

Assessing the impact of virtual learning on family medicine trainees' medical knowledge using progress tests: a retrospective cohort study

Évaluation de l'impact de l'apprentissage virtuel sur les connaissances médicales des résidents en médecine familiale à l'aide de tests de progression : une étude de cohorte rétrospective

Karina Prucnal,¹ Stuart Murdoch,^{1,2} Kulamakan Kulasegaram,^{1,2} Fok-Han Leung^{1,2}

¹Department of Family & Community Medicine, University of Toronto, Ontario, Canada; ²Temerty Faculty of Medicine, University of Toronto, Ontario, Canada

Correspondence to: Karina Prucnal¹ MD, CCFP; Department of Family and Community Medicine, 500 University Avenue, 5th Floor Toronto, Ontario M5G 1V7; email: karina.prucnal@mail.utoronto.ca

Published ahead of issue: May 28, 2025; published: Nov 6, 2025. CMEJ 2025, 16(5) Available at <https://doi.org/10.36834/cmej.78343>

© 2025 Prucnal, Murdoch, Kulasegaram, Leung; licensee Synergies Partners. This is an Open Journal Systems article distributed under the terms of the Creative Commons Attribution License. (<https://creativecommons.org/licenses/by-nc-nd/4.0>) which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is cited.

Abstract

Background: Progress testing provides residents with an opportunity to identify strengths and weaknesses, encouraging self-directed learning. The University of Toronto's Department of Family & Community Medicine administers the Family Medicine Mandatory Assessment of Progress (FM-MAP) biannually to track resident competency and medical knowledge. Our aim was to determine the impact of virtual learning on Family Medicine residents.

Methods: We administered previous iterations of the FM-MAP to the virtual learning cohort and compared scores to those of the in-person cohort between October 2020 - Spring 2022.

Results: There were no statistically significant differences between in-person and virtual cohorts of first- and second-year postgraduate family medicine trainees regarding their overall FM-MAP score. Second-year family medicine trainees outperformed first year trainees in both cohorts.

Conclusion: The study found no significant effect on the scores of first- and second-year family medicine trainees caused by the shift to virtual learning, suggesting medical curricula can incorporate virtual learning without compromising trainee progress, offering flexibility in medical education. Future studies could explore its applicability across different residency programs and long-term effects on clinical performance.

Résumé

Contexte : Les tests de progression permettent aux résidents d'identifier leurs points forts et leurs points faibles, ce qui encourage l'apprentissage autonome. Le département de médecine familiale et communautaire de l'université de Toronto administre deux fois par an le Family Medicine Mandatory Assessment of Progress (FM-MAP) afin d'évaluer les compétences et les connaissances médicales des résidents. Notre objectif était de déterminer l'impact de l'apprentissage virtuel sur les résidents en médecine familiale.

Méthodes : Nous avons administré les versions précédentes du FM-MAP à la cohorte d'apprentissage virtuel et avons comparé les scores à ceux de la cohorte en présentiel entre octobre 2020 et le printemps 2022.

Résultats : Il n'y avait pas de différence statistiquement significative entre les cohortes en présentiel et virtuelles des résidents de première et deuxième année en médecine familiale en ce qui concerne leur score global au FM-MAP. Les résidents en médecine familiale de deuxième année ont obtenu de meilleurs résultats que ceux de première année dans les deux cohortes.

Conclusion : L'étude n'a révélé aucun effet significatif sur les scores des résidents en médecine familiale de première et deuxième année résultant du passage à l'apprentissage virtuel, ce qui suggère que les programmes d'études médicales peuvent intégrer l'apprentissage virtuel sans compromettre les progrès des résidents, offrant ainsi une certaine souplesse dans l'enseignement médical. De futures études pourraient explorer son applicabilité dans différents programmes de résidence et ses effets à long terme sur le rendement clinique.

Introduction

The sudden shift to virtual medical education in 2020 due to the COVID-19 pandemic significantly altered the training environment for incoming family medicine trainees.¹ Incoming first-year postgraduate trainees faced reduced in-person clerkship opportunities and disrupted rotations which had never been experienced to this extent by a particular cohort.^{1,2,3} Trainees were encouraged to remain proactive in identifying knowledge gaps.²

To monitor the impact of these changes, the University of Toronto's Department of Family and Community Medicine (DFCM) continued to administer the Family Medicine Mandatory Assessment of Progress (FM-MAP), a bi-annual assessment tool for first- and second-year postgraduate family medicine trainees to assess learner progress, knowledge acquisition with respect to the family medicine expert role and to identify gaps over time.^{4,5,6} Progress testing, which provides ongoing assessment of medical knowledge and encourages self-directed learning, remained a key tool for tracking trainee development despite educational disruptions.^{4,7,8}

There is a gap in the evaluation of virtual medical education on incoming first-year family medicine trainees during COVID restrictions. This study examines the impact of disrupted clinical experiences and subsequent transition to virtual medical education on the medical knowledge of incoming first- and second-year family medicine trainees during the 2020-2021 and 2021-2022 academic years. By comparing FM-MAP scores from the in-person (2018-2020) and virtual (2020-2022) cohorts, our study explored potential lasting effects of reduced clinical exposure on trainee knowledge progression.

Methods

This retrospective cohort study took place at the University of Toronto's DFCM, involving first- and second-year Family Medicine Residents (PGY1 and PGY2, respectively).

We administered the FM-MAP biannually to all Family Medicine residents ($n = 320$): approximately four, eight, seventeen and twenty-one months into their two-year family medicine training, a practice in place since 2009.^{4,6,9} Previous pilot testing demonstrated strong validity evidence, predicting performance on the Certification Examination of the College of Family Physicians of Canada with increasing Spearman correlation coefficients across all four test iterations ($p < 0.05$).^{4,6}

The FM-MAP consists of 120 case-based multiple-choice questions with 10 questions assigned to each of the 12

assessed competencies.^{4,6} While we administered proctored on-site computer examinations for in-person cohorts, the pandemic allowed for distance learning, enabling residents to write the exam electronically from home. We accommodated residents who missed the FM-MAP by providing an alternate date. Residents who missed both the original and make-up FM-MAP dates were excluded from the study.

The DFCM reported scores using deciles, percentages, and performance zones (red, yellow green) and emailed them to all residents.⁴ "Red" and "yellow" zones indicated performance below 1.5 Standard Deviations (SD) and between 1.5 and 1 SD below the class mean, respectively. We also provided site directors with site-specific scores in each competency domain.⁴

The DFCM updates the FM-MAP questions annually. However, to compare in-person (Cohort 1) and virtual (Cohort 2) cohorts, the DFCM administered the pre-pandemic versions of the FM-MAP to the virtual cohort of residents, ensuring a standardized measure of progress over time. The virtual cohort, which experienced clinical disruptions, completed the same four progress tests as the in-person cohort, which did not undergo any virtual curricular changes. Trainees do not receive access to test questions or answers. The Fall 2018 and Spring 2019 test versions were administered in the Fall 2020 and Spring 2021, while the Fall 2019 and Spring 2020 tests were administered in Fall 2021 and Spring 2022.

After emailing individual test scores to residents, the researchers anonymized the data and used unique identifiers to track resident progress throughout their residency training. University of Toronto Research Ethics Board provided ethics approval.

Data Analysis

We used SPSS 26.0 (IBM Corp., USA) statistical quantitative software to analyze the data. Descriptive statistics including mean, median, mode and measure of variability summarized performance in overall FM-MAP scores and within each competency domain (Figure 1). We performed repeated measures ANOVA to measure resident progress over time while controlling for individual variability. This analysis allowed us to compare the virtual (2020-2022) and in-person (2018-2020) cohorts using overall FM-MAP scores and domain performance as the dependent variables. We treated cohort and postgraduate status (PGY-1 vs. PGY-2) as between subject factors, with FM-MAP Test Iteration as the repeated measures. If the rapid shift to virtual medical education negatively impacted a

resident's medical knowledge, we expected lower scores for the virtual cohort.

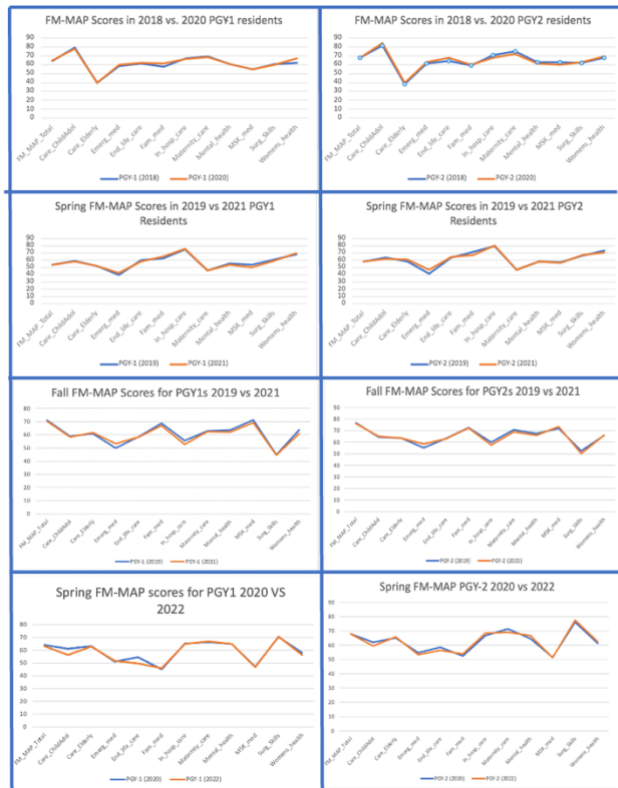


Figure 1. Descriptive statistics including mean, median, mode and measure of variability summarized performance in overall FM-MAP scores and within each competency domain.

Results

We included all first- and second-year Family Medicine residents who wrote the four FM-MAPs between 2018 - 2022 in the data analysis. The in-person cohort of the 2018 - 2019 academic year wrote the Fall 2018 ($n = 329$) and Spring 2019 ($n = 318$) FM-MAP examinations and was compared to the virtual cohort of the 2020 - 2021 academic year with the Fall 2020 ($n = 321$) and Spring 2021 ($n = 324$) FM-MAP results. Similarly, we analyzed the in-person cohort from the 2019-2020 academic year, who wrote the FM-MAP examinations in the Fall 2019 ($n = 314$) and Spring 2020 ($n=314$), alongside the virtual cohort who completed the test in Fall 2021 ($n = 298$) and Spring 2022 ($n = 298$) (Table 1).

In the first year of testing this two-year residency program, we did not detect a statistically significant difference between the in-person and virtual cohorts with respect to their overall FM-MAP score after the first two FM-MAP tests comparing Fall 2018 and Spring 2019 with Fall 2020 and Spring 2021 [$F(1)=0.384$, $p < 0.536$]. As expected second-year family medicine trainees outperformed first-year trainees in Fall and Spring for both cohorts ($F(1)=64.482$, $p < 0.0001$).

We began the second year of testing in the following academic year, comparing the in-person cohort's Fall 2019 and Spring 2020 test results with the virtual cohort's Fall 2021 and Spring 2022 results. Once again, our analysis did not detect a statistically significant difference between the in-person and virtual cohorts in their overall FM-MAP score [$F(1)=2.231$, $p < 0.136$]. However, second-year family medicine trainees outperformed first-year trainees on both tests [$F(1)=131.864$, $p < 0.001$].

Table 1. Descriptive Statistics comparing mean scores between PGY Status and Cohorts

Test	Year Administered	Cohort*	PGY	Number of Residents	Mean Score	Standard Deviation
Fall 2018	Fall 2018	1 In-person	1	177	64.32	5.3929
			2	152	67.341	5.5066
	Fall 2020	2 Virtual	1	161	64.884	5.9527
			2	160	67.814	5.5138
Spring 2019	Spring 2019	1 In-person	1	175	54.111	5.9937
			2	143	58.252	6.5214
	Spring 2021	2 Virtual	1	160	53.908	6.3461
			2	164	58.235	6.5695
Fall 2019	Fall 2019	1 In-person	1	160	71.214	6.5421
			2	154	76.667	6.345
	Fall 2021	2 Virtual	1	157	70.232	7.6853
			2	141	76.294	6.3863
Spring 2020	Spring 2020	1 In-person	1	160	64.089	6.0717
			2	154	68.12	6.0591
	Spring 2022	2 Virtual	1	157	63.054	3.2576
			2	141	67.864	6.6911

*Cohort 1 is in-person (2018-2020) and Cohort 2 is virtual (2020-2022)

Discussion

This retrospective cohort study provided objective progress test data, showing that the assessing the impact of the shift to virtual medical education had no impact on the medical knowledge of incoming first-year postgraduate family medicine trainees. The learners were affected during their medical school in-person clinical rotations when many assessment opportunities were placed on hold or modified to accommodate COVID restrictions.¹⁰ Tests were deferred; clinical skills were assessed over video.¹⁰ Despite challenges posed by the transition to virtual learning, our study data demonstrated that medical knowledge remained consistent between the in-person and virtual cohorts. The lack of statistically significant differences between the two groups indicates that virtual learning, while presenting logistical challenges, was effective in maintaining medical knowledge acquisition at levels comparable to traditional in-person clinical training.

There are a few possible reasons for our finding. First, the mode of learning, whether virtual or in-person, may not affect students and their respective exam scores. Residents are familiar with technology and are quick to adapt to learning virtually.¹¹ Alternately, the strength and effectiveness of the residency training program such as curriculum design, faculty support and adaptations in training may have compensated for the knowledge gaps. Although incoming residents transitioned into residency after several-months of virtual-only experiences, the DFCM offered both in-person and virtual clinical experiences from the start of their training, potentially ensuring that residents have sufficient clinical exposure to prevent any measurable decline in performance. The curriculum included administering the Fall FM-MAP four months into residency, providing learners with the opportunity to identify potential areas of weakness early on. This early diagnostic assessment allowed them to focus on specific knowledge gaps, subsequently improving test scores and maintaining consistent performance levels between in-person and virtual learners.^{3,4} Progress testing has been shown as a positive influence on student learning, strengthening long-term knowledge, encouraging self-directed learning, while offering better predictive validity.^{4,7} Finally, it is possible that the sudden shift to virtual medical education may have impacted application and adaptation of knowledge for clinical reasoning, rather than formal medical knowledge itself. Developing, implementing, and evaluating virtual case-based learning and virtual patient education tools—both which enhance clinical reasoning skills—require time. The shift to virtual

learning in the case of the COVID-19 pandemic was rapid. Lecture-style and self-study methods are simpler to implement in the virtual medical education context.^{12,13}

As expected, we observed consistent differences between postgraduate years in both years of our study, with second-year trainees outperforming the first years. Pilot testing of the FM-MAP demonstrated a significant difference in the scores of first- and second-year trainees.^{4,6} This finding reinforces the FM-MAP's ongoing use and utility of the FM-MAP as a predictor of problem-solving, knowledge and performance on the certification examination in family medicine.^{4,6,9}

The use of progress testing to assess the impact of the shift to virtual medical education offers suggestions for future educational planning. The longitudinal administration makes progress testing effective in periods of disruption as it allows educators to track trainee development and focus on knowledge application instead of memorization.⁸

Our study had several weaknesses. It lacked data on redeployment despite our trainees often being reassigned to other services. Their exposure to core Family Medicine training may have been reduced, potentially impacting test performance. Next, our study did not track where trainees wrote tests. In-person cohorts typically wrote the computerized progress tests on-site at their respective teaching hospitals. To accommodate distancing guidelines upon the shift to virtual medical education, trainees wrote the progress tests off-site without proctoring. While the formative nature of the test should minimize any potential security issues, as results do not impact residency summative evaluations, inconsistencies in test-taking environments could have influenced test performance. We did not specifically track potential curricular changes that may have occurred simultaneously which may have accounted for the lack of any statistically significant differences between cohorts. It is important to note, however, that most curricular changes, clinical rotations, assessments were placed on pause to address new virtual learning as well as to dedicate resources towards public health and patient care. Additionally, prior analyses of the FM-MAP determined that Canadian Medical Graduates (CMGs) outperformed International Medical Graduates (IMGs) by 7%.^{4,6} Our study did not compare CMG and IMG performance, and further testing may highlight whether IMGs were more heavily impacted by the virtual shift. Future studies may use progress tests to evaluate residency programs including CMG versus IMG performance.¹⁴ We also appreciate the limits of a low-stakes assessment and

potential trainee attitudes towards a test that does not bear any weight on their evaluations in residency.

Conclusion

In conclusion, we did not find a difference between in-person and virtual first- and second-year postgraduate family medicine trainees with regards to their medical knowledge, as depicted by their FM-MAP scores. The results suggest that shifting to virtual learning did not have a significant negative (or positive) impact on resident medical knowledge.

Conflicts of Interest: There are no conflicts of interest.

Funding: There was no funding.

Edited by: Henry Moon (senior section co-editor) Cindy Schmidt (senior section co-editor); Marcel D'Eon (editor-in-chief)

References

- Rose S. Medical student education in the time of COVID-19. *JAMA*. 2020;323(21):2131–2. <https://doi.org/10.1001/jama.2020.5227>
- McCarthy C, Carayannopoulos K, Walton JM. COVID-19 and changes to postgraduate medical education in Canada. *CMAJ* 2020;192(35):E1018–20. <https://doi.org/10.1503/cmaj.200882>
- The Association of Faculties of Medicine of Canada (AFMC). *AFMC principles and guidelines in the era of COVID-19*. Ottawa, ON; AFMC 2020. Available from: <https://afmc.ca/en/priorities/covid19>. [Accessed Apr 2021].
- Leung FH, Herold J, Iglar K. Family medicine mandatory assessment of progress: results of a pilot administration of a family medicine competency-based in-training examination. *Can Fam Physician*. 2016;62(5):e264–7.
- Royal College of Physicians and Surgeons of Canada. *CanMEDS framework*. Royalcollege.ca. Available from: <https://canmeds.royalcollege.ca/guide> [Accessed on Jul 1, 2023].
- Iglar K, Leung F-H, Moineddin R, Herold J. FM-MAP: a novel in-training examination predicts success on family medicine certification examination. *Fam Med*. 2017;49(5):369–73.
- Chen Y, Henning M, Yelder J, Jones R, Wearn A, Weller J. Progress testing in the medical curriculum: students' approaches to learning and perceived stress. *BMC Med Educ* 2015;15(1). <https://doi.org/10.1186/s12909-015-0426-y>
- Schuwirth LWT, Van der Vleuten CPM. The use of progress testing. *Perspect Med Educ*. 2012;1(1):24–30. <https://doi.org/10.1007/s40037-012-0007-2>
- Department of Family and Community Medicine. *Family medicine medical expert assessment of progress (FM-MAP) performance*. Toronto; DFCM. Updated 2023. Available from: <https://dfcm.utoronto.ca/family-medicine-medical-expert-assessment-progress-fm-map-performance>. [Accessed Jul 1, 2023]
- Rajab M, Gazal A, Alkattan K. Challenges to online medical education during the COVID-19 pandemic. *Cureus*. 2020;12(7):e8966. <https://doi.org/10.7759/cureus.8966>
- Tabatabai S. COVID-19 impact and virtual medical education. *J Adv Med Educ Prof*. 2020;8(3):140–3. <https://doi.org/10.30476/jamp.2020.86070.1213>.
- Lim JJ and Veasuvalingam B. Do virtual case-based discussions foster clinical reasoning in medical students? [version 1; not peer reviewed]. *MedEdPublish* 2023, 13:55 (slides) (<https://doi.org/10.21955/mep.1115223.1>)
- Plackett R, Kassianos AP, Mylan S, et al. The effectiveness of using virtual patient educational tools to improve medical students' clinical reasoning skills: a systematic review. *BMC Med Educ*. 2022;22, 365 <https://doi.org/10.1186/s12909-022-03410-x>.
- Andrew RF. How do IMGs compare with Canadian medical school graduates in a family practice residency program? *Can Fam Physician*. 2010;56(9), e318–e322.
- Nath A, Yadav K, Chagnon N, Cheung WJ. Competency based medical education (CBME) in CCFP(EM) programs. *CJEM* 2022;24(6):599–605. <https://doi.org/10.1007/s43678-022-00345-6>.
- Rutgers DR, van Raamt F, van Lankeren W, et al. Fourteen years of progress testing in radiology residency training: experiences from The Netherlands. *Eur Radiol*. 2018;28(5):2208–15. <https://doi.org/10.1007/s00330-017-5138-8>.
- Ramlogan S, Raman V. An educational approach for early student self-assessment in clinical periodontology. *BMC Med Educ*. 2022;22(1). <https://doi.org/10.1186/s12909-021-03078-9>.
- Weiss PM, Koller CA, Hess LW, Wasser T. How do medical student self-assessments compare with their final clerkship grades? *Med Teach*. 2005;27(5):445–9. <https://doi.org/10.1080/01421590500046999>.