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The impact of team-based primary care on medication-related outcomes in older adults: A comparative analysis of two Canadian provinces

David Rudoler [a,b,c,*], Nichole Austin [d], Sara Allin [e], Lise M. Bjerre [g], Lisa Dolovich [h], Richard H. Glazier [c,e,n], Agnes Grudniewicz [i], Audrey Laporte [c,e,f], Elisabeth Martin [j], Sue Schultz [c], Caroline Sirois [k], Erin Strumpf [f,l,m]

[a] Ontario Shores Centre for Mental Health Sciences, Whitby, Ontario, Canada
[b] Faculty of Health Sciences, Ontario Tech University, Oshawa, Ontario, Canada
[c] ICES, Toronto, Ontario, Canada
[d] School of Health Administration, Dalhousie University, Halifax, Canada
[e] Institute of Health Policy, Management and Evaluation, University of Toronto, Toronto, Ontario, Canada
[f] Canadian Centre for Health Economics, University of Toronto, Toronto, Ontario, Canada
[g] Department of Family Medicine, University of Ottawa, Ottawa, Ontario, Canada
[h] Leslie Dan Faculty of Pharmacy, University of Toronto, Toronto, Ontario, Canada
[i] Telfer School of Management, University of Ottawa, Ottawa, Ontario, Canada
[j] Faculty of Nursing Sciences, Université Laval, Québec City, Québec, Canada
[k] Faculty of Pharmacy, Université Laval, Québec, Québec, Canada
[l] Department of Epidemiology, Biostatistics and Occupational Health, McGill University, Montréal, Québec, Canada
[m] Department of Economics, McGill University, Montréal, Québec, Canada
[n] Family and Community Medicine, St. Michael's Hospital and University of Toronto, Toronto, Ontario, Canada

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ABSTRACT

Objective: To evaluate if access to team-based primary care is related to medication management outcomes for older adults.

Methods: We completed two retrospective cohort studies using administrative health data for older adults (66+) in Ontario (n = 428,852) and Québec (n = 310,198) who were rostered with a family physician (FP) between the 2001/02 and 2017/18 fiscal years. We generated matched comparison groups of older adults rostered to an FP practicing in a team-based model, and older adults rostered to an FP in a non-team model. We compared the following outcomes between these groups: any adverse drug reactions (ADRs), any potentially inappropriate prescription (PIP), and polypharmacy. Average treatment effects of access to team-based care were estimated using a difference-in-differences estimator.

Results: The risk of an ADR was 22 % higher (RR = 1.22, 95 % CI = 1.18, 1.26) for older adults rostered to a team-based FP in Québec and 6 % lower (RR = 0.943, 95 % CI = 0.907, 0.978) in Ontario. However, absolute risk differences were less than 0.5 %. Differences in the risk of polypharmacy were small in Québec (RR = 1.005, 95 % CI = 1.001, 1.009) and Ontario (RR = 1.004, 95 % CI = 1.001, 1.007) and had absolute risk differences of less than 1 % in both provinces. Effects on PIP were not statistically or clinically significant in adjusted models.

Interpretation: We did not find evidence that access to team-based primary care in Ontario or Québec meaningfully improved medication management outcomes for older adults.

1. Introduction

As people age, their likelihood of acquiring complex medical conditions increases, as does their likelihood of accumulating multiple prescription medications to manage these conditions. The proliferation of providers and medications — particularly in siloed and uncoordinated healthcare systems — may increase the risk of receiving potentially harmful medications (Tamblyn et al., 1994) and experiencing adverse drug events (ADRs) (Allin et al., 2017). Patient-centered medical homes and team-based primary care models — where health professionals from

* Corresponding author.
E-mail address: david.rudoler@ontariotechu.ca (D. Rudoler).

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multiple disciplines work together to provide primary care — are potential solutions to this coordination problem (Glazier and Redelmeier, 2010). Evaluations of interprofessional medication management interventions have not shown consistent improvements in patient outcomes (Cooper et al., 2015; Sellors et al., 2003), but there is limited research on the impact of team-based primary care on medication management, medication use, and related outcomes.

In Canada, several provinces have implemented team-based primary care models. This study focuses on teams implemented in Québec and Ontario. Québec introduced *Groupes de médecine de famille* (GMFs) in 2002, and Ontario introduced the Family Health Team (FHT) model in 2005. GMFs include family physicians (FPs), nurses, and (in recent years) other health professionals (e.g., social workers, pharmacists, etc.). GMFs are now common throughout the province, with about 60 % of the population enrolled (Ministère de la santé et des services sociaux. Plan stratégique, 2019). FHTs, on the other hand, have included a wide range of health professionals since their inception — they can include, but are not limited to, FPs, nurses, and pharmacists. As of 2016, FHTs served approximately 25 % of the Ontario population (Allin et al., 2021; Rudoler et al., 2019). In 2018, about 67 % and 19 % of FPs with a family medicine specialty were participating in GMFs and FHTs, respectively (Austin et al., 2023).

Evaluations of team-based primary care models in Canada have largely focused on avoidable acute care utilization as their outcome of interest and have shown mixed results (Carter et al., 2017; Glazier et al., 2015; Kiran et al., 2022; Strumpf et al., 2017). For instance, Glazier et al. found that ED visits were higher in FHTs relative to group and solo FP practices (Glazier et al., 2015). However, a longitudinal study by Kiran et al. found that ED visits increased over time across primary care models in Ontario, but less quickly in FHTs (Kiran et al., 2022). Kiran et al. concluded that team-based care may reduce emergency department (ED) use due to improved chronic disease management. In Québec, Carter et al. found that every 10 percentage point increase in the Québec population enrolled in GMFs was associated with a 3 percent reduction in the risk of avoidable emergency department visits (Carter et al., 2017). A study by Strumpf et al. found that access to GMFs for older or chronically ill adults reduced primary care and specialist visits, but not costs associated with hospitalization or ED visits. Strumpf et al. suggested that organizational reforms in primary care sectors will have limited impact without broader changes to the incentives that drive the behaviours of healthcare professionals (Strumpf et al., 2017).

In this paper, we add to this existing literature by exploring the impact of access to team-based primary care models in Québec and Ontario on medication management outcomes, including polypharmacy — the use of multiple prescription medications — potentially inappropriate prescriptions (PIPs) — medications whose expected or actual benefits are lower than their risks — and hospitalizations resulting from ADRs among older adults. We hypothesize that being rostered to GMFs or FHTs lowers the risk of these outcomes for older adults relative to older adults rostered to other primary care models.

2. Methods

2.1. Design, setting, and population

In Canada, healthcare falls under provincial and territorial jurisdiction. Each province establishes its own policies with respect to health human resource planning, provider payment, and practice models. Each province also collects its own administrative health data. We used administrative health data to complete two independent cohort studies in Ontario and Québec. The studies were conducted independently given differences in data elements and regulations prohibiting provincial administrative data from being merged. But efforts were made to create comparable cohorts, variables, and models in both provinces.

We constructed panels of older adults (66 years and older) in Ontario and Québec from 2001/02 to 2017/18 fiscal years who were eligible for provincial health insurance for at least three quarters of the preceding fiscal year. We excluded older adults who did not have valid data on sex and date of birth, and older adults who were long-term care residents. The exposed group in both provinces included older adults who rostered to a FHT/GMF FP at any point during the study period, and the comparison group included older adults who rostered to an FP in a non-team model at any point during the study period. In both the exposed and comparison groups, patients were unrostered at baseline; thus, our study design focuses specifically on *new users* previously unexposed to rostering with a family physician. The process and benefits of rostering to an FP were the same in both groups. Thus, using a comparison group of older adults who rostered with non-teams allowed us to net out the effects of team-based care over-and-above the effects of rostering. We also restricted the analysis to older adults who were observed for at least three years prior to rostering with a FHT/GMF (exposed group) or non-team practice (comparison group). Since rostering with a team or non-team could occur at any time during the study period, this inclusion criteria enabled us to construct comparable pre-exposure time periods for older adults in the exposed and comparison groups.

2.2. Data

In Québec, we partnered with the *Institut national d'excellence en santé et en services sociaux* (INESSS) to construct our cohort (Austin et al., 2021). In Ontario, comparable data were requested through and compiled by ICES (formerly the Institute for Clinical Evaluative Sciences). Databases accessed for this study included: registry files from provincial regulatory colleges, physician billing information, hospital separation and emergency department visit data, prescription drug claims to the provincial insurers, and patient registration files for provincial insurers. Nearly all older adults (66+) in Québec and Ontario were eligible for public prescription drug coverage (Government of Ontario; Gouvernement du Québec; Gouvernement du Québec); thus, our data contained nearly all insured drug dispensations in community pharmacies in the two provinces. In Ontario, these datasets were linked using unique encoded identifiers and analyzed at ICES. The use of the data in this project is authorized under section 45 of Ontario's Personal Health Information Protection Act (PHIPA) and does not require review by a Research Ethics Board. An expedited approval was issued by the McGill University Institutional Review Board (IRB Study Number A08-E61-18A) for analyses conducted in Québec.

Our data contained 3,743,046 and 2,132,053 older adults in Ontario and Québec, respectively. We excluded 2,750,952 older adults in Ontario, and 1,632,793 in Québec who were always rostered during the study period and had not pre-exposure trend, those who had insufficient pre-exposure observations (i.e., less than 3 years), or who were never rostered during the study period. We excluded an additional 5,055 (Ontario) and 15,144 (Québec) older adults due to incomplete data. The analysis sample prior to matching included 987,029 older adults (219,367 in FHT group) in Ontario and 484,116 older adults (163,937 in GMF group) in Québec. After matching, 214,426 (Ontario) and 155,099 (Québec) remained in both the exposed and comparison groups. Older adults in our sample were observed for an average 11.1 time periods (fiscal years) in Ontario and 10.3 time periods in Québec.

2.3. Outcomes

Our outcomes were binary and included the following: an ADR, any selected PIPs, and polypharmacy. ADRs were defined based on a definition developed by the Canadian Institute of Health Information (CIHI) (Canadian Institute for Health Information, 2013), which is based on ICD-10 codes for adverse drug reaction-related hospitalizations (see supplementary materials). Commonly used measures of PIP like the Beers Criteria (American Geriatrics Society, 2019) and STOPP/START (O'Mahony et al., 2015) were not available in the Québec data holdings. Instead, we worked with the pharmacists on our team (LD, CS) to

develop a common PIP measure across provinces. We conducted a review of distinct drugs that have been the focus of deprescribing efforts, and combinations of drugs that are often contraindicated in older adults. This process yielded the list of drugs and combinations in Table 1. We indicate in Table 1 whether the specific drug classes or combinations were drawn from the Beers Criteria or STOPP/START. For combination prescriptions, we required the prescriptions to overlap for at least 14 days.

Our PIP outcome was a binary indicator of having any one of the prescriptions listed in Table 1. For the polypharmacy outcome, we used a crosswalk file to map drug identification numbers to Anatomical Therapeutic Chemical (ATC) codes. Polypharmacy was defined as five or more unique prescriptions per fiscal year at ATC code level three.

2.4. Other variables

Rostering to an FP affiliated with a FHT/GMF model was the main exposure variable. In each fiscal year, we created FP-older adult combinations by assigning older adults to the FP they were rostered to for at least three quarters of the year. We also constructed a cohort by linking older adults to the FP they saw the most during the year. Most older adults were rostered to the same FP they saw most during the year (see supplementary materials), so we relied on the rostered cohort for the analysis presented below. Before the introduction of FHTs in Ontario, patient rostering was already in place. Therefore, physicians who joined FHTs early on already had a list of patients assigned to them. To make sure that these patients were not left out of our analysis, we included older adults who had already rostered with FHT FPs before FHTs were introduced in 2005. To test the robustness of our findings, we varied this period from zero years (i.e., excluding these older adults) to three years and found no material impact on our results.

We captured a range of patient sociodemographic and service-related controls: age, sex/gender, rurality, number of unique prescribers per year, and number of unique prescriptions per year. Given differences in the availability of data elements across the two provinces, we included different proxies for patient need and socioeconomic status. For the former, we captured the number of unique family FP-day contacts per year as a proxy for patient need for primary care in Ontario (no similar measure was available in Quebec). For the latter, we included area-level social and material deprivation in Québec, and eligibility for the low-income drug program in Ontario.

2.5. Statistical analyses

We used a difference-in-differences estimator to estimate the effect of rostering to a FHT/GMF FP on the medication management outcomes listed above. This effect was modeled as an interaction between rostering with an FP and joining an FHT/GMF. A core assumption of the difference-in-differences estimator is that the pre-exposure trends in the comparison groups are parallel (Strumpf et al., 2017). Propensity score matching was used to improve the comparability of the groups and help satisfy this assumption (Basu et al., 2017). We used one-to-one nearest neighbour matching on the basis of sex, year of rostering, and propensity score (within a caliper distance of 0.2) to identify the comparison group (Austin, 2011). The propensity score was estimated using individual patient age, rurality, sociodemographic proxies, and pre-enrollment observations on the three outcome variables: ADR, any PIP, and polypharmacy. Standardized differences were used to assess the balance of observed differences between the groups on these variables. Difference-in-differences estimates were generated using a population averaged model (exchangeable correlation structure with standard errors estimated with Huber/White sandwich estimator) using the *xtreg* command in Stata 15. Estimates were converted into relative risks, with associated standard errors generated using the delta method (Dowd et al., 2014). First, we generated crude estimates of the treatment effects controlling only for time-period using year dummies. For models of ADRs and PIPs, we also estimated adjusted effects controlling for the number of unique medications. Due to differences in data availability, additional analyses were conducted in Ontario where we controlled for the number of unique FP/day contacts to control for patient need for and access to primary care.

Table 1
Specific drug classes and combinations.

Opioids[1]	Opioids + benzodiazepines[5]
Benzodiazepines[2]	NSAIDs + antiplatelets (without PPI)[6]
Anticholinergics[3]	NSAIDs + anticoagulants[7]
Long acting sulfonylureas[4]	

Abbreviations: NSAIDs = Nonsteroidal anti-inflammatory drugs; PPI = Proton pump inhibitor

1. Less specific than STOPP/START recommendation to avoid long-term strong opioids as first line therapy for mild-moderate pain. 2. STOPP/START recommendation to avoid long-term use; Beers Criteria recommendation to avoid. 3 STOPP/START and Beers Criteria recommendations concerning anticholinergic drug burden. 4. STOPP/START and Beers Criteria recommendation to avoid. 5. Beers Criteria recommendation to avoid. 6. STOPP/START and Beers Criteria. 7. STOPP/START and Beers Criteria.

3. Results

Table 2 compares descriptive statistics for the exposed and comparison group in the year prior to enrollment. The standardized differences between the matched groups indicate a reasonable balance of observed characteristics (i.e., less than 0.1). Table A1 in the Supplementary Materials shows the standardized differences between the exposed and comparison groups prior to matching (Fig. 1).

Table 3 displays the estimated effect of rostering to a FHT/GMF affiliated FP on the three outcomes. In Québec, crude estimates of the relative risk (RR) for an ADR show that the risk was 22 % higher (RR = 1.22, 95 % CI = 1.18, 1.26) for older adults rostered to a GMF FP. The magnitude of the effect for older adults in GMFs diminished when we controlled for the number of unique prescriptions (RR = 1.17, 95 % CI = 1.13, 1.20). Despite the large relative effect, the absolute risk difference was 0.3 %, which is a small clinical effect. Crude estimates of the risk of polypharmacy (RR = 1.005, 95 % CI = 1.001, 1.009) and any PIP (RR = 1.007, 95 % CI = 1.001, 1.012) were greater for patients rostered to GMF FPs, but were small in magnitude and had absolute risk differences of less than 1 % (a small effect size for outcomes with a base rate that is greater than 35 %). The effect for any PIP was not statistically significant in adjusted models.

In Ontario, crude estimates of the RR for an ADR show that the risk was 6 % lower (RR = 0.943, 95 % CI = 0.907, 0.978) for older adults rostered to a FHT FP. In the fully adjusted model — where we controlled for the number of unique FP/day contacts — the estimates were consistent with the null hypothesis of no effect (RR = 0.999, 95 % CI = 0.962, 1.036). Crude estimates of the risk of polypharmacy (RR = 1.004, 95 % CI = 1.001, 1.007) and PIP (RR = 1.007, 95 % CI = 1.003, 1.012) were greater for patients rostered to GMF/FHT FPs in both provinces but were small in magnitude (absolute risk differences were less than 1 %). The effect on PIP was not statistically significant in adjusted models.

3.1. Interpretation

In this study, we evaluated whether access to team-based models in Ontario and Québec had an impact on medication management outcomes for older adults. The results of our comparative analysis do not provide strong evidence that access to FHTs or GMFs impacted these outcomes. While crude estimates suggest that access to team-based primary care did predict higher likelihood of ADRs in Québec and lower likelihood of ADRs in Ontario, the absolute risk differences were not clinically important. The differences in effects between Québec and Ontario could also be due to unobserved morbidity differences in

Table 2
Baseline characteristics in matched sample in year before enrollment.

	Quebec			Ontario		
	Non-GMF n = 155,099	GMF n = 155,099	Std. Difference	Non-FHT n = 214,426	FHT n = 214,426	Std. Difference
Age, mean (SD)	74 (6)	74 (6)	0.05	76 (6)	76 (6)	0.02
Female (%)	56.2	56.1	0.001	57.3	57.7	−0.008
Rural (%)	24.6	27.8	−0.07	25.8	26.1	−0.006
Low-income drug program (%)	–	–	–	19.8	19.4	0.009
Material deprivation (%)						
1	15.7	14.5	0.03	–	–	–
2	16.5	18.0		–	–	–
3	20.3	20.2		–	–	–
4	21.6	22.0		–	–	–
5	24.9	23.9		–	–	–
Social deprivation (%)						
1	13.2	14.8	0.03	–	–	–
2	17.3	16.5		–	–	–
3	19.0	18.9		–	–	–
4	23.0	21.8		–	–	–
5	27.2	27.8		–	–	–
1 + ADRs (%)	1.1	1.1	0.01	0.6	0.7	−0.005
Polypharmacy (%)	56.2	55.2	0.05	61.2	60.5	0.02
1 + PIP (%)	39.7	39.1	0.02	43.8	43.1	0.01

Abbreviations: GMF = "les Groupes de médecine de famille", FHT = "Family Health Team", Std. Difference = "standardized difference", sd = standard deviation, ADR = adverse drug reaction, PIP = potentially inappropriate prescription.

patients rostered to these models. Previous research suggests that patients in GMFs, particularly in earlier phases of implementation, had higher levels of need for healthcare services than patients in other practices (Strumpf et al., 2017). Meanwhile, evidence in Ontario suggests that FPs with healthier than average patient populations were more likely to select into FHTs (Rudoler et al., 2015). After controlling for contacts with FPs in Ontario — a proxy for need and access — the estimated effects were more consistent with the null hypothesis of no effect in Ontario.

Other studies have had similar findings. For instance, a study completed in British Columbia found that a pharmacist medication review program in British Columbia did not impact prescription drug use (Kolhatkar et al., 2016). A randomized controlled trial of specially trained pharmacist consultations with FPs in Ontario did not find significant effects of the intervention on medication use, health care use, or health care costs (Sellors et al., 2003). A study completed in Alberta, Canada assessed the impact of pharmacist-led medication review in team-based primary care models on the appropriateness of prescription medication for frail older adults (Khera et al., 2019). The study found no change in the number of prescription medications taken, but a significant decrease in the number of inappropriate medications taken (assessed using the Beers and STOPP/START criteria); the authors found an average decrease of 0.25 PIPs. While our study did not find a similar effect for PIPs, few GMFs — particularly at the start of the study period — included pharmacists. While many FHTs do employ pharmacists, they are not required to engage in standardized medication review with all patients; each FHT may have different roles in place for pharmacists and other members of the team. There are mixed findings with respect to the effect of access to team-based primary care on utilization outcomes (e.g., emergency department visits and hospitalizations) (Glazier et al., 2015; Kiran et al., 2022; Strumpf et al., 2017; McAlister et al., 2018; Carter et al., 2016 Jul; Wranik et al., 2019). One study found that patients rostered to FHTs had similar rates of emergency department visits compared to patients in other non-team practices (Glazier et al., 2015). However, a subsequent study found that rates of emergency department visits increased more slowly in patients rostered to team-based practices (Kiran et al., 2022). A study in Québec found no difference in hospitalizations, or the costs of ED visits in patients rostered to GMFs compared to patients in other practices (Strumpf et al., 2017). However, none of these studies focused specifically on emergency department visits or hospitalizations associated with adverse drug events or reactions.

This result should not be taken as an indication that team-based models do not have the capability of improving medication-related outcomes. There is evidence from experimental and quasi-experimental studies that the integration of pharmacists into primary care teams can improve medication appropriateness (Riordan et al., 2016). However, one of the challenges of evaluating team-based models is the heterogeneity of their construction, implementation, and clinical practices. Even within jurisdictions like Ontario there is variation in team design and functioning (Howard et al., 2011), and teams with similar construction may still have different organizational cultures and team practices. This likely explains the mixed results concerning the effectiveness of team-based primary care across a variety of outcomes. Wranink et al. (Wranik et al., 2019) suggest that more research is needed to understand the specific elements of team construction and functioning that are required to achieve positive patient and system outcomes. We reiterate this claim and suggest that more research is needed on whether variation in team construction (e.g., the inclusion of pharmacists) or team functioning produce meaningful differences in patient-level outcomes related to prescription medication use and medication management.

Our study has several limitations. First, our definition of ADRs was based on an established list of ICD-10 codes that likely produced a conservative estimate of the number of ADRs severe enough to warrant hospitalization. Second, our data allows us to observe whether prescriptions were filled, but not whether the medication was taken as prescribed. Third, data limitations prevented us from using harmonized measures of socioeconomic status and describing and adjusting for patient case mix. Our study also had some important strengths. First, while data limitations prevented us from using widely accepted measures of PIP (e.g., STOPP/START), we were able to develop a measure of potentially inappropriate prescribing that was harmonized across provincial datasets. Second, while Ontario and Québec rely on different drug classification systems, which initially prevented the development of comparable outcomes in the provinces, we resolved this issue by mapping drug identification numbers to common ATC codes.

4. Conclusion

When we formulated this study, our hypothesis was that access to team-based primary care would lead to improvements in medication

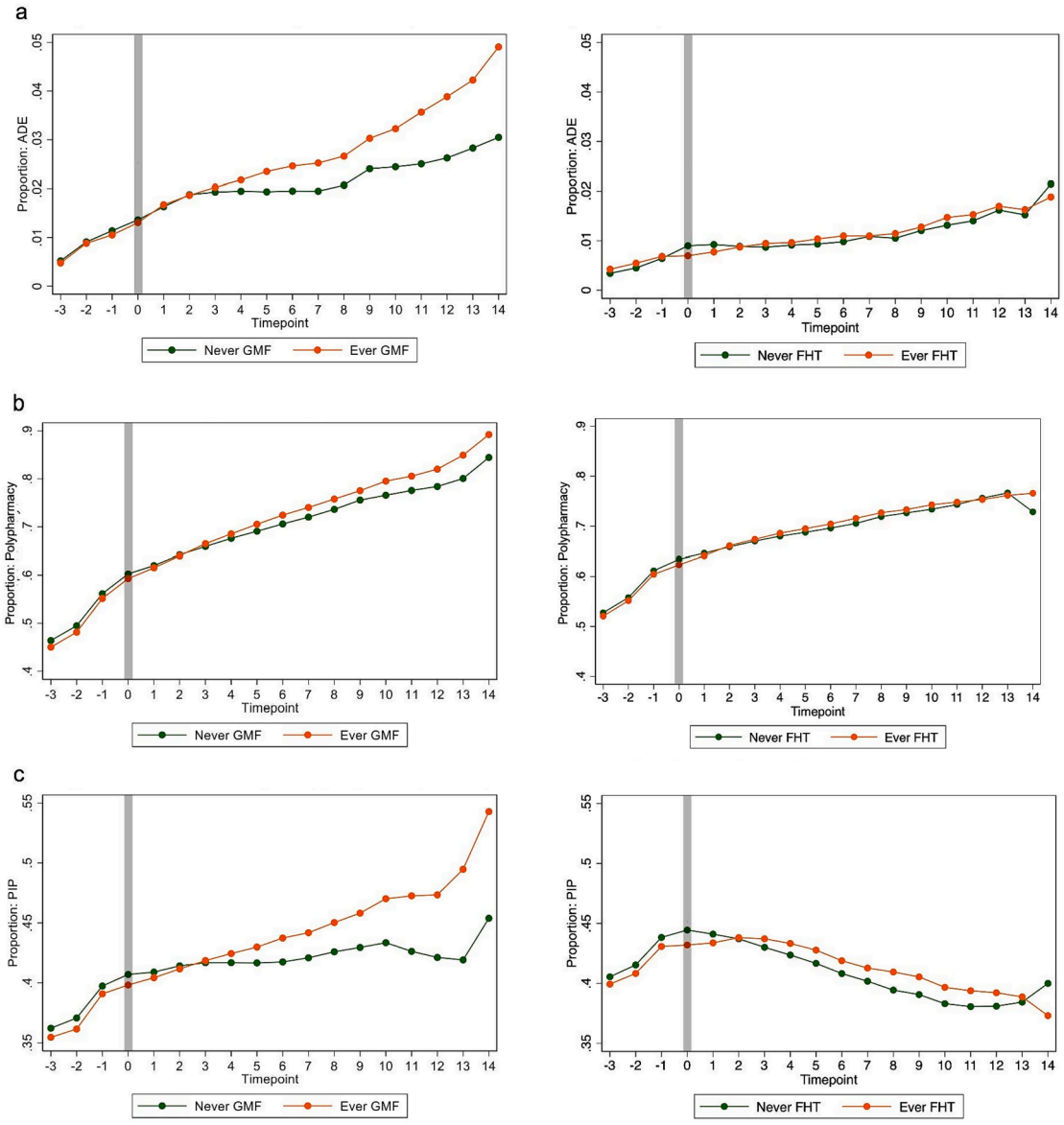

Fig. 1. a to c show the trends for all three outcomes in Québec (left) and Ontario (right) indexed at year of rostering with an FP (year of rostering occurs at Timepoint = 0). Visual inspection of the trends revealed that they are approximately parallel and overlapping in the pre-intervention period (Timepoints −3 to −1).

Table 3
Difference-in-differences model estimates.

	Québec		Ontario		
	Crude	Model 1	Crude	Model 1	Model 2
1 + ADR, RR (95 % CI)	1.22 (1.18,1.26)	1.17 (1.13, 1.20)	0.943 (0.907, 0.978)	0.907 (0.873, 0.941)	0.999 (0.962, 1.036)
Polypharmacy, RR (95 % CI)	1.005 (1.001, 1.009)	–	1.004 (1.001, 1.007)	–	–
1 + PIP, RR (95 % CI)	1.007 (1.001, 1.012)	0.994 (0.989, 1.000)	1.007 (1.003, 1.012)	1.003 (0.999, 1.008)	1.002 (0.998, 1.007)

Notes: Model 1 includes adjustment for the number of unique prescriptions. This covariate was not used to model polypharmacy. Model 2 includes adjustment for number of unique prescriptions and number of unique FP/day contacts. **Abbreviations**: ADR = "adverse drug reaction", "PIP" = "potentially inappropriate prescription", RR = "relative risk", 95 % CI = "95 % confidence interval"

management outcomes relative to alternative primary care practice models. We did not, however, find strong evidence to support this hypothesis. This finding indicates that, at a population-level, the major team-based primary care models in Ontario and Québec have not meaningfully impacted medication-related outcomes. But, given the variety of ways team-based models are implemented and constructed in the Canadian context, it is possible our result reflects this heterogeneity. Individual teams could be leaders in this space and could have lessons to share with us. It is important we give additional attention to optimal team construction — including the roles of different providers and how they work as a team — before making firm conclusions about the effectiveness of team-based primary care. Future research could focus on measuring and learning from variation in medication-related outcomes across providers and teams. We also suggest further in-depth qualitative and quantitative studies of the independent elements of teams that contribute to improvements in outcomes related to medication management and use. Canadian governments have invested in team-based care, and teams remain a vital element of primary care systems — no doubt they will play an increasingly important role as populations age.

Declaration of Competing Interest

The authors declare the following financial interests/personal relationships which may be considered as potential competing interests: The authors have no conflict of interest to declare. The Quebec component of this work was completed through a traineeship at Institut national d'excellence en santé et services sociaux (INESSS). We thank INESSS for their guidance and support throughout the analytical process. The Ontario component of this study was supported by ICES, which is funded by an annual grant from the Ontario Ministry of Health (MOH) and the Ministry of Long-Term Care (MLTC). Parts of this material are based on data and information compiled and provided by the Ontario Ministry of Health and the Canadian Institute for Health Information. The analyses, conclusions, opinions and statements expressed herein are solely those of the authors and do not reflect those of the funding or data sources; no endorsement is intended or should be inferred. We thank IQVIA Solutions Canada Inc. for use of their Drug Information File. Parts of this material are based on data and/or information from the Canadian Drug Product Database and Data Extract, compiled and provided by Health Canada, and used by ICES with the permission of the Minister of Health Canada, 2017. This work was supported by the Canadian Institutes of Health Information (CIHR) (PJT156326).

Data availability

The authors do not have permission to share data.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.pmedr.2023.102512.

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