary regression analysis was used to analyse the relationship between binary categorical independent variables data with continuous dependent variables. One way ANOVA was used for categorical independent variables with continuous dependent data. Linear regression was used to compare two sets of continuous data (dependent and independent).

Mixed methods ANOVA was used to compare school (between) and motivation measures (within). Test for normality was calculated using the Shapiro-Wilk test. The Kruskal-Wallis test was used to assess categorical independent data, and continuous non-parametric dependent data.

Surgeon's postal code of their official address was obtained from the CPSO. This was converted to longitude and latitude co-ordinates. These coordinates were obtained from a public data base of a security company[51]. A sample of 10 was checked manually with GoogleMaps™ for cross validation and was deemed accurate.

Distance was calculated using the formula. Distance=ACOS(COS(RADIANS(90-Lat1))* COS(RADIANS(90-Lat2))+SIN(RADIANS(90-Lat1))*SIN(RADIANS(90-Lat2))*
COS(RADIANS(Long1-Long2))) * 6371 where Lat1 and Lat 2 are latitude of practice and school respectively, Long1 and Long2 are latitude and longitude of the practice and school respectively.

5.6 Results

Geographical analysis: Where are our graduates?

A total of 618 graduates met the criteria, with the mean 2008, median 2010, and mode in 2015 of graduation year (*Figure 5-1*).

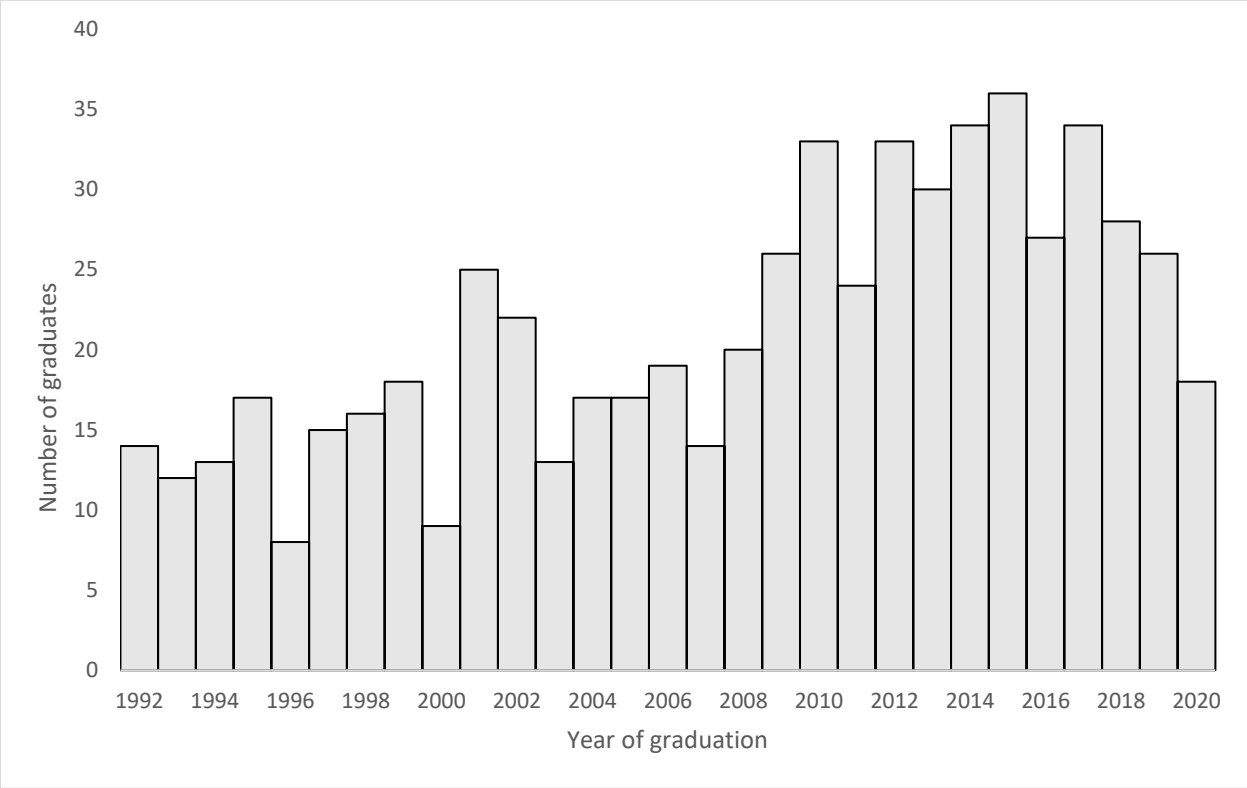

Figure 5-1: Number of orthopedic surgery graduates in Ontario per year

The majority of graduates practiced in Canada (76.2%), with the second largest being in the United States (23.3%). Full distribution can be found in (Table *5-1*).

Table 5-1: Distributions of orthopedic surgery graduates' country of current practice.

Countries	Number of surgeons	Percent
Bahamas	1	0.2
Canada	471	76.2
New Zealand	1	0.2
United Kingdom	1	0.2
United States	144	23.3
Total	618	100

Due to the low number of countries represented outside the United States, the data was simplified to "Canada" and "Not Canada" for analyses. There was ***not*** an effect of time on the distribution (B=-0.02 SE=0.01 p=0.13). NB: SE represents standard error. There ***is*** an effect of school ($\chi 2(5)=15.2$ p=0.01). This appears to be driven by graduates from the University of Ottawa having a standard residual of 2.5 in the Not Canada group (Table 5-2). This implies there are more graduates ***not*** in Canada than expected for Ottawa graduates. Due to a count of less than 5 for NOSM in "not Canada", this analysis was repeated without NOSM. Results did not change, as such data is represented with NOSM for completeness.

Table 5-2: $\chi 2$ analysis of school distribution of Canada and Not Canada. Std.R represents the standard residual.

School		Not Canada	Canada	Total
McMaster	Count	15	81	96
	Std.R	-1.6	0.9	
NOSM	Count	2	5	7
	Std.R	0.3	-0.1	
Ottawa	Count	40	74	114
	Std.R	**2.5**	-1.4	
Queens	Count	19	45	64
	Std.R	1.0	-0.5	
UofT	Count	51	174	225
	Std.R	-0.3	0.2	
Western	Count	20	92	112
	Std.R	-1.3	0.7	
Total	Count	147	471	618

Analysis of Canadian practicing surgeons

When looking at the 471 graduates practicing in Canada, 387 (82.2%) were in Ontario, with the 2nd largest province being British Columbia (7.9%) (Table 5-3). Provinces with less than 5 were grouped as "other" for subsequent analysis. These were Manitoba, Newfoundland and Labrador, Prince Edward Island, Saskatchewan, and Yukon.

Table 5-3: Province distributions of graduates practicing in Canada.

Provinces	Number of graduates	Percent
Ontario	387	82.2
British Columbia	37	7.9
Alberta	15	3.2
Quebec	7	1.5
New Brunswick	6	1.3
Nova Scotia	6	1.3
Manitoba	4	0.8
Newfoundland and Labrador	3	0.6
Saskatchewan	3	0.6
Prince Edward Island	2	0.4
Yukon	1	0.2
Total	471	100

Due to low sample sizes we grouped the provinces into "Ontario, BC (British Columbia), and Other". This analysis was run without NOSM as they had <5 cell count. There was an effect of school $\chi 2(8)=19$, $p=0.015$. with UofT being less likely to be in the "other" category (Table 5-4). Analysis was run without NOSM and did not change the results for the other schools. There was no effect of year of graduation on province of practice ($F(6,464)=112.78$, $p=0.08$).

Table 5-4. $\chi 2$ analysis of school of graduation and province of practice with provinces grouped as other if cell less than 5. NB Std.R represents standard residual.

		McMaster	Ottawa	Queens	UofT	Western	Total
Other	Count	8	11	8	8	10	45
	Std. Res	0.1	1.4	1.8	-2.1	0.4	
BC	Count	4	6	5	9	12	36
	Std. Res	-0.9	0.1	0.8	-1.2	1.8	
Ontario	Count	69	57	32	157	70	385
	Std. Res	0.3	-0.5	-0.8	1.1	-0.7	
Total	Count	81	74	45	174	92	466

Analysis of surgeons practicing in the United States

Of the 147 surgeons practicing in the United States, the two most common states were California and New York (10.2%), followed by Texas (6.1%). States with less than 5 surgeons were grouped as "other" (Table 5-5). The distribution was too small per state in order to do meaningful inferential statistics, as such only descriptive statistics are shown.

Table 5-5: Distribution of US based Ontario orthopaedic surgery graduates.

State	Number of surgeons	Percent
California	15	10.2
New York	15	10.2
Texas	9	6.1
Florida	8	5.4
Illinois	8	5.4
Ohio	8	5.4
Michigan	7	4.8
Washington	7	4.8
Massachusetts	6	4.1
Pennsylvania	6	4.1
Arizona	5	3.4
Other	53	36.1
Total	147	100

Survey analysis

Detailed breakdown of survey responses can be found in chapter 4. But in summary, there were 235 total responses, with 224 complete responses (Table 5-6).

Table 5-6: Survey response rates. Table reproduced from Chapter 4.

Country	Number of graduates	Completed e-mail survey	Partially completed e-mail survey	Completed physical mail survey	Total responses (partial and complete)	Total complete responses	Percent response rate (fully completed)
Canada	471	111	8	70	190	181	38.64
United States	144	27	3	16	46	43	29.86
Other	3	0	0	0	0		0
Total	618	138	11	86	235	224	36.25

Motivations for immigration

Surgeons who were practicing in the United States were asked 5 questions regarding their motivations for immigrating. These were graded on a 7-point Likert scale ranging from strongly disagree (1) to strongly agree (7). The first two questions asked about lack of opportunities in the type of practice (community vs academic), or location type (urban vs rural). The third question stated lack of opportunities in their subspecialty. Fourth was better income opportunities than in Canada. Factor analysis was performed on these items.

Analysis of motivations

Factor analysis showed 2 factors with Eigen values greater than 1.

Factor 1 had the items "lack of opportunities in the type of practice (academic vs community), lack of opportunities in the type of location (urban vs rural), and "lack of opportunities in the subspecialty I wanted". These fit the theme of lack of employment opportunities. Factor 2 had items "Better income opportunities than in Canada" and "better practice type opportunities". These fit the theme of extrinsic motivators.

There was a significant relationship between year of graduation and immigrating to the United states out of **necessity** ($F_{1,41}=19.20$, $p=0.006$, with more recent graduates more likely to emigrate out of necessity. $B=0.09$, $SE=0.03$ $\beta=0.42$. However, this was a weak association $R^2=0.18$ with the model only predicting 18% of the variability. Year of graduation did not predict emigration to the US for extrinsic motivations. $B=-0.01$ $SE=0.04$, $\beta=-0.06$ $p=0.72$.

A mixed methods ANOVA was performed comparing school of graduation (between subject) and emigration out of necessity (within subject). There was a main effect $F(4,37)=3.34$ $p=0.02$. However, with post hoc analysis after Bonferroni correction the difference between UofT and Western approached, but did not meet, conventional levels of significance ($p=0.06$) (Figure 5-2)

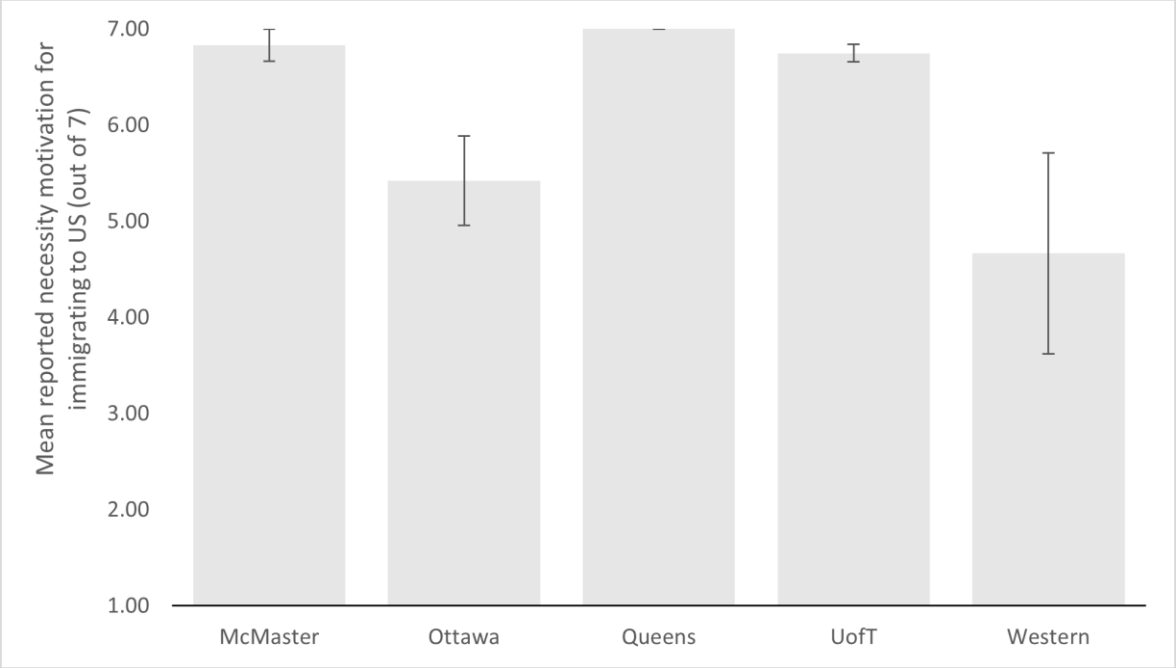

Figure 5-2: Mean reported motivation being necessity for immigration to US (out of 7) (Y axis). School of graduation (x axis).

There was no effect of school of graduation on immigration based on extrinsic factors $F(4,37)=0.40$ $p=0.81$

Analysis of practice type

The majority of respondents described themselves as a community subspecialist (46.8%), with the second most common being academic subspecialist (35.7%) (Table *5-7*). We performed a binary regression analysis. Year of residency graduation did not predict likelihood of community subspecialist vs generalist B=-0.03 SE 0.03 p=0.26. Year of graduation does not predict academic vs community B=-0.01 SE=0.02 p=0.65. School of graduation did not predict academic vs community ($\chi2(5)=2.59$ $p=0.76$) or community generalist vs subspecialist ($\chi2(5)=9.75$ $p=0.08$).

Table 5-7: Distribution of practice types

Type of practice	Number of responses	Percent
Community subspecialist	110	46.8
Academic subspecialist	84	35.7
Community generalist	29	12.3
No response	9	3.8
Academic and community subspecialist	1	0.4
Academic generalist	1	0.4
Academic subspecialist, community generalist	1	0.4
Total	235	100.0

Resources available

The mean for average OR days in a week was 1.75, with a median and mode of 2. Mean of reported clinic days in an average week was 1.99, with a median and mode of 2 (Table *5-8*).

Table 5-8: Distribution of the average number of days of OR and clinic in a week

	Average number of OR days per week	Average number of clinic days per week
Responses	228	227
No response	7	8
Mean	1.75	1.99
Median	2.00	2.00
Mode	2.00	2.00

The average number of days per week from respondents in Canada and the USA are shown in *Table 5-9*. Graduates from Canada have **less** OR days than those in the US (1.65 vs 2.17), B=-0.52 SE 0.12 β=-0.28 p<0.001, with no effect of year of graduation (B=-0.01 SE=0.01 β=-0.05 p=0.43) and no interaction between country and year of graduation (B=0.01, SE=0.02, β=0.04, p=0.50). Graduates from Canada have **less** Clinic days than those in the USA, B=-0.55 SE 0.12 β =-0.25 p<0.001, with no effect of year of graduation (B=0 SE=0.01 β =-0.00 p=0.96) and no interaction between country and graduate year (B=0.01, SE=0.02, β =0.04, p=0.58).

Table 5-9: Average number of (operating room) OR days, and clinic days reported by participants practicing in Canada or the United States (USA)

	Country	Mean	Median	Number of responses
Average number of clinic days in a week	USA	2.44	3.00	43
	Canada	1.88	2.00	184
Average number of OR days in a week	USA	2.17	2.00	43
	Canada	1.65	2.00	185

For those who are practicing in Ontario, how far from their residency school of graduation were they working?

The postal code for each school was found on their public website (Appendix C: School postal codes).

Of the 387 surgeons with an Ontario practice, 157 (40.6%) were from UofT, followed by 70 (18.1%) from Western (Table 5-10).

Table 5-10: Distributions of orthopedic surgeons' graduation from Ontario programs currently practicing in Ontario.

School of residency graduation	Number of surgeons	Percent
UofT	157	40.6
Western	70	18.1
McMaster	69	17.8
Ottawa	57	14.7
Queens	32	8.3
NOSM	2	0.5
Total	387	100.0

Table 5-11 shows the mean, median, and mode of distance from school of graduation of surgeons practicing in Ontario.

Table 5-11: Distance of current practice (km) from school of graduation

	Mean	Median	Mode
UofT	59.88	20.17	1.26
McMaster	94.56	43.22	4.08
Western	139.54	99.73	3.43
Ottawa	194.60	118.88	3.86
Queens	211.82	209.96	1.28
NOSM	497.52	497.52	335.16

We assessed the data for normality using the Shapiro-Wilk test for normality. $W(385)=0.68$, $p<0.001$, which demonstrates that the data is *not* normally distributed. There was an effect of school on distance of practice from school of graduation $H(5)=44.56$, $p<0.001$ (Figure 5-3). Due to the sample size of NOSM, the analysis was repeated with NOSM excluded and remained the same. As such, we are presenting data with NOSM included.

NOSM graduates had the highest average distance from school (498km). They were significantly further than McMaster, UofT, and Western graduates. Second highest was Queens. Queens graduates practiced farther than McMaster, UofT, and Western graduates. Third highest was Ottawa, with their graduates practicing farther than McMaster, and UofT. Fourth highest was Western, with graduates practice distance compared to their residency location being higher than UofT, and closer than NOSM. Fifth highest was McMaster, with their graduates practicing closer than NOSM, Ottawa, and Western. Figure 5-3 is a visual representation of the findings.

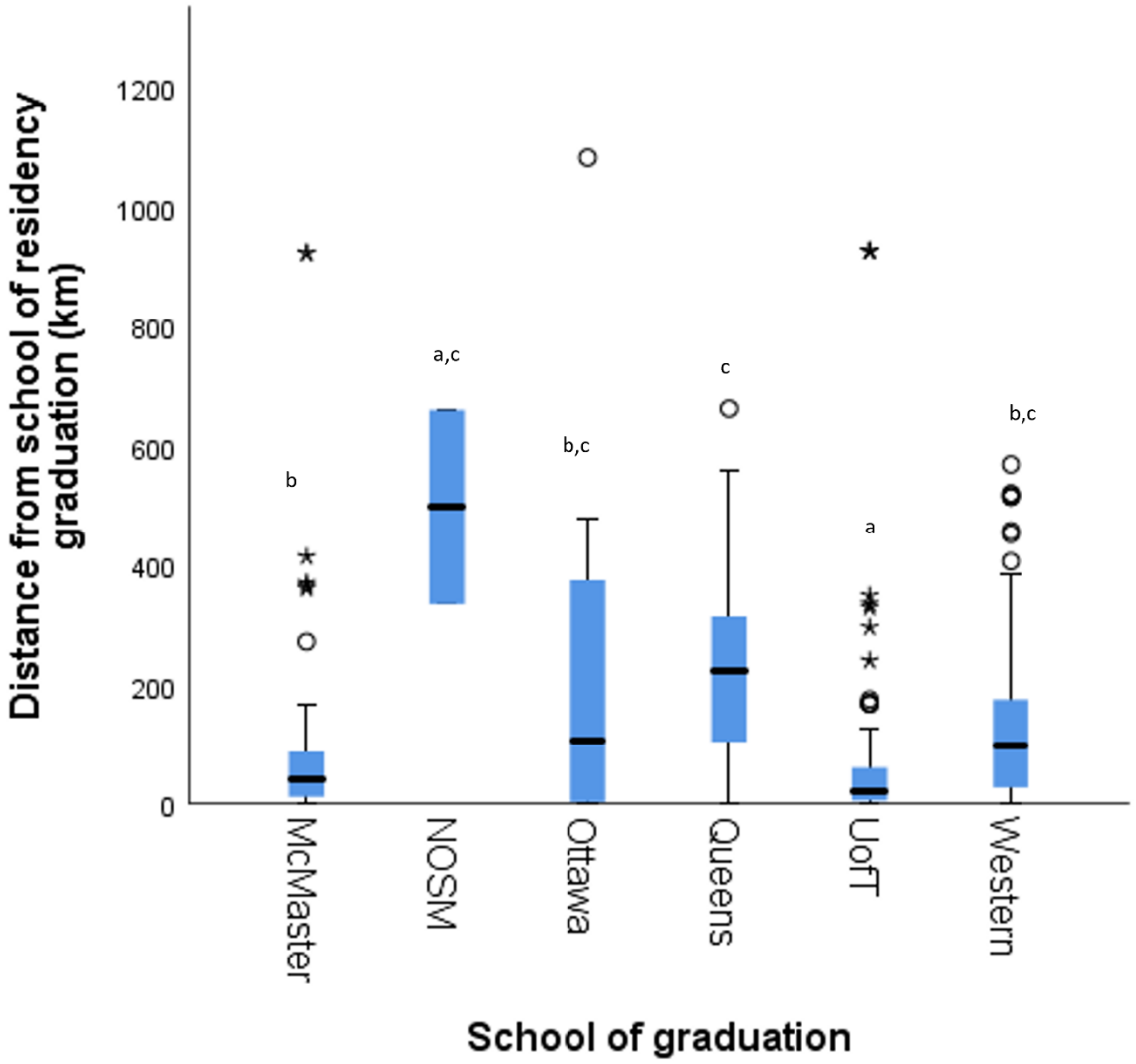

Figure 5-3: Mean difference of practice location in Ontario from school of graduation (km). Error bars represent 95% confidence interval. NB: schools sharing similar letter above the graph are NOT significantly different from each other. p>0.05 after Bonferroni correction. Ie. McMaster, Ottawa and Western are NOT different (they all share the letter b). NOSM, Ottawa, and Queens are NOT different (they share the letter c).

Figure 5-4 is a frequency distribution of distance from school of graduation. NOSM and distances >600km were excluded due to low sample sizes. Graduates from Ottawa appear to cluster around a distance of 400km as a second distribution.

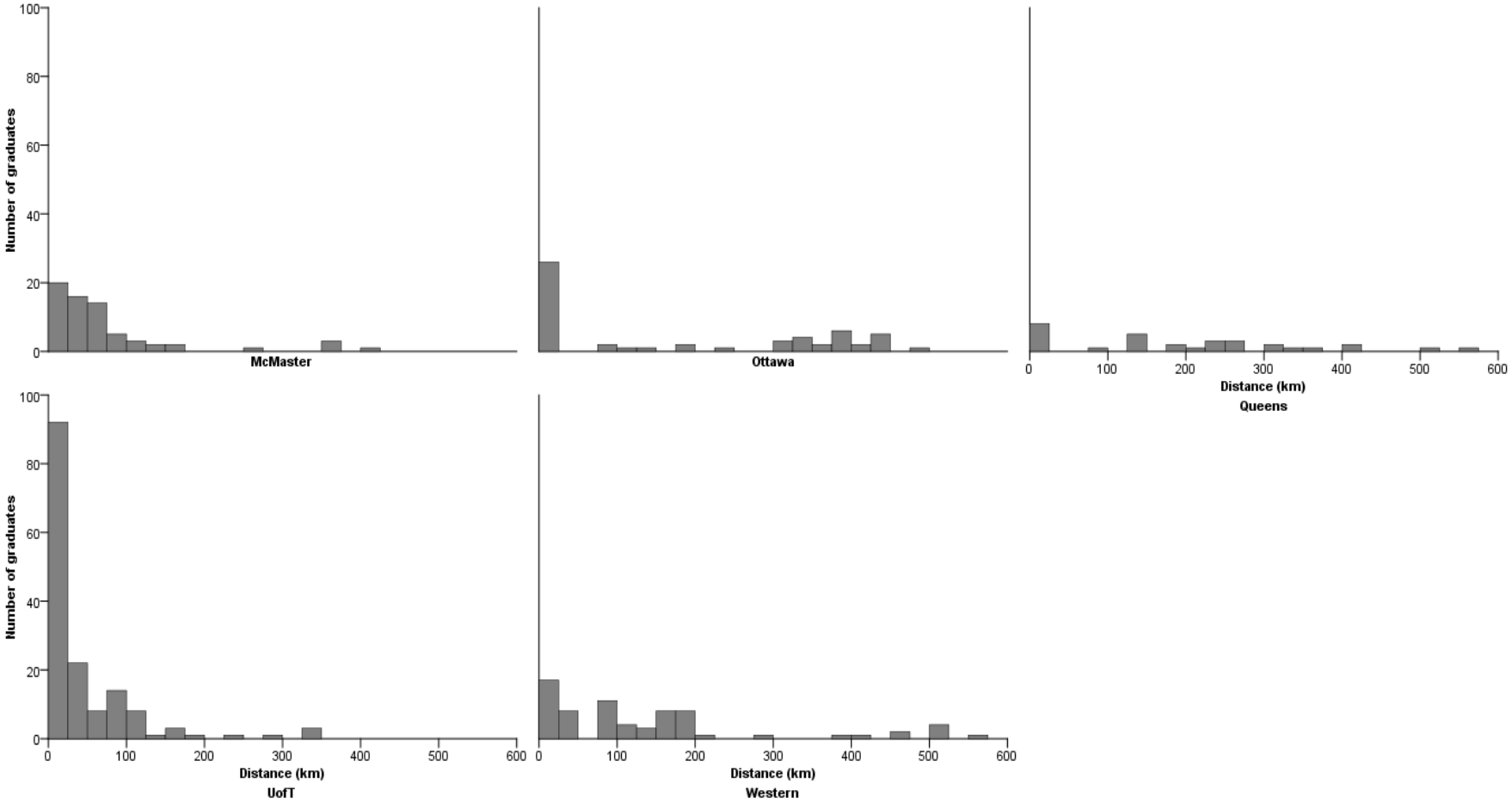

Figure 5-4: Histogram of distance of current practice from school of graduation. per school.

There is an effect of school $\chi 2(5)=45.9$, $p<0.05$. UofT has a higher-than-expected number of graduates working less than 50km from the institution. While, Queens and Western have a higher-than-expected number of graduates working *more* than 50km. We chose 50km as a rough proxy for those working within the same academic institution of where they graduated.
When filtering out distances less than 50km there is an effect of school ($F(5,172)=5.15$, $p<0.05$), graduates from Ottawa have the highest mean (353) distance (Table 5-12).Graduates from Ottawa work on, on average, farther than graduates from McMaster, UofT, and Western ($p=0.003$, 0.002, 0.016 respectively).

Table 5-12: Distance (km) of current practice from school of graduation. Distances less than 50km filtered out.

			Mean	Median	Mode
School	Ottawa	Distance	353.10	353.77	427.10
	Queens	Distance	282.06	250.76	142.15
	Western	Distance	209.04	165.50	81.60
	UofT	Distance	180.57	93.18	93.18
	McMaster	Distance	177.42	92.71	62.62

5.7 Discussion

Emigration patterns

While the majority stay in Canada (76%), graduates from Ottawa were more likely to be outside of Canada than other schools. The number of people going to the USA has not changed with time. However, more recent graduates state they immigrate to the USA out of necessity. There was an effect of school, however post hoc analysis did not show a statistical difference. Graduates of UofT compared to Western showed the greatest difference in emigration out of necessity (UofT being higher), however p=0.06. Those in the USA have more operating room (2.17 days compared to 1.65) time and clinic time (2.44 compared to 1.88) than those in Canada. The top 3 states for emigration to the USA were California, New York, and Texas.

Practice types

The majority of respondents described themselves as a subspecialist. However, this has not changed with time, nor by school.

Those in Canada

Most graduates stay in Ontario (82.2%). However, graduates from Ottawa are more likely to practice in Alberta than those of other schools. It would not be appropriate to make conclusions of from other findings as other findings, while significant, had events less than 5 which is the minimum for a valid $\chi 2$ test.

Those in Ontario

There appears to be an effect of school of graduation on location of practice for surgeons practicing in Ontario. Graduates of UofT had the lowest distance from school of graduation, with a mean of 60km. They were also the school to have more graduates than expected to be working less than 50km from school of graduation. Queens graduates appear to be equally spread out, and Ottawa graduates either stay very close to their location of training or cluster around 400km away.

Overall discussion

There are two main takeaways from the data. Firstly, while the rate of emigration from Canada does not appear to have changed throughout the years, what has changed is the reasons behind it—more recent graduates appear to be emigrating out of necessity. While this statistically supports the notion that more recent graduates have had to leave Canada due to a lack of opportunities this must be interpreted with caution due to the low correlation in the, statistically significant, model. We may not have been able to capture an overall difference of immigration due to not being powered to do so. Our results seem to show that graduates from Ottawa are more likely to go to the United States. If they stay in Ontario, they either stay very close to their school, or they cluster approximately 400km away.

The second takeaway is that there was a paucity of self-described community generalists. As we discussed in Chapter 4, the majority of graduates are doing 1-2 fellowships. This further re-iterates the point that a critical look at the goal of residency training is required. While the supposed goal is to train surgeons ready to enter general practice, it is evident that residents do not feel ready.

5.8 Limitations

Limitations of this study are the same as that of chapter 4. A limitation in this study is the dataset and there is a small possibility that we did not capture graduates from McMaster, Queens and NOSM

5.9 Conclusion

This study demonstrates important implications for HHR planning. We have shown that more recent graduates are emigrating to the United States out of necessity, further supporting the notion of graduates not having resources in Canada. Graduates from Ottawa appear to be the most affected as they have a higher propensity to leave Canada, more likely to go to Alberta, and have the highest distance from their school if they stay in Ontario. One possibility for this finding is that there are not enough resources or population around the region of Ottawa to support the number of graduates produced. This was not the focus of this thesis and needs to be further investigated to optimize HHR planning in Ontario.

5.10 References

1. Zeng A, Brenna C, Ndoja S. Fundamental trends within falling match rates: insights from the past decade of Canadian residency matching data. *Can Med Educ J*. 2020. doi:10.36834/cmej.69289
2. Royal College of Physicians and Surgeons of Canada. Competence by Design (CBD) Cohort Roll Out Plan. website. http://www.royalcollege.ca/rcsite/documents/icre/2018-07-16-cohort-roll-out-revised-e.pdf. Published 2018. Accessed February 11, 2020.
3. Gofton WT, Dudek NL, Wood TJ, Balaa F, Hamstra SJ. The Ottawa Surgical Competency Operating Room Evaluation (O-SCORE). *Acad Med*. 2012;87(10):1401-1407. doi:10.1097/ACM.0b013e3182677805
4. Kouzmina E, Mann S, Chaplin T, Zevin B. An evaluation of the surgical foundations curriculum: a national study. *J Surg Educ*. 2021;78(3):914-926.
5. Frank JR, Snell LS, Cate O Ten, et al. Competency-based medical education: theory to practice. *Med Teach*. 2010;32(8):638-645. doi:10.3109/0142159X.2010.501190
6. Blankush JM, Shah BJ, Barnett SH, et al. What are the associations between the quantity of faculty evaluations and residents' perception of quality feedback? *Ann Med Surg*. 2017;16:40-43.
7. Richard K.Reznick HM. Changes in the wind. *N Engl J Med*. 2006;355:2664-2669. doi:10.1021/jf052913o
8. Ten Cate O. Nuts and bolts of entrustable professional activities. *J Grad Med Educ*. 2013;5(1):157-158.
9. Roediger HL, Karpicke JD, Roediger III HL, Karpicke JD. Test-enhanced learning: Taking memory tests improves long-term retention. *Psychol Sci*. 2006;17(3):249-255. doi:10.1111/j.1467-9280.2006.01693.x
10. Koh AWL, Lee SC, Lim SWH. The learning benefits of teaching: A retrieval practice hypothesis. *Appl Cogn Psychol*. 2018;32(3):401-410. doi:10.1002/acp.3410
11. Roediger HL, Butler AC. The critical role of retrieval practice in long-term retention. *Trends Cogn Sci*. 2011;15(1):20-27. doi:10.1016/j.tics.2010.09.003
12. Kromann CB, Bohnstedt C, Jensen ML, Ringsted C. The testing effect on skills learning might last 6 months. *Adv Heal Sci Educ*. 2010;15(3):395-401.
13. Ndoja S, Dion C-A, Pirshahid AA, et al. Active Retrieval Improves Procedural Learning in Orthopedic Surgery. *J Surg Educ*. 2022.
14. Fréchette D, Datta I, Jacob C, Shrichand A, Hollenberg DB. *What's Really Behind Canada's Unemployed Specialists?: Too Many, Too Few Doctors? Findings from the Royal College's Employment Study-2013*. Royal College of Physicians and Surgeons of Canada; 2014.
15. Frechette D, Shrichand A, Manogaran M, Jacob C, Dimillo S. Employment patterns of Canada's newly certified medical specialists: findings from the Royal College Employment Study. *Ottawa R Coll Physicians Surg Canada*. 2019.
16. CIHI. *Physicians in Canada, 2018*. Ottawa; 2019. doi:978-1-77109-848-9
17. OECD. Doctors (indicator). doi:10.1787/4355e1ec-en
18. Clement ND, Wickramasinghe NR, Bayram JM, et al. Significant deterioration in quality of life and increased frailty in patients waiting more than six months for total hip or knee arthroplasty. *Bone Joint J*. 2022;104-B(11):1215-1224. doi:10.1302/0301-620X.104B11.BJJ-2022-0470.R2
19. Health Quality Ontario. Measuring wait times. King's Printer. https://www.ontariohealth.ca/public-reporting/wait-times. Published 2022. Accessed

December 6, 2022.
20. Ontario G of. *2013 Annual Report*.; 2013. https://www.auditor.on.ca/en/content/annualreports/arreports/en13/2013ar_en_web.pdf.
21. Tang B, Zhou LL, Koushan K. Physician workforce planning in Ontario must move from short-term reactivity to long-term proactivity. *Can Med Educ J*. 2018;9(2):e84-e88.
22. Markovic S, Ndoja S, Zhong A, et al. *Physician Services Planning and The Unmatched Medical Graduate*. Toronto Ontario; 2019. https://omsa.ca/sites/default/files/page/12/lobby_day_2019_-_backgrounder.pdf.
23. Shipton D, Badley EM, Mahomed NN. Critical Shortage of Orthopaedic Services in Ontario, Canada. *JBJS*. 2003;85(9). https://journals.lww.com/jbjsjournal/Fulltext/2003/09000/Critical_Shortage_of_Orthopaedic_Services_in.9.aspx.
24. Chan B, Anderson GM, Theriault M-E. Patterns of practice among older physicians in Ontario. *CMAJ*. 1998;159(9):1101-1106.
25. Government of Ontario. Ontario population projections. King's Printer. https://www.ontario.ca/page/ontario-population-projections. Published 2021. Accessed December 6, 2022.
26. Ludwig J, Jakobsen RB, Charles YP, et al. What it takes to become an orthopaedic surgeon: A comparison of orthopaedic surgical training programmes in 10 countries focusing on structure and fellowship requirements. *Int J Surg*. 2021;95:106150.
27. Holmboe ES, Sherbino J, Long DM, Swing SR, Frank JR. The role of assessment in competency-based medical education. *Med Teach*. 2010;32(8):676-682. doi:10.3109/0142159X.2010.500704
28. Frank JR, Snell L, Englander R, Holmboe ES, Collaborators I. Implementing competency-based medical education: moving forward. *Med Teach*. 2017;39(6):568-573.
29. Daniels AH, DiGiovanni CW. Is subspecialty fellowship training emerging as a necessary component of contemporary orthopaedic surgery education? *J Grad Med Educ*. 2014;6(2):218-221.
30. Hariri S, York SC, O'Connor MI, Parsley BS, McCarthy JC. Career plans of current orthopaedic residents with a focus on sex-based and generational differences. *JBJS*. 2011;93(5):e16.
31. Herndon JH. Orthopaedic surgery fellowships: a ten-year assessment. Subspecialty training during residency and the ideal academic fellowship. *J Bone Joint Surg Am*. 1998;80(12):1836-1838.
32. Theelen L, Bischoff C, Grimm B, Heyligers IC. Current practice of orthopaedic surgical skills training raises performance of supervised residents in total knee arthroplasty to levels equal to those of orthopaedic surgeons. *Perspect Med Educ*. 2018;7:126-132.
33. Mitchell PM, Gavrilova SA, Dodd AC, Attum B, Obremskey WT, Sethi MK. The impact of resident involvement on outcomes in orthopedic trauma: An analysis of 20,090 cases. *J Clin Orthop Trauma*. 2016;7(4):229-233.
34. Giordano L, Oliviero A, Peretti GM, Maffulli N. The presence of residents during orthopedic operation exerts no negative influence on outcome. *Br Med Bull*. 2019;130(1):65-80.
35. Nousiainen MT, Latter DA, Backstein D, Webster F, Harris KA. Surgical fellowship training in Canada: what is its current status and is improvement required? *Can J Surg*. 2012;55(1):58-65. doi:10.1503/cjs.043809
36. Chowdhury MM, Dagash H, Pierro A. A systematic review of the impact of volume of surgery and specialization on patient outcome. *Br J Surg*. 2007;94(2):145-161.

doi:10.1002/bjs.5714
37. Shervin N, Rubash HE, Katz JN. Orthopaedic procedure volume and patient outcomes: a systematic literature review. *Clin Orthop Relat Res*. 2007;457:35-41.
38. Cooper RR. Impact of fellowships on orthopaedic surgery residencies, patient care, and orthopaedic practice. Part I. *J Bone Joint Surg Am*. 1998;80(12):1829-1830.
39. Mead M, Atkinson T, Srivastava A, Walter N. The Return on Investment of Orthopaedic Fellowship Training: A Ten-year Update. *JAAOS - J Am Acad Orthop Surg*. 2020;28(12). https://journals.lww.com/jaaos/Fulltext/2020/06150/The_Return_on_Investment_of_Orthopaedic_Fellowship.10.aspx.
40. Almansoori KA, Clark M. Increasing trends in orthopedic fellowships are not due to inadequate residency training. *Educ Res Int*. 2015;2015.
41. Ontario C of P and S of. No Title. https://doctors.cpso.on.ca/. Accessed July 20, 2023.
42. IBM. SPSS Statistics for Windows. 2017.
43. DePasse JM, Daniels AH, Durand W, Kingrey B, Prodromo J, Mulcahey MK. Completion of Multiple Fellowships by Orthopedic Surgeons: Analysis of the American Board of Orthopaedic Surgery Certification Database. *Orthopedics*. 2018;41(1):e33-e37. doi:10.3928/01477447-20171106-05
44. Friedell ML, VanderMeer TJ, Cheatham ML, et al. Perceptions of graduating general surgery chief residents: are they confident in their training? *J Am Coll Surg*. 2014;218(4):695-703.
45. Badley EM, Canizares M, Mahomed N, Veinot P, Davis AM. Provision of Orthopaedic Workforce and Implications for Access to Orthopaedic Services in Ontario. *JBJS*. 2011;93(9). https://journals.lww.com/jbjsjournal/Fulltext/2011/05040/Provision_of_Orthopaedic_Workforce_and.8.aspx.
46. Salsberg ES, Grover A, Simon MA, Frick SL, Kuremsky MA, Goodman DC. An AOA critical issue: Future physician workforce requirements: Implications for orthopaedic surgery education. *J Bone Jt Surgery Am Vol*. 2008;90(5):1143.
47. Comeau P. Crisis in orthopedic care: surgeon and resource shortage. *CMAJ*. 2004;171(3):223.
48. Rullán PJ, Deren ME, Zhou G, et al. The Arthroplasty Surgeon Growth Indicator: A Tool for Monitoring Supply and Demand Trends in the Orthopaedic Surgeon Workforce from 2020 to 2050. *JBJS*. 2023;105(13). https://journals.lww.com/jbjsjournal/Fulltext/2023/07050/The_Arthroplasty_Surgeon_Growth_Indicator__A_Tool.9.aspx.
49. Sielatycki JA, Sawyer JR, Mir HR. Supply and Demand Analysis of the Orthopaedic Trauma Surgeon Workforce in the United States. *J Orthop Trauma*. 2016;30(5). https://journals.lww.com/jorthotrauma/Fulltext/2016/05000/Supply_and_Demand_Analysis_of_the_Orthopaedic.12.aspx.
50. Horst PK, Choo K, Bharucha N, Vail TP. Graduates of Orthopaedic Residency Training Are Increasingly Subspecialized: A Review of the American Board of Orthopaedic Surgery Part II Database. *JBJS*. 2015;97(10). https://journals.lww.com/jbjsjournal/Fulltext/2015/05200/Graduates_of_Orthopaedic_Residency_Training_Are.14.aspx.
51. Manser R. US and Canada GeoCoordinates. US and Canada GeoCoordinates. https://www.serviceobjects.com/blog/free-zip-code-and-postal-code-database-with-geocoordinates/. Published 2020. Accessed July 16, 2023.
52. Marsh JL. Avoiding burnout in an orthopaedic trauma practice. *J Orthop Trauma*.

2012;26:S34-S36.
53. Simons BS, Foltz PA, Chalupa RL, Hylden CM, Dowd TC, Johnson AE. Burnout in US military orthopaedic residents and staff physicians. *Mil Med*. 2016;181(8):835-839.
54. Foran IM. A Perspective on the Effect of the 80-hour Work Week: Has it Changed the Graduating Orthopaedic Resident? *J Am Acad Orthop Surg*. 2020;28(10):e418-e419.
55. Hui RWH, Leung KC, Ge S, et al. Burnout in orthopaedic surgeons: A systematic review. *J Clin Orthop Trauma*. 2019;10:S47-S52. doi:https://doi.org/10.1016/j.jcot.2019.01.028
56. Kakiashvili T, Leszek J, Rutkowski K. The medical perspective on burnout. *Int J Occup Med Environ Health*. 2013;26:401-412.
57. Shanafelt TD, Bradley KA, Wipf JE, Back AL. Burnout and self-reported patient care in an internal medicine residency program. *Ann Intern Med*. 2002;136(5):358-367.
58. West CP, Huschka MM, Novotny PJ, et al. Association of perceived medical errors with resident distress and empathy: a prospective longitudinal study. *Jama*. 2006;296(9):1071-1078.
59. Kwah J, Weintraub J, Fallar R, Ripp J. The effect of burnout on medical errors and professionalism in first-year internal medicine residents. *J Grad Med Educ*. 2016;8(4):597-600.
60. Campbell Jr DA, Sonnad SS, Eckhauser FE, Campbell KK, Greenfield LJ. Burnout among American surgeons. *Surgery*. 2001;130(4):696-705.
61. Torp S, Grimsmo A, Hagen S, Duran A, Gudbergsson SB. Work engagement: a practical measure for workplace health promotion? *Health Promot Int*. 2013;28(3):387-396.
62. Schaufeli WB, Salanova M, González-Romá V, Bakker AB. The measurement of engagement and burnout: A two sample confirmatory factor analytic approach. *J Happiness Stud*. 2002;3:71-92.
63. Schaufeli WB, Bakker AB, Salanova M. Utrecht work engagement scale-9. *Educ Psychol Meas*. 2003.
64. Schaufeli WB, Bakker AB, Salanova M. The measurement of work engagement with a short questionnaire: A cross-national study. *Educ Psychol Meas*. 2006;66(4):701-716.
65. Hernández Vargas CI, Llorens Gumbau S, Rodríguez Sánchez AM, Dickinson Bannack ME. Validation of the UWES-9 Scale in Mexican Health Professionals. *Pensam Psicológico*. 2016;14(2):89-100.
66. Arora M, Diwan AD, Harris IA. Burnout in orthopaedic surgeons: a review. *ANZ J Surg*. 2013;83(7-8):512-515.

Chapter 6 : How engaged are orthopaedic surgeons in their work?

The previous chapters looked at understanding orthopedic surgeons' clinical practice: location, subspecialty, as well as how busy surgeons are. These are objective measures of their career decisions and give us insight as to how our graduates are doing once they finish their training. This chapter adds to the previous work by asking: how engaged are surgeons in their work?

6.1 Abstract

There has been considerable discussion in the medical literature around burnout. Burnout has been shown to correlate with negative patient outcomes, and negative patient care. There is an emerging interest in the idea of workplace engagement, looking at factors that make individuals thrive in their workplace. The most common engagement scale is the Utrecht Work Engagement Scale (UWES-9), a 9 item well validated 7 item Likert scale. We sought to see if there was an influence of year of graduation, number of fellowships, or country of practice, on orthopedic surgery graduates.

Results: 235 surgeons responded (36%) with 224 full responses. The average response on the scale was 4, corresponding to "often". There was no influence of country of practice, school of graduation, year of graduation, number of fellowships, or gender on the UWES score.

Discussion and conclusion: Surgeons in our study appear to be satisfied and engaged in their work. We were unable to identify a predictive factor for UWES. Overall it appears that despite challenges in the field, orthopedic surgeons appear to be satisfied with their current work.

6.2 Introduction

Orthopaedic surgery can be a gruelling specialty. There are significant physical and psychological demands required by the surgeon[52]. Orthopaedic surgery residency and practice, requires long hours and are notoriously difficult[53,54]. Due to all this, there is an emergence of interest in burnout among orthopaedic surgeons[55]. Burnout is defined as a "state of vital exhaustion" and "low sense of personal accomplishment [56]. Physician burnout has been shown to negatively affect patient care, with physicians scoring higher on burnout scales performing more medical errors[57–59]. Burnout has also been associated with lower career satisfaction[60], with early career surgeons being more susceptible to burnout.

The burnout literature focuses on the negative aspects of an individual's state of mind and performance. There is an emerging focus on *workplace engagement* as the antithesis of burnout[61]. Workplace engagement literature focuses on how individuals can succeed and flourish in their

workplace. Engagement has been defined as "a positive work-related state of mind characterized by vigor, dedication and absorption"[62].

> "Vigor is characterized by high levels of energy and mental resilience while working, the willingness to invest effort in one's work, and persistence even in the face of difficulties. Dedication is characterized by a sense of significance, enthusiasm, inspiration, pride, and challenge. […] The final dimension of engagement, absorption, is characterized by being fully concentrated and deeply engrossed in one's work, such time passes quickly and one has difficulties in detaching oneself from work" [62], p. 74–75

The most common measurement tool for measuring engagement is the Utrecht Work Engagement Scale -9 which has shown high internal consistency and validity(UWES-9)[63,64] and has been validated in healthcare professionals[65]. Engaged physicians report fewer medical errors (Prins et al., 2009) and perform better clinically (Scheepers, Boerebach, Arah, Heineman, & Lombarts, 2015). The UWES-9 is a short 9 question self-reported scale capturing the 3 factors of engagement. The reports ranging from "never" to "always" of individual's attitude to their work[63] (Appendix A: Survey). To our knowledge workplace engagement has not been assessed in an orthopaedic surgery context.

6.3 Study rationale

The purpose of this study was to assess how engaged orthopedic surgeons are in their work. Has this changed over time? Is there an effect of fellowship, location, or where they did their training.

6.4 Hypothesis

We hypothesize that more recent graduates, those who have done more fellowships, and those in the USA are less engaged in their work and will score lower on the UWES-9.

6.5 Methods

These were fully discussed in previously chapters.

Orthopaedic surgery graduates from 1992 to 2020 out of Ontario residency programs were surveyed. Residents with foreign funding were excluded as they are attached to a return of service and motivations for fellowship choices are different than those not with a return of service.

Ontario residency programs were limited to: University of Ottawa, Queen's University, University of Toronto, Northern Ontario School of Medicine, McMaster University, and Western University.

Where possible the survey was distributed electronically with 1 reminder 1 week after, and a second reminder 1 month after distribution. A paper copy of the survey was sent through physical mail with return postage to the surgeon's office address.

This study was approved by our institutional ethics review board.

6.6 Survey

Demographics data was collected from publicly available sources. These included the College of Physicians and Surgeons of Ontario (CPSO) for surgeons practicing in Ontario, and the relevant regulatory body where each surgeon was practicing. The data collected were: gender, school of graduation, year of graduation, and practice address.

The UWES-9 was distributed as part of the survey. The 9 questions of the UWES were: 1. At my work, I feel bursting with energy, 2. At my job, I feel strong and vigorous, 3. I am enthusiastic about my job, 4. My job inspires me, 5.When I get up in the morning, I feel like going to work, 6. I feel happy when I am working intensely, 7. I am proud of the work that I do, 8. I am immersed in my work, 9. I get carried away when I'm working.

While compiling the survey there was a human error in that the survey options were inputted out of 6 instead of 7. The option of "almost never" was inadvertently omitted. However, given that the literature averages the UWES scores, and we are comparing to other data collected in the same participant pool, the decision was made to proceed with the analysis. All data was analyzed using SPSS[42].

6.7 Results

There were 235 partial respondents and 224 complete responses to the survey. *Table 6-1* breaks down respondents by country. Full descriptive statistics of the survey can be found in Chapter 4.

Table 6-1: Survey response rates. Table reproduced from Chapter 4.

Country	Number of graduates	Completed e-mail survey	Partially completed e-mail survey	Completed physical mail survey	Total responses (partial and complete)	Total complete responses	Percent response rate (fully completed)
Canada	471	111	8	70	190	181	38.64
United States	144	27	3	16	46	43	29.86
Other	3	0	0	0	0		0
Total	618	138	11	86	235	224	36.25

The average UWES-9 response is 4, which corresponds to "Often (once a week). Similar responses can be found in the subcategories (*Table 6-2*).

Table 6-2: Descriptive statistics of UWES responses

	UWES average	UWES_VIGOR	UWES_Dedication	UWES_Absorption
N	226	227	227	227
No response	9	8	8	8
Mean	4.19	4.02	4.16	4.37
Median	4.22	4.00	4.00	4.33
Mode	4.89	5.00	5.00	4.33

A simultaneous regression model with UWES score as the dependent, and fellowship, year of graduation, school, gender, and country did not predict UWES scores (Table 6-3).

Table 6-3 Simultaneous regression model predicting overall UWES scores.

Independent variable	Sum of Squares	df	Mean Square	F	p
UWES Average	3.91	5.00	0.78	1.13	0.34
UWES_Vigor	6.27	5.00	1.25	1.10	0.36
UWES_Dedication	8.42	5.00	1.68	1.69	0.14
UWES_Absorption	3.64	5.00	0.73	1.17	0.33

NB: Independent variables were fellowship, year of graduation, school, gender, and country.

6.8 Conclusion and Discussion

We were unable to identify any variables predicting workplace engagement. Overall, it appears that orthopaedic surgeons are engaged in their work, with the average response being "always" to items on the UWES. The literature has shown burnout rates in Orthopeadic surgeons around 50%[66]. While we did not specifically measure burnout, workplace engagement has been viewed as the opposite of burnout. Despite all the challenges facing orthopaedic surgery graduates outlined in the previous graduates, respondents appear to be decently satisfied with their career and where they ended up. We did not show an effect of time, nor number of fellowships, which is contrary to our hypothesis. Nevertheless, this is a welcoming finding and shows that orthopedic surgery is a meaningful career for those that have chosen it.

6.8 References

1. Zeng A, Brenna C, Ndoja S. Fundamental trends within falling match rates: insights from the past decade of Canadian residency matching data. *Can Med Educ J*. 2020. doi:10.36834/cmej.69289
2. Royal College of Physicians and Surgeons of Canada. Competence by Design (CBD) Cohort Roll Out Plan. website. http://www.royalcollege.ca/rcsite/documents/icre/2018-07-16-cohort-roll-out-revised-e.pdf. Published 2018. Accessed February 11, 2020.
3. Gofton WT, Dudek NL, Wood TJ, Balaa F, Hamstra SJ. The Ottawa Surgical Competency Operating Room Evaluation (O-SCORE). *Acad Med*. 2012;87(10):1401-1407. doi:10.1097/ACM.0b013e3182677805
4. Kouzmina E, Mann S, Chaplin T, Zevin B. An evaluation of the surgical foundations curriculum: a national study. *J Surg Educ*. 2021;78(3):914-926.
5. Frank JR, Snell LS, Cate O Ten, et al. Competency-based medical education: theory to practice. *Med Teach*. 2010;32(8):638-645. doi:10.3109/0142159X.2010.501190
6. Blankush JM, Shah BJ, Barnett SH, et al. What are the associations between the quantity of faculty evaluations and residents' perception of quality feedback? *Ann Med Surg*. 2017;16:40-43.
7. Richard K.Reznick HM. Changes in the wind. *N Engl J Med*. 2006;355:2664-2669. doi:10.1021/jf052913o
8. Ten Cate O. Nuts and bolts of entrustable professional activities. *J Grad Med Educ*. 2013;5(1):157-158.
9. Roediger HL, Karpicke JD, Roediger III HL, Karpicke JD. Test-enhanced learning: Taking memory tests improves long-term retention. *Psychol Sci*. 2006;17(3):249-255. doi:10.1111/j.1467-9280.2006.01693.x
10. Koh AWL, Lee SC, Lim SWH. The learning benefits of teaching: A retrieval practice hypothesis. *Appl Cogn Psychol*. 2018;32(3):401-410. doi:10.1002/acp.3410
11. Roediger HL, Butler AC. The critical role of retrieval practice in long-term retention. *Trends Cogn Sci*. 2011;15(1):20-27. doi:10.1016/j.tics.2010.09.003
12. Kromann CB, Bohnstedt C, Jensen ML, Ringsted C. The testing effect on skills learning might last 6 months. *Adv Heal Sci Educ*. 2010;15(3):395-401.
13. Ndoja S, Dion C-A, Pirshahid AA, et al. Active Retrieval Improves Procedural Learning in Orthopedic Surgery. *J Surg Educ*. 2022.
14. Fréchette D, Datta I, Jacob C, Shrichand A, Hollenberg DB. *What's Really Behind Canada's Unemployed Specialists?: Too Many, Too Few Doctors? Findings from the Royal College's Employment Study-2013*. Royal College of Physicians and Surgeons of Canada; 2014.
15. Frechette D, Shrichand A, Manogaran M, Jacob C, Dimillo S. Employment patterns of Canada's newly certified medical specialists: findings from the Royal College Employment Study. *Ottawa R*

Coll Physicians Surg Canada. 2019.

16. CIHI. *Physicians in Canada, 2018*. Ottawa; 2019. doi:978-1-77109-848-9
17. OECD. Doctors (indicator). doi:10.1787/4355e1ec-en
18. Clement ND, Wickramasinghe NR, Bayram JM, et al. Significant deterioration in quality of life and increased frailty in patients waiting more than six months for total hip or knee arthroplasty. *Bone Joint J*. 2022;104-B(11):1215-1224. doi:10.1302/0301-620X.104B11.BJJ-2022-0470.R2
19. Health Quality Ontario. Measuring wait times. King's Printer. https://www.ontariohealth.ca/public-reporting/wait-times. Published 2022. Accessed December 6, 2022.
20. Ontario G of. *2013 Annual Report*.; 2013. https://www.auditor.on.ca/en/content/annualreports/arreports/en13/2013ar_en_web.pdf.
21. Tang B, Zhou LL, Koushan K. Physician workforce planning in Ontario must move from short-term reactivity to long-term proactivity. *Can Med Educ J*. 2018;9(2):e84-e88.
22. Markovic S, Ndoja S, Zhong A, et al. *Physician Services Planning and The Unmatched Medical Graduate*. Toronto Ontario; 2019. https://omsa.ca/sites/default/files/page/12/lobby_day_2019_-_backgrounder.pdf.
23. Shipton D, Badley EM, Mahomed NN. Critical Shortage of Orthopaedic Services in Ontario, Canada. *JBJS*. 2003;85(9). https://journals.lww.com/jbjsjournal/Fulltext/2003/09000/Critical_Shortage_of_Orthopaedic_Services_in.9.aspx.
24. Chan B, Anderson GM, Theriault M-E. Patterns of practice among older physicians in Ontario. *CMAJ*. 1998;159(9):1101-1106.
25. Government of Ontario. Ontario population projections. King's Printer. https://www.ontario.ca/page/ontario-population-projections. Published 2021. Accessed December 6, 2022.
26. Ludwig J, Jakobsen RB, Charles YP, et al. What it takes to become an orthopaedic surgeon: A comparison of orthopaedic surgical training programmes in 10 countries focusing on structure and fellowship requirements. *Int J Surg*. 2021;95:106150.
27. Holmboe ES, Sherbino J, Long DM, Swing SR, Frank JR. The role of assessment in competency-based medical education. *Med Teach*. 2010;32(8):676-682. doi:10.3109/0142159X.2010.500704
28. Frank JR, Snell L, Englander R, Holmboe ES, Collaborators I. Implementing competency-based medical education: moving forward. *Med Teach*. 2017;39(6):568-573.
29. Daniels AH, DiGiovanni CW. Is subspecialty fellowship training emerging as a necessary component of contemporary orthopaedic surgery education? *J Grad Med Educ*. 2014;6(2):218-221.

30. Hariri S, York SC, O'Connor MI, Parsley BS, McCarthy JC. Career plans of current orthopaedic residents with a focus on sex-based and generational differences. *JBJS*. 2011;93(5):e16.
31. Herndon JH. Orthopaedic surgery fellowships: a ten-year assessment. Subspecialty training during residency and the ideal academic fellowship. *J Bone Joint Surg Am*. 1998;80(12):1836-1838.
32. Theelen L, Bischoff C, Grimm B, Heyligers IC. Current practice of orthopaedic surgical skills training raises performance of supervised residents in total knee arthroplasty to levels equal to those of orthopaedic surgeons. *Perspect Med Educ*. 2018;7:126-132.
33. Mitchell PM, Gavrilova SA, Dodd AC, Attum B, Obremskey WT, Sethi MK. The impact of resident involvement on outcomes in orthopedic trauma: An analysis of 20,090 cases. *J Clin Orthop Trauma*. 2016;7(4):229-233.
34. Giordano L, Oliviero A, Peretti GM, Maffulli N. The presence of residents during orthopedic operation exerts no negative influence on outcome. *Br Med Bull*. 2019;130(1):65-80.
35. Nousiainen MT, Latter DA, Backstein D, Webster F, Harris KA. Surgical fellowship training in Canada: what is its current status and is improvement required? *Can J Surg*. 2012;55(1):58-65. doi:10.1503/cjs.043809
36. Chowdhury MM, Dagash H, Pierro A. A systematic review of the impact of volume of surgery and specialization on patient outcome. *Br J Surg*. 2007;94(2):145-161. doi:10.1002/bjs.5714
37. Shervin N, Rubash HE, Katz JN. Orthopaedic procedure volume and patient outcomes: a systematic literature review. *Clin Orthop Relat Res*. 2007;457:35-41.
38. Cooper RR. Impact of fellowships on orthopaedic surgery residencies, patient care, and orthopaedic practice. Part I. *J Bone Joint Surg Am*. 1998;80(12):1829-1830.
39. Mead M, Atkinson T, Srivastava A, Walter N. The Return on Investment of Orthopaedic Fellowship Training: A Ten-year Update. *JAAOS - J Am Acad Orthop Surg*. 2020;28(12). https://journals.lww.com/jaaos/Fulltext/2020/06150/The_Return_on_Investment_of_Orthopaedic_Fellowship.10.aspx.
40. Almansoori KA, Clark M. Increasing trends in orthopedic fellowships are not due to inadequate residency training. *Educ Res Int*. 2015;2015.
41. Ontario C of P and S of. No Title. https://doctors.cpso.on.ca/. Accessed July 20, 2023.
42. IBM. SPSS Statistics for Windows. 2017.
43. DePasse JM, Daniels AH, Durand W, Kingrey B, Prodromo J, Mulcahey MK. Completion of Multiple Fellowships by Orthopedic Surgeons: Analysis of the American Board of Orthopaedic Surgery Certification Database. *Orthopedics*. 2018;41(1):e33-e37. doi:10.3928/01477447-20171106-05
44. Friedell ML, VanderMeer TJ, Cheatham ML, et al. Perceptions of graduating general surgery chief residents: are they confident in their training? *J Am Coll Surg*. 2014;218(4):695-703.

45. Badley EM, Canizares M, Mahomed N, Veinot P, Davis AM. Provision of Orthopaedic Workforce and Implications for Access to Orthopaedic Services in Ontario. *JBJS*. 2011;93(9). https://journals.lww.com/jbjsjournal/Fulltext/2011/05040/Provision_of_Orthopaedic_Workforce_and.8.aspx.
46. Salsberg ES, Grover A, Simon MA, Frick SL, Kuremsky MA, Goodman DC. An AOA critical issue: Future physician workforce requirements: Implications for orthopaedic surgery education. *J Bone Jt Surgery Am Vol*. 2008;90(5):1143.
47. Comeau P. Crisis in orthopedic care: surgeon and resource shortage. *CMAJ*. 2004;171(3):223.
48. Rullán PJ, Deren ME, Zhou G, et al. The Arthroplasty Surgeon Growth Indicator: A Tool for Monitoring Supply and Demand Trends in the Orthopaedic Surgeon Workforce from 2020 to 2050. *JBJS*. 2023;105(13). https://journals.lww.com/jbjsjournal/Fulltext/2023/07050/The_Arthroplasty_Surgeon_Growth_Indicator__A_Tool.9.aspx.
49. Sielatycki JA, Sawyer JR, Mir HR. Supply and Demand Analysis of the Orthopaedic Trauma Surgeon Workforce in the United States. *J Orthop Trauma*. 2016;30(5). https://journals.lww.com/jorthotrauma/Fulltext/2016/05000/Supply_and_Demand_Analysis_of_the_Orthopaedic.12.aspx.
50. Horst PK, Choo K, Bharucha N, Vail TP. Graduates of Orthopaedic Residency Training Are Increasingly Subspecialized: A Review of the American Board of Orthopaedic Surgery Part II Database. *JBJS*. 2015;97(10). https://journals.lww.com/jbjsjournal/Fulltext/2015/05200/Graduates_of_Orthopaedic_Residency_Training_Are.14.aspx.
51. Manser R. US and Canada GeoCoordinates. US and Canada GeoCoordinates. https://www.serviceobjects.com/blog/free-zip-code-and-postal-code-database-with-geocoordinates/. Published 2020. Accessed July 16, 2023.
52. Marsh JL. Avoiding burnout in an orthopaedic trauma practice. *J Orthop Trauma*. 2012;26:S34-S36.
53. Simons BS, Foltz PA, Chalupa RL, Hylden CM, Dowd TC, Johnson AE. Burnout in US military orthopaedic residents and staff physicians. *Mil Med*. 2016;181(8):835-839.
54. Foran IM. A Perspective on the Effect of the 80-hour Work Week: Has it Changed the Graduating Orthopaedic Resident? *J Am Acad Orthop Surg*. 2020;28(10):e418-e419.
55. Hui RWH, Leung KC, Ge S, et al. Burnout in orthopaedic surgeons: A systematic review. *J Clin Orthop Trauma*. 2019;10:S47-S52. doi:https://doi.org/10.1016/j.jcot.2019.01.028
56. Kakiashvili T, Leszek J, Rutkowski K. The medical perspective on burnout. *Int J Occup Med Environ Health*. 2013;26:401-412.

57. Shanafelt TD, Bradley KA, Wipf JE, Back AL. Burnout and self-reported patient care in an internal medicine residency program. *Ann Intern Med*. 2002;136(5):358-367.
58. West CP, Huschka MM, Novotny PJ, et al. Association of perceived medical errors with resident distress and empathy: a prospective longitudinal study. *Jama*. 2006;296(9):1071-1078.
59. Kwah J, Weintraub J, Fallar R, Ripp J. The effect of burnout on medical errors and professionalism in first-year internal medicine residents. *J Grad Med Educ*. 2016;8(4):597-600.
60. Campbell Jr DA, Sonnad SS, Eckhauser FE, Campbell KK, Greenfield LJ. Burnout among American surgeons. *Surgery*. 2001;130(4):696-705.
61. Torp S, Grimsmo A, Hagen S, Duran A, Gudbergsson SB. Work engagement: a practical measure for workplace health promotion? *Health Promot Int*. 2013;28(3):387-396.
62. Schaufeli WB, Salanova M, González-Romá V, Bakker AB. The measurement of engagement and burnout: A two sample confirmatory factor analytic approach. *J Happiness Stud*. 2002;3:71-92.
63. Schaufeli WB, Bakker AB, Salanova M. Utrecht work engagement scale-9. *Educ Psychol Meas*. 2003.
64. Schaufeli WB, Bakker AB, Salanova M. The measurement of work engagement with a short questionnaire: A cross-national study. *Educ Psychol Meas*. 2006;66(4):701-716.
65. Hernández Vargas CI, Llorens Gumbau S, Rodríguez Sánchez AM, Dickinson Bannack ME. Validation of the UWES-9 Scale in Mexican Health Professionals. *Pensam Psicológico*. 2016;14(2):89-100.
66. Arora M, Diwan AD, Harris IA. Burnout in orthopaedic surgeons: a review. *ANZ J Surg*. 2013;83(7-8):512-515.

Chapter 7 : Thesis conclusions

The goal of this project was to gain an understanding of orthopedic surgery graduates from Ontario residency programs in the last 30 years. For years there has been discussion about lack of opportunities, forcing newly trained surgeons to pursue additional training while waiting for a job opportunity to arise. The thought has been that when they get a job, they get less resources than their predecessors, leading to a negative economic impact, and diminished job satisfaction. We sought to test all these hypotheses and provide insight into how our graduates are faring.

7.1 Summary of our results

Chapter 3 asked the question: How many surgeons are we training and has there been an economic impact on those who stay in Ontario. Using a combination of Ministry of Health billing data, residency graduation, and residency matching data we provided some insight. We showed that between 2007 and 2018 there was an increase in the number of surgeons being trained without a compensatory increase in the number of surgeons actively billing in Ontario, suggesting there was not a corresponding increase in funding to retain the surgeons being trained. We demonstrated that although we trained more surgeons, the ones that remained in Ontario did not suffer a negative economic impact. The average billings did not change compared to their predecessors.

Chapter 4 asked the question: What does life look like for graduates immediately after residency? What are they doing, and do they feel ready to practice? We showed that our graduates do not feel ready to enter practice directly out of residency, with graduates from UofT feeling less ready than their colleagues from other schools, and more recent graduates also feeling less ready overall. Surgeons attributed most of their current surgical techniques to ones learned in fellowship—even those who stated they felt comfortable entering practice out of residency.

We also showed that the vast majority of graduates are doing 1-2 fellowships, with just as many graduates doing 2 fellowships as there are graduates doing 1 fellowship. This is significantly different from our colleagues in the United States, who very rarely do 2 fellowships. While most people reported doing fellowships out of interest, it raises the question why they are interested in doing 2 fellowships? Despite all this, these results do not appear to have changed with time. We also showed that people are getting jobs out of training at the same rate as their predecessors and doing more fellowships did not necessarily change that. What did change with time was that orthopedic trainess are now less likely to do graduate degrees out of interest. This suggests that the orthopedic landscape in Ontario has been challenging for decades and is not necessarily getting worse.

Chapter 5 asked the question: Once they start practice, where are they? What does their practice look like? We showed that graduates from the University of Ottawa appear to be disproportionally affected as they are more likely to work in the USA, more likely to work in Alberta if they stay in Canada, and more likely to work far from their school of graduation if they stay in Ontario. This is an area that needs to be explored. The rate of emigration out of Canada did not change with time or the number of fellowships. However, more recent graduates are more likely to work in the USA out of necessity despite the overall numbers not changing. Those who work in the USA have more OR time and more clinic time. We also showed that very few surgeons identify as generalist, and this has not changed with time.

Chapter 6 asked the question: How are our graduates doing? Are they thriving in the workplace? We showed that our graduates are generally satisfied with their work and there were no variables that predicted a change in workplace engagement. There were no effects of time, gender, country, school, number of fellowships etc, suggesting that despite all the struggles involved in training to be an orthopedic surgeon, graduates are satisfied with where they ended up in life.

7.2 Implications

Our findings have important implications with regards to the state of orthopedic surgery training in Ontario and guidance for further investigation. While there was a divergence in the surgeons trained and actively retained in the system between 2007 and 2018, there was not a significant effect of year of graduation in many of our analyses. Perhaps the graduates have made various choices and not a singular choice stands out in the analyses. Further research must be done in that specific time period.

One of the most important implication of our results is that graduates are incurring a significant opportunity cost in doing two fellowships. While this has not significantly changed with time, that is not to detract from the fact that two fellowships are a significant time investments, and there is an opportunity cost. This project was not designed to investigate the nuances of why surgeons do their second fellowship. As such, we did not have the granularity to comment on it. Certainly, respondents stated the main reason for pursuing fellowship training was “interest”. It would be interesting to see how they would have responded if they had gotten an employment offer directly out of training. If they still would have pursued two fellowships—we would think they would not have.

Perhaps it's a consequence of the number of fellowships, or simply a sign of the times, but most community surgeons view themselves as specialist. Given that the majority describe themselves as subspecialist, is there room for re-thinking how we view residency training? Is there an opportunity to start specializing earlier in the training. In the era of Competency Based training, the opportunity is there.

The other important finding is investigating the number of opportunities around the Ottawa area. Graduates from the University of Ottawa stood out in our analyses in that they were more likely to be working outside of Canada than any other school, and more likely to be situated far from Ottawa if they stay in Ontario. This raises more questions than answers. The goal of HHR planning is having the appropriate number of surgeons in the right geographical area. This then implies that there must be a mismatch between supply and demand in the Ottawa, and surrounding, regions. Further research needs to be done on the population demographics and the need for orthopedic care in the region before coming to any conclusions on what the cause for these findings are.

There are a few reassuring results. First: orthopaedic surgeons appear to be engaged in their work, and this is a stable finding. While we did not test for burnout, a low UWES score has been associated with burnout and our sample size had a consistently high UWES score. Showing that our respondents were engaged in their work and were thriving psychologically. This is a reassuring finding, supporting the notion that orthopaedics can be a rewarding field. The other reassuring finding was that, for the most part, things have not gotten worse with time. Overall, the orthopedic surgeons trained in Ontario programs are doing well and that is something that is worthy of recognition and celebration. We hope that this thesis has provided some insight into orthopedic surgery training in Ontario and raised questions worthy of future endeavours.

Appendix

Appendix A: Survey

How many fellowships did you complete?

None	Half Fellowship (6 months)	1	2	More than 2	I am currently in fellowship
○	○	○	○	○	○

Why did you do the fellowship(s) that you did?

Please check one circle per row. You may skip this if you did not complete a fellowship.

	Strongly disagree	Disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Agree	Strongly agree
This was an interest of mine	○	○	○	○	○	○	○
There was a specific opening that required that fellowship	○	○	○	○	○	○	○
There were more job openings in that specific fellowship than others	○	○	○	○	○	○	○
That specific fellowship(s) had better renumeration than others	○	○	○	○	○	○	○
This was not an area I felt I was fully comfortable in being independent in	○	○	○	○	○	○	○

What did you do your fellowship (s) in?

○ Pediatrics	○ Sports	○ Upper extremity
○ Trauma	○ Foot & Ankle	○ Arthroplasty (lower extremity reconstruction)
○ Spine	○ Tumor	○ Other:_____

What city(s) did you do your fellowship(s) in: _____

Did you locum during fellowship?

- ☐ Yes
- ☐ No

How long did it take to gain full-time permanent employment AFTER formal training?
(Fellowships are considered formal training)

Directly out of training	0-6 months	6 months – 1 year	1-2 years	More than 2 years	I still do not have permanent full-time employment
○	○	○	○	○	○

Are you currently looking for full time employment?
Skip this question if you have a permanent employment

- Yes
- No, I prefer flexible employment by choice
- No, I would prefer secure employment but I have given up looking for one

Did you get a graduate degree during or after residency?

- No
- Yes (Masters)
- Yes PhD
- Yes other (MPH, MBA etc):_____

Did you get your graduate degree during or after residency?
Skip this question if you did not get a graduate degree, or had one pre-residency

- During
- After

Why did you get a graduate degree?
Skip this question if you did not get a graduate degree, or had one pre-residency

	Strongly Disagree	Disagree	Somewhat	Neither agree nor disagree	Somewhat agree	Agree	Strongly agree
I did it to expand my expertise/ skills because I wanted to	○	○	○	○	○	○	○
My job required a lot of research and I felt I did not have the skills to do it.	○	○	○	○	○	○	○
I felt like I had to in order to make myself more advantageous for the job market	○	○	○	○	○	○	○
This was a requirement for my job	○	○	○	○	○	○	○

How would you describe your practice?

○Academic subspecialist ○ Community subspecialist

○Academic generalist ○ Community generalist

How many OR days on average do you currently have allocated?

<1	1	2	3	4 or more
○	○	○	○	○

How many clinic days on average do you currently have allocated?

<1	1	2	3	4 or more
○	○	○	○	○

Mark on this line what percentage (%) would you say that your current operative techniques are based on skills you learned in fellowship?
Skip this question if you did not complete a fellowship

My current operative techniques are not at all based on my fellowship	0	10	20	30	40	50	60	70	80	90	100 My current operative techniques are exclusively based on my fellowship

Mark on this line what percentage (%) would you say that your current operative techniques are based on skills you learned in residency?

My current operative techniques are not at all based on my residency	0	10	20	30	40	50	60	70	80	90	100 My current operative techniques are exclusively based on my residency

These questions ask how you feel about your work <u>on an average day this month</u>
Please check one circle per row.

	Never	Rarely (once a month or less)	Sometimes (A few times a month	Often (once a week)	Very often (A few times a week)	Always (every day)
At my work, I feel bursting with energy	○	○	○	○	○	○
At my job, I feel strong and vigorous	○	○	○	○	○	○
I am enthusiastic about my job	○	○	○	○	○	○
My job inspires me	○	○	○	○	○	○
When I get up in the morning, I feel like going to work	○	○	○	○	○	○
I feel happy when I am working intensely	○	○	○	○	○	○
I am proud of the work that I do	○	○	○	○	○	○
I am immersed in my work	○	○	○	○	○	○
I get carried away when I'm working	○	○	○	○	○	○

How long has it been since you finished formal training (residency and fellowship(s))?

<1 year	1-2 years	2-3 years	3-4 years	4-5 years	5-10 years	10+ years	I have not finished formal training yet
○	○	○	○	○	○	○	○

How long after finishing formal training (residency and fellowship) did you feel comfortable operating independently?

0-6 months	6 months – 1 year	1-2 years	2-3 years	3-4 years	4-5 years	6+ years	I do not feel comfortable operating independently yet
○	○	○	○	○	○	○	○

What year did you graduate residency? _____

Did you feel like your residency prepared you for independent practice?

- Yes I could have entered practice directly out of residency
- Yes, but I feel like doing a fellowship helped make things easier
- No, but with trial and error in practice I could have figured things out
- No, I would have needed help from colleagues early on
- No, I definitely needed to do a fellowship and extra training.

What gender do you identify with?

- Male
- Female
- Non-binary
- Prefer not to say
- Other:_____

Where are you currently located

- Canada
- United states
- Other:_____

What state/ province do you currently practice in? _____

What prompted you to emigrate?

Skip this question if you are practicing in Canada

	Strongly disagree	Disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Agree	Strongly agree
Lack of opportunities in Canada in the type of practice I wanted (i.e., academic vs community.)	○	○	○	○	○	○	○
Lack of opportunities in Canada in the type of location I wanted (i.e., dense urban, medium urban, rural etc).	○	○	○	○	○	○	○
Lack of opportunities in Canada in the subspecialty I wanted	○	○	○	○	○	○	○
Better income opportunities than in Canada	○	○	○	○	○	○	○
Better practice opportunities than were offered in Canada (ie. call patterns, OR resources, administrative responsibilities etc).	○	○	○	○	○	○	○
Other, please specify: _____	○	○	○	○	○	○	○

Thank you for completing the survey. By sending the data back to us in the pre-paid envelope you are agreeing to partake in this study. The data will be recorded and de-anonymized immediately and will not be able to be removed on request as we will be unable to identify it.

Appendix B: REB approval

Western Research

Date: 18 January 2023

To: Dr. Brent Lanting

Project ID: 120483

Review Reference: 2023-120483-74975

Study Title: Orthopaedic surgeon practice pattern and job satisfaction over the last 30 years and their implications for Health Human Resource (HHR) planning

Application Type: HSREB Initial Application

Review Type: Delegated

Meeting Date / Full Board Reporting Date: 07/Feb/2023

Date Approval Issued: 18/Jan/2023 08:35

REB Approval Expiry Date: 18/Jan/2024

Dear Dr. Brent Lanting

The Western University Health Science Research Ethics Board (HSREB) has reviewed and approved the above mentioned study as described in the WREM application form, as of the HSREB Initial Approval Date noted above. This research study is to be conducted by the investigator noted above. **All other required institutional approvals and mandated training must also be obtained prior to the conduct of the study**.

Documents Approved:

Document Name	Document Type	Document Date	Document Version
Protocol_v3	Protocol	15/Nov/2022	3
Email_V3	Email Script	23/Dec/2022	3
Cover_Letter_V2	Letter Document	12/Jan/2023	2
LOI_V4_online	Written Consent/Assent	12/Jan/2023	4
LOI_V4_paper	Written Consent/Assent	12/Jan/2023	4
Orthopaedic_surgeon_practice_pattern_and_job_satisfaction_Paper_V5	Paper Survey	12/Jan/2023	5
Orthopaedic_surgeon_practice_pattern_and_job_satisfaction_ONLINE_V5	Online Survey	12/Jan/2023	5

Documents Acknowledged:

Document Name	Document Type	Document Date	Document Version
References	References	05/Mar/2022	1

Appendix C: School postal codes

School	Postal Code
UofT	M5S 1A1
McMaster	L8S 4L8
Western	N6A 3K7
Ottawa	K1N 6N5
Queens	K7L 3N6
NOSM	P3E 2C6

Curriculum Vitae

Silvio Ndoja

Department of Surgery, Division of Orthopaedic Surgery

Western University

London, ON

EDUCATION

2022-08 - Current	**Master of Science: Surgery** *Western University - London, ON*
2020-07 - Current	**FRCPSC: Orthopaedic Surgery** *Western University - London Ontario*
2016-05 - 2020-06	**M.D.: Medicine** *Western University, Schulich School of Medicine - London Ontario*
2010-09 - 2014-05	**Bachelor of Science: Biology & Psychology** *McMaster University - Hamilton, ON*

AWARDS

2018 **Undergraduate Medical Education (UME) Scholar of Merit**
Schulich School of Medicine & Dentistry – London
Nominated by members of the Quality Committee at UME curriculum committee for my contributions to curriculum development in UME.

LEADERSHIP ROLES

2022-Present **Quality committee resident representative**

- Oversee the implementation of quality improvement initiatives at a resident level.
- Represent resident's interest at a faculty level.
- Advocate for initiatives improving clinical workflow.

June 2018 – June 2019 **Director of Representation**
Ontario Medical Student Association (OMSA) – Toronto

- Represented medical student's advocacy priorities at governmental bodies and external organizations. Focused on reducing unmatched medical students, mental health disclosure to the CPSO, and standardizing quality improvement (QI) curricula.
- Managed a team of 20 members which comprised 5 files focusing on: lobby day, partnership, government relations, partnership, and policy.
- Directly liaised with the Ministry of Health and Long-Term Care regarding health planning and advocate for unmatched medical students leading in student representation in residency allocation decision bodies.
- Worked with Health Quality Ontario (HQO) to organize a student ambassadorship program for medical students to be exposed to QI work.
- Oversaw a budget of $20,000 while organizing provincial lobby day at Queen's park advocating for unmatched medical students.

September 2017 – September 2019 **Competency Based Medical Education (CBME) File Lead**
Canadian Federation of Medical Students (CFMS) – Ottawa

- Liaised with directors of CBME at various institutions in order to better understand how they are implementing it and various struggles at their schools.
- Worked directly with the Royal College of Physicians and Surgeons of Canada (RCPSC) to prepare workshop for VP Academics to understand CBME implementation across the country.
- Co-led a session with Dr. Ken Harris, Director of Specialty education for the Royal College, at CFMS Spring general meeting in Halifax informing attendees on CBME.
- Co-authored a CBME primer included the transition to residency guide designed by CFMS.

May 2017 – August 2019 **Curriculum Renewal: Executive Committee**
Schulich School of Medicine & Dentistry – London

- Represented student's perspective in the undergraduate curriculum executive committee meetings.
- Provided guidance on proposed changes in curriculum and how changes could affect students.

May 2017 – August 2019 **Curriculum Renewal: Assessment Committee**
Schulich School of Medicine & Dentistry – London

- Attended monthly meetings on CBME implementation and provided practical contributions on ways to optimally implement assessments tools.

September 2016– August 2017 **Curriculum Renewal: EPA Committee**
Schulich School of Medicine & Dentistry – London

- Provided student perspective on implementation of Entrustable Professional Activities (EPAs) in undergraduate curriculum
- Contributed to defining expectation of EPA entrustment criteria in pre-clerkship and clerkship

September 2016– April 2019 **Curriculum Renewal: Curriculum and Pedagogy Committee**
Schulich School of Medicine & Dentistry – London

- Contributed to discussions on pedagogical principles of CBME in undergraduate curriculum.
- Co-led subcommittee on implementation of clinical skills curriculum in CBME in UME.
- Co-authored report on clinical skills curriculum to be delivered to executive committee.

PEER REVIEWED PUBLICATIONS

Ndoja, S., Dion, C. A., Pirshahid, A. A., Charron, B. P., Durocher, A., McCarton, A., & LeBel, M. E. (2022). Active Retrieval Improves Procedural Learning in Orthopedic Surgery. Journal of Surgical Education, 79(5), 1308-1314.

Pasic N, Akindolire J, Churchill L, **Ndoja S,** Del Balso C, Lawendy AR, Lanting B, Degen RM. Cost and safety of inpatient versus outpatient open reduction internal fixation of isolated ankle fractures. Can J Surg. (2022) Apr 8;65(2):E259-E263. doi: 10.1503/cjs.016420. PMID: 35396267; PMCID: PMC9259383.

Bryce, J., **Ndoja, S**., Goyal, P., Lanting, B., & Howard, J. (2021). Patients' perspectives on the extent of resident participation in the operating room for total hip or knee arthroplasty. Canadian Medical Education Journal, 12(1), e21-e31.

Zeng, A. G., Brenna, C. T., & **Ndoja, S.** (2020). Fundamental trends within falling match rates: insights from the past decade of Canadian residency matching data. Canadian Medical Education Journal, 11(3), e31.

Broberg, J. S., **Ndoja, S.**, MacDonald, S. J., Lanting, B. A., & Teeter, M. G. (2020). Comparison of contact kinematics in posterior-stabilized and cruciate-retaining total knee arthroplasty at long-term follow-up. The Journal of Arthroplasty, 35(1), 272-277.

Ndoja, S., Chahine, S., Saklofske, D. H., & Lanting, B. (2020). The erosion of ambiguity tolerance and sustainment of perfectionism in undergraduate medical training: results from multiple samplings of a single cohort. BMC Medical Education, 20(1), 1-7.

Naudie, D. D., **Ndoja, S.,** Wood, T. J., Somerville, L. E., Howard, J. L., McCalden, R. W., MacDonald, S J., & Lanting, B. A. (2020). Three femoral stem designs without corrosion: A review of 2095 stems. Orthopedic Research and Reviews, 145-150.

Thangarasa, T., **Ndoja, S.**, Gohal, S., Lee, D., Silverberg, S., Mikhail, M., Kuk, M., & Apramian, T. (2018) Curricular Advocacy Guidelines. *Canadian Federation of Medical Students*.

Ndoja, S., & Lima, H. (2016). Monoclonal antibodies. *Current Developments in Biotechnology and Bioengineering: Human and Animal Health Applications*, 71.

Ndoja, S., Teeter, C. J., Kim, J.A. (2014). An examination of retrieval enhanced learning as a function of review strategy and student note taking behaviour. Poster presented at The *Current Research in Science, Engineering, and Technology conference*. Hamilton, ON

Ndoja, S., Riediger, M., Evaniew, N., Ghert, M. (2014) What is the evidence for post-operative prophylactic antibiotics after primary hip and knee arthroplasty? A systematic review. Oral presentation given *at Ontario Biology Day*. Mississauga, ON

Goff, L., Knorr, K., Mahiri, K., **Ndoja, S.,** Tang, B. (2014) Developing courses for students by students: Engaging students as co-creators of curricula. Talk given at the *Canadian Society for the Study of Higher Education conference*. St. Catherines, ON

SUBMITTED MANUSCRIPTS

Ndoja, S., Vivekandan, A., Frost, S., Schemitsc, E., Sibley, S., Papp, S., Lanting, B. (2023). Has the transition into full-time practice changed over the last 20 years for Orthopaedic Surgeons? An analysis using Ministry of Health billing data. *Submitted to the Canadian Journal of Surgery*

Lanting, B., **Ndoja, S.,** Milne, K., Howard, J. Physiological and psychological responses of performing orthopaedic surgeries: an analysis of surgeons and trainees. *Submitted to the Canadian Journal of Surgery*

ONGOING RESEARCH PROJECTS

Ndoja, S., Howe, H., Papp, S., Schemitsch, E., Lanting, B. The changing landscape of orthopaedic surgery in Ontario: Where we are, where we have been, and where we are going. *Currently in data analysis*

Black, D., **Ndoja, S.,** Loshusan, B., Brahmbatt., LeBel, ME. Active retrieval in procedural learning: does the mode of retrieval matter? *Data collection currently ongoing*

Ndoja, S., Frazer, A., Lawendy, A., MacLeod, M., Inculet, C., Schemitsch, E., Del Balso, C., Nowak, L., Grad, V., Sanders, D. Incidence of neurologic injury with pelvic fractures *Participant recruitment ongoing*

Frazer, A., **Ndoja, S.,** Lawendy, A., MacLeod, M., Inculet, C., Schemitsch, E., Del Balso, C., Nowak, L., Grad, V., Sanders, D. Don't mess with the talus: Patient outcomes after talus fractures *Participant recruitment ongoing*

Frazer, A., **Ndoja, S.,** Howe, H., Singh, S. Analyzing gender trends in orthopaedic surgical residents in Canada over 20 years *Manuscript in preparation*

ONGOING QI PROJECTS

Laxdall, I., **Ndoja, S.,** Katchky, R. Optimizing workflow in a pediatric fracture clinic *data collection ongoing*

Ndoja, S., Rasoulinejad, P., Katchky, R. Implementation of a texting-paging system for nurses at a Level-1 trauma center *Data collection ongoing*

Ndoja, S., Katchky, R. Improving discharge medication reconciliation and summaries in orthopaedic surgery *Data collection ongoing*

PEER REVIEWED PRESENTATIONS

Ndoja, S., Frazer, A., Lawendy, A., MacLeod, M., Inculet, C., Schemitsch, E., Del Balso, C., Nowak, L., Grad, V., Sanders, D. (2023) Incidence of neurologic injury with pelvic fractures *Presented at the Canadian Orthopaedic Trauma Association meeting, Calgary*

Frazer, A., **Ndoja, S.,** Lawendy, A., MacLeod, M., Inculet, C., Schemitsch, E., Del Balso, C., Nowak, L., Grad, V., Sanders, D. (2023) Don't mess with the talus: Patient outcomes after talus fractures *Presented at the Canadian Orthopaedic Trauma Association meeting, Calgary*

Ndoja, S., Vivekandan, A., Frost, S., Schemitsch, Papp, S., Lanting, B. (2022). Has the transition into full-time practice changed over the last 20 years for Orthopaedic Surgeons? An analysis using Ministry of Health billing data. *Virtual poster at the Canadian Orthopaedic Association (COA) annual meeting, Quebec*

Ndoja, S., Dion, C. A., Pirshahid, A. A., Charron, B. P., Durocher, A., McCarton, A., & LeBel, M. E. (2020). Active retrieval and procedural learning in orthopaedics. *Virtual poster at the Canadian Orthopaedic Association (COA) annual meeting*