Assessing the effects of primary care reform in a population of patients with diabetes in Quebec

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SUMMARY

Since 2000, province-led initiatives to bring about sustained changes to the organization of primary care services have taken place in Canada. These efforts were aimed to address the health service needs of the country's ageing population and growing burden of chronic disease. Common objectives were in keeping with the patient-centered medical home: increase access to primary care, promote multidisciplinary team-based care, and improve chronic disease management. In Quebec, Family Medicine Groups were introduced in 2002 as a new organizational model for primary care practice. Family Medicine Groups were intended to be primary care teams serving an enrolled patient population with the average practice being comprised of 10 family physicians, 2 nurses, and 2 administrative support staff. The model's emphasis on enrolment and group practice were anticipated to increase access to family physicians and the quality of care delivered to patients.

An avoidable visit to the emergency department to treat acute complications from an ambulatory care sensitive condition is commonly used as an indicator for measuring access to and quality of primary care services. Diabetes is often the subject of these studies given the wide agreement among clinicians on the guidelines for diabetes care and the important role family physicians play in the delivery and coordination of services. It is estimated that up to 80% of diabetes management in Canada takes place in a primary care practice. Furthermore, the continued rise in the prevalence of the disease with over 7% of the population diagnosed with diabetes in Quebec, understanding health service use in this population is among one of the key priorities for chronic disease surveillance in the province.

The aim of this thesis was to empirically assess the effects of the province's primary care reform on policy relevant indicators of performance. I exploited changes to primary care practice organization as sources of variation in exposure to assess their effects on markers for access to and quality of services. This was accomplished through a series of

population-based studies of people with diabetes identified using provincial health administrative databases.

The first objective of this thesis was to conduct a systematic review of the literature to assess the existing research and identify gaps in knowledge on primary care reform in Canada supported in part by the Primary Health Care Transition Fund. With regard to health service utilization, the studies reviewed found small reductions in the use of the emergency department and non-significant to moderate effects on hospital admissions. Studies on processes of care related to diabetes generally found small to moderate increases in disease management that were associated with blended capitation payment models. Blended capitation and pay-for-performance were also associated with small increases in the delivery of screening and prevention services. With regard to physician costs and productivity, those practicing in the blended capitation model were found to treat fewer patients and deliver fewer services in comparison to the control groups. However, there was no evidence of cost-shifting and risk selection by physicians participating in this payment model. Among the observations drawn from the risk of bias assessment, subsequent studies should provide clear definitions of intervention and control groups to facilitate the ability to draw inferences and guide future policy.

The second objective was to examine the effect of the Family Medicine Group model's diffusion over time on the rate of avoidable visits to the emergency department. Marginal structural models were used to account for time varying exposure and confounding variables. Our results indicated that for every 10-percentage point increase in the population enrolled with a Family Medicine Group in the year prior to an event, there was a 3% reduction in avoidable visits to the emergency department made by an individual (Rate ratio = 0.97; 95% CI = 0.95, 0.99). When examining this further, we found evidence that for every 10-percentage point increase in Family Medicine Group enrolment at $t - 1$ there was a significant decrease in avoidable emergency department visits among diabetic patients who had at most 1 visit to the emergency department per year (Rate ratio = 0.97; 95% CI = 0.95, 0.99), and non-significant effects among more frequent users. Our results also indicated that within low enrolment regions, every 10-

percentage point increase in enrolment in Family Medicine Group practices at *t* -1 led to an 18% decrease in the number of avoidable emergency department visits (Rate ratio = 0.82; 95% CI = 0.78, 0.87). The effect disappeared when the analyses were restricted to the high enrolment regions (Rate ratio = 1.00; 95% CI = 0.92, 1.09), suggesting that an early protective effect may have been diluted over time in regions with greater diffusion of the reform.

The final objective focused on an extension to patient enrolment policies that was introduced in 2007 with the goal to promote and optimize group practice. In principle, clinics that opted to be accorded group practice status by the province's public health insurance board (*Régie de l'assurance maladie du Québec*) could provide more streamlined service delivery among physicians in the group practice by sharing responsibility for vulnerable patients who are unable to be seen by the family physician with whom they were enrolled with. Using a difference-in-differences approach that propensity score matched physicians at baseline, the analysis measured the effect of a clinic's group practice status on physician adherence to diabetic retinopathy screening guidelines. Our main results indicated that compared to physicians who did not opt for group practice status (control group), there was no change in the rate of guideline recommended retinopathy screening among patients seen by physicians who registered a change in group practice status (Rate ratio= 1.00 95% CI: 0.95, 1.05). Additional analyses showed that effects did not differ according to early versus late physician uptake nor was there evidence of any lead or lag policy effects.

This thesis contributes to the current dialogue on the delivery of primary care in Quebec in the context of a recent agreement struck between the Ministry of Health and Social Services and the province's federation of family physicians (*Fédération des médecins omnipraticiens du Québec*). Features of Quebec's primary care reform such as the FMG model and patient enrolment are often identified as the way forward for increasing access to and quality of health services. The results from these studies suggest that although patient enrolment in FMGs has contributed to reductions in avoidable ED use, there is heterogeneity in implementation that appears to correlate with early versus

late physician adoption. Additionally, the effect of changes to practice incentive policies on quality of care, as it pertains to diabetic patients, appeared to have had no effect. These findings align with the literature in suggesting that greater implementation support is required for shifting practices toward a medical home model.

RÉSUMÉ

Depuis l'an 2000, les provinces canadiennes ont initié des changements soutenus à l'organisation des services de soins de première ligne. Ces efforts visaient à combler les besoins de la population vieillissante en matière de services de santé et à diminuer le fardeau grandissant des maladies chroniques affectant cette population. Les objectifs étaient reliés aux 'medical home model' axées sur les patients: améliorer l'accès aux soins de première ligne, promouvoir les soins prodigués par les équipes multidisciplinaires, et améliorer la gestion des maladies chroniques. Au Québec, les groupes de médecine de famille (GMF) ont été introduits en 2002 en tant que nouveau modèle organisationnel pour la pratique des soins de première ligne. Les GMF étaient destinés à être des équipes servant une population de patients inscrits. L'équipe moyenne comprenait 10 médecins de famille, 2 infirmières et 2 employés faisant du support administratif. Ce modèle, en mettant l'accent sur l'adhésion et la pratique de groupe, devait favoriser l'accès aux médecins de famille ainsi qu'améliorer la qualité des soins livrés aux patients.

Une visite aux soins d'urgence afin de traiter les complications d'une condition peut parfois être évitée grâce aux soins ambulatoires. Ces visites sont souvent utilisées comme indicateurs de la qualité des services de soins de première ligne ainsi que leur facilité d'accès. Le diabète est souvent le sujet de ces études, étant donné le consensus chez les cliniciens quant aux façons de traiter le diabète et l'importance qu'ils ont dans la prestation et la coordination des services. Jusqu'à 80% de la gestion du diabète au Canada a lieu dans une pratique de soins de première ligne. De plus, considérant la prévalence grandissante du diabète, avec plus de 7% de la population Québécoise diagnostiquée, bien comprendre comment la population utilise les soins de santé est une priorité afin de surveiller les maladies chroniques au sein de la province.

L'objectif de cette thèse était d'évaluer empiriquement l'effet de la réforme de soins de première ligne sur les indicateurs de performances. J'ai utilisé les changements apportés à l'organisation de la pratique des soins de première ligne comme des sources de

variation pour évaluer les effets sur les marqueurs d'accessibilité et de qualité des services. Ceci a été fait à travers une série d'études sur des populations d'individus diabétiques identifiés à l'aide des bases de données administratives provinciales.

L'objectif premier de cette thèse était d'effectuer une revue systématique de la littérature afin d'évaluer les recherches existantes et d'identifier les manques en connaissance sur la réforme des soins de première ligne au Canada, subventionnée en partie par le Primary Health Care Transition Fund. En lien avec l'utilisation des services de santé, les études couvertes ont trouvé des légères réductions dans l'utilisation du département d'urgence ainsi que des effets négligeables à modérés sur le taux d'hospitalisation. Les études portant sur les processus de soins du diabète ont, en général, trouvé des augmentations faibles à modérées de la gestion de la maladie associé aux modèles de rémunération fondés sur la capitation pondérée. La capitation pondérée et la rémunération au rendement ('pay-for-performance') étaient aussi associées à de faibles augmentations dans la prestation des services de dépistage et de prévention. En lien avec les coûts et la productivité des médecins, ceux qui adhèrent au modèle de capitation pondérée traitaient en moyenne moins de patients et fournissaient moins de services en comparaison aux groupes de contrôle. Cependant, il n'y avait aucune évidence de déplacement de coûts ou de sélection des risques par les médecins participant à ce modèle de rémunération. Parmi les observations tirées de l'évaluation des risques de partialité, les études ultérieures devraient fournir des définitions claires des groupes de contrôle et d'intervention afin de faciliter l'aptitude à tirer des conclusions et à guider les politiques futures.

Le second objectif était d'examiner l'effet de la diffusion du modèle GMF dans le temps sur le taux de visites évitables au département d'urgence. Les modèles structuraux marginaux ont été utilisés pour tenir compte de l'exposition variable dans le temps et des variables de confusion. Nos résultats indiquent que pour chaque augmentation de 10% de la population inscrite auprès d'un GMF au courant de l'année précédent d'un événement, il y a eu une diminution de 3% des visites évitables à l'urgence pour un individu (ratio des taux = 0.97; 95% IC = 0.95, 0.99). Nous avons prouvé un effet graduel par lequel une

augmentation de 10% des adhésions aux GMF à $t - 1$ produisait une diminution significative des visites évitables à l'urgence chez les patients diabétiques qui ont au plus 1 visite par an à l'urgence (ratio des taux = 0.97 95% CI = 0.95, 0.99), ainsi que des effets négligeables chez les utilisateurs fréquents. Nos résultats ont aussi indiqués que parmi les régions à faible adhésion, une augmentation de 10% des adhésions aux pratiques de GMF a $t - 1$ menait à une diminution de 18% du nombre de visites évitables à l'urgence (ratio des taux = 0.82; 95% CI = 0.78, 0.87). L'effet disparait lorsque les analyses étaient restreintes aux régions avec un haut volume d'adhésion (ratio des taux =1.00; 95% CI = 0.92, 1.09), indiquant qu'un effet protecteur prématuré a pu être dissous dans le temps pour les régions avec une meilleure diffusion de la réforme.

Le dernier objectif ciblait un prolongement des politiques d'adhésion des patients qui était introduite en 2007 avec le but de promouvoir et d'optimiser les pratiques de groupes. En principe, les médecins des cliniques choisissant un statut de pratique de groupe, accordé par la Régie de l'assurance maladie du Québec, pouvaient prodiguer des meilleurs services, simplifiés par le partage de la responsabilité des patients vulnérables qui n'ont pu voir le médecin de famille auprès duquel ils étaient inscrits. Selon une approche de différence parmi les différences ('difference-in-differences') qui appariait les médecins selon un score de propension, l'analyse mesurait l'effet du statut de la pratique de groupe d'une clinique sur l'adhésion des médecins aux lignes directrices concernant le dépistage de la rétinopathie diabétique. Nos résultats principaux ont indiqué que, comparé aux médecins qui ont choisis de ne pas avoir le statut de pratique de groupe (groupe de contrôle), il n'y avait aucun changement quant au taux de dépistage de rétinopathie suivant les lignes directrices chez les patients suivis par des médecins qui ont changés de statut de pratique de groupe (ratio de taux = 1.00; 95% CI; 0.95, 1.05). Des analyses supplémentaires ont démontré que les effets n'ont pas variés selon l'adoption précoce ou tardive des médecins.

Cette thèse contribue au dialogue concernant la prestation des soins de première ligne au Québec dans un contexte d'une entente récente entre le Ministère de la santé et des services sociaux et la Fédération des médecins omnipraticiens du Québec. Les

caractéristiques de la réforme des soins de première ligne au Québec, tels que le modèle GMF et l'adhésion des patients, sont souvent mis de l'avant comme le chemin à suivre pour améliorer l'accessibilité et la qualité des services de santé. Les résultats de nos études suggèrent que, même si l'adhésion des patients aux GMF a contribué à une diminution des visites évitables à l'urgence, il y a une hétérogénéité dans l'exécution qui semble corréler avec l'adoption précoce et l'adoption tardive des médecins. De plus, l'effet des changements sur les politiques d'incitation de qualité des soins, relatif aux patients diabétiques, est négligeable. Ces constats sont en accord avec la littérature et suggèrent qu'un plus grand soutien et encadrement dans la mise en œuvre des réformes sont nécessaires afin d'orienter les pratiques vers le modèle du 'medical home'.

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CONTRIBUTION OF AUTHORS

Manuscript 1: Carter R, Riverin BR, Quesnel-Vallée A, Lévesque JF, Gariepy G. The impact of primary care reform on health system performance in Canada: A systematic review. [Under editorial board review at *BMC Health Services and Research*]

Manuscript 2: Carter R, Quesnel-Vallée A, Lévesque JF, Harper S. Measuring the effect of Family Medicine Group enrolment on avoidable visits to emergency department by diabetic patients in Quebec, Canada. [Submitted to *Social Science & Medicine*]

Manuscript 3: Carter R, Strumpf E, Quesnel-Vallée A, Lévesque JF, Plante C. Physician response to shared payment incentives in relation to diabetic retinopathy screening guidelines: A difference-in-differences analysis of a natural experiment [Submitted to *Canadian Journal of Diabetes*]

The studies presented in this thesis are the products of the research I conducted under the guidance of my co-authors. I was granted analyst status at the Institut national de santé publique du Québec in order to access the Quebec Integrated Chronic Disease Surveillance System. I wrote all of the SAS programs that were required for data linkage, data management, descriptive analyses, regression analyses and sensitivity analyses. I travelled to Quebec City in order to execute the programs and derive output for analysis. I also wrote all of the manuscripts that were subsequently reviewed by my co-authors. I received methodological and substantive input from Dr. Quesnel-Vallée, Dr. Lévesque, Dr. Strumpf and Dr. Harper.

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input for all 3 manuscripts regarding the conceptualization of the research questions, interpretation of the results, and critical revisions of the manuscripts and thesis.

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Bruno Riverin is a PhD candidate in the Department of Epidemiology, Biostatistics and Occupation Health at McGill University. Mr. Riverin was my second reviewer for the systematic literature review in Manuscript 1. He was also involved in the protocol development, interpretation and critical revision of Manuscript 1.

Céline Plante, MSc, is a scientific advisor at the Bureau d'information et d'études en santé des populations in the Institut national de santé publique du Québec. She was involved in the critical revision of Manuscript 2.

Geneviève Gariépy, PhD, is a post-doctoral fellow at the Institute for Health and Social Policy at McGill University. Dr. Gariépy was involved in the protocol development and critical revision of Manuscript 1.

STATEMENT OF ORIGINALITY

This thesis contributes to advancing knowledge on the effects of primary care reform in Quebec and Canada. In Manuscript 1, I present the first systematic review of the literature on the effects of organizational change in three provinces (Alberta, Ontario and Quebec) that undertook primary care reform to the greatest extent. Manuscripts 2 and 3 are the first studies from Quebec to use administrative data to examine the effects of primary care reform beyond the early years of implementation. Furthermore, they are the first studies to assess these effects among diabetic patients, a population whose care is largely managed in primary care clinics. These studies are relevant to the current changes to primary care in Quebec that aim to increase access to and quality of services.

Although I received valuable input from my committee members and co-authors on the substantive and methodological aspects of the thesis, I confirm that the conceptualization, execution and writing of all components in this thesis are solely mine.

ACRONYMS AND ABBREVIATIONS

CCDSS = Canadian Chronic Disease Surveillance System
CCM = Chronic Care Model
CDA = Canadian Diabetes Association
CI = confidence interval
CIHI = Canadian Institute for Health Information
CLSC = local community health center
CPCSSN = Canadian Primary Care Sentinel Surveillance Network
DAG = Directed acyclic graph
DD = Difference-in-differences
ED = emergency department
FFS = Fee-for-service
FIPA = Fichier d'inscription des personnes assures
FMG = Family Medicine Group
FMOQ = Fédération des médecins omnipraticiens du Québec
GEE = Generalized estimating equations
HbA1c = Glycated hemoglobin
ICD-9-CM (or ICD-9) = International Classification of Diseases (9^{th} revision)
ICES = Institute for Clinical Evaluative Sciences
INSPQ = Institut national de santé publique du Québec
MED-ECHO = Fichier des hospitalization
MSM = Marginal structural model
MSSS = Ministère de la santé et des services sociaux
NDSS = National Diabetes Surveillance System
NPV = Negative predictive value
QIC = Quantum information and computing
QICDSS = Quebec Integrated Chronic Disease Surveillance System
PCMH = Patient-Centered Medical Home
PHCTF = Primary Health Care Transition Fund
PPV = Positive predictive value
RAMQ = Régie de l'assurance maladie du Québec
RR = Rate ratio
RSU = Régistre de la salle d'urgence
YCG = Yearly contact group

INTRODUCTION

Between 2000 and 2006, $800 million in federal funding was distributed to the Canadian provinces and territories with the aim to address the health service needs of the country's aging population.[1] Although reform initiatives were distinct in each province and territory, they largely incorporated quality improvement and incentive-based levers, or changes to the way practices were organized, with emphasis on supporting physician teams or networks.[2] Common objectives aligned with the ideals outlined by the Patient-Centered Medical Home (PCMH) model that promoted increased accessibility, comprehensiveness, coordination and quality of care.[2,3]

Family Medicine Groups (FMGs) were introduced in Quebec in 2002. The reform aimed in part to address the province's poor rankings in terms of access to primary care and avoidable use of the emergency department (ED).[4,5] Key features of FMGs consisted of team-based care, patient enrolment and longer clinic opening hours.[5,6] Family physician participation in the reform was on a voluntary basis and those that opted in received government funds to offset the costs of team-based practice conditional on meeting requirements such as continued patient enrolment and extended opening hours.[6]

Since 2000, syntheses of Canadian primary care reforms have called for research that evaluates these initiatives using appropriate health system performance indicators.[1,2] By March 2014, Quebec spending on FMGs had reached $85.6 million.[7] A 2015 report released by the Quebec Auditor General identified variation in adherence to FMG model guidelines and raised concerns regarding poor oversight and administration of resources within FMG practices.[7] In light of recent statements by the government and the *Fédération des médecins omnipraticiens du Québec* (FMOQ) to continue supporting the current organization of primary care in the province,[8] generating evidence on the impact of key components of the reform in addition to its implementation process is relevant to policymakers, providers and patients.

Since the launch of the most recent wave of primary care reform in Quebec, researchers have raised awareness for the need to take stock of the impacts of these changes on the continuity, accessibility and comprehensiveness of services.[9-11] Using indicators of health system performance that touch upon key policy, family physician and patient stakeholder interests, the first manuscript in this thesis aims to provide the reader with a contextual basis for assessing the effects of reform in Quebec via a systematic review of primary care reforms across Canada. The subsequent empirical studies in the thesis address some of the questions raised in the systematic review that merit further inquiry. Notably, the majority of the studies' findings pertained to early adoption periods and may not be generalizable to determining long-term impacts. The second manuscript responds to this by examining how changes in levels of FMG patient enrolment within regions between 2003/04 and 2011/12 affected access to care as measured by avoidable visits to the ED. The systematic review also revealed inconsistencies regarding the impacts of payment incentives on quality of care. Based on a change in policy in 2007, the third manuscript examined whether the introduction of a shared incentive fee among family physicians in group practices impacted technical quality of care.

After over a decade of reform, these studies address emerging questions about whether changes to the organization of services have succeeded in meeting their objectives including improved access to and quality of care.[7,12,13] This thesis presents an empirical assessment of two key features of Quebec's recent primary care reforms, patient enrolment and incentive payments, and their effects on patient health outcomes and processes of care according to measures of avoidable visits to the ED and adherence to retinopathy screening guidelines, respectively. These endpoints were selected as complementary indicators of access to and quality of primary care.

This thesis addresses 3 main objectives:

- To conduct a systematic review to synthesize the evidence of a causal effect of Canadian primary care reforms on 3 health system performance indicators: health service utilization, processes of care and family physician productivity. (Manuscript 1)

- Based on changes in levels of FMG patient enrolment as an indicator for performance, to measure the effect of FMG diffusion across regions on avoidable use of the emergency department among diabetic patients. (Manuscript 2)

- Using changes in incentive fee structures as a natural experiment, to determine whether family physician practice in clinics with official group status improved diabetes quality of care, as measured by changes in rates of guideline recommended retinopathy screening. (Manuscript 3)

The thesis is comprised of 6 chapters. Chapter 1 provides the context for the manuscripts by outlining the main features of primary care reform in Canada and the key elements of the changes that occurred in Quebec. Chapter 2 describes the data used for the analyses conducted in Manuscripts 2 and 3. Chapter 3 presents Manuscript 1 that contains the systematic review of the literature on organizational reforms to primary care in Canada that occurred from 2000 onward. Chapter 4 presents Manuscript 2 that is a study examining the effect of changes in FMG patient enrolment on avoidable use of EDs by diabetic patients between 2003/04 and 2011/12. Chapter 5 contains Manuscript 3 that is a study assessing whether changes in incentive fee structures that aimed to promote family physician collaboration in chronic disease management influenced physician adherence to diabetic retinopathy screening guidelines. Chapter 6 contains a discussion of the main findings, their implications for future primary care policies in Quebec, and concluding remarks. The appendices contain further explanations on the rationale for the methodologies adopted in each empirical analysis, and additional descriptive and model-based output. Unless specified otherwise, family physicians will hereafter be referred to as physicians.

CHAPTER 1

Literature review

1.1 Primary care reform in Canada

Cross-country comparisons have consistently identified primary care as a critical component to health system performance citing the strength of a nation's primary care sector as a determining factor for improving health outcomes.[14-16] Quality primary care is comprised of 4 defining features: (1) accessibility; (2) continuity of care; (3) comprehensive care to meet physical and mental health needs; and (4) coordinated and integrated care.[15] In a comparative country analysis examining patient outcomes in relation to health system organization, primary care was shown to reduce premature mortality for conditions sensitive to ambulatory services.[17] The same study also noted that although changes to the organization and delivery of primary care in industrialized countries was gaining prominence, countries embarked upon reforms at different times.[17] Early adopters such as the Nordic countries, the United Kingdom, Italy and Spain, began primary care reform in the 1970s and 1980s. By comparison, countries with weaker primary care sectors were primarily made up of those that pursued re-organization later from the 1990s onward.[17]

Although reforms in the organization and delivery of primary care in Canada began in the 1980s, these primarily consisted of small pilot projects that did not achieve system wide change.[2] The late commitment to strengthening primary care arguably contributes to the country's consistent lag behind other jurisdictions that adopted reform strategies decades earlier.[2] In 2000, the Canadian federal government launched an 800 million dollar funding program to support primary care reform across the provinces and territories.[18] Accordingly, between 2000 and 2006, the Primary Health Care Transition Fund (PHCTF) financed changes to primary care that emphasized to varying degrees new organization and service delivery strategies in each province and territory.[1] Additionally, a 16 billion dollar federal investment stemming from the First Ministers Accord in 2003 aimed to specifically address primary care, home care services and prescription drug

coverage.[2] Yet the variation in the intensity of the changes implemented across Canada in addition to the fact that complex reforms often require time before benefits for health outcomes can be observed, have translated into the country trailing behind other industrialized nations with regard to indicators of health system performance related to primary care.[1,2] In a Commonwealth Fund report from 2010 that compared 7 countries, Canada ranked fifth in the percentage of adults reporting no regular physician.[19] In a more recent survey from 2014 of individuals aged 55 and over, respondents in Canada, the United States, and Sweden were the least likely to obtain a same-day appointment with a family doctor.[20] In these same countries, adults were also the most likely to have relied on EDs in the previous 2 years for health needs that could have been addressed in a primary care setting.[20]

Among the reforms to primary care adopted by the provinces and territories, 6 common objectives included: (1) increased access to services; (2) increased coordination of care; (3) better chronic disease management; (4) support for team-based care models; (5) support for patient self-care; and (6) support for implementing electronic medical health records.[2] In comparison to the other provinces and territories, Quebec, Ontario and Alberta have pursued reforms to a greater extent and although the changes adopted in each province are distinct from one another[1,2] their efforts to establish inter-disciplinary team-based models of practice strive toward securing the PCMH.[2] Chapter 2 presents greater details on these initiatives in a systematic review of the reforms implemented in these provinces from 2000 onward.

1.2 The Patient-Centered Medical Home

The idea of the medical home was introduced by the American Academy of Pediatrics in 1967. It initially emphasized a location of care in which patients could seek services and later encompassed principles of comprehensive, coordinated and patient-centered care (i.e. recognition of the contextual factors that affect patient needs).[21] This was closely followed by the World Health Organization's Alma-Ata Declaration in 1978, that echoed the importance of the medical home particularly with regard to social

determinants of health.[22] In the 1990s, the Institute of Medicine in the U.S. began referring to the 'medical home' as a distinct concept in family medicine practice.[21]

Another key contribution to the development of the PCMH was Wagner's Chronic Care Model (CCM) that promoted primary care as the main site for chronic disease management.[21] In its initial proposal, the CCM called for an integrated approach to chronic disease management that shifted focus away from simply meeting acute care needs.[23] The CCM's emphasis on the importance of the organization of primary care for supporting those with chronic illness drew from evidence stemming from the Diabetes Control and Complications Trial of the 1980s.[23] While the trial highlighted the benefits of intensive glycemic control for reducing the risk of retinopathy, neuropathy and nephropathy, it also raised awareness for the importance of the organization of primary care services that is conducive to facilitating tight diabetes control.[24,25] A review of the evidence finds that the CCM is associated with improved health outcomes.[26] However given that the CCM tends to be implemented in practices comprised of motivated physicians who support innovation, it is unclear whether these benefits are sustained over time and whether the findings would apply when adoption takes place within the average practice.[26] Indeed, introducing tangible and discrete interventions, such as patient reminder systems in electronic medical records, can be done with greater ease relative to complex initiatives that aim to re-organize practice models.[27] In a study examining the implementation of the CCM in Quebec, Lévesque et al.[28] highlighted a series of barriers to its application. These included fragmentation between primary care physicians and specialists, the need for greater training support for multi-disciplinary practice, and payment structures that emphasized acute rather than preventive and chronic care.[28]

Taken together, these historical influences have shaped the 5 key elements of the PCMH that closely align with the tenets of primary care: (1) comprehensive care; (2) patient-centeredness; (3) coordinated and integrate care; (4) accessibility of care; and (5) quality and safety.[3] In 2006, the American Academy of Family Physicians launched a 2-year trial in which 36 practices opted to implement the PCMH. The project aimed to study the processes of change within practices and measure the effectiveness of different

model implementation strategies (self-directed or guided).[29] Guided practices had access to consultants and information sessions regarding the realization of PCMH components. In comparison to self-directed practices, those that received guidance were able to implement a broader range of PCMH aspects and were more likely to sustain the changes.[30] However, some components were more difficult to implement than others, including team-based care and population management (e.g. the ability to generate patient lists with specific conditions).[30]

Although the PCMH was developed in the U.S., a number of countries have adopted the model in recognition of its potential to strengthen their primary care sectors and ultimately improve health system performance. Innovation in primary care organization in the U.S. was among one of the important influences in guiding the development of the FMG model in Quebec.[5,31]

1.3 Quebec's Family Medicine Groups

Aspects of the medical home began appearing in Quebec as early as 1972 via the introduction of local community health centers (CLSCs). The CLSC model sought to respond to many of the issues raised in the Alma-Ata Declaration of 1978 namely, the need for primary care to be integrated in communities with an emphasis on prevention, public health, and social determinants of health.[22,32] CLSCs were comprised of a multi-disciplinary team of salaried health care professionals that offered a range of services to meet the needs of the population for a given territory.[5] Yet the model failed to take hold in Quebec and was for the most part rejected by physicians who objected to the salary payment model. Issues also arose with regard to disparities in the range of services offered between the CLSCs that were viewed as inconsistencies as opposed to valid differences based on population need.[5,32] Consequently, private, often solo, practices in which physicians were paid fee-for-service by the province's health insurance board, the *Régie de l'assurance maladie du Québec* (RAMQ), dominated the primary care landscape with the percentage of physicians practicing in CLSCs never reaching beyond 20%.[2]

Prior to 2000, little attention had been granted to the organization of primary care resulting in a fragmented system that was generally viewed as more reactive in its approach to service delivery. On June 15, 2000, the Clair commission was named to examine the problems faced by the health and social services sector in Quebec particularly with regard to funding and organization.[4] The commission proposed the FMG practice model that was intended to re-organize the delivery of primary care in the province by changing physician remuneration and promoting multi-disciplinary teams of healthcare professionals. As such, the orientation of FMGs toward the health needs of a population in a given territory resembled that of CLSCs. However FMGs contained key elements that were novel to primary care in Quebec namely, the introduction of a blended capitation payment to align with the objectives of the patient enrolment model that was proposed by the commission.[5] Blended capitation was rejected by the FMOQ who viewed the new payment scheme as a means to reduce physician revenues.[5] Following negotiations between the government and the FMOQ, the resulting FMG model differed notably from the one proposed by the commission: patient enrolment would be implemented however the base remuneration would remain fee-for-service.[5] Flat rate amounts would be paid annually for every patient enrolled with FMG physicians. These amounts would vary as a function of case severity, defined by a vulnerability classification system.[33,34] FMG practices would also receive funds to hire nurses and administrative staff.[33]

Among one of the main objectives of the FMG reform was to integrate primary care into a regional network of providers in order to facilitate a focus on population health.[31] Contractual agreements between FMG practices and the government stipulated that physicians could receive additional funding for meeting the requirements associated with FMG clinic status, for instance, extended opening hours. Furthermore, a contractual arrangement between the FMG practice and the local services center on the same territory granted FMG clinics access to a nurse who could practice alongside FMG physicians.[12] FMG clinics are typically comprised of 6 to 10 physicians that serve a patient population of roughly 10,000 to 20,000 per clinic. Services are available by appointment and on a

walk-in basis. At the outset, the government outlined 4 main objectives of the FMG reform: (1) to instill greater access to primary care services while ensuring continuity of care for patients enrolled with physicians; (2) improve the quality and organization of services; (3) improve integration of primary care practices with the population health objectives defined for a given territory, and; (4) place greater value on family practice and improve working conditions for physicians.[12]

A number of studies from Quebec have looked at the effect of FMGs on processes of care including preventive services[35], quality of care,[13] specialist involvement for complex care needs,[36] and patient experiences of care,[37,38] including patient reported quality of life.[39] In a study examining the association between the type of primary care organization and the delivery of clinical preventive services, the authors reported a significant 22% increase in the odds of achieving a clinical preventive services score of 75% and over among patients affiliated with FMG practices relative to those in private or non-FMG group practices.[35] Scores were calculated as the mean of the sum of recommended services received by an individual divided by the total number of services for which she was eligible for.[35] The extent to which organizational characteristics of primary care practices influenced technical quality of care (i.e. adherence to practice guidelines) were multi-faceted, suggesting that policymakers should consider how different aspects of organizations are implemented as opposed to devising the 'best' reform model.[13] When examining the level of integrated services specifically with regard to the involvement of specialists as co-managers for adults with chronic conditions, the authors found that primary care models that place an emphasis on chronic care, including FMGs, were associated with less co-management by a specialist.[36] The authors hypothesized that this finding may be attributed to the innovative and team-based nature of FMGs that promote nurse involvement in clinical activities. As such, for conditions that can be managed in primary care settings, such as diabetes, nurses in FMG practices may have played a greater role in patient co-management.[36]

In a study comparing patient perceptions of chronic disease management between types of primary care organizations, the authors reported higher patient assessment scores

among those treated in FMGs though this did not significantly differ from the assessments of those seen in community health centers.[37] The findings suggested that improvement in chronic disease management across all primary care models in Quebec was required and that certain models were more conducive to fostering aspects of care such as patient self-management and counseling.[40] In particular, components such as coordination and patient activation appeared to lack integration in approaches to chronic disease management.[37] Looking at the effect of the FMG reform on patient experiences of care, the authors reported variation in the percentage of respondents who had visits with nurses and an increase in the use of the clinic's emergency on-call services.[38] In a study examining the association between primary care organizational models and physical or mental health related quality of life, FMGs were found to have no significant effects.[39]

Results from a study assessing the impact of patient enrolment in FMGs on health service utilization indicated a significant 7% decrease in the rate of ED use compared to non-enrolled patients.[41] No significant reductions were reported for the rate of hospital admissions.[41] In a cost analysis of the reform, authors reported that although FMGs were associated with significant reductions in health service use costs in early years, in relation to the FMG implementation expenditures the net gains were small.[42]

In sum, the evidence reviewed suggests that FMGs did not produce significant changes in quality of care or patient reported experiences of care across the entire population of patients. Although significant reductions in the use of the ED were observed in the early years of the reform, this did not appear to translate into notable cost savings. To date, the majority of the literature on primary care reform in Quebec stems from survey-based studies that have focused on the regions of Montreal and Montérigie. The work presented in this thesis project contributes to the small yet growing body of evidence on primary care reform in Quebec that uses population-based administrative data to isolate the effect of interventions on patient outcomes for a specific chronic condition.[41,43] Furthermore, the studies in this project are the first to draw inferences on the effects of the reform beyond the early adoption period.

1.4 Policy diffusion processes

The field of implementation science emerged from the need to support evidence based practice in health care delivery. It seeks to ensure that empirical studies have the theoretical underpinning to facilitate the interpretation of results and guide future practice.[44] The literature identifies 3 main aims for the use of implementation science: (1) to describe or guide the translation of research to practice; (2) to explain the outcomes produced by the implementation of a policy; and/or (3) to assess the implementation process.[44]

Rogers' diffusion of innovation theory is frequently cited in the implementation science literature to explain intervention outcomes. Inherent to the theory is the distinction between different types of innovation adopters according to the point in time that they accepted change during the diffusion process (eg. early versus late in the adoption period).[45] Particularly in the case of complex interventions, knowledge regarding the implementation process prior to the application of the intervention is an important component to successful integration.[45] Accordingly, in the context of voluntary uptake of innovation, legislative change is likely insufficient in successfully diffusing reform. Previous work on the diffusion of FMGs in Quebec highlighted the importance of physicians' receptivity to change.[46] Specifically, normative and mimetic influences within practices were shown to be key elements in the successful implementation of the model.[46] As such, establishing the legislative framework for new models of primary care were deemed insufficient for driving reform. Professional values, peer pressure and the desire to mimic high performing practices were identified as key factors for successful diffusion of the reform since these were considered important for supporting uptake by late adopters.[46]

Rogers' theory of innovation diffusion therefore raises important questions: do the effects of innovation vary according to early versus late adoption? If variation exists, what drives heterogeneity in implementation? And, what measures can be introduced to facilitate successful implementation? Addressing these questions can inform study

design, enhance the interpretability of empirical results, and raise the policy relevance of findings.

1.5 Assessing Quebec's primary care reforms using ambulatory care sensitive chronic conditions

Features of FMG practices such as patient enrolment, team-based care, and extended opening hours, align with PCMH principles that aim to foster accessible, continuous, comprehensive, coordinated and integrated care particularly for chronically ill patients. While chronic disease management is a critical component of medical homes, assessments of a model's performance with regard to chronic disease management must take steps to avoid misattributing results to performance. Ambulatory care sensitive conditions that are prevalent and largely managed in primary care are often used to assess the effects of primary care reform on health system performance indicators.[47] Such indicators include avoidable visits to the ED which are considered proxies for access to and quality of care.[48] It is estimated that 7.2% of the population in Quebec is diagnosed with diabetes, with this figure expected to reach 9.9% by 2020.[49] As shown in Figure 1, the prevalence of diabetes between 2000/01 and 2012/13 among individuals aged 20 years and older in Quebec has been steadily increasing. While these trends are observed in both sexes, the prevalence is higher among men (Figure 2). Similar observations are drawn for the incidence of new cases among those aged 20 years and older (Figure 3 & 4).

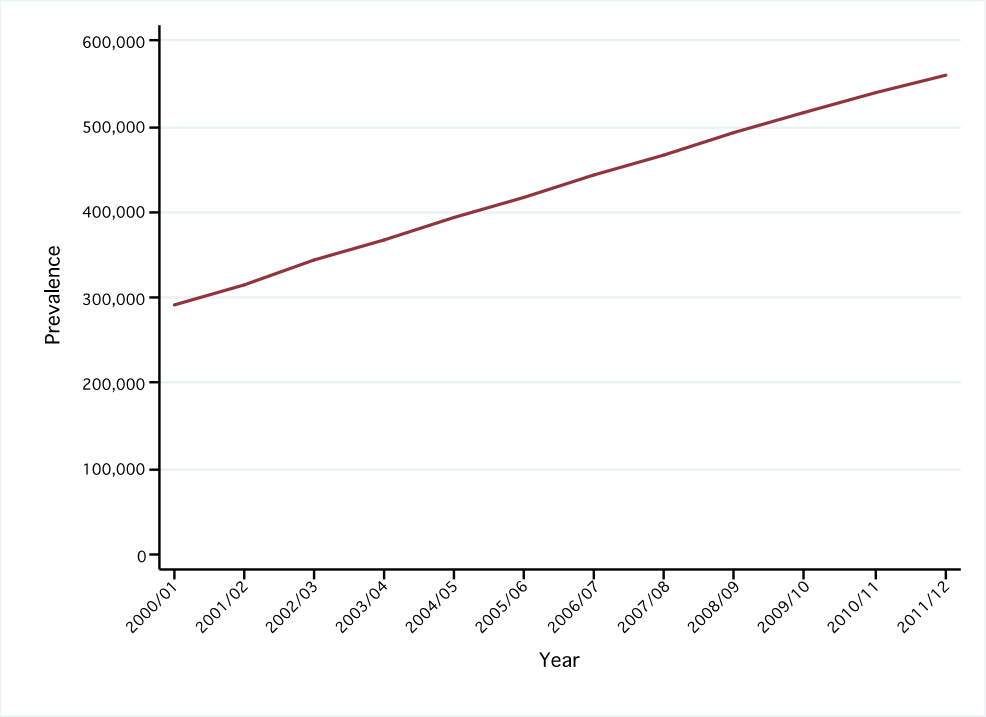

Figure 1. Diabetes prevalence in Quebec among individuals aged 20 years and older, 2000/01 to 2011/12

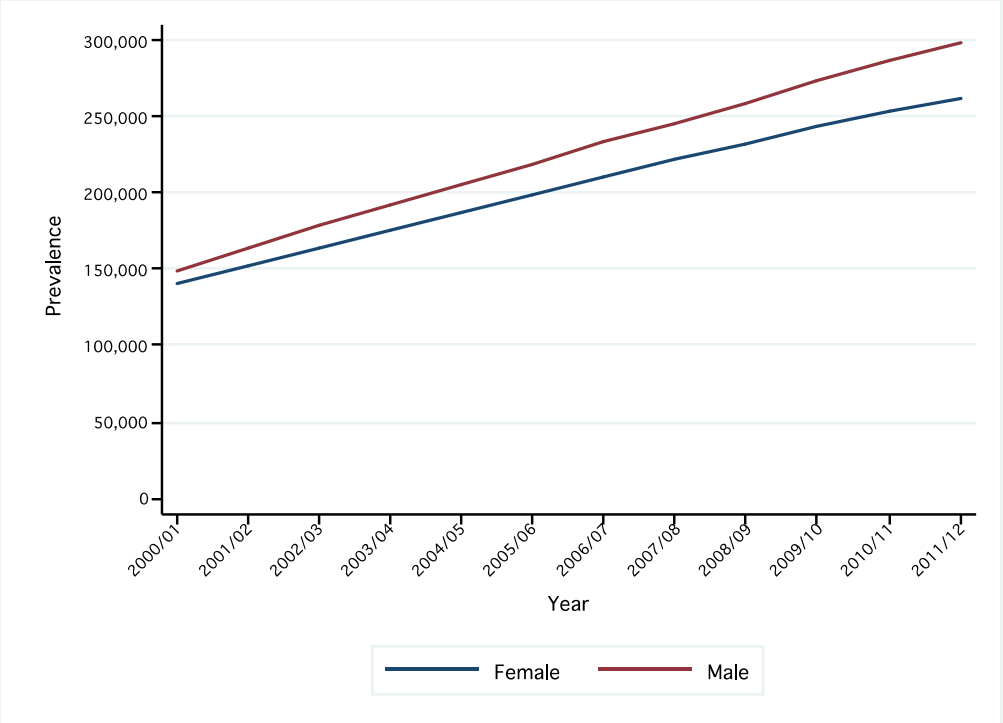

Figure 2. Diabetes prevalence in Quebec stratified by sex among individuals aged 20 years and older, 2000/01 to 2011/12

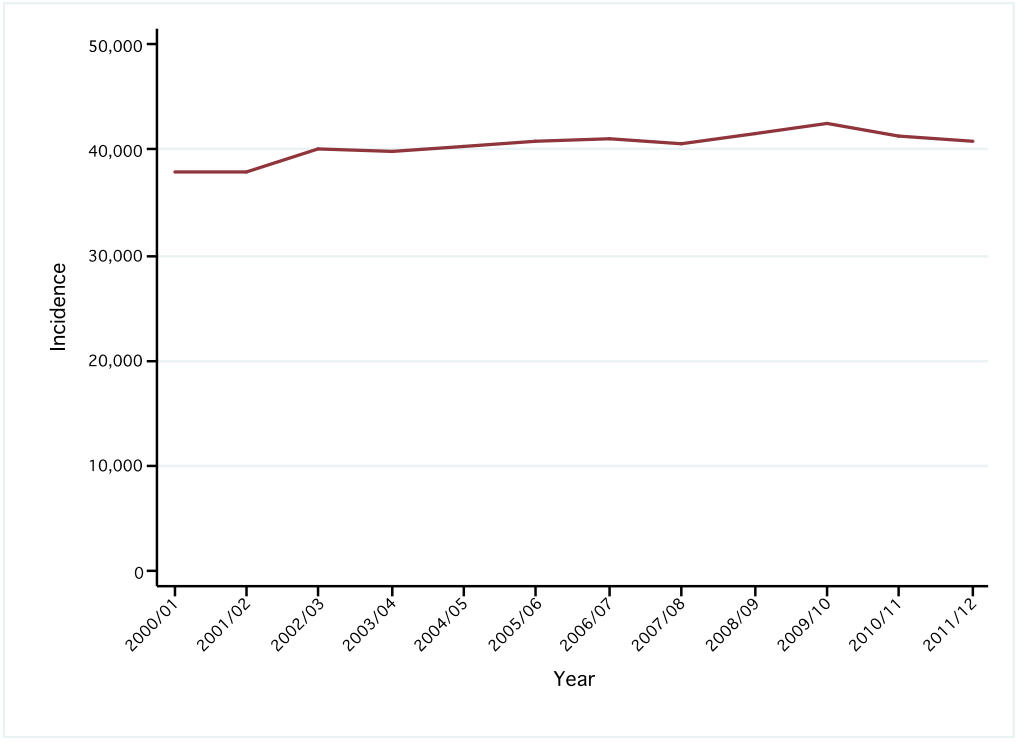

Figure 3. Diabetes incidence in Quebec among individuals aged 20 years and older, 2000/01 to 2011/12

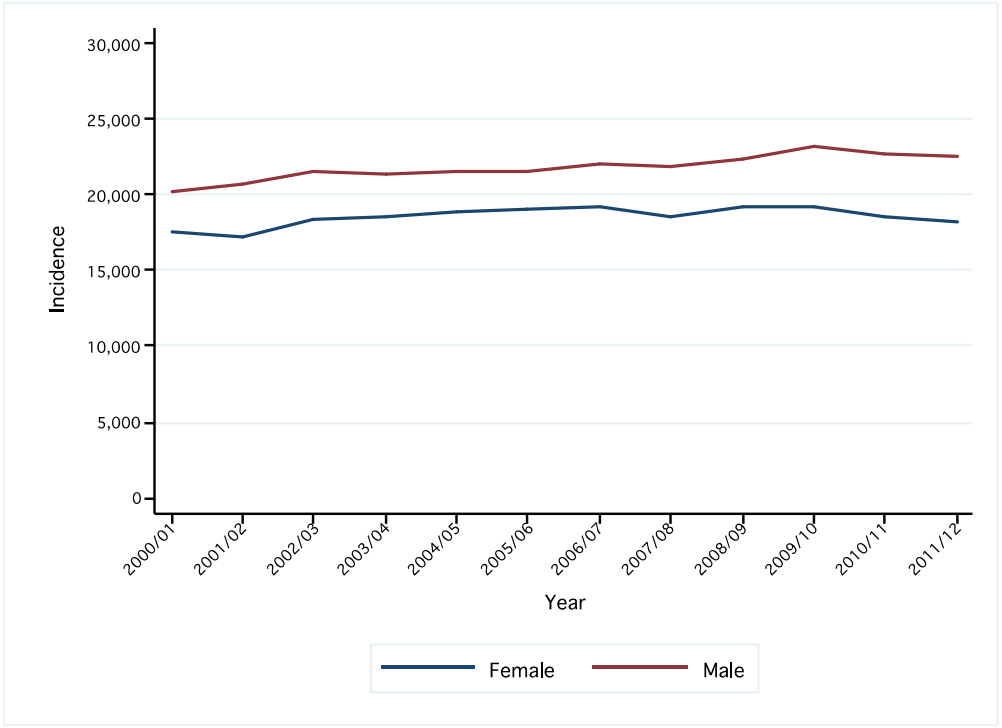

Figure 4. Diabetes incidence in Quebec stratified by sex among individuals aged 20 years and older, 2000/01 to 2011/12

Diabetes is frequently the focus of PCMH evaluations[47] given the general agreement among providers on the clinical guidelines for bringing it under control.[50] Primary care clinics in Canada are the main sites where diabetes management by practitioners takes place.[51] However, it is unclear whether reforms to promote the medical home model in Quebec have resulted in changes to avoidable health service use and quality of care. The studies that follow examine this question within Quebec's diabetic patient population.

CHAPTER 2

Data source

The following outlines the data that were used in the completion of the analyses. Section 2.1 describes the data that were relevant for Manuscripts 2 and 3. Section 2.2 describes a complementary dataset required for Manuscript 2.

2.1 Quebec Integrated Chronic Disease Surveillance System (QICDSS)

In 2002, the *Institut national de santé publique du Québec* (INSPQ) was mandated by the *Ministère de la santé et des services sociaux* (MSSS) to develop a diabetes surveillance system using administrative databases from the RAMQ and the MSSS. Among the main objectives of this mandate was to provide annual estimates of the incidence and prevalence of diabetes in Quebec.[52] Beyond this primary function, the surveillance system also aims to develop indicators for measuring diabetes-related complications, mortality, consumption of prescription medication and patterns of health service utilization.[52] For this purpose and for the purposes of developing surveillance systems for other chronic diseases, the INSPQ has access to the Quebec Integrated Chronic Disease Surveillance System (QICDSS) that links different population medico-administrative databases. Figure 5 illustrates the linkage units for each database. The creation of the QICDSS and access to its data meet stringent standards of security and privacy procedures. Data are kept in a secure location at the chronic disease and trauma surveillance unit in Quebec. This project was considered relevant in regards to indicator development and I was therefore accorded analyst status in order to access the QICDSS. The *Fichier d'inscription des personnes assurées* (FIPA), the *Ficiher des hospitalisations* (MED-ECHO) and billing databases were used to complete the research objectives.

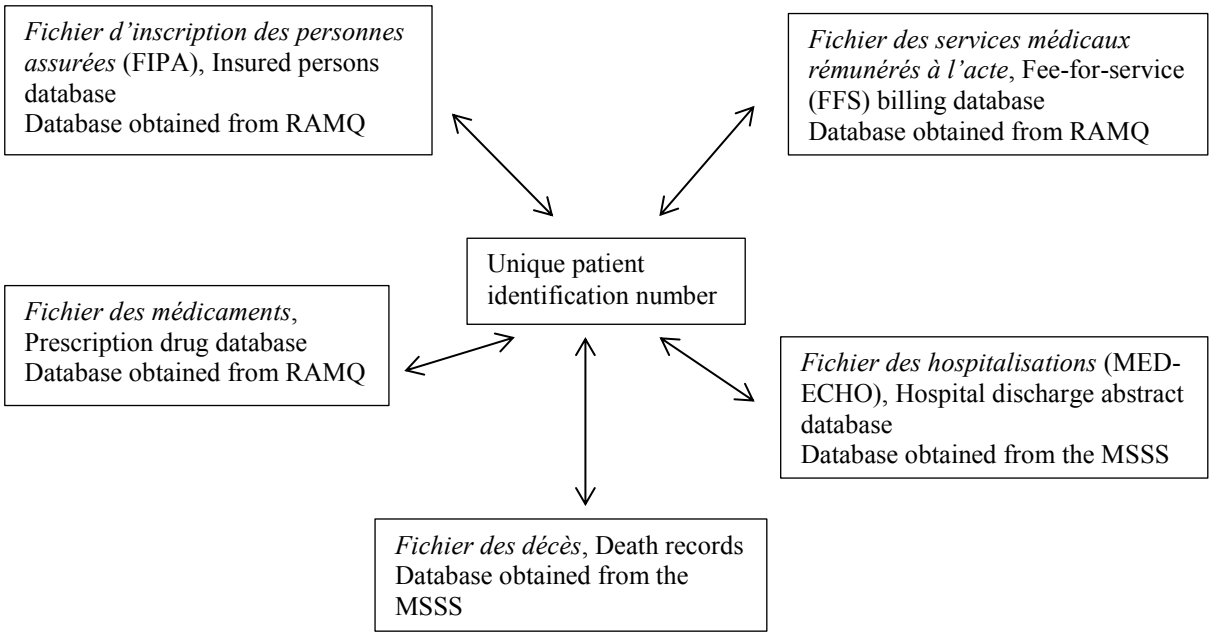

Figure 5. Linkage of the databases included in the Quebec Integrated Chronic Disease Surveillance System

Soon after the end of each fiscal year, the databases are updated to incorporate information from the previous fiscal year. The current available data on which the analyses are based span from 1996/97 to 2013/14. The INSPQ is a collaborator of the Canadian Chronic Disease Surveillance System (CCDSS), a project formerly named the National Diabetes Surveillance System (NDSS) launched by Health Canada in 1997 to establish a provincial and territorial data network on pan-Canadian trends in diabetic populations.[53] It is now supported by the Public Health Agency of Canada and has broadened its scope by integrating several other chronic diseases.[54] To facilitate cross-provincial comparisons, the case definition used by the INSPQ to identify diabetic patients from administrative records is based on the one developed and used by the CCDSS.[52] Accordingly, a new case is defined by:

- At least two physician claims with a diagnosis of diabetes (ICD-9-CM code 250) on two separate days within a two-year window, or;
- A hospital discharge abstract that contains a diagnosis code for diabetes.[55]

In order to exclude gestational diabetes which is transitional but sometimes miscoded as diabetes mellitus, all diagnosis codes in medical service claims or hospital discharge records within 120 days prior and 180 days after an obstetrical hospitalization are not considered part of the case definition.[55,56] A validation study examining the sensitivity and positive predictive value of this case definition was conducted in Quebec using blood glucose lab test results and patient medical files.[57] It was found to have a sensitivity of 94.6% (95% CI: 93.1, 96.0) and a positive predictive value of 87.9% (95% CI: 86.4, 89.4).[57] A systematic review and meta-analysis of validation studies examining the diabetes case identification strategy from administrative data concluded that although this definition may miss up to a fifth of cases and inaccurately include 2% of individuals, it was still deemed appropriate for surveillance purposes.[58]

There are limitations to relying on administrative data for conducting surveillance or etiologic studies. Firstly, the data only capture patients who are in contact with the health system and have been diagnosed with diabetes. In instances where patients are asymptomatic and therefore not screened for this condition, no diabetes code would appear in billing or hospital records thereby producing under-estimates in measures of incidence and prevalence. Under-estimation is also a concern if health service utilization is influenced by one's ability to pay for care. The latter is less relevant in this context given universal health coverage for physician and hospital services in Canada.[59]

The follow-up period in each of the research objectives that rely on administrative data utilized records from fiscal year 2000/01 onwards to align with how incident and prevalent cases are captured in the data. The main challenge in identifying cases of chronic disease in administrative data compared with clinical registries is distinguishing between incident cases that are diagnosed for the first time and prevalent cases. To address this, a time window, or 'run-in' period, was defined to accurately distinguish between incident cases and the prevalent cases that were already diagnosed before the surveillance system was put into place.[59] This 'run-in' period varies according to the disease under consideration. For instance, if a diagnosis code appeared for a patient at time *t*, records from previous years must be assessed to determine whether the code at

time *t* identified a first diagnosis (incident case) or an episode of care (prevalent case). Based on administrative health data in Quebec, a 'run-in' period of at least 4 years was considered sufficient for distinguishing between incident and prevalent cases of diabetes.[59] For this reason, fiscal years 1996/97 to 1999/00 comprise the 'run-in' period for identifying diabetes cases and were not included as part of each study's follow-up period.

2.2 Complementary datasets

Additional data were required for exposure measurement and covariate adjustment in Manuscript 2. Exposure was defined as the percentage of a health and social services region's population enrolled with a family physician practicing in an FMG. Data on the number of individuals enrolled with family physicians in each health and social service's region between fiscal years 2002/03 and 2011/12 were obtained from the *Direction de l'organisation des services de première ligne intégrés* at the MSSS. The data contained information on family physicians and patient enrolment (Table 1).

Table 1. List of variables in the dataset from the Direction de l'organisation des services de première ligne intégrés

Level of information	Variables
Practice	Number of FMG practices
Physician	Number of family physicians Number of family physicians practicing in FMGs
Patient*	Number of vulnerable patients enrolled with a family physician Number of non-vulnerable patients enrolled with a family physician Total number of patients enrolled with a family physician

*Each variable was defined for patients enrolled with physicians in FMG and non-FMG practices.

For each health and social services region between fiscal years 2003/04 and 2011/12, data from the *Institut de la statistique du Québec* were used to define the denominator for the percentage of the population enrolled with a physician in an FMG practice.

CHAPTER 3

Manuscript 1: The impact of primary care reform on health system performance in Canada: A systematic review

3.1 Preface to Manuscript 1

As increasingly large numbers of individuals are surviving to older ages with often multiple and complex chronic conditions, the organization and delivery of primary care in Canada and in other industrialized countries are changing as family physicians take on a larger role in the coordination of patient care.[60,61] A strong primary care sector is widely accepted as a necessary component to a high performing health system.[16] The PCMH framework was developed in the U.S. in response to the need for improved chronic disease management and patient centered primary care. Its five components include: (1) comprehensive care; (2) patient-centered care; (3) coordinated care; (4) accessibility, and; (5) safety and quality of care.[62] Although the PCMH has been adapted to different countries' health system contexts, and to varying degrees within Canada, organizational scale-up leading to the formation of a partnership, network, or federation of physicians, is seen as a necessary condition to achieving it.[63]

In recognition of Canada's ageing population and the growing burden of chronic disease, 800 million dollars in federal funding was distributed across all provinces and territories between 2000 and 2006 through the PHCTF.[1] Since 2000, reforms to primary care across Canadian jurisdictions have emphasized to different extents quality and incentive-based levers, and/or organizational changes that include either the creation or re-definition of regional health territories or changes to practice-level organizational structures, and in some instances, both of these.[1,64] To respond to the growing need for health services,[18] the PHCTF outlined common objectives among which were to increase access to primary care, promote multi-disciplinary practices, and improve chronic disease management.[65] Reforms have largely strived to bring about changes to the delivery of care and to the organization of primary care services and practices.[66] Organizational

changes have generally emphasized team-based practice, inter-disciplinary practice involving allied health professionals, and blended capitation payments to promote patient enrollment with physicians.

Provinces have adopted different approaches to primary care reform though not all have targeted organizational factors. However, the main changes include the creation of team-based models of care comprised of a group of family physicians, nurses, and in some instances other allied health professionals. Recent syntheses of primary care reforms in Canada called for more evidence on the impact of these reforms on various health system outcomes.[1,2] Since then, a number of studies have been published examining their effect on health service utilization, quality of care, and physician productivity. To date, no systematic review of the literature has been published on the effects produced from organizational reforms. Given that models are evolving and new ones are being proposed, systematically summarizing the evidence regarding the effect of these changes is relevant to stakeholders at all levels including policy makers, practitioners and patients. This systematic review aimed to synthesize the peer-reviewed evidence of a causal effect and determine whether Canadian primary care reforms increased health system performance according to measures of health service utilization, processes of care, and physician productivity.

3.2 Approach

This systematic review will focus on the organizational reforms to practice and their effects on health service delivery. Using Aldrich's (1999) conceptualization, an organization can be defined as:

1. Driven by a set of common objectives that guides the actors involved
2. Drawing a distinction between member and non-members of the organization
3. Supported by a framework within which activities that seek to meet the organization's objectives are performed[67]

In the context of this review, these elements are applicable to a primary care practice since: (1) the primary care practice aims to deliver health services that pertain to the treatment and prevention of illness; (2) membership in the practice is based on a recognized skill set that is either medical or administrative in nature; and, (3) the delivery of services in the form of consultations with health professionals within the practice is the main means through which a practice's objectives are met. Organizational change can target a number of dimensions including the content, context, processes, and outcomes.[68] Using this conceptual framework, this review adopts a focus on the content of organizational change that affects primary care practices. More specifically, content refers to the new actors, orientations and strategies within these practices.

The outcomes of interest selected for this review seek to address stakeholder interests at different levels of the health system (government, physician, and patient) in relation to organizational changes stemming from new practice or payment models:

1. Change in health service utilization would be of interest to government policy makers particularly in a single payer health system. For instance, if a practice model succeeds in reducing avoidable use of secondary and tertiary care services, there would be a decrease in health care costs borne by the public payer.

2. Change in patient satisfaction and experience of care relate to organizational shifts that improve or worsen perceived access to and quality of care. Quality of care can also be measured by physician adherence to clinical guidelines.

3. Change in the costs of practice is of concern to physicians since these impact their income and affect productivity. As such, studies looking at impacts on physician income, volume of provided services, and levels of patient enrolment that result from organizational reform are important when drawing inferences on the motivation for organizational change. This is particularly relevant for Canadian primary care reforms that have, up to now, been implemented on a voluntary basis by physicians.

The impact of primary care reform on health system performance in Canada: A systematic review

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3.3 Abstract

Objective: We aimed to synthesize the evidence of a causal effect and draw inferences about whether Canadian primary care reforms improved health system performance based on measures of health service utilization, processes of care, and physician productivity.

Methodology: We searched the Embase, PubMed and Web of Science databases for records from 2000 to September 2015. We based our risk of bias assessment on GRADE guidelines. Full-text studies were synthesized and organized according to the three outcome categories: health service utilization, processes of care, and physician costs and productivity.

Results: We found moderate quality evidence that team-based models of care led to reductions in emergency department use, but the evidence was mixed for hospital admissions. We also found low quality evidence that team-based models, blended capitation models and pay-for-performance incentives led to small and sometimes non-significant improvements in processes of care. Studies examining new payment models on physician costs and productivity were of high methodological quality and provided a coherent body of evidence assessing enhanced fee-for-service and blended capitation payment models.

Conclusion: A small number of studies suggested that team-based models contributed to reductions in emergency department use. Regarding processes of care, increases in preventive care services could be attributed to blended capitation models and pay-for-performance in Ontario. Although blended capitation appeared to lead to decreases in the number of services delivered and patients seen per day, the number of enrolled patients and number of days worked in a year was similar to that of enhanced fee-for-service practices.

Key words: primary care reform, payment models, team-based practice, Canada

3.4 Introduction

Between 2000 and 2006 the Primary Health Care Transition Fund (PHCTF) contributed $800 million towards reforming primary care in Canadian provinces and territories. This effort was aimed to address the health service needs of the country's ageing population and growing burden of chronic disease.[1] Common objectives were in keeping with the idea of the patient-centered medical home (PCMH): increase access to primary care, promote multidisciplinary team-based care, and improve chronic disease management.[65]

The reform initiatives implemented across Canadian jurisdictions have largely emphasized quality improvement and incentive-base levers, and/or organizational changes to practice, including the formation of primary care teams, partnerships, networks, or federations of physicians.[2] In addition, there is growing recognition that the mechanism of physician remuneration plays a role in upholding primary health care objectives such as continuity and quality of care.[69,70] Organizational change to primary care practice in Canada is understood to encompass both team-based service delivery involving allied health professionals, and new blended payment models that seek to promote patient enrolment, continuity, and coordination of care.

Syntheses of primary care reforms in Canada have called for rigorous evaluation of reforms using appropriate health system performance indicators.[1,2] Although a number of studies on various aspects of provincial reforms have been published, no systematic review of the literature exists on the effects produced from practice-level organizational changes.[71] Given that models are evolving and new ones are being proposed, it is imperative to synthesize the knowledge accumulated on these reforms to support future policies. We sought to systematically review and assess the published and peer-reviewed literature that describes practice-level organizational reforms in Canada introduced during or after the PHCTF. We specifically aimed to synthesize the evidence of a causal effect and draw inferences about whether Canadian primary care reforms improved health system performance based on measures of health service utilization, processes of care, and physician productivity.

3.5 Methods

Data sources and inclusion criteria

Our review focused on organizational reforms to primary care in Canada, namely, the formation of group practices (including team-based practices), new payment models intended to support group practice, or both. Provinces that introduced quality and incentive-based reforms without an emphasis on providing financial support for group or team-based practices were not included in this review. Further, those that did implement organizational reforms to practice but only did so in pilot projects were also excluded. We limited the scope of our review to Alberta, Ontario and Quebec where system-wide reform initiatives that meet the above criteria have been pursued.[2]

We searched the Embase, PubMed and Web of Science databases for records from 2000 to September 2015. Studies were eligible if they sought to draw inferences on the effects of new organizational or payment models in the Canadian provinces of interest. Search terms were modified according to the database, where appropriate. We also conducted a hand-search of references cited in the articles included in the review.

Study selection

Two reviewers (RC and BDR) independently screened titles and abstracts of records identified from the database search and included those based on the following criteria: (1) the study pertained to Canada; (2) the study examined reforms in Alberta, Quebec, or Ontario; and (3) the study reported quantitative measures of effect. Articles were excluded if the intervention could not be classified under the defined categories, if the outcome did not fall into the categories outlined in Table 2, or if the article was a commentary. The same two reviewers further investigated articles eligible for inclusion as full text.

Table 2. Outcome assessment for systematic review

Outcome	Examples
Health service utilization	Visits to the emergency department Hospital admissions Visits to specialists
Processes of care	Delivery of guideline recommended chronic disease management Delivery of clinical preventive services
Physician costs/productivity	Number of services delivered Number of patients seen Risk selection of patients

Data extraction and quality assessment

Two reviewers (RC and BDR) independently extracted data and performed a risk of bias assessment for each full-text article included in the review. We first piloted our extraction and quality assessment forms on four studies to standardize our approach. We based our risk of bias assessment on GRADE guidelines[72] with adaptations to account for issues of selection bias and exposure definitions specific to our context. Because physician and patient participation in new primary care models is voluntary, studies that addressed the underlying mechanisms determining individual membership in the intervention or control groups either by design or analytical approach were rated favorably. By comparison, a study that did not provide a clear definition of the intervention or control groups received a lower rating due to a greater risk of bias. The body of evidence for each outcome was then summarized according to GRADE categories of high, medium, or low (Table 3).[73] We held reconciliation meetings to compare the information extracted from each article and each reviewer's evaluation of study quality. A third party arbitrator (AQV) was available in the event that disagreements between the two reviewers could not be resolved (a situation that did not arise).

Table 3. Quality rating categories according to GRADE guidelines for assessing the body of evidence

Quality rating	Definition
High	Confidence that the true effect is close to the estimated effect
Moderate	True effect is expected to be close to the estimated effect however it may be significantly different
Low	True effect may be very different from the estimated effect

Data synthesis and analysis

We qualitatively synthesized and organized the results of the full-text studies included in the review according to the three outcome categories: health service utilization, processes of care, and physician costs and productivity. We reported estimates of adjusted measures of effect and precision. We did not synthesize results from studies that did not provide adjusted measures of association. Our synthesis also excluded cross-sectional studies. Although cross-sectional studies can be used to detect associations between factors, they cannot provide evidence for the effect of interventions because temporality cannot be established. Considerable heterogeneity between studies with regard to interventions and measures of outcome precluded a meta-analysis. Our review follows the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) statement.[74]

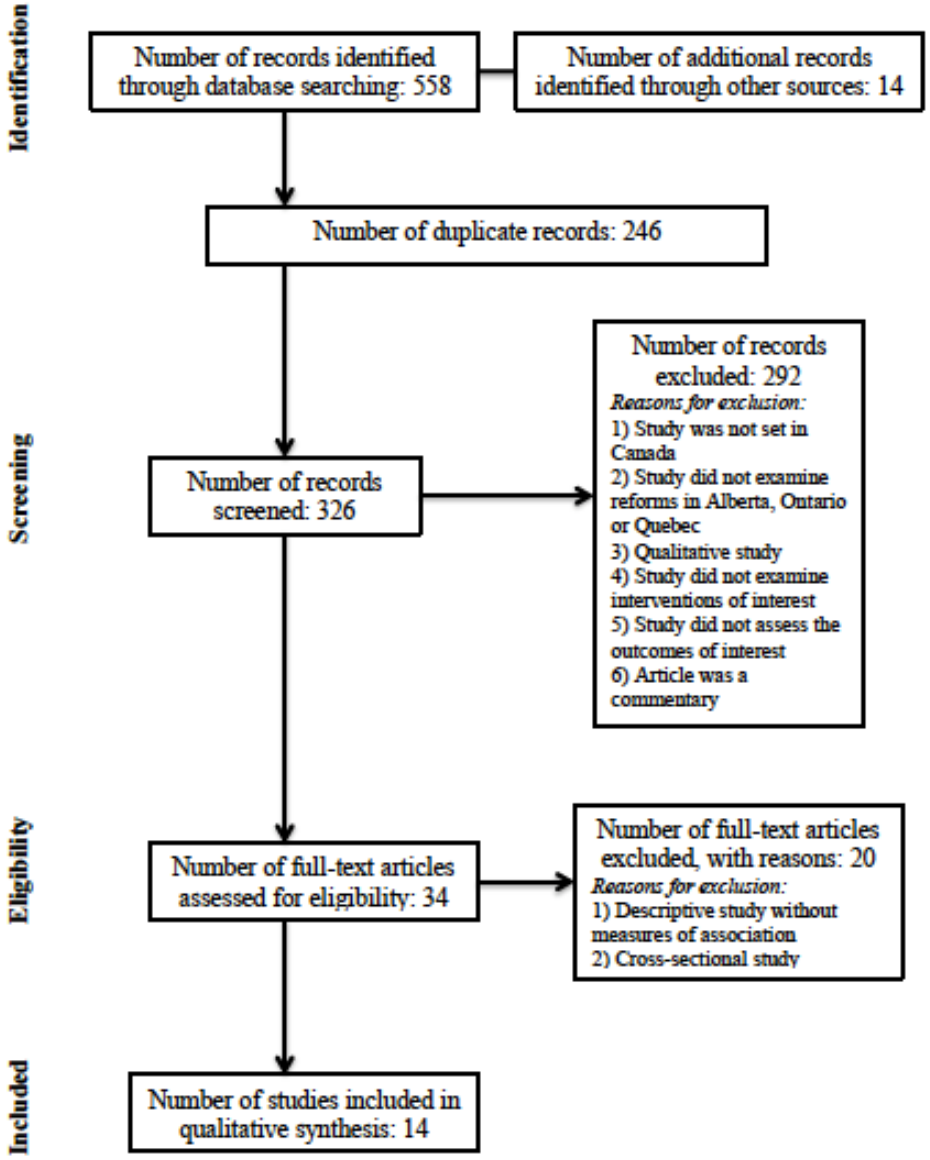


Figure 6. Selection of studies for inclusion in the systematic review

3.6 Results

Search results and study characteristics

Our search identified 572 articles, 558 of which were from the databases and 14 from a hand search. Following the removal of duplicates and the title/abstract review, 34 articles were eligible for full-text data extraction and risk of bias assessment. The PRISMA flow chart in Figure 6 outlines the number of records and exclusion criteria for each stage: identification, screening, eligibility and final inclusion. Of the 14 articles included, the majority focused on the effects of new payment models in Ontario[75-83] (Table 4). The remaining 5 studies from Quebec and Alberta focused on the effects of team-based aspects of primary care reforms.[37,39,84-86] The publication dates spanned from 2009 to 2015. In 8 of the studies, specific sub-populations were used all of which were comprised of individuals with chronic disease. These included 4 studies on diabetic patients[77-79,84], and 4 on chronic conditions in general.[37,39,81,85] With regard to primary outcomes of interest, 3 studies focused on health service utilization[84-86], 7 on processes of care [37,39,75-79], and 4 on physician costs and productivity[80-83] (Table 4). Of the 14 articles, 2 assessed independent associations between several predictors (including primary care reform models) and health system performance outcomes, and 12 specifically assessed the causal effect of defined interventions compared to a control group.

Table 4. Characteristics of studies included in the systematic review

Organizational change	Study				Population				Intervention		
	Source	Year	Design	Province	Study population	N	Sub-population	Study follow-up	Intervention[a]	Comparison group	Primary Outcome
Team-based primary care models	Héroux, J. et al.	2014	Cohort study	Quebec	Patients	231,938	Vulnerable patients	3 years	Family medicine groups	Individuals not enrolled in a Family medicine group	Health service utilization
	Lévesque, J.F. et al.	2012	Cohort study	Quebec	Patients	598	Chronically ill (diabetes, heart failure, COPD, arthritis)	18 months	Family medicine groups[b]	Individuals receiving care in community health centers	Processes of care
	Feldman, D.E. et al.	2012	Cohort study	Quebec	Patients	598	Chronically ill (diabetes, heart failure, COPD, arthritis)	18 months	Family medicine groups[b]	Individuals receiving care in community health centers	Processes of care
	Manns, B.J. et al.	2012	Cohort study	Alberta	Patients	154,928	Diabetes	1 year	Primary care networks	Individuals not enrolled in a Primary Care Network	Health service utilization
	Campbell, D.J.T. et al.	2012	Cohort study	Alberta	Patients	106,653	Diabetes Low-income First Nations	1 year	Primary care networks	Individuals in the sub-population of interest not enrolled with a Primary Care Network	Health service utilization

[a] Where the name of the practice model was not specified, only the payment modality is listed. Accordingly:
Harmonized (blended capitation) models include: Family Health Networks and Family Health Organizations; Non-harmonized (enhanced FFS) models include: Family Health Group and Chronic Care Model

[b] The control group was identified according to how the comparisons were being made in the article and by what was listed as the reference category in a results table from a regression model.

[c] The intervention group was identified as 'payment models' in instances where studies from Ontario survey all payment models as opposed to studying the effect of a single payment model in relation to a control group. Where the name of the practice model is given, we also specified the payment modality associated with it.

[d] The authors examined the Family Health Group model (enhanced FFS) and the Family Health Network model (blended capitation).

[e] The authors examined the Family Health Group model (enhanced FFS).

Organizational change	Study				Population				Intervention		
	Source	Year	Design	Province	Study population	N	Sub-population	Study follow-up	Intervention[a]	Comparison group	Primary Outcome
Payment models and incentives	Kiran, T. et al.	2014	Before and after	Ontario	Patients	Cervical cancer: 3,056,337 Breast cancer: 1,600,645 Colorectal cancer: 3,713,963	NA	10 years	Pay for performance	Outcome measures in the pre-intervention period	Processes of care
	Li, J. et al.	2014	Before and after	Ontario	Physicians	2,154	NA	10 years	Pay for performance	FFS	Processes of care
	Kantarevic, J. et al.	2013	Before and after	Ontario	Physicians	3,588	Diabetes	2 years	Blended capitation	Enhanced FFS	Processes of care
	Kiran, T. et al.	2012	Cohort study	Ontario	Patients	58, 927	Diabetes	5 years	Payment models[c]	Outcome measures in the pre-intervention period	Processes of care
	Jaakimainen, L.R. et al.	2011	Before and after	Ontario	Physicians	3,940	NA	4 years	Payment models[d]	Outcome measures in the pre-intervention period	Processes of care
	Kantarevic, J. et al.	2015	Before and after	Ontario	Physicians	3,428	NA	7 years	Blended capitation	Enhanced FFS	Physician costs/productivity
	Kantarevic, J. et al.	2014	Before and after	Ontario	Physicians	673	Complex and vulnerable patients	2 years	Capitated incentive payment	Enhanced FFS	Physician costs/productivity
	Kralj, B. et al.	2013	Before and after	Ontario	Physicians	4,156	NA	4 years	Blended capitation	Enhanced FFS	Physician costs/productivity
	Kantarevic, J. et al.	2011	Before and after	Ontario	Physicians	7,003	NA	17 years	Enhanced FFS[e]	FFS	Physician costs/productivity

Effectiveness of interventions

Health service utilization (Table 5)

Included studies relied on emergency department (ED) visits and hospital admissions as measures of health service utilization. The populations were similar across studies and consisted mainly of chronically ill patients. Overall, studies that examined team-based primary care reforms in Quebec and Alberta found small reductions in the rate of ED visits and both significant and non-significant changes in the rate of hospital admissions.

More specifically, three studies examined health service utilization as a primary outcome focusing on team-based aspects of reforms among chronically ill or elderly patients in Quebec[85] and Alberta.[84,86] Although the observed tendency pointed to statistically significant decreases in ED visits, the evidence on admissions was mixed. Héroux et al.[85] found a decrease in the rate of visits to the ED attributed to Family Medicine Group (FMG) enrolment within a vulnerable group of patients defined by chronic disease or older age (RR 0.93; 95% CI 0.90, 0.95), yet null effects on hospital admissions (RR 1.02; 95% CI 0.98, 1.06). In studies on the effects of Primary Care Networks (PCNs), Manns et al.[84] reported an 18% reduction in the rate of avoidable ED visits made by diabetic patients affiliated with PCNs relative to those in non-PCNs (RR 0.82; 95% CI 0.76, 0.88) and a 19% reduction in the rate of avoidable admissions for the same patient group (RR 0.81; 95% CI 0.75, 0.87). Campbell et al.[86] also found significant reductions in the rate of avoidable use of the ED and admissions within the general population (RR 0.75 95% CI 0.67, 0.85), low-income population (RR 0.71; 95% CI 0.54, 0.94), and First Nations (RR 0.74; 95% CI 0.59, 0.93).

Processes of care (Tables 6 & 7)

Studies on processes of care were broadly categorized according to whether they focused on diabetes management or the delivery of screening and prevention services. Team-based and blended capitation payment models were generally associated with increases in diabetes management. Blended capitation payment models and pay-for-

performance (P4P) were also attributed to small increases in the delivery of screening and prevention services. Team-based primary care models in Quebec were not associated with improvements in patient-reported health or chronic illness care.

The three studies that examined outcomes related to the process of care for diabetes patients consisted of 1 pre/post study with control group on payment reforms in Ontario,[77] 1 pre/post study with no control group,[79], 1 cohort study,[78] and 1 cohort study on team-based practices in Alberta where processes of diabetes care were secondary outcomes.[84,86] Manns et al.[84] found that relative to diabetic patients not enrolled in a PCN, the rate of patients receiving blood glucose monitoring was 2% higher than non-enrolled patients (RR 1.02; 95% CI 1.01, 1.03). For the same comparison, the rate of visits to the ophthalmologist was 19% higher (RR 1.19; 95% CI 1.17, 1.21) in addition to a 3% increase in the rate of cholesterol measurement (RR 1.03; 95% CI 1.02, 1.04). Both pre/post studies assessed the effect of payment reforms in Ontario on diabetes processes of care. Jaakimainen et al.[79] estimated decreases of 15% and 14% in the percentage of diabetic patients receiving an annual eye exam after enrolling with physicians receiving blended capitation and enhanced FFS payments, respectively. Kiran et al.[78] found an increase in recommended testing for diabetes patients in the years following the introduction of an incentive fee code (RR 1.22; 95% CI 1.21, 1.23) however the increases in trend were already occurring prior to introducing the incentive. Using a difference-in-differences analysis, Kantarevic et al.[77] studied physician participation in the Diabetes Management Initiative, another P4P scheme designed to incentivize adherence to guidelines. They found that diabetes patients enrolled in the Family Health Organization (FHO) blended capitation model experienced a 5% increase in the number of patients receiving recommended tests relative to those in the Family Health Group (FHG) enhanced FFS model. Furthermore, there was an 8% increase in the number of physicians providing the recommended services in FHOs versus FHGs.

All four studies examining various outcomes related to screening and prevention activities in new payment models used pre/post study designs.[75,76,79,82] Two of these studies included a control group using a difference-in-differences analysis.[76,82] Kralj et

al.[82] examined the effect of blended capitation payment on the delivery of the cancer screening and preventive care targets (senior flu shots, Pap smears, mammograms, immunizations and colorectal cancer screening). Their findings showed an increase of 7 to 11% in the delivery of services in FHO (blended capitation) practices versus FHG enhanced FFS practices. Two studies[75,76] examined the effect of a P4P incentive on delivery of the same cancer screening and preventive care with results indicating null to moderate effects. Li et al.[76] measured the effect of P4P in new patient enrolment models. Relative to physicians in traditional FFS practices, results indicated statistically significant increases of 2.8, 4.1, 1.8 and 8.5 percentage points in senior flu shots, Pap smears, mammograms and colorectal cancer screening, respectively. Using an interrupted time-series, Kiran et al.[75] found a statistically significant increase of 4.7% in the rate of colorectal cancer screening after the introduction of the P4P incentive. However, the results showed no statistically significant changes in the rates of breast and cervical cancer screening. Finally, Jaakimainen et al.[79] reported overall changes of less than 5% in the proportion of women screened for cervical and breast cancer after joining an FHG or FHN. However, changes of over 5% were reported for the proportion of individuals receiving any type of colorectal cancer screening.

Two studies from Quebec examined outcomes related to patient-reported health and chronic illness care in FMGs.[37,39] Levesque et al. reported a small but non-significant effect of FMGs on patient assessment of chronic illness care when compared to community health centers. Additionally, Feldman et al. found no significant effects of FMGs on improving patients' physical health, mental health or health related quality of life when compared to community health centers.

Table 5.Results for health service utilization outcome

Organizational change	Study	Outcome: Health service utilization			
		Emergency department visit (general)	Emergency department visit (avoidable)	Hospitalization (general)	Hospitalization (avoidable)
Team-based models of primary care	Héroux, J. et al. (2014)	↓	–	NS	–
	Manns, B.J. et al. (2012)	–	↓	–	↓
	Campbell, D.J.T. et al.* (2012)	–	↓	–	↓

* Results reported for different sub-populations. For the general population, individuals receiving a health care subsidy, and First Nations, the authors found a statistically significant decrease in the outcome measures. The findings were non-significant for the individuals receiving income support.

↑ = Significant increase in outcome of interest ↓ = Significant decrease in outcome of interest **NS** = Non-significant result - = Not reported

Table 6. Results from processes of care outcome (diabetes)

Organizational change	Study	Outcome: Processes of care (diabetes)			
		Receipt of recommended tests	Recommended HbA1c measurement	Recommended retinal eye exam	Recommended cholesterol measurements
Team-based models of primary care	Manns, B.J. et al. (2012)	–	↑	↑	↑
Payment models	Kantarevic, J. et al. (2013)	↑	–	–	–
	Kiran, T. et al. (2012)	↑	↑	↑	↑
	Jaakkimainen, L.R. et al. (2011)	–	–	↓	–

↑ = Significant increase in outcome of interest ↓ = Significant decrease in outcome of interest **NS** = Non-significant result - = Not reported

Table 7. Results from processes of care outcome (screening, prevention services and patient perception of care)

Organizational change	Study	Outcome: Processes of care (screening, prevention services & patient perceptions of care)						
		Cervical cancer	Breast cancer	Colorectal cancer	Flu shots	Immunizations	Chronic disease management	Patient perception of health and quality of life
Team-based models of primary care	Lévesque, J.F. et al. (2012)	–	–	–	–	–	NS	–
	Feldman, D.E. et al. (2012)	–	–	–	–	–	–	NS
Payment models	Kiran, T. et al. (2014)	NS	NS	↑	–	–	–	–
	Li, J. et al. (2014)	↑	↑	↑	↑	NS	–	–
	Kralj, B. et al. (2013)	↑	↑	↑	↑	↑	–	–
	Jaakkimainen, L.R. et al. (2011)	NS	↑	–	–	–	–	–

↑ = Significant increase in outcome of interest ↓ = Significant decrease in outcome of interest **NS** = Non-significant result - = Not reported

Physician costs and productivity (Table 8)

Studies examining physician productivity and costs associated with practicing in payment models focused on the volume of services delivered and number of visits. Physicians in enhanced FFS practices were found to see fewer patients and deliver fewer services compared to physicians paid via FFS.[83] However in comparison to enhanced FFS physicians, those in blended capitation models treated fewer patients per day yet worked the same number of days and enrolled the same number of patients.[80,82] Although quality of care in relation to reduced services and visits was not addressed in these studies, based on the indicators used, there was no evidence of cost-shifting and risk selection by physicians in blended capitation models.[81]

All 4 studies approached the analyses using difference-in-differences and propensity score matched physicians at baseline.[80-83] Kantarevic et al.[80] studied the differences in the number of patient visits and services delivered by physicians per day. Relative to EFFS models, physicians paid by blended capitation reduced the number of patient visits per day between 3.8% and 4.2%, and reduced the number of services delivered per day between 5% and 6%. Kralj et al. found similar reductions of 6% for the number of visits per day and 7% for the number of services delivered per day.[82] In an earlier study, Kantarevic et al.[83] examined similar outcomes comparing physicians in enhanced FFS models with those in traditional FFS models. Relative to physicians in traditional FFS practices, those paid by enhanced FFS increased the number of patient visits by 6.3% and the number of services by 9.3%. Kantarevic et al.[81] also addressed the question of cost-shifting and risk selection in blended capitation models following the introduction of a new incentive payment to enroll complex and vulnerable patients. The results revealed no statistically significant changes in physician behavior relative to those practicing in traditional FFS models that were not eligible for the incentive payment. Kralj et al.[82] also found non-significant results regarding risk selection when comparing blended capitation practices with enhanced FFS practices.

Table 8. Results from physician costs and productivity outcome

Organizational change	Study	Outcome: Physician costs and productivity			
		Number of services delivered	Number of visits	Number of patients seen	Risk selection
Payment models	Kantarevic, J. et al. (2015)	↓	↓	–	–
	Kantarevic, J. et al. (2014)	–	–	–	NS
	Kralj, B. et al. (2013)	↓	↓	–	NS
	Kantarevic, J. et al. (2011)	↑	↑	↑	–

↑ = Significant increase in outcome of interest ↓ = Significant decrease in outcome of interest **NS** = Non-significant result - = Not reported

Quality of evidence assessment

GRADE guidelines identify 4 main components for assessing the quality of the body of evidence: study design, risk of bias, inconsistency and indirectness of results.[87] All of the studies included in the review were observational. The risk of bias varied by outcome categories (Table 9) according to whether the methodology accounted for the selection of physicians and patients into reform models, and whether definitions of intervention and control groups were provided. Several studies relied on administrative population-based data allowing for increased statistical power to detect effects. In 7 studies, large longitudinal databases facilitated the use of propensity scores to create matched samples of patients or physicians at baseline prior to the introduction of an intervention. This approach aimed to address the selection of physicians and patients into new primary care models.

Variations within team-based or payment-based reform initiatives across Canadian jurisdictions and across included studies resulted in indirect comparisons, which decreased the overall quality. Despite this, studies on team-based reforms from Alberta and Quebec provided consistent evidence of reductions in emergency department use, which resulted in a moderate quality rating. For processes of care, risk of serious bias and evidence of indirectness in outcome measures and interventions also led to low quality evidence. The methodologies and analytical approaches used in studies examining physician productivity outcome measures presented no risk of serious bias and no serious indirectness or inconsistencies in their comparisons. We therefore judged the overall quality of the evidence as high for this outcome.

Table 9. Quality of evidence assessment

Outcome	Reform	Number of studies	Study design	Risk of bias	Directness	Consistency	Overall assessment of the evidence
Health service utilization	Team-based models	3	Cohort studies	No risk of serious bias	Serious indirectness[1]	No serious inconsistency	Moderate
Process of care	Team-based models	3	Cohort studies	Risk of serious bias	Serious indirectness[1]	Serious inconsistency	Low
	Payment models	6	Before and after and cohort studies	Risk of serious bias	Serious indirectness[4]	Serious inconsistency	Low
Physicians costs and productivity	Payment models	4	Before and after	No risk of serious bias	No serious indirectness	No serious inconsistency	High

[1] The main source of indirectness stems from the evaluation of different team-based interventions. Given the small number of studies, we conducted a pooled assessment of the evidence from Alberta and Quebec in order to provide an overall assessment of the evidence.

[2] Based on one study, we could not determine the directness or consistency of the results.

[3] Given that there was only one study in this category, we were unable to determine directness or consistency of the results in comparison to other studies.

[4] The main source of indirectness stems from results on a number of different interventions examined in relation to payment models in Ontario that we pooled in order to provide an overall assessment of the evidence.

3.7 Interpretation

Our review provides the first systematic evidence synthesis of the literature on the effects of recent organizational changes to primary care in Canada on health system performance outcomes. We found moderate quality evidence that interdisciplinary team-based models of care such as Quebec's FMGs and Alberta's PCNs led to reductions in emergency department use, but the evidence was mixed for hospital admissions. We also found low quality evidence that team-based models, blended capitation models and pay-for-performance incentives led to small and sometimes non-significant improvements in processes of care as measured by the delivery of screening and prevention services and chronic disease management. Studies examining the effects of new payment models in Ontario on physician costs and productivity were of high methodological quality and provided a coherent body of evidence assessing enhanced FFS and blended capitation payment models. Findings indicated that moving from enhanced FFS to blended capitation reduced the number of patients seen per day yet the number of enrolled patients and days worked per year remained the same.

Our findings on new payment models in Ontario align with economic theory that FFS incentivizes increasing the volume of services while blended capitation tends to produce reductions. A blended capitation model may be more efficient than FFS if quality of care is maintained or elevated and the delivery of inappropriate services is reduced.[88] Also, similar to findings from other systematic reviews, we found that pay-for-performance incentives yielded some benefits but the evidence was inconsistent across outcomes, suggesting that these types of interventions must be carefully designed and executed.

Our review also indicated discrepancies in findings across studies that may be attributable to jurisdictional differences in implementation. Notably, findings from evaluations of Quebec's FMGs are less convincing than those from evaluations of Alberta's PCNs, although both are team-based primary care models adapted from the PCMH. In fact, a systematic review on the effects of the PCMH in the US highlighted that despite shared objectives of better coordination of care, increased access to and

continuity of services, definitional frameworks and implementation approaches varied widely.[89] And indeed, a 2015 report from Quebec's Auditor General highlighted the lack of a government framework for their implementation and evaluation, which may provide some insight into why FMGs are not performing as well as expected.[7]

Our review also revealed gaps in the Canadian evidence of effects of primary care reforms. First, most longitudinal studies included in this review were performed with samples of chronically ill adults, while fewer were conducted in the general adult population and none were conducted in children. Few studies accounted for selection of physicians and patients into emergent reform initiatives by employing analytical techniques, such as difference-in-differences, propensity scores or instrumental variables. Future research should aim to evaluate indicators of health utilization, processes of care and physician productivity for which a change over time clearly shows improvements for patients and for the health system. Such indicators might include hospital readmissions and timely post-discharge follow-up care for targeted patient subgroups. Further, early adopters of reforms are generally more receptive to change,[90] and an investigation into the dynamics of early versus late adopters could help gain insight into the potential for reforms to improve quality and performance.

Our results have implications for both policymakers and researchers. Firstly, we find evidence that interventions succeed in meeting health system objectives when they are targeted and carefully designed. For instance, although FMGs in Quebec were introduced with an aim to improve access to and quality of care for chronically ill patients, it is unclear whether this can be achieved when the establishment of chronic disease management programs is not integral to the reform. Where financial incentives such as pay-for-performance are concerned, consideration for the overarching physician payment model is central to designing a reward payment that avoids perverse incentives for patient risk selection by physicians. Secondly, the different nature of the interventions is of importance to researchers seeking to assess impacts of primary care reform. Unlike reforms to payment that can only be implemented in one way (eg. a physician is either paid via blended capitation or FFS), identifying effects is more difficult in team-based

reforms since versions of the intervention differ by how each practice implements the model (eg. the extent to which nurses are integrated in patient case management). Finally, policy-makers and researchers should provide clear definitions of the roles, activities and processes enacted under the transformations intended by the reforms to best inform future efforts to enhance primary care.

3.8 Limitations

In this review, we tried to minimize heterogeneity by including only population-wide interventions that occurred after 2000, and by restricting our criteria to studies with a longitudinal design. Nevertheless, considerable heterogeneity in interventions and in methodological approaches remained, which precluded a meta-analysis and sub-group analysis. Another important limitation was the exclusion of qualitative studies. Although administrative data is useful for quantifying the change induced by the introduction of reforms, it is limited in terms of gauging the heterogeneity of reform implementation within practices. The effects of new models may be attenuated if high and low performing practices are not distinguishable from each other. Qualitative studies from Quebec and Ontario have described variation in how nurses are integrated into practice according to whether they hold responsibilities for patient care or are treated as assistants.[13,91] Future reviews should consider the body of qualitative evidence to address normative questions that take stock of what is taking place within healthcare organizations versus what should be taking place.

3.9 Conclusion

The quality of evidence ranged from low to high for each indicator of performance. Given our interest in isolating the causal effects of reforms we focused on methodologies that used an appropriate comparison group that controlled for factors contributing to the selection of physicians and patients into new primary care models and secular time trends in the outcome. The small number of studies from Alberta and Quebec suggested that team-based models contributed to reductions in ED use. Regarding processes of care, the

evidence indicated that increases in preventive care services could be attributed to blended capitation models and P4P in Ontario. Although blended capitation appeared to lead to decreases in the number of services delivered and patients seen per day, the number of enrolled patients and number of days worked in a year was similar to that of enhanced FFS practices. Based on this review, we recommend methodologies that generate evidence on reform effects, particularly in Quebec and Alberta where only a small body of literature exists.

CHAPTER 4

Manuscript 2: Measuring the effect of Family Medicine Group enrolment on avoidable visits to the emergency department by diabetic patients in Quebec, Canada

4.1 Preface to Manuscript 2

In principle, three main features define the FMG model: patient enrolment, longer opening hours and physician remuneration.[5] Increased patient enrolment was a key objective of the FMG reform and continues to be a priority for primary care in Quebec.[5,8] Previous research on FMGs covering the early implementation period between 2002 and 2005 found that physicians and patients who subscribed to the model systematically differed from those that did not.[43] In this study, the level of patient enrolment across health and social services regions between 2003 and 2011 was used as a performance indicator of the model's breadth of coverage with increased patient enrolment conceptualized as a policy diffusion process. In the context of interventions driven by voluntary uptake, Rogers' theory of the diffusion curve hypothesizes that early adopters of change are likely to be innovators in their field while those joining later in the post-reform period may be more reluctant to change due to a greater effort required to conform to new ideals.[90] To this end, objective 2 sought to model the policy diffusion process.

Given that patient enrolment was intended to promote continuity and quality of care with a physician, it is of relevance to assess whether increased patient enrolment was attributed to reductions in avoidable use of the ED by patients with an ambulatory care sensitive condition. Accordingly, this objective sought to answer the following question: *Does an increase in the percentage of a health and social services region's population that is enrolled with a physician practicing in an FMG have an effect on avoidable ED use by diabetic patients?*

The objectives of the study were three-fold: (1) to measure the effect of policy diffusion on avoidable use of the ED, (2) to establish whether the effects of growing enrolment differed according to patient frequency of ED use, and (3) to determine whether effects varied by high versus low levels of enrolment at the regional level.

4.2 Methodological considerations for addressing policy diffusion effects

This study used the time-varying nature of enrolment levels to gain insight on the implementation process and its effect on avoidable ED use. This question is of particular relevance given the recent media coverage and an Auditor General's report that have raised concerns regarding the heterogeneity in FMG practice performance.[7,92,93]

Intuitively, as physicians adopted the FMG model over time, this would have led to increased access to primary care assuming a greater number of patients could be enrolled and therefore benefit from team-based practices. However a recent survey of FMG clinics revealed that the intervention is in fact quite complex with effects that are suspected to vary across time and primary care practices.[46] Indeed, the nature of the reform, combined with voluntary uptake by physicians, has led to variation in its implementation as highlighted in the recent Auditor General's report citing a number of problems related to governance and accountability.[7] Furthermore, differences in regional uptake of the reform point to factors that may make the model more appealing to physicians based on the contexts in which they work.

Descriptive analyses of the data revealed strong secular trends in the outcome and exposure variables (Figure 7). It was not only important to control for these trends in the analyses but to also consider how the exposure variable was measured. In an attempt to separate the effect of the intervention from overarching long-term trends, the definition of exposure had to be as much as possible independent of time. For instance, creating categories of exposure for each year would anchor the definition of exposure to time and therefore the risk of bias would remain despite controlling for secular trends in the model. This was the primary reason for keeping the exposure variable continuous.

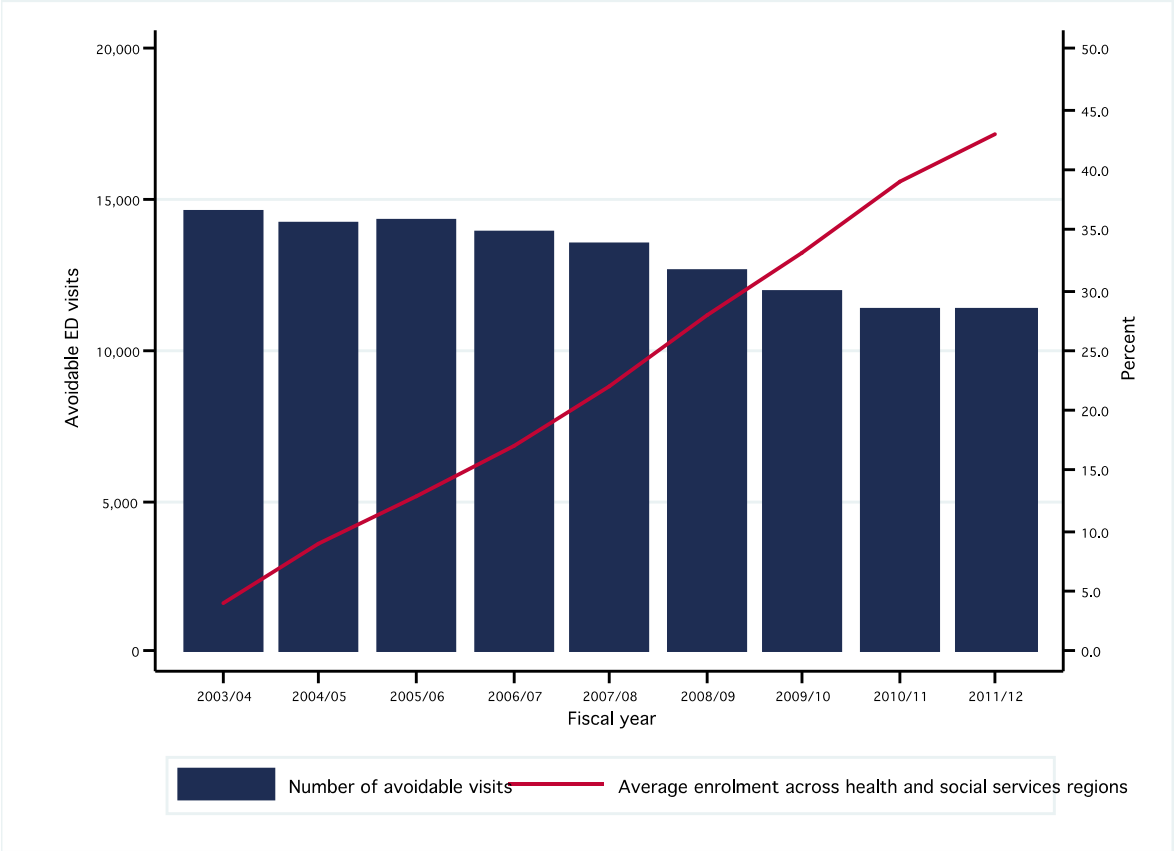


Figure 7. Secular trends in avoidable ED visits and FMG enrolment

The presence of secular trends for both the FMG enrolment and avoidable ED visits can pose challenges in parsing out the effect of enrolment, particularly if the long term trend for avoidable ED visits was stronger than the one for enrolment. Additionally, interventions that target problems with health service delivery are often coupled with increased public awareness of the issue, especially if challenges are relevant to both providers and patients.[94] This may induce unobserved behaviors that cause a shift in outcome trend. In the context of diabetes, heightened awareness of the importance of glucose control from clinical trials in the 1980s and 1990s[25] was plausibly a driving factor in the decrease of avoidable ED visits over time in Quebec. A study examining trends in acute diabetes complications in Ontario observed a decline throughout the 1990s and attributed this to greater awareness of the effects of improved glycemic control.[95]

Accounting for secular trends was therefore a critical component to conceptualizing the analytical approach. Failure to account for them would likely produce an overestimate

of FMG enrolment's effect on avoidable visits to the ED. Fixed effects for each year were included in the models to address some of the concerns regarding secular trends that are due to unobserved factors, such as greater awareness of the need for glycemic control, improved technology to support diabetes self-management, and greater affordability of medication brought about by Quebec's pharmacare program in 1997. These are plausibly correlated with changes in FMG enrolment and avoidable visits to the ED.

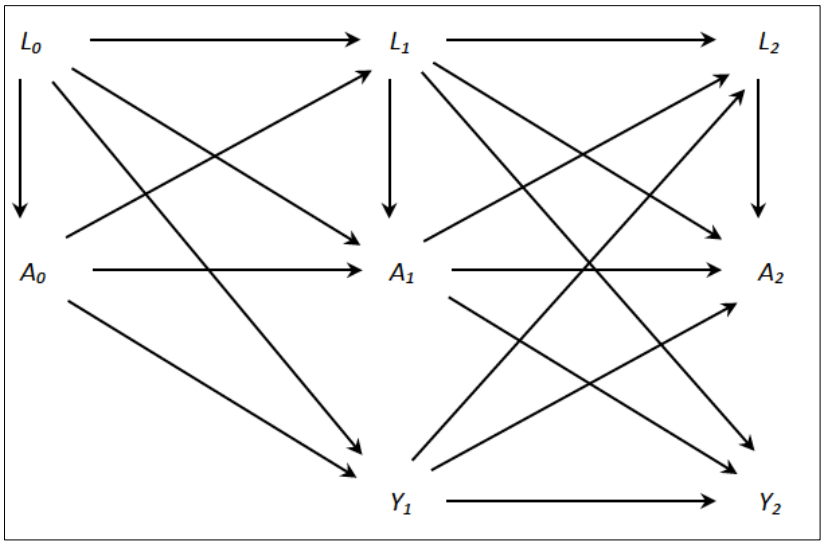
Fixed effects for the province's health and social services regions were also included in the models to account for stable unobserved differences in physician practice settings that were correlated with FMG uptake and patient use of the ED. This aimed to address the differences in health service delivery that are known to exist between regions in Quebec.[96] Furthermore, given that physicians who practiced in FMGs could not be distinguished from those that did not, the fixed effects controlled for unobserved stable within-physician characteristics that predicted FMG uptake and varied by region.

While the fixed effects for year and region addressed concerns pertaining to secular trends and the persistent differences in FMG uptake between regions, these did not control for time-varying factors that predicted FMG diffusion and avoidable visits to the ED. At the diabetic patient level, factors related to comorbidity and patterns of health service use may be both predictors of the levels of FMG enrolment and a consequence of its growth over time. To deal with this issue, the analysis made use of marginal structural models (MSM). The following section provides a description of the approach and its applicability to the study.

4.3 Theoretical support for using marginal structural models

The time-varying nature of the exposure (treatment) and confounders raised considerations for study design and analysis. Cross-sectional studies run the risk of deriving biased estimates since they cannot account for any lagged effects of the reform. As such, policy consequences are implicitly assumed to be static and produce immediate results on health outcomes. Furthermore, confounding factors affected by previous levels

of exposure potentially made them mediators of the effect of FMG population coverage on avoidable ED visits. Additionally, previous levels of the exposure and outcome may also have affected covariates considered for adjustment in repeated measure models. Figure 8 illustrates these dynamics using a directed acyclic graph (DAG).



L = Confounder variable, A = Exposure variable, and Y = Outcome variable

Figure 8. Directed acyclic graph of time-varying exposure and confounders

In this scenario L_1 is affected by the previous level of the exposure (A_0). For example, a region with high FMG enrolment levels (A) may reduce a diabetic patient's number of consultations with different family physicians (L). However, L_1 also confounds the relationship between A_1 and Y_2. Meaning, the number of different family physicians seen by a diabetic patient at baseline (L_0) may influence the level of FMG enrolment in a region at time 1 (A_1) and the number of avoidable visits to the ED at time 1 (Y_1). However the number of different physicians consulted at t_2 could be predicted by enrolment with an FMG physician at t_1. As such, consultations with different physicians are predicted by previous levels of FMG enrolment, and also predict both future FMG enrolment and ED visits. Adjusting for L will lead to over-adjustment in the regression model since it is on the causal pathway between exposure (A) and outcome (Y). Yet failing to adjust for L would not account for confounding bias.

In the context of time-varying exposures and confounders whereby previous levels of exposure affect predictive factors of the outcome, an MSM can be useful for estimating the effect of interest. The probability of exposure conditional on measured stable and time-varying factors was calculated to create a 'pseudo-population' in which every individual was weighted by her inverse probability of treatment. Individuals that were more likely to have an observed level of treatment were assigned lower weights in comparison to those that were less likely to be observed at a given level of exposure. This achieves a balanced population with regard to stable and time-varying factors across levels of the exposure thereby removing the association between treatment and observed confounders in the weighted population.

4.4 Example of creating a pseudo-population

Based on the explanation provided by Hernan and Robins[97], inverse probability weighting can be described using a simple example. The outcome, exposure and confounder variables are all dichotomous for ease of representation. In a population of 32 individuals, for confounder L, 0.67 of the sample (i.e. 20 people) had the observed value of $L = 0$ and 0.33 (i.e. 12 people) were observed at $L = 1$. Within $L = 0$ there were 10 of 20 individuals (0.5) that were unexposed and 10 of 20 individuals (0.5) that were exposed. Taking the inverse probability, each person within $L = 0$ who was unexposed was granted a weight of 2 (i.e. 1 / 0.5). The same holds true within $L = 0$ and the exposed branch. Since each individual was attributed a weight of 2, the pseudo-population for the unexposed group consisted of 20 people (2 x 10 people in the observed initial population) and 20 people in the exposed group. The same procedure was used for the $L = 1$ level of the confounder. Within $L = 1$, 9 of 12 individuals (0.75) were exposed leaving 3 individuals (0.25) unexposed. Thus, among the exposed individuals of $L = 1$, each was accorded a weight of 1.33 (i.e. 1/0.75) and for the unexposed, each was granted a weight of 4 (i.e. 1/0.25). As such, in the pseudo-population there would be 12 exposed individuals (i.e. 1.33 x 9) and 12 unexposed individuals (i.e. 4 x 3). The total number of people in the pseudo-population was therefore twice as large as in the initial population: (2*20) + (2*12) = 64. The result was an equal distribution of individuals within each

branch of the confounder variable across the levels of exposure. In other words, the exposed and unexposed groups were exchangeable in the pseudo-population because there was no association between the confounder and the exposure.[97]

The effect of exposure on outcome was then estimated using a weighted regression model that included only baseline covariates with robust standard errors.[98] Appendix A contains sections describing the approach to constructing the inverse probability weights for this analysis and outlines the assumptions underlying MSMs.

Measuring the effect of Family Medicine Group enrolment on avoidable visits to the emergency department by diabetic patients in Quebec, Canada

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4.5 Abstract

Background: The Family Medicine Group (FMG) model of primary care in Quebec, Canada was driven by the voluntary implementation of family physicians. Our main objective was to measure the effect FMG enrolment on avoidable use of the emergency department (ED) by diabetic patients. We also sought to determine if effects differed according to whether patients were infrequent or frequent users of the ED, and according to high versus low regional levels of enrolment.

Methods: We used data from provincial health administrative databases to identify the diabetic patient population over the age of 20 for each fiscal year between 2003/04 and 2011/12. We used fixed effects and marginal structural models to estimate the effect of enrolment in FMGs on avoidable use of the ED.

Results: Our results indicated that for every 10-percentage point increase in the population enrolled with an FMG in the year prior to an event, there was a 3% reduction in avoidable visits to the ED made by an individual (RR = 0.97; 95% CI = 0.95, 0.99). We found a significant reduction among diabetic patients who had at most 1 visit to the ED per year (RR = 0.97; 95% CI = 0.95, 0.99), and non-significant effects among more frequent users. Within low enrolment regions, a 10-percentage point increase in enrolment in FMG practices at t -1 led to an 18% decrease in the number of avoidable ED visits (RR = 0.82; 95% CI = 0.78, 0.87). The effect disappeared when the analyses were restricted to the high enrolment regions (RR = 1.00; 95% CI = 0.92, 1.09).

Conclusion: The design and implementation of the incentive to promote team-based practice may not have borne much influence on early adopters who may have been over-represented by physicians from innovative and high performing practices before the introduction of the reform.

4.6 Introduction

In 2002, the Family Medicine Group (FMG) model of primary care was introduced in Quebec with the aim to provide the population with accessible, continuous, coordinated and high quality health services.[12] The reform was presented as part of the solution to the province's low performance ranking in terms of access to primary care and avoidable use of the emergency department (ED).[4,5] The FMG model was defined by a number of core features namely, multidisciplinary care, patient enrolment with a family physician (FP), and longer clinic opening hours.[5] FPs opting to participate in the reform received government funding to offset the costs of establishing a team-based practice conditional on meeting certain requirements, notably continued patient enrolment and longer opening hours.[6]

The agreement between the government and the *Fédération des médecins omnipraticiens du Québec* (FMOQ) in 2001 regarding patient enrolment with FPs practicing in FMG clinics was cited early on as an innovative step in reforming primary care in the province.[5] It marked an important shift in the relationship between the government, FPs and patients, by placing greater focus on FPs' responsibility for the health of a defined patient population.[5] Given its mandate to meet regionally defined population health objectives and be integrated in a local territory's primary and tertiary care network, the FMG model was argued to be more effective when practices were concentrated in a given region rather than left to scattered voluntary uptake.[99]. Using patient enrolment as an indicator, regional changes in levels of FMG patient enrolment can be conceptualized as a policy diffusion process. This suggests that consistent growth in patient enrolment over time, as measured by the proportion of patients enrolled with an FMG physician relative to the region's population, may have resulted in health outcome benefits at the individual level.[99]

Recent evaluations from Quebec showed large discrepancies between practices with regard to levels of patient enrolment that may be attributed to insufficient administrative oversight to ensure adherence to the practice model.[7,100] In light of the fact that

government spending on FMGs reached $85.6 million in the 2013/14 fiscal year,[7] and recent statements from the government and the FMOQ to continue supporting the expansion of the model,[8] three key questions are of relevance to policy makers: (1) did increases in the percentage of individuals enrolled in FMG practices reduce avoidable use of the ED at the individual level? (2) did the effects of enrolment differ according to regular or infrequent use of the ED? and (3) if levels of population enrolment did decrease avoidable ED use, were certain regions driving the reform's performance?

4.6 Methods

Data source

Data from the Quebec Integrated Chronic Disease Surveillance System (QICDSS) were used for the development of healthcare utilization indicators.[101] The health insurance billing database contained records on the type and location of service delivery for diabetic patients seeking healthcare in the province. The hospital admissions database provided information on diagnoses related to hospital stays. Finally, the registered persons database provided information on individual sociodemographic characteristics for those diagnosed with diabetes in Quebec. The datasets were linked using encrypted identification numbers. We excluded 4 of 18 health and social services regions in Quebec due to the structurally different service provision arrangements in remote northern areas or the tendency for patients to seek care across the provincial border in Ontario thereby producing under-estimates of annual health service utilization. The exposure was defined at the aggregate regional level. We used data produced by the Direction de l'organisation des services de première ligne intégrés at the Ministry of Health and Social Services to determine the number of individuals in each health and social services region enrolled in an FMG from April 1, 2003 to March 31, 2012. Data from the Institut de la statistique du Québec were used to determine the denominator, defined as the number of individuals inhabiting each health and social services region in the fiscal years spanning April 1, 2003 to March 31, 2012.

Study sample

The study was conducted using patients as the unit of analysis. Cases of diabetes (excluding gestational diabetes) were identified from the medical claims and hospital admissions data using an algorithm previously validated in a Canadian study.[55,102] Individuals with at least 2 physician services claims and a diabetes diagnosis within a 2-year period, or individuals admitted to hospital with a diabetes diagnosis, were included in the study population.[55,102] We limited our analyses to diabetic patients aged 20 years or older. Accounting for these exclusions, the patient population ranged from 336,052 in 2003/04 to 533,438 in 2011/12.

Variables

The outcome was the frequency of avoidable ED visits defined as a count variable for the number of visits made by a patient in a given year. An ED visit was classified as avoidable according to the Canadian Institute of Health Information's list of ICD-9 codes for diabetes-specific complications (eg.: hyperglycemic and hypoglycemic events).[103] Using the medical service claims data, we applied a previously validated algorithm to identify distinct visits to the ED in Quebec.[104] The analysis included ED visits occurring between April 1, 2004 and March 31, 2012. The exposure was defined as the proportion of the population in a health and social services region enrolled with physicians practicing in FMGs. This measured the individual's exposure to the FMG model's level of coverage in the health and social services region of residence. To ensure that exposure occurred before outcome ascertainment, we modeled the effect of exposure at time $t - 1$ on avoidable visits to the ED at time t. Exposure measurement covered April 1, 2003 to March 31, 2011.

Both fixed and time-varying covariates were included in the analyses. Covariates for individual characteristics included: sex, age, Charlson comorbidity score, and material deprivation quintile (measured at the aggregate level). Covariates for individual patterns of health service utilization were measured every year and included: a measure of usual provider of continuity (the proportion of total visits to health care providers made to FPs),

number of visits to health care providers, number of different providers seen, number of visits to specialists, number of visits to FPs, number of admissions to hospital, number of admissions to hospital for ambulatory care sensitive conditions, and previous visits to the emergency department. At the aggregate level, we measured the proportion of FPs who delivered care to diabetic patients in the ED. We also included dummy variables for fiscal year and health and social services regions. T_0 was defined as either the start of follow-up in 2003/04 which captured incident and prevalent cases of diabetes in that year, or when an incident case of diabetes was identified over the follow-up period. To adjust for the amount of time in which we could observe an event for each diabetic patient, we used person-years at risk as the offset term in the model.

4.7 Analysis

Approach

We hypothesized that increased FMG coverage, as measured by growing patient enrolment, contributed to sustained reductions in ED use across all regions. Yet given the variation in patient enrolment levels that existed between the regions, this raises 2 key questions. Is it that increases in patient enrolment over time led to reductions in avoidable ED use? Or, is it that greater enrolment in certain regions was due to specific patient characteristics and provider service delivery arrangements that were also predictors of subsequent levels of enrolment?

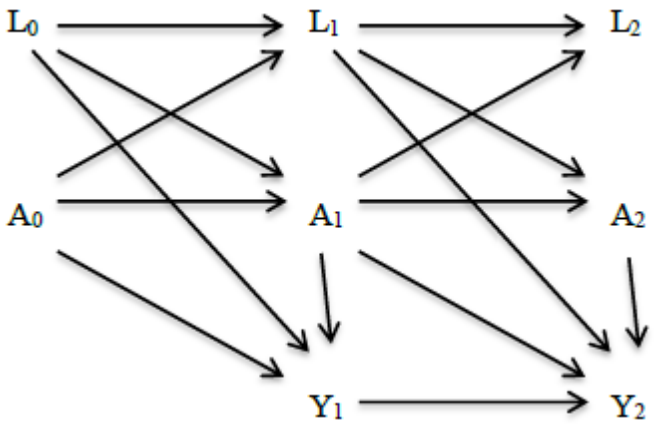
Our analytical approach aimed to deal with 2 potential sources of bias: (1) unobserved time fixed FP characteristics that influenced the level of FMG take-up in the region and diabetic patients' avoidable use of the ED, and (2) time-varying diabetic patient characteristics that may have been affected by previous levels of exposure and confound the effect of current or future exposure on avoidable ED use. We employed two separate modeling strategies to address each potential source of bias: fixed effects models and marginal structural models (MSMs).

Previous work demonstrated the systematic differences between FPs who opted to practice in an FMG versus those that did not.[43] We could not identify from our data the FPs who joined the new practice model. The nature of an FP's practice, for instance a preference for working full or part-time or service agreements mandating them to work a given number of hours outside of their family practice, may have affected both the number of patients enrolled in their FMG clinic and a patient's use of health services. Furthermore, there may be regional differences in FP practice patterns that encouraged greater patient use of the ED.[96,105] As such, omission of FP level variables by FMG participation status could induce biased estimates. We sought to address this concern by using a fixed effects model with $k - 1$ dummy variables to represent the 14 health and social services regions. Dummy variables were used to account for variation in avoidable ED use that was attributable to fixed differences between health and social services regions. This would include any stable characteristics of FPs' practices that differed between regions.

A previous study observed higher levels of patient enrolment in suburban and rural regions. This suggests that certain physician and patient characteristics in specific areas produce service delivery arrangements that vary across regions.[43] For instance, when compared to patients who were not enrolled in FMGs , FMG enrolment predicted greater avoidable use of the ED to treat ambulatory care sensitive conditions.[43] Furthermore, individuals in rural areas in Quebec are known to have a greater propensity to seek non-urgent care in EDs.[96,106] An individual's history of avoidable ED use is therefore conceptualized as a time dependent confounder of the effect of levels of FMG enrolment on future avoidable visits to the ED. Accordingly, past avoidable ED visits predict future avoidable ED use and levels of FMG enrolment, while levels of FMG enrolment also act as a predictor of future avoidable ED use. The directed acyclic graph in Figure 9 illustrates how time-varying confounding may play out in this context. Let *Y(t)* be a subject's number of avoidable visits to the ED in year *t*. Let *A(t)* be the percentage of the population in a region that is enrolled with an FMG. Finally, let *L(t)* be a vector of time-varying covariates that includes *Y(t)* since past avoidable visits to the ED is a time-varying confounder. As such, while we are interested in the effect of *A* on *Y*, this could be

an indirect effect mediated through L (eg. $A_0 \rightarrow L_1 \rightarrow Y_2$) or an effect confounded by L (eg. $A_2 \leftarrow L_1 \rightarrow Y_2$).

Both failing to adjust or adjusting for mediating factors (L) has the potential to produce biased estimates of the effect of FMG population coverage on avoidable ED use.[107] We fit an MSM to address these problems by weighting the dataset according to an individual's probability of exposure conditional on observed covariates. In addition to examining the change in estimates and confidence intervals as covariates were added and removed from the model, our choice of the final model was also based on assessing the stability of the mean weight values across time points.



L = Time-varying confounder variable, A = Exposure variable, and Y = Outcome variable

Figure 9. Directed acyclic graph illustrating time-varying confounding of the relationship between FMG enrolment and avoidable visits to the ED

Statistical analyses

We used negative binomial models with a log link to address overdispersion in the data. The following fixed effects model was fit using robust standard errors:

$$\log(Y_{irt}) = \alpha + \mu_t + \beta X_{irt} + \gamma Z_r + \theta_r + \log(PT_i) + \epsilon_{irt}$$

Where i is the individual diabetic patient, r is the health and social services region, and t is the year of observation. Y_{irt} denotes the number of avoidable ED visits. μ_t represents the set of fixed effects for year. X_{irt} is a vector of time varying covariates at the individual or

regional levels. Z_r is the main exposure, regional level of FMG enrolment. θ_r represents fixed effects for the health and social services regions. Finally, $\log(PT_i)$ and ε_{irt} are the offset and error terms, respectively.

Estimation of the MSM was done in two stages: (1) we derived the inverse probability of treatment and censoring weights for each individual, and (2) we ran a weighted generalized estimated equation (GEE) model. In the first step, we estimated two separate weights for each individual: the conditional probability density function of receiving the given level of exposure (the proportion of the population enrolled with an FMG defined as a continuous variable) and the conditional probability of being censored (eg. individuals moving out of province or death). The numerator of the weight was calculated as the conditional probability density of the given level of exposure at time *t* conditional on the exposure history and the baseline covariates. The denominator was calculated as the conditional probability density of the given level of exposure at time *t* conditional on the exposure history and time-varying covariates. The censoring weights were estimated similarly by replacing the conditional probability density with the probability of not being censored at *t*. In notation form, the process can be expressed as:[107]

$$SW(t) = \prod_{k=0}^{t} \frac{f\{A(k) \mid \bar{A}(k-1), L(0)\}}{f\{A(k) \mid \bar{A}(k-1), \bar{L}(k)\}}$$

where $A(k)$ represents the time-varying exposure at time k, $\bar{A}(k-1)$ is the exposure history understood to be the proportion of the population enrolled in the individual's health and social services region up to time $k-1$, $L(0)$ is the set of baseline covariates, and $\bar{L}(k)$ is the time dependent covariate history up to time k (that also includes the baseline covariates). $SW(t)$ denotes the calculation of each individual's stabilized weight at time *t*. Stabilized weights were used to reduce their variability.[98] The exposure and censoring weights produced for each individual were multiplied to derive the final weight for the regression model. In the second step, we ran a weighted GEE repeated measures MSM using the stabilized weights. To address correlated standard errors, we compared the quantum information and computing (QIC) statistic across different models to inform

our choice of an appropriate working correlation structure. Based on the smallest QIC value, we selected an independent working correlation structure for our final model. Fixed effects for year and region were added to the weighted GEE model.

We conducted additional analyses to determine whether the effect of regional level enrolment differed according to how often an individual visited the ED. Frequent use of the ED in a year may be an indicator for serious illness that required more intensive use of specialized services. As such, we might only expect to observe an effect among sporadic users of the ED and non-significant findings among those who visit the ED on a regular basis. Accordingly, we conducted separate analyses among diabetic patients with 1 visit per year, 2 visits per year and 3 or more visits per year.

We also examined whether the effect of regional level enrolment on avoidable ED visits differed by high versus low enrolment regions. Level of enrolment was used as a proxy for FP adoption of the reform. We identified high versus low adoption according to whether a region was below the provincial average level of enrolment throughout the study period We ran separate regression models to measure the effect within high and low adopter regions. All analyses were conducted using SAS 9.4.

Ethics approval

Government bodies in legal possession of the databases, in addition to Quebec's Comité d'éthique de santé publique and the Commission d'accès à l'information du Québec, have approved the creation of the QICDSS and its use for chronic disease surveillance. The creation of the QICDSS and access to its data meet stringent standards of security and privacy. This study is part of a doctoral project that was approved by the Faculty of Medicine's Institutional Review Board at McGill University.

4.8 Results

Table 10 contains the descriptive results from the study population. The average percentage of the population in Quebec enrolled with an FMG increased steadily over time across the regions from 7% in 2004/05 to 37% in 2011/12. However, as shown in Figure 10, in 2011/12, or about 10 years after the onset of the reform, substantial variation in patient enrolment was evident across regions, as the proportion of the regional population enrolled ranged from a low of 20% in some regions to a high of 60% in others. Table 10 also indicates that the average percentage of FPs practicing in FMGs increased consistently over time from 14% in 2004/05 to 42% in 2011/12. Turning to patients, Table 10 shows that the diabetic population was getting older over the follow-up period with the average age being 64.79 years in 2004/05 and 66.11 years in 2011/12. Interesting patterns of health service utilization emerged over time with overall decreases in the number of contacts with providers and hospitalizations. Given that the decrease was stronger for primary care type services compared to hospitalizations, it is possible that growing enrolment allowed FPs to see more patients but less often. Between 2004/05 and 2011/12, the average number of consultations and the average number of different providers decreased from 2.57 to 1.85 and 2.57 to 1.93, representing a 28% and 25% decline, respectively. The average number of consultations with FPs also decreased by 25%, from 1.74 to 1.31 visits. With regard to tertiary care, the decreases were less pronounced. The number of hospitalizations for ambulatory care sensitive conditions declined by 15% from 0.26 to 0.22 while the number of total hospitalizations decreased by 5% from 0.35 to 0.33. We also observed a decrease in diabetic patients' Charlson comorbidity score from 5.44 to 5.22 that accounted for a 4% decline. There was also evidence of a decrease in the percentage of individuals with diabetes making an avoidable visit to the ED between 2004/05 and 2011/12: 2.94% to 1.96%, respectively. Finally, the distribution of diabetes patients living in more urban versus more rural regions remained consistent over the follow-up period.

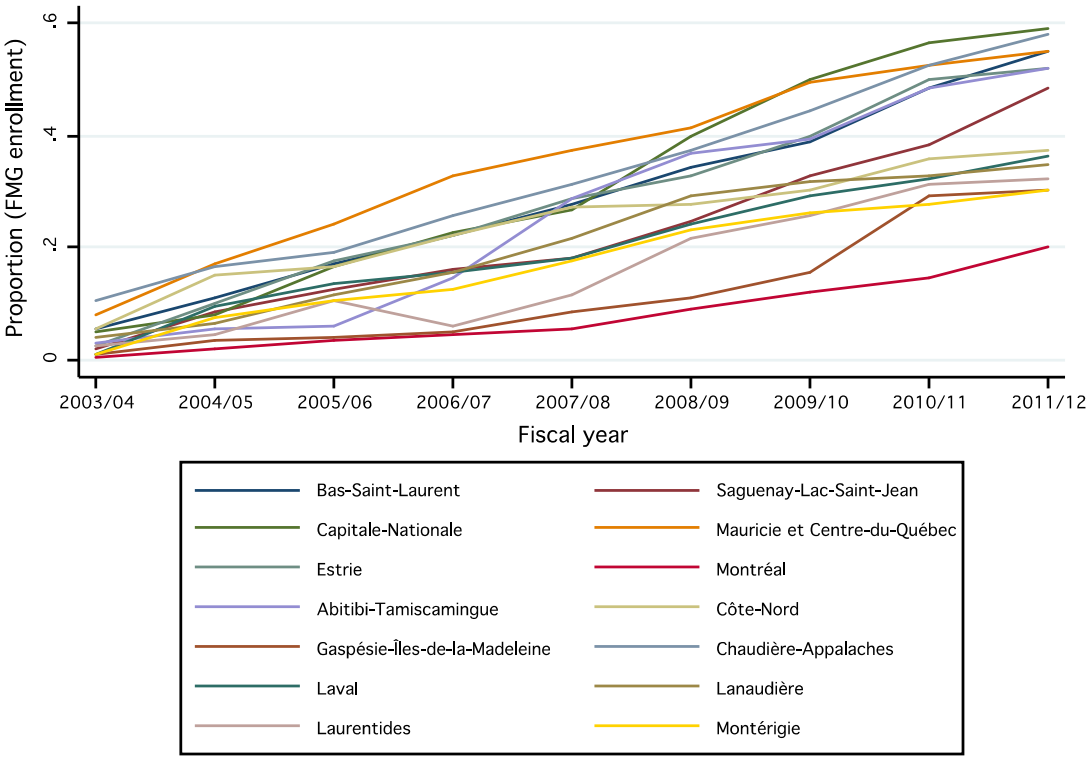


Figure 10. Proportion of the population enrolled in an FMG by health and social services region

Table 10. Regional and diabetic patient population characteristics by fiscal year, 2004/05 to 2011/12

Regional level	2004/05	2005/06	2006/07	2007/08	2008/09	2009/10	2010/11	2011/12
Proportion of population enrolled in a FMG; mean (SD)	0.07 (0.05)	0.11 (0.06)	0.14 (0.09)	0.18 (0.10)	0.24 (0.11)	0.29 (0.13)	0.33 (0.14)	0.37 (0.14)
Number of FMGs; mean (SD)	9.91 (5.33)	10.70 (5.31)	12.41 (5.71)	16.22 (7.36)	19.67 (8.98)	20.88 (8.96)	21.95 (8.92)	24.74 (10.86)
Proportion of practicing FPs; mean (SD)	0.80 (0.06)	0.79 (0.06)	0.79 (0.06)	0.79 (0.05)	0.79 (0.05)	0.79 (0.04)	0.79 (0.04)	0.79 (0.04)
Proportion of FPs practicing in FMGs; mean (SD)	0.14 (0.06)	0.18 (0.11)	0.20 (0.09)	0.26 (0.09)	0.32 (0.09)	0.34 (0.10)	0.38 (0.11)	0.42 (0.08)
Proportion of FPs delivering care to diabetes patients in the ED; mean (SD)	0.22 (0.06)	0.21 (0.10)	0.19 (0.09)	0.18 (0.08)	0.16 (0.08)	0.15 (0.07)	0.15 (0.07)	0.15 (0.07)
Patient level								
Male (%)	52.29	52.39	52.49	52.57	52.70	52.82	53.00	53.20
Age; mean (SD)	64.79 (13.81)	64.93 (13.78)	65.11 (13.75)	65.30 (13.72)	65.54 (13.69)	65.76 (13.66)	65.95 (13.64)	66.11 (13.62)
Charlson comorbidity score; mean (SD)	5.44 (2.71)	5.43 (2.68)	5.37 (2.52)	5.36 (2.47)	5.38 (2.48)	5.41 (2.53)	5.41 (2.52)	5.22 (2.75)
Material deprivation quintile (%)								
1 (most privileged)	15.14	15.27	14.37	15.53	15.63	15.77	15.89	15.94
2	18.23	18.35	18.51	18.61	18.75	18.77	18.84	18.93
3	20.95	20.90	20.96	20.91	20.97	20.95	20.96	20.97
4	22.25	22.14	22.02	21.96	21.87	21.94	21.85	21.77
5 (least privileged)	23.44	23.34	23.14	22.99	22.79	22.57	22.45	22.38
Regional category (%)								
University	42.51	42.23	41.89	41.55	41.21	40.89	40.55	40.26
Peripheral	35.30	35.57	35.78	36.04	36.36	36.68	36.93	37.14
Intermediate	17.00	17.05	17.15	17.22	17.29	17.32	17.45	17.56
Remote	5.19	5.16	5.18	5.19	5.14	5.11	5.08	5.05

Table 10. ***Continued***

Patient level	2004/05	2005/06	2006/07	2007/08	2008/09	2009/10	2010/11	2011/12
Ambulatory health service utilization; mean (SD)								
Number of consultations	2.57 (4.15)	2.41 (3.97)	2.31 (3.77)	2.20 (3.57)	2.12 (3.57)	2.01 (3.35)	1.94 (3.11)	1.85 (2.96)
Number of consultations with a FP	1.74 (2.24)	1.65 (2.17)	1.59 (2.11)	1.52 (2.04)	1.47 (2.00)	1.40 (1.90)	1.38 (1.86)	1.31 (1.79)
Number of consultations with a specialist	0.89 (2.93)	0.82 (2.73)	0.77 (2.55)	0.71 (2.35)	0.67 (2.37)	0.62 (2.23)	0.57 (1.97)	0.55 (1.86)
Number of different providers	2.57 (4.15)	2.41 (3.97)	2.31 (3.77)	2.20 (3.57)	2.12 (3.57)	2.01 (3.35)	1.94 (3.11)	1.93 (2.93)
Usual provider of continuity (%)	0.53 (0.47)	0.53 (0.47)	0.53 (0.47)	0.52 (0.47)	0.45 (0.48)	0.51 (0.48)	0.51 (0.48)	0.51 (0.48)
Tertiary health service utilization; mean (SD)								
Number of hospitalizations	0.35 (0.86)	0.35 (0.85)	0.34 (0.85)	0.33 (0.83)	0.33 (0.82)	0.33 (0.82)	0.33 (0.82)	0.33 (0.82)
Number of hospitalisations for ACSCs	0.26 (0.74)	0.25 (0.74)	0.23 (0.68)	0.21 (0.66)	0.21 (0.66)	0.22 (0.68)	0.22 (0.69)	0.22 (0.68)
Avoidable ED visits by diabetic patients (%)	2.94	2.79	2.60	2.45	2.30	2.15	2.06	1.96

Table 11 presents the results from the crude model, fixed effects model and the MSM. The crude model contained stable and time-varying covariates, including the indicator variables for year. The fixed effects model contained the aforementioned variables in addition to indicator variables for the regions. The MSM included only variables measured at baseline and was weighted by the inverse probability of treatment. We modeled a 1-year lagged effect of exposure interpreted as follows: a 1-percentage point increase in FMG enrolment at $t - 1$ produced a given change in a diabetic patient's rate of avoidable visits to the ED at time t. We re-scaled the exposure variable to a 10-percentage point increase to facilitate interpretation. Using a crude repeated measures model, we estimated an 8% reduction in the number of avoidable visits to the ED by a diabetic patient for every 10-percentage point increase in population FMG enrolment at $t - 1$ (RR = 0.92; 95% CI = 0.91, 0.93). After fitting a fixed effects model that controlled for time-fixed regional factors, we estimated a 7% reduction in the number of avoidable ED visits (RR = 0.93; 95% CI = 0.91, 0.95). Comparing the crude and fixed effects models, we observed a change in estimate toward the null and larger confidence intervals for the fixed effects model. When accounting for the time-varying confounder variables in the MSM, we estimated a 3% reduction in the number of avoidable ED visits for a 10-percentage point increase in population enrolment in FMG practices at $t - 1$ (RR = 0.97; 95% CI = 0.95, 0.99).

Table 11. Results from models for single-point exposure and cumulative exposure

Model Specification[1]	Estimate (95% CI)[2]
Crude model[3]	0.92 (0.91, 0.93)
Fixed effects model[4]	0.93 (0.91, 0.95)
Marginal structural model[5]	0.97 (0.95, 0.99)

[1] Final models included: age, sex, material deprivation quintile, Charlson comorbidity score, number of consultations (total), number of consultations with family physicians, number of consultations with specialists, number of different providers seen, usual provider of continuity, number of hospitalizations, number of hospitalizations for ambulatory care sensitivity conditions, previous visits to the ED, percentage of the population enrolled in FMG practices, percentage of family physicians practicing in FMGs, percentage of family physicians seeing diabetic patients in EDs
[2] Estimates are rate ratios that are interpreted as a 10-percentage point increase in population enrolment in FMG practices at t - 1.
[3] Model did not include fixed effects for regions
[4] Fixed effects for regions were included in the model
[5] Inverse probability of treatment weighted models. Year and region fixed effects were added to the final model.

Using the MSM, we conducted sub-analyses to determine whether the effect of FMG enrolment differed according to sporadic or frequent use of the ED. Table 12 indicates that a 10-percentage point increase in FMG enrolment at $t - 1$ produced a significant decrease in avoidable ED visits among diabetic patients who had at most 1 visit to the ED per year (RR = 0.97; 95% CI = 0.95, 0.99). However the results were non-significant among diabetic patients with 2 avoidable visits per year (RR = 0.97; 95% CI = 0.87, 1.07) and 3 or more avoidable visits per year (RR = 1.26; 95% CI = 0.97, 1.63). The differences in coefficient estimates between the first model (patients with at most 1 avoidable visit to the ED per year) and model 3 (patients with 3 or more avoidable ED visits per year) were statistically significant.

Table 12. Results based on frequency of visits to the ED

Model specification[1]	Estimate (95% CI)[2] [3]
1 visit	0.97 (0.95, 0.99)
2 visits	0.97 (0.87, 1.07)
3 or more visits	1.26 (0.97, 1.63)

[1] Separate models were run based on sample restrictions. For instance, the first model was run on the diabetic patient population that had no more than one visit per year.
[2] Estimates are rate ratios that are interpreted as a 10-percentage point increase in population enrolment in FMG practices at t - 1.
[3] Estimates were produced using the MSM.

We conducted a second set of sub-analyses using the MSM to examine whether the effect of a 10-percentage point increase in population FMG enrolment differed by the breadth of enrolment. Increases in the percentage of the population enrolled with physicians in FMG practices was expected to be correlated with the number of FPs choosing to participate in the FMG model. Accordingly, regions in which enrolment levels remained low were assumed to have a smaller percentage of FPs participating in the reform relative to regions where enrolment was high. High versus low enrolment was defined as the regions falling above or below the annual provincial level. Based on this definition, we found that regions that started low tended to remain so throughout the follow-up period with similar observations applying to the high enrolment regions. As such, 6 regions remained below the provincial average level of enrolment in each year of follow-up and 6 regions remained above the average throughout the study period. The remaining 2 regions switched their status over time and were included in the high enrolment group. Our results in Table 13 indicated that within low enrolment regions, a 10-percentage point increase in enrolment in FMG practices at *t* -1 led to an 18% decrease in the number of avoidable ED visits (RR = 0.82; 95% CI = 0.78, 0.87). The effect disappeared when the analyses were restricted to the high enrolment regions (RR = 1.00; 95% CI = 0.92, 1.09).

Table 13. Results based on level of population enrolment in FMG practices

Model specification	Estimate (95% CI)[1] [2]
Low enrolment regions[3]	0.82 (0.78, 0.87)
High enrolment regions[4]	1.00 (0.92, 1.09)

[1] Estimates are rate ratios that are interpreted as a 10-percentage point increase in population enrolment in FMG practices at t - 1.
[2] Estimates were produced using the MSM.
[3] A region was considered a low adopter if the percentage of the population enrolled in FMG practices was below the provincial average throughout the study period.
[4] A region was considered a high adopter if the percentage of the population enrolled in FMG practices was above the provincial average throughout the study period.

4.9 Discussion

This study aimed to provide insight into the expansion of the FMG model in Quebec over time and its effect on diabetic patients' avoidable use of the ED. We used the proportion of the population in a health and social services region enrolled in FMG practices as an indicator for the policy's diffusion. We found a 3% reduction in the rate of avoidable ED visits attributed to population enrolment in FMG practices in the year prior to the observed outcome. When we assessed whether this effect depended on the frequency of an individual's avoidable use of the ED, we found that beyond sporadic visits (i.e. at most 1 visit per year) the effect became non-significant.

On average, 2.5% of diabetic patients made avoidable visits to the ED between 2003/04 and 2011/12. The skewed nature of health care utilization data supports the assertion that users of health care are often a heterogeneous group of patients and therefore even after controlling for patient comorbidity, ED users may be non-exchangeable. Severity of illness is a main factor determining health care consumption and frequent avoidable use of the ED is plausibly correlated with a patient's complex health needs. Our results indicated that for individuals who may be habitual users of the ED, the reform did not alter their patterns of utilization. These may be comprised in part by people who have a preference for using the ED over primary care due to potentially easier and quicker access to specialized services. Additionally, this small group was also likely made up of patients who required tertiary care and therefore reforms to re-organize

the front line would have minimal to no effect on their use of specialized services. Indeed, there is an emerging literature on the need to distinguish between different categories of primary care patient populations. In recognition of the fact that some patient health service utilization patterns are better addressed by the medical home in relation to other types of needs, predictive models that aim to stratify patients according to risk could facilitate health services planning and distribution of resources.[108] Patient risk stratification is argued to be able to inform providers about which patients are likely to benefit from specific interventions and therefore improve the delivery of care.[109]

Our sub-analysis of high versus low enrolment highlights the complexity of the policy diffusion effect. The lower enrolment areas tended to be urban regions where practice models that were not conducive to team-based practice, such as walk-in clinics, held a greater stake in the organization of primary care relative to rural regions. As such, the effects of the reform would be more apparent in urban regions where the difference between practices that became FMGs versus those that did not was clearer. Conversely, we might expect to find non-significant effects of the reform in rural areas where previous research suggests that there was already an inclination to work in groups[43,110] regardless of whether practices had FMG status. We found significant reductions in diabetic patients' avoidable use of the ED in regions where enrolment was consistently below the provincial average throughout the study period. This result is consistent with an earlier study examining the effect of an individual's enrolment in FMG practices established between 2002 and 2005 in which a 7% reduction in ED visits was observed.[41] Previous work on FMGs has also shown that FP uptake of the model exhibited systematic differences in individual physician and practice characteristics.[41,43] Given that early adopter FPs would become the minority within the total number of FPs participating in the reform over time, we may be observing a dilution effect in the high enrolment regions. This suggests that early adopters were sensitive to the reform's incentives in implementing changes to their practice, but that other policy instruments would have been necessary to support the greater effort required by later adopters to implement change.[46]

In accordance with our observations regarding the frequent users of health care, of relevance to these results were the potential differences in ED patient case mix between the high versus low enrolment regions. Wait times can serve as a proxy measure of the severity of cases seen in the ED. Between 2003 and 2013, the average wait time for people presenting to the ED in Quebec moved from 3.1 to 4.6 hours.[111] However, notable wait time variation was observed between the regions: from 2.5 hours in Chaudière-Appalaches to 6.3 in Lanaudière by 2013.[111] However, other factors that are not related to case severity could affect wait times in the ED such as the organization of work flow from the time of patient intake to the time of hospital admission or release from the ED. The relationship between ED patient case mix, ED wait times, urban versus rural regional status and population enrolment in FMGs is undoubtedly complex. While a recent report revealed that the areas surrounding Montreal were found to have the longest wait times by 2013,[111] these were also the regions in our study that were consistently below the provincial average for FMG enrolment and where enrolment was attributed to significant reductions in avoidable ED use. Patient health status may be more predictive of ED use in urban and surrounding areas than in more rural regions where it is not uncommon for patients to be told to go see their FP for follow-up care on the day she is working in the local hospital ED. If this were indeed the case, there would be greater potential for the FMG model to decrease avoidable ED use in urban and surrounding regions.

These observations regarding ED patient case mix and patterns of health service utilization have two important implications. Firstly, these factors are confounders of the relationship between FMG enrolment and avoidable ED use. Assuming these differences were stable over time, our inclusion of regional fixed effects in the models would control for this. From a policy standpoint, the presence of these factors raises questions about the appropriateness of a blanket reform that is expected to perform uniformly across the province. Although there was an expectation that physicians in FMGs would organize their practices in a way that responded to the needs of their patient populations, this strategy assumed that physicians in different practices were all receptive to change and had the know-how to implement the organizational restructuring of their clinics.

Our analyses build on previous research conducted on the FMG reform. In a survey of FMG clinics, Pineault et al.[46] found that practices that obtained FMG status in the early stages of the reform between 2003 and 2005 demonstrated greater organizational change in line with the model's ideals. Although clinics that became FMGs later in the post-reform period may have required more time in bringing about organizational change, this may also be due to insufficient support available for the development of clinics and poor oversight of the reform's implementation.[7,46] This may also speak to variation in FP receptivity to change: despite additional resources and new practice organization, conforming to an ideal type requires FP motivation and desire for change.[46]

FPs that immediately adopted the reform may indeed have systematically differed from those who did so years after it was initially introduced, assuming early implementation was correlated with an FP's interest in innovative practice and openness to change.[90] An early adopter effect combined with evidence that the effectiveness of the reform varied by regional context, suggests that FMGs may have been catalysts for change within a highly motivated group of FPs receptive to adopting new strategies for increasing access to and quality of primary care. Accordingly, a study on primary care reforms in Ontario found a greater impact in FP productivity among those who joined the reform later.[83] This study suggested that FPs who subscribed to the new model early on were already adhering to practice standards and therefore only had to make small changes versus the late adopters who were forced to alter their practice in larger ways in order to meet participation requirements.[83]

Our results point to some limitations in both the design of the FMG reform and its implementation strategy that relied on voluntary uptake without sufficient guidance to support changes in how primary care was organized. Unlike Ontario's primary care reforms that introduced blended capitation remuneration schemes and performance-based payments to promote the medical home model, Quebec limited its reform to offering financial incentives and compensation payments to offset the costs of setting up an FMG. In the spring of 2015, the province's Auditor General released a report highlighting a number of major governance and accountability shortcomings with the implementation of

FMGs, particularly concerning the contracts between health and social services agencies and the FMG clinics on their territories.[7]

In a recent review of primary care reform implementation in 5 Canadian provinces, the authors noted that key barriers were insufficient investment, resistance from medical associations, and a lack of flexibility in centrally administered models.[66] Regardless of its design, an incentive promoting the medical home would support early adopters who were likely be over-represented by physicians coming from innovative and high performing practices before the introduction of the reform. In these cases, incentives were rewards for what was already being done. As such, a broad and untargeted set of incentives would plausibly have no effect over time among late adopters if receipt of financial bonuses were not accompanied by greater implementation support.

4.10 Limitations

We did not have access to FMG enrolment data that could identify which FPs practiced in FMGs and which patients were enrolled with them. Given the systematic differences in characteristics between the FPs and patients who opt into the FMG model, this is likely a source of bias. This motivated our use of fixed effects to capture the regional differences in the characteristics of physicians and patients in FMG clinics. The series of indicator variables in the model would control for the persistent differences between regions that would confound the effect of enrolment on avoidable ED visits (eg. regional differences in patterns of health service use). However, if these unobserved factors were time-varying, this strategy would not provide a full safeguard against bias. Specifically, our results raised issues regarding the consistency of exposure assumption and the possibility that reform implementation differed according to early or late adopters of the model. These results warrant further investigation in order to better inform recommendations for contractual arrangements and incentive schemes. Data capturing the time at which early and late implementers switched to practicing in FMGs would provide additional and necessary information to determine in what ways these groups may systematically differ from one another.

At the patient level, our data could not reliably capture the number of years an individual was a known diabetes case if the diagnosis occurred prior to the 2000/01 fiscal year. The QICDSS is an administrative as opposed to clinical database. Although data are available from 1996 onward, a 4-year run-in period was necessary in order to distinguish between incident and prevalent cases. Consequently, the number of years since diagnosis for individuals identified with diabetes prior to 2000 is inaccurate. Although categorical variables can be used, residual confounding is likely to affect the highest category of patients with considerable variation in diagnosis dates prior to 2000.

4.11 Conclusion

In conclusion, the results of our study suggest the potential for FMGs to increase access to and quality of primary care. However, we also found evidence of an early reform protective effect that may have been diluted over time in certain regions. Our findings support recent reports calling for the need to ensure that contractual arrangements between the territorially defined integrated health and social services centers and physicians in FMGs, provide sufficient governance and support in re-organizing primary care practices.

CHAPTER 5

Manuscript 3: Assessing the impact of financial incentives on adherence to diabetic retinopathy screening guidelines: A panel data difference-in-differences analysis

5.1 Preface to Manuscript 3

While Chapter 4 used avoidable visits to the ED as a proxy for access to and quality of primary care, the following manuscript focuses on adherence to screening for diabetic retinopathy as a specific indicator for technical quality of care. Since the onset of primary care reform in Quebec in 2002, policies have encouraged shifts away from the single-provider model toward group practice. Integral to this progression was the introduction of non-performance linked financial incentives that were offered to physicians to promote patient enrolment. Changes in the incentive fee structure in 2007 sought to enhance continuity of care for vulnerable patients by allowing physicians in a group practice to share revenues from incentive payments. Findings from studies on English primary care practices suggested that group practice had the potential to increase the technical quality of care delivered to patients, particularly those with diabetes.[112] However it remains unclear how shared revenues among physicians affect quality of care.

Non-compliance with diabetic retinopathy screening guidelines is influenced by a number of factors, some of which are beyond a physician's control. These characteristics include the patient's socioeconomic status, language or cultural impediments, and geographic barriers to accessing screening services.[113] Fear of a retinopathy diagnosis may also dissuade patients from seeking routine screening.[113] However, in patient surveys on retinopathy screening uptake, facilitating factors for the most part related to physician or practice characteristics namely, physicians emphasizing the importance of routine monitoring and their recommendation to seek screening services.[114] Barriers identified by patients that were amenable to physician intervention included: deficits in

levels of coordinated and integrated care, a lack of patient reminders to attend their screening appointments, prioritizing newly diagnosed cases of diabetes for screening over those with longstanding diabetes, and discouragement among health professionals for the patients that consistently missed screening appointments.[113]

In 2007, Quebec doctors working in clinics in which there were two or more physicians could obtain group practice status from RAMQ. Although financial bonuses were normally restricted to physicians who treated patients on their roster, group practice status allowed them to share incentives upon treating patients enrolled with another physician in the same clinic. While the term 'team-based' practice continues to be reserved for FMG clinics, the group practice policy could henceforth apply to non-FMG practices and aimed in part to promote the case management sharing that was encouraged in FMGs. The policy sought to address two main issues: (1) confusion among physicians (and patients) as to who was on their patient roster, and (2) limited availability of physicians in family practices due to part-time working arrangements.

Practices that obtained group status were attributed unique identification codes that were available in the medical service claims data held by the QICDSS. Physicians working in group practices versus those who did not could therefore be distinguished from one another. This study used the introduction of group practice status in 2007 as a natural experiment to determine whether physician participation led to improved quality of care for diabetic patients, as measured by changes in rates of retinopathy screening.

5.2 Diabetic retinopathy

Retinopathy is a microvascular complication due to diabetes and is the primary cause of blindness in North America among individuals of working age.[115] In the U.S., the prevalence of diabetic retinopathy is estimated to be 40.3%.[115] Retinopathy is typically classified as non-proliferative or proliferative. Non-proliferative retinopathy arises from the swelling or leakage of vessels in the middle layers of the retina. The leaking fluid can lead to macular edema, defined as the swelling of the macula that can ultimately lead to

vision loss.[116] Proliferative retinopathy results from new blood vessels developing over the surface of the retina that can lead to hemorrhaging or the creation of scar tissue causing a pull on the retina that ultimately can lead to its detachment. Proliferative retinopathy can result in more serious vision loss because it affects both peripheral and central vision.[116]

Two studies from the 1980s, the Diabetic Retinopathy Study and the Early Treatment Diabetic Retinopathy Study, demonstrated the importance early retinopathy detection through routine screening as a means of reducing the risk of vision loss. Depending on the population, studies estimate a wide range of compliance rates whereby between 32% and 85% of diabetic patients receive guideline recommended screening.[117] Results from the *Canadian Community Health Survey* in 2007 indicated that only 66% of individuals with diabetes were screened for retinopathy within a two-year period.[118] In a Swiss study using Markov models to examine the cost-effectiveness of different approaches to diabetes management, the authors concluded that tight glycemic control in addition to retinopathy screening was the more effective and less expensive intervention in comparison to only intensive insulin therapy.[119] A recent systematic review examining the international evidence on the costs associated with diabetic retinopathy screening concluded that the intervention was cost-effective.[120]

5.3 Empirical approach to analyses

This analysis sought to determine how much change in retinopathy screening rates was attributable to physician participation in group practices. To this end, a difference-in-differences (DD) approach was implemented which in addition to a control group, made use of data in the pre and post intervention periods. A DD analysis combines two distinct approaches that are often used separately to assess the intervention effects: (1) a simple pre-post analysis that compares the treatment group to itself, and (2) observational studies that include a control group but are limited to post-intervention periods.[121] In the former, while observing the treatment group in the pre and post intervention period controls for time fixed factors, this assumes no other elements varied over time to influence trends in

the outcome. In the latter, without accounting for pre-intervention trends, it is impossible to assess whether the control group serves as an appropriate counterfactual for what would have occurred to the treatment group had treatment not been assigned. A DD analysis therefore attempts to combine the two approaches in order to benefit from their strengths while offsetting their weaknesses. Accordingly, while comparing the treatment group in the pre and post-intervention periods controls for observed and unobserved time fixed confounding factors, the addition of the control group accounts for secular trends in the outcome (i.e. the factors associated with changes in the outcome that vary over time). If the common trend assumption in the pre-intervention period is satisfied thereby offering assurance that the treatment and control groups are exchangeable, the DD analysis can provide a causal estimate of the effect.

Figure 11 offers a visual depiction of the basic DD analysis in which there are two groups and two time periods (before and after). The red dotted line represents the counterfactual of the treatment group: had the treatment group not experienced the intervention, the red dotted line is the trend that would have been observed. Given that it is impossible to observe the counterfactual, the control group (black line) acts as a stand-in. From the graph, it is clear that in order to obtain an unbiased DD estimate, the trends between the treatment and control groups in the pre-intervention period must be similar. Referring back to the explanation of the combined approach, the estimate is derived as follows: the average within-group effect for both the treatment and control groups is calculated by subtracting mean outcome Y in the pre-intervention period from mean outcome Y in the post-intervention period. Subtracting the within-control group effect from the within-treatment group effect makes up the second difference that removes the influence of secular changes in the outcome. Figure 11 also illustrates the key assumption for the second difference: the difference in the counterfactual trend (i.e. $Y'_{1T} - Y_{0C}$) equals the difference in the control trend ($Y_{1C} - Y_{0C}$).

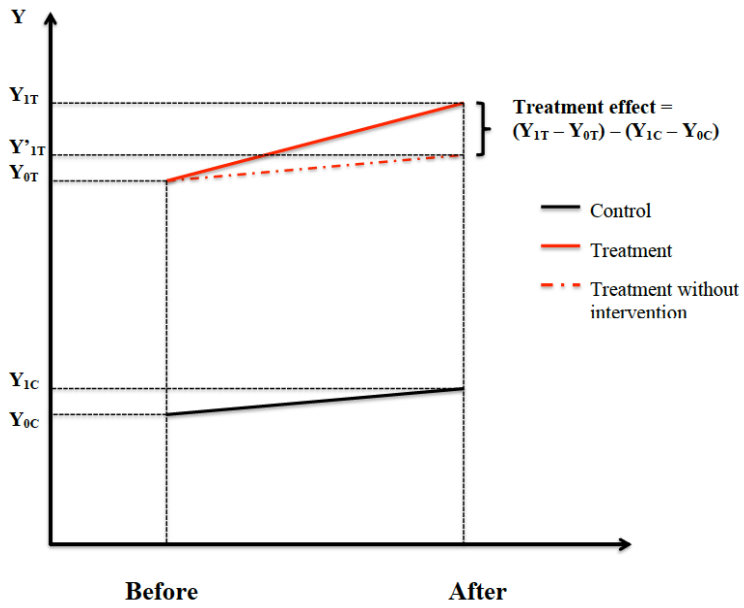


Figure 11. Visual representation of the basic DD empirical strategy

The mechanics of the DD approach can also be illustrated by a regression equation whereby the combination of coefficients show how the intervention effect can be estimated while accounting for group and time effects. The following equation expresses the basic DD model in which, similar to Figure 11, there are only two groups and two time periods (before and after):

$$Y = \beta_0 + \beta_1(Tx) + \beta_2(Post) + \beta_3(Tx * Post) + \varepsilon$$

β_1 is a dummy variable that takes the value of 1 if the individual is in the treatment group and 0 if she is in the control group. β_2 is also a dummy variable that takes the value of 1 if the observation is in the post-intervention period and 0 if otherwise. β_3 is an interaction term that takes the value of 1 if the observation is attributed to an individual in the treatment group in the post-intervention period and 0 if otherwise. β_3 is the estimate for the intervention effect. Finally, β_0 is the intercept and ε is the error term. Using the model's coefficients, Table 14 displays how the intervention effect is derived. The within-control group effect (first difference) is: $(\beta_0 + \beta_2) - (\beta_0) = \beta_2$. The within-

treatment group effect is: $(\beta_0 + \beta_1 + \beta_2 + \beta_3) - (\beta_0 + \beta_1) = \beta_2 + \beta_3$. Subtracting the within-control group effect from the within-treatment group effect results in the impact estimate: $(\beta_2 + \beta_3) - (\beta_2) = \beta_3$.

Table 14. Deriving the DD estimator

Group	Time period	Coefficient	First difference	Second difference *(Intervention effect)*
Control	Pre	β_0	β_2	β_3
Control	Post	$\beta_0 + \beta_2$		
Treatment	Pre	$\beta_0 + \beta_1$	$\beta_2 + \beta_3$	
Treatment	Post	$\beta_0 + \beta_1 + \beta_2 + \beta_3$		

Assessing the impact of financial incentives on adherence to diabetic retinopathy screening guidelines: A panel data difference-in-differences analysis

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5.4 Abstract

Introduction: Beginning in 2007, Quebec's physicians working in the same primary care clinic could be recognized as a group practice, which sought to increase access to services and facilitate the case management of vulnerable patients. Group status was defined through an agreement between physicians to claim bonuses for seeing patients enrolled with another colleague in the same practice.

Objective: Using the introduction of group practices as a natural experiment in our panel data, our objective was to determine the impact of physician participation on adherence to diabetic retinopathy screening guidelines.

Methods: Using a difference-in-differences approach, we conducted a population-based study that compared adherence to diabetic retinopathy screening guidelines by physicians in the treatment and control group between pre and post intervention periods. Physicians in the treatment and control groups were propensity score matched at baseline in the year prior to the introduction of group practice status. The total number of patients per physician screened for retinopathy within 2 years was modeled for each year of follow-up using a negative binomial distribution. The analysis covered 12 fiscal years from April 1, 2000 to March 31, 2012.

Results: Our main results indicated that, compared to physicians in the control group, there was no change between the pre and post intervention periods in the rate of diabetic patients receiving guideline recommended retinopathy screening among physicians in the treatment group (rate ratio= 1.00; 95% CI= 0.95, 1.05). Results did not differ by the year physicians opted to join group practices.

Conclusion: Although the introduction of group practices had the potential to facilitate a collaborative approach to chronic disease management by supporting continuity of care, our study finds no significant change in adherence to diabetic retinopathy screening guidelines among physicians who obtained group practice status. This raises questions

regarding how financial incentives are implemented as a means of achieving the government's health system objectives.

5.5 Introduction

Since 2000, primary care reforms across Canada have largely focused on strengthening organization and service delivery. Among the main objectives of primary care reform in Canada were to ameliorate access to services, coordination of care, chronic disease management and support team-based practice.[2] Financial incentives, support for group and team-based practices, and patient enrolment were introduced as key policy levers in certain provinces to meet health system priorities, to improve physicians' working conditions and alter practice governance structures.[2]

Since the onset of primary care reform in Quebec in 2002, support for patient enrolment and the formation of clinics in which a group of physicians practice were at the forefront of health care policies. These initiatives were based on these practices' recognized potential to increase access to services and facilitate coordination of care.[5] Two types of financial incentives were offered to physicians as a means of encouraging patient enrolment and follow-up of vulnerable patients (with vulnerability defined by specific chronic illness and age categories: (1) the *forfait de prise en charge et de suivi* (enrolment fees) paid annually for each patient enrolled on a physician's roster, and (2) the *forfait de responsabilité* (commitment fee) paid for each vulnerable patient visit to the physician identified as responsible for their care. Changes to the incentive structure were introduced in 2007 to allow other physicians within the same group practice to claim the commitment fee when seeing a patient rostered with another member of the same clinic. The initiative sought to support greater team-like conditions within group practices and address confusion among patients and physicians regarding the former's enrolment status in addition to instances where the same patient appeared concurrently on different physicians' enrolment lists.[122] As such, the 2007 reform sought to facilitate continuity of services for vulnerable patients by changing the incentive fee structure among physicians working in clinics that sought group practice status.[123,122] In contrast to the notion of

group practice upheld by the medical home model, the intervention in 2007 defined group practice on a financial basis through an agreement between physicians to claim the commitment fee for a patient enrolled with a colleague in the same practice.

Previous research on the effect of Quebec's Family Medicine Groups (FMGs) in the early reform period between 2002 and 2005 showed non-significant effects on levels of retinopathy screening.[124] Although the change in incentive fee structure in 2007 that allowed physicians to share revenues had the potential to facilitate group practice whereby physicians could support each other's caseloads, it is unclear whether this has translated into higher quality of care in Quebec. Previous research on organizational change in English primary care practices found that group practices offer greater technical quality of care particularly for diabetes patients.[112] However, the evidence regarding the effect of shared revenues within group practice on quality of care is unclear; while economic theory points to the risk of free-riding among lower performing physicians in a group, other hypotheses suggest that shared income can encourage collaboration which in turn increases quality of care.[125] Using the introduction of group practices in 2007 as a natural experiment, we aimed to determine whether physician participation improved quality of care for a specific vulnerability group, diabetic patients, as measured by changes in rates of retinopathy screening.

5.6 Context

The introduction of group practice status in 2007 applied to all clinics in which 2 or more physicians worked and was embedded in the overarching evolution of patient enrolment policies that occurred between 2002 and 2009. Importantly, the group practice intervention was defined by a change in the incentive fee structure as opposed to shifts in patient enrolment regulations. While incentive fees and patient enrolment were distinct interventions, understanding how these have changed concurrently provides a contextual framework within which this study was conducted. Figure 12 outlines the incremental approach to patient enrolment with primary care providers in Quebec beginning with the introduction of the FMG model in 2002. To incentivize participation in the FMG reform,

physicians were offered flat rate fees for each patient that agreed to become enrolled with them. These enrolment fees *(forfait de prise en charge et de suivi)* varied as a function of the patient's vulnerable or non-vulnerable status.[5,126] In addition to encouraging patient enrolment, the bonuses were also intended to attract physicians to practice in teams and improve their working conditions.[5]

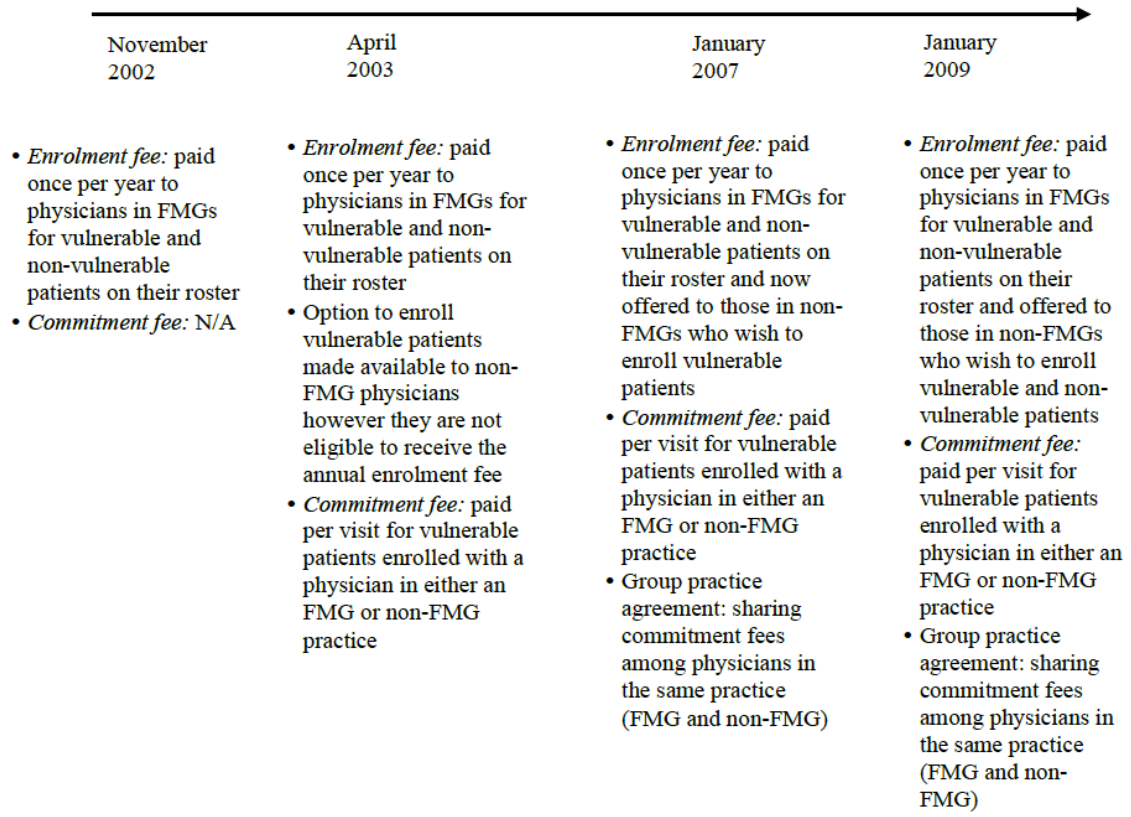


Figure 12. Evolution of patient enrolment in Quebec

In 2003, vulnerable patients could identify non-FMG physicians as their main provider.[127,128] Physicians in both FMG and non-FMG practices received a commitment fee *(forfait de responsabilité)* for every visit made by a vulnerable patient on their roster.[127] These bonuses were introduced in recognition that vulnerable patients often require complex and continuous care that result in greater demands on a physician's time, require multidisciplinary services and frequent contacts with primary care providers.[127] However, the incentive structure discouraged optimal group practice, as other practice members were not allowed to claim the commitment fee when they saw a patient rostered

with another colleague from the same practice. This was particularly an issue with physicians working in the same clinic: when their main provider of care was unavailable, patients would seek treatment from another physician. Patients would then often sign a second form identifying them as part of a new roster, often not knowing that doing so nullified the previous agreement with their primary physician.[122,127] Upon doing so, the first physician could no longer claim the commitment and enrolment fees for that patient.

To address this confusion and instances where patients appeared on multiple physicians' enrolment lists, beginning in 2007, clinics in which two or more physicians practiced and where vulnerable patients were already enrolled could obtain group practice status from the *Régie de l'assurance maladie du Québec* (RAMQ) which allowed them to share the commitment fee when treating the same vulnerable patient.[34,123,129] Obtaining group practice status meant that physicians who treated a patient enrolled with another provider in the same practice could now bill for the commitment fee. This arrangement was conditional on physicians in the practice signing a consent form *(Consentement à la pratique de groupe aux fins du paiement du forfait de responsabilité)*.[129] By November 2007, any group of physicians, regardless of their choice of practice model, could submit the consent form.[130] The new policy aimed to address two issues: (1) confusion among physicians as to whether a patient remained on their roster, and (2) physicians with limited availability in their family practice due to part-time arrangements. Once consent to sharing the commitment fee between physicians was formalized, patient medical files were shared and updated accordingly.[34]

Intervention: defining physician eligibility for obtaining group practice status

This study aims to determine the effect of group practice status on physicians' adherence to diabetic retinopathy screening guidelines. Physicians were eligible for group practice membership if they worked in a clinic with two or more physicians and already had a vulnerable patient roster. Upon signing a consent form, RAMQ ascribed each group practice a unique identification number. It was mandatory for all physicians in the same group practice to identify their 5-digit code for every vulnerable patient visit.[34] As such,

the ability to share the commitment fee was only offered to physicians in a group practice that agreed to participate. At face value, the agreement resulted in physicians benefiting from additional bonus payments linked to vulnerable patient enrolment. However, it also implied the distribution of caseloads and potential for greater patient follow-up in the context of persistent difficulties in accessing primary care in Quebec.[7]

Voluntary participation in group practices that agreed to share the commitment fees for enrolled vulnerable patients plausibly induced non-random selection of physicians into seeking group practice status. Previous work on primary care reform in Quebec has shown that physicians who participated in new organizational models were more likely to be female, recent medical school graduates, and practice outside urban centres.[43] Similar observations may hold true for physicians that opt for group status recognition from RAMQ. To address this concern, we propensity score matched physicians in group practices to physicians in non-group practices in the year preceding the intervention. Physicians working in the former will hereafter be referred to as the treatment group. All physicians who never worked in group practices, and therefore were not attributed the unique practice identification number, will be referred to as the control group.

5.7 Data

Administrative data from the Quebec Integrated Chronic Disease Surveillance System (QICDSS) were used for the development of healthcare utilization indicators.[101] The health insurance billing database provided information on the type and location of service delivery by physicians that were remunerated through fee-for-service, including exams performed by ophthalmologists. The registered persons database provided individual sociodemographic information to describe the physicians' patient populations. The physician database contained information on provider specialties and graduation year from medical school. The optometrist database contained information on optometry services that were reimbursed by the RAMQ. Complete eye exams performed by optometrists that included viewing the back of the eye were covered for individuals in defined vulnerability categories including those under 18 years old, those 65 years and

older, and recipients of last-resort financial assistance.[131] In 2009, dilated eye exams delivered by optometrists fell under RAMQ inclusion for coverage for those with treated diabetes or with myopia of 5 diopters or more.[131]

Cases of diabetes (excluding gestational diabetes) were identified from the medical claims and hospital admissions data using a previously validated algorithm.[55,102] Individuals with at least 2 physician claims with a diabetes diagnosis within a 2-year period, or individuals admitted to hospital with a diabetes diagnosis, were included in the cohort.[55,102] We excluded 4 of 18 health and social services regions in Quebec due to the structurally different service provision arrangements in remote northern areas or the tendency for patients to seek care across the provincial border in Ontario thereby producing under-estimates of annual health service utilization. We also limited our analyses to diabetic patients aged 20 years or older. All data were linked using an encrypted identification number. For each family physician, we defined a diabetic patient population with information on health services delivered to each individual for every fiscal year between 2000/01 and 2011/12. We totaled the number of patients per physician that were screened for retinopathy within a 2-year time window for each year of follow-up. To accommodate the 2-year window, the outcome was ascertained between 2000/01 and 2011/12 and the follow-up period for the analyses spanned from 2000/01 to 2010/11.

Study sample

The study was conducted using general practitioners (hereafter referred to as physicians) as the unit of analysis. After regional exclusions, the number of physicians in Quebec ranged between 5,516 and 5,584 between 2000/01 and 2010/11. Physicians practicing in community health centers who were paid by salary did not appear in the medical claims data and were therefore excluded from the sample. Furthermore, given that the data only contained records for diabetic patients, our physician sample was limited to those who ever treated people with diabetes. Nonetheless, our sample was expected to capture the majority of practicing physicians in Quebec due to the growing

prevalence of diabetes among individuals aged 20 years and older over the study period (5.19% in 2000/01 to 8.77% in 2010/11),[132] and due to diabetic patients typically being high users of health care.

The number of physicians in the treatment group ranged from 805 in 2007/08 to 1,130 in 2010/11. Since we aimed to measure the impact of physicians becoming part of a group practice, we excluded providers who stopped practicing before 2007 and those who began practicing after 2007. The full sample was comprised of 4,902 physicians. Those with missing data were removed (n = 21) leaving 4,881 providers. The final sample contained 1,112 physicians in the treatment group and 3,769 physicians in the control group.

Outcome definition

We defined our outcome of interest as physician adherence to diabetic retinopathy screening guidelines. Accordingly, we modeled the number of patients in a physician's diabetic practice population that received guideline recommended screening for retinopathy. Reflecting the rise in diabetes prevalence, the volume of services delivered to diabetic patients in both the treatment and control groups increased over the study period. In order to measure the impact of shared commitment fees within group practices on physician adherence to guidelines, we defined a diabetic patient population for every physician in each year of the study period. Although data on vulnerable patient enrollees exists, this information was unavailable to us. Instead, we applied a previously validated algorithm developed by Hutchison et al.[133] that defines primary care physician patient populations using billing sequences in medical claims data. The practice population for each year of follow-up was defined as: (1) all patients for whom the physician submitted a claim for in the year prior to the current observation, and (2) all patients for whom the physicians submitted at least one claim in each of the two previous years.[133] A patient visiting more than one physician in a given year was attributed to the provider that was visited the most frequently. A patient with an equal number of visits to different physicians was attributed to the provider with the most recent visit.[133]

Physicians' adherence was measured in every year of follow-up by the number of diabetic patients within each of their practice populations that were screened for retinopathy according to the Canadian Diabetes Association's (CDA) recommendations. The CDA advises to begin screening for retinopathy 5 years after a type 1 diabetes diagnosis among those 15 years and older, and at the time diagnosis for type 2 diabetes.[134-137] If the patient was diagnosed with retinopathy, monitoring intervals should be no more than 1 year long. If there are no clinical indications, screening is recommended on an annual basis for type 1 patients and every 1 to 2 years for type 2 patients.[137] Given that we could not distinguish between type 1 and type 2 patients in our data, we used a less conservative screening interval of 2 years to determine adherence. These guidelines remained consistent throughout the study period.[134-137]

Our strategy for identifying whether retinopathy screening had occurred was comprised of 3 steps. Firstly, we searched the medical claims data for billing codes linked to specific procedures (eg. dilated eye exam). Secondly, we searched the codes identifying complete and dilated eye exams in the database for optometrists. Finally, we defined any visit to an ophthalmologist as a retinopathy screening event under the assumption that the exam was likely administered. Similar strategies for identifying retinopathy screening have been used with medical service claims data elsewhere in Canada.[138] We totaled the number of patients per physician that were screened for retinopathy within a 2-year time window for each year of follow-up.

Exposure definition

Physicians who consented to share the commitment fee for their enrolled vulnerable patient population were attributed a unique practice identification number. This number had to appear on all claims pertaining to vulnerable patients enrolled with a physician in the same practice. The first two digits in this number were used to denote this new type of practice and were used to designate physicians in the treatment group between 2007/08 and 2010/11. Accordingly, we constructed an indicator variable identifying whether the

physician had ever been a member of a group practice or not and an indicator variable for whether the year of observation was in the pre-treatment period (2000/01 to 2006/07) or the post-treatment period (2007/08 to 2010/11). We defined an interaction term coded as 1 if the observation was of a physician in the treatment group and in the post-treatment period, and 0 if otherwise.

Covariates

Covariates in the analysis included physician and practice attributes, and the characteristics of their diabetic patient population. The variables pertaining to practice patterns were in relation to treating diabetic patients. Physician and practice features included: the number of years since graduating medical school, location of practice (defined by 14 health and social services regions), number of patients seen in emergency departments, number of patients seen in hospital, number of patients seen in outpatient clinics, and the number of patients seen in office-based practice. Characteristics of the diabetic patient population included: average age, average comorbidity score, and average level of material deprivation.

5.8 Analysis

Approach

Our empirical approach to measuring the impact of group practice membership dealt with 2 main issues: (1) physicians who consented to share the commitment fee for their enrolled vulnerable patients may have systematically differed from physicians in the control group, and (2) concurrent policy or practice changes may have affected levels of diabetic retinopathy screening in both groups.

We used propensity score matching to address selection factors into the treatment group based on observable characteristics. We regressed the probability of being in the treatment group on physician traits, practice patterns and diabetic patient population

characteristics. To inform our selection of a final propensity score model, we used logistic regression to assess the univariate and multivariate relationships between physician, practice and diabetic patient population characteristics, and the probability of a physician being assigned to the treatment group. We looked at the change in estimates and confidence intervals between each model to determine which variables were predictive of treatment assignment. Upon deriving the estimated propensity score for each physician, we applied 1:1 nearest neighbor matching without replacement and calculated the standardized differences between the treatment and control groups to assess whether we had achieved balance. Matching was performed in the 2006/07 fiscal year (i.e. the year prior to the introduction of the intervention). The standardized difference is useful for comparing the means or prevalence of continuous and binary variables, respectively, since it is not influenced by sample size. Although there is no universal threshold for determining whether balance has been achieved, we used a value of 0.10 based on recommendations in the literature.[139] Under 0.10, the difference between the treatment and control groups is considered non-significant.

To address confounding from secular trends and from time-invariant differences between the treatment and control groups, we used a difference-in-differences (DD) approach to modeling the data. A DD model compares the average change in outcome in the treatment group between the pre and post intervention periods with the average change in the control group occurring between the same time points. Subtracting the average outcome in the pre-intervention period from the average outcome in the post-intervention period controls for observed and unobserved time invariant characteristics of the treatment group. The biases resulting from time-varying factors are addressed using the control group by subtracting the average outcome in the pre-intervention period from the average outcome in the post-intervention period. The control group therefore accounts for changes occurring over time that are also common to the treatment group and may influence outcome levels. A critical assumption of the DD model is exchangeability between the treatment and control groups that can be verified by examining whether there are common trends in the outcome between both groups in the pre-intervention period. If common trends exist, it is assumed that they would have remained similar had the

treatment group not experienced the intervention. As such, the trend in outcome for the control group in the post-intervention period represents the counterfactual trend in outcome for the treatment group had the intervention not been introduced.

Statistical analyses

The simple 2-group and 2-period DD model can be expressed as follows:

$$\bar{Y}_{it} = \alpha + \gamma(T_t) + \rho(D_i) + \delta(T_t * D_i) + \beta(X_{it}) + \mu_{it}$$

Where i identifies the treatment or control group and t denotes the pre or post intervention time point. T_t is an indicator variable that takes the value of 1 when the observation is in the post-intervention period and D_i is also an indicator variable that takes the value of 1 if the individual is in the treatment group. T_t*D_i is an interaction term that takes the value of 1 if the observation is an individual in the treatment group in the post-intervention period. The coefficient for δ is the intervention effect. X_{it} is a set of time-varying and individual characteristics, and μ_{it} is the error term.

To fit our multiple time period analysis in a propensity score matched sample of physicians using a negative binomial distribution for count data, the basic model was extended as follows:

$$\log(\bar{Y}_{irt}) = \alpha + \rho(D_i) + \delta(T_t * D_i) + \varphi_r + \theta_t + \log(P_{it}) + \mu_{irt}$$

Where all are defined as above in addition to θ_t as the fixed effect for each year, φ_r as the fixed effect for each region (identified by subscript r), and $log(P_{it})$ is the offset term for physician-years. Robust standard errors were used to account for within physician correlation over time.

The results from a DD model can provide a measure of an intervention's impact if there are no systematic deviations in trends between the treatment and control groups in the pre-intervention period. This can be verified when data from multiple time periods prior to the intervention are available. Relative to the year in which each physician switched to the treatment group, we produced lag and lead indicator variables to examine change in treatment effect estimates. Non-significant effects for the lead variables denoting earlier switching years would indicate that there was no anticipation of the intervention among treatment physicians. Should the intervention have an effect in the year the physician actually switched to the treatment group, we might expect consistently significant effects when the year of the switch is delayed. We conducted a second sensitivity analysis to determine whether the effect of treatment varied by the year in which a physician switched to the treatment group. Variation in the impact of the intervention between physician cohorts would suggest early versus late adopter effects (i.e. a heterogeneous treatment group of physicians).

Ethics approval

Government bodies in legal possession of the databases, in addition to Quebec's Comité d'éthique de santé publique and the Commission d'accès à l'information du Québec, have approved the creation of the QICDSS and its use for chronic disease surveillance. The creation of the QICDSS and access to its data meet stringent standards of security and privacy. This study is part of a doctoral project that was approved by the Faculty of Medicine's Institutional Review Board at McGill University.

5.9 Results

Figure 13 shows the percentage of individuals with diabetes by health and social services region who were screened for retinopathy within a 2-year period. In every year, there was roughly a 20-percentage point range between the regions with the highest and lowest levels of screening. In most regions, there was a slight decrease in the percentage

of individuals screened for diabetic retinopathy. In the regions combined, approximately 42% of diabetic patients were examined for retinopathy within a 2-year period.

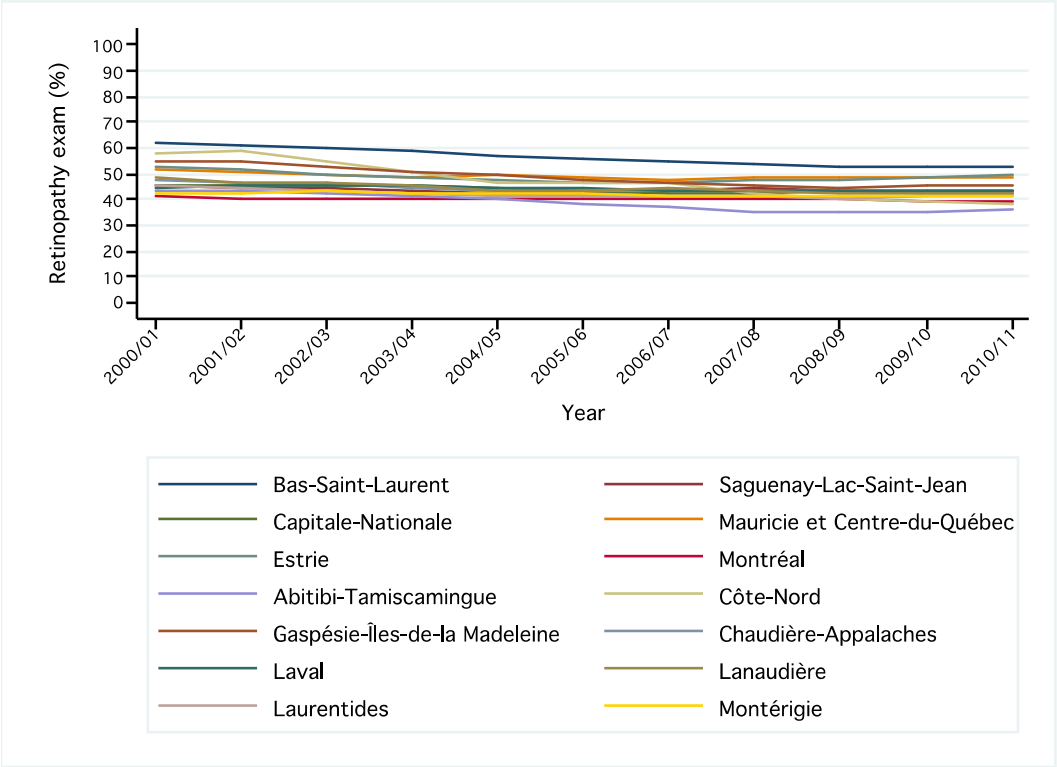
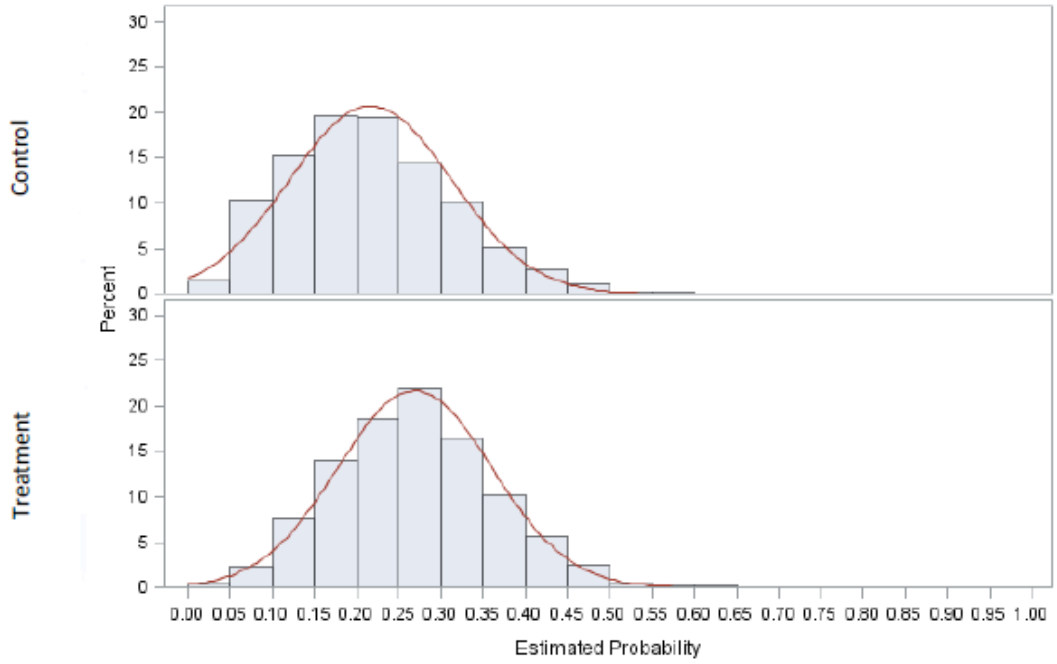


Figure 13. Percentage of diabetes population screened for retinopathy within a 2-year period

Figure 14 shows the distribution of the propensity scores among physicians in the treatment and control groups. The unmatched sample in the first panel showed sufficient overlap in the propensity scores between the treatment and control groups to warrant 1:1 nearest neighbor matching without replacement. Of note is the relatively low propensity of treatment estimated for the treatment group. This may indicate that predictors of treatment were weak and did not explain much of the variation in group membership, or that the groups are in fact relatively similar. After matching, the second panel showed perfect overlap in the distribution of the propensity scores. This suggested that the physicians in the treatment and control groups were exchangeable for the range of propensity scores based on observed factors that predicted their exposure to the intervention.

Panel A



Panel B

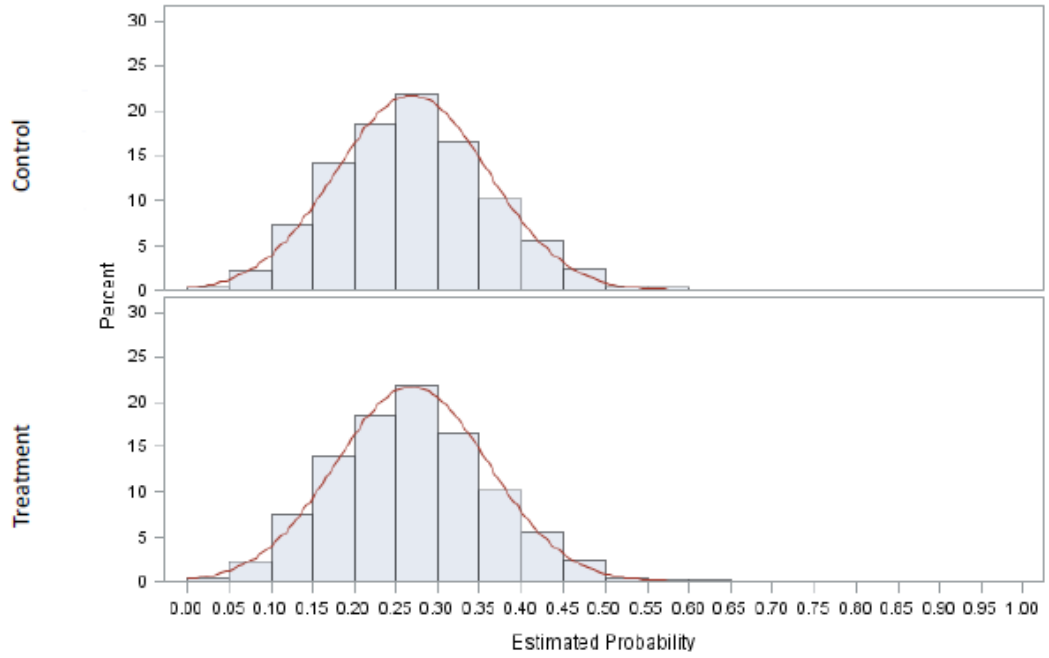


Figure 14. Distribution of the probability of treatment between the treatment and control groups before (panel A) and after (panel B) matching on propensity scores

Table 15 provides the baseline characteristics of physicians with their practice patterns and patient characteristics for the pre-reform year in 2006/07. The treatment group was made up of physicians in group practices that consented to the shared commitment fee for their enrolled vulnerable patient population whereas the control group was comprised of physicians who never made the switch. The differences between the treated and control physicians in the unmatched sample were quantified by the standardized difference between variable means. Physicians in the control group were more likely to practice in urban areas, see a greater number of diabetic patients in their office-based practice and see no diabetic patients in an outpatient hospital-based clinic. Physicians in the treatment group also tended to be more recent medical school graduates and followed diabetic patients who on average had higher Charlson comorbidity scores. Nearest neighbor matching produced a more balanced sample with standardized differences all falling under 0.10. After matching, our sample consisted of the 1,112 providers in the treatment group and 1,112 providers in the control group.

Table 15. Physician, practice and patient population characteristics at baseline (2006/07)

	Unmatched			Matched*		
	Treatment	Control	Standardized difference	Treatment	Control	Standardized difference
Number of physcians	1112	3769		1112	1112	
Physician and practice level covariates						
% of physicians in each regional category						
University	31.4	41.1	-0.21	31.4	31.8	0.00
Peripheral	45.3	37.0	0.16	45.3	45.0	0.00
Intermediate	19.0	16.5	0.05	19.0	19.9	-0.02
Remote	4.1	5.2	-0.05	4.1	3.1	-0.05
% of physicians treating diabetic patients in the ED						
No patients	86.3	83.2		86.3	88.0	
1 or more patients	13.6	16.7	-0.08	13.6	11.9	0.06
% of physicians treating diabetic patients in hospital-based clinic						
No patients	71.5	70.6		71.5	73.7	
1 or more patients	28.4	29.3	-0.01	28.4	26.2	0.04
% of physicians treating diabetic patients in office-based practice						
≤ 19 patients	18.9	32.8	-0.33	18.9	19.6	-0.02
20-49 patients	29.8	23.3	-0.13	29.8	30.4	-0.02
50-79 patients	21.5	15.5	0.15	21.5	19.6	0.05
80+ patients	29.5	28.2	0.02	29.5	30.3	-0.02
% of physicians treating diabetic patients in outpatient clinics						
No patients	92.0	84.5		92.0	93.5	
1 or more patients	7.9	15.4	0.40	7.9	6.4	-0.04
Average number of years since graduating from medical school	22.4 (10.18)	24.3	0.20	22.4 (9.16)	22.5	-0.01
% of physicians with diabetic patient population						
Under 49 patients	57.7	58.3		57.7	57.0	
Over 50 patients	42.2	41.6	-0.02	42.2	42.9	0.00
Patient level covariates						
% of physicians with an average diabetic patient population age over 65 years	38.0	42.5	-0.08	38.0	39.7	0.02
Average comorbidity score	5.0 (0.95)	4.9	-0.11	5.0 (0.84)	5.0	0.00
Average deprivation score	3.1 (0.84)	3.1	-0.08	3.1 (0.81)	3.1	0.00

*Nearest neighbor 1:1 matching (without replacement)
Covariates for the propensity score model included: practice region, patients seen in the ED, patients seen in hospital clinic, patients seen in office-based clinic, patients seen in outpatient clinics, average number of years since medical school, average diabetic patient population age, average comorbidity score, average material deprivation score

Figure 15 provides a visual inspection of the common trend assumption for the DD model. The graph shows not only common but equal levels of the percentage of the diabetic patient population screened for retinopathy in both the treatment and control groups. Similar to Figure 1, there was a slight decrease in the percentage screened over time. After the introduction of the intervention in 2007/08, there was a small divergence in the curves in which the treatment group experienced a greater decrease. Based on the graph, the assumption of common trends was satisfied for the DD analysis.

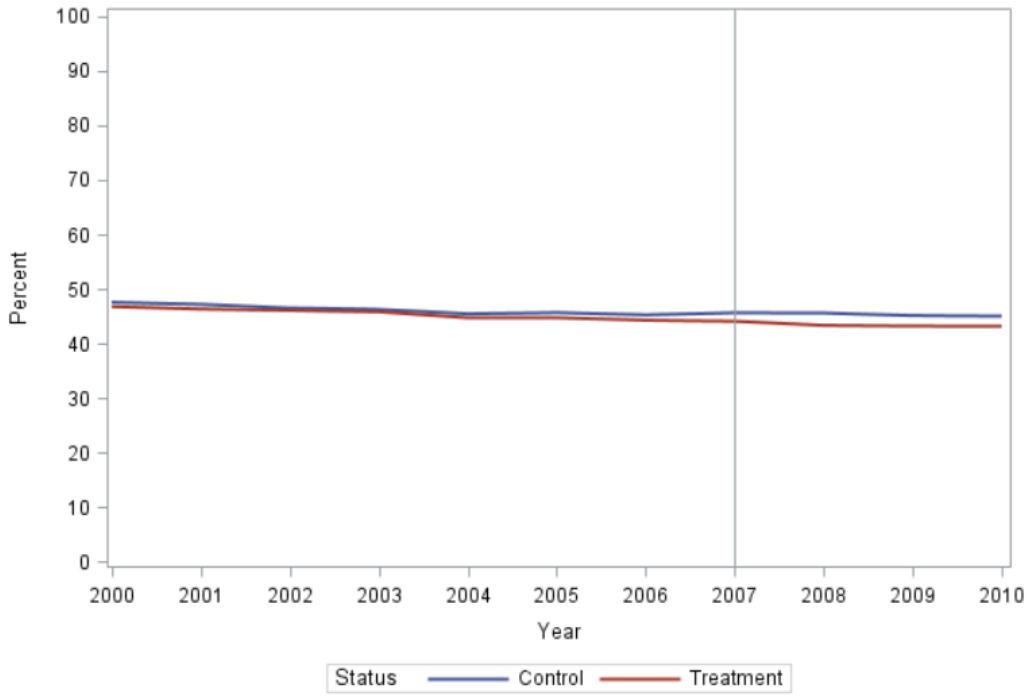


Figure 15. Assessing DD assumptions: common trends between the treatment and control groups in the pre-intervention period (percent of diabetic patient populations screened for retinopathy within a 2-year timespan)

The results from the simple DD model (Table 16) that pooled the pre and post intervention periods indicated that compared to the control group, there was a non-significant 3% decrease in the rate of retinopathy screening among diabetic patients seen by physicians in group practices that consented to the shared commitment fee (RR = 0.97; 95% CI = 0.91, 1.03). When extending the DD model to account for region fixed effects and multiple time periods, the estimate was null (RR = 1.00; 95% CI = 0.95, 1.05). The results were consistent with Figure 15 in which there was very little change in the percentage of diabetic patients receiving retinopathy screening in either the treatment or control groups. Our findings confirmed that the small deviation between the groups after the introduction of the intervention was non-significant.

Table 16. Main results from pooled and fixed effects difference-in-differences models

Specification	Number of observations	Estimate (95% CI)
Pooled DD model[1]	22,292	0.97 (0.91, 1.03)
DD model with fixed effects[2]	22,292	1.00 (0.95, 1.05)

[1] Simple DD model that pools the years into 2 time periods: pre and post intervention

[2] DD model that allows multiple time periods and fixed effects for region of practice. This translates into 10 indicator variables for year and 13 indicator variables for region.

Figure 16 displays the results from the first sensitivity analysis in which lag and lead indicator variables were added to the fixed effects DD model to further probe the common trend assumption. Consistent with what was observed in Figure 3, the confidence intervals for the lead variables crossed the null value of 1.0. The non-significant estimate for the impact of lagged intervention additionally showed that there were no delayed effects.

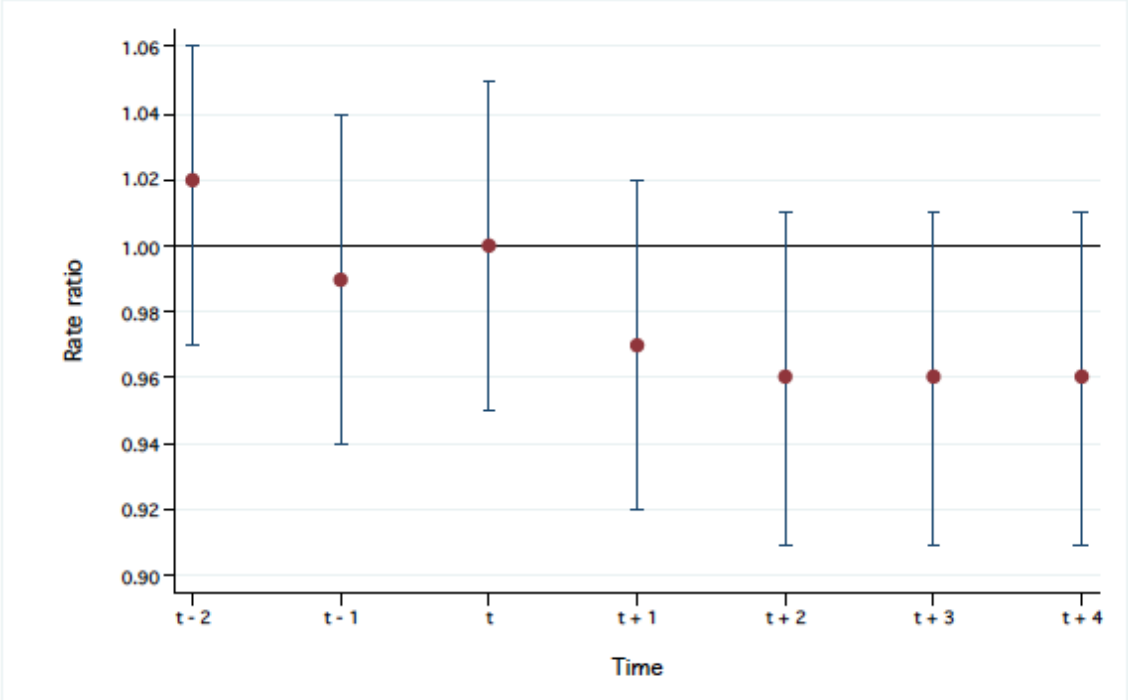


Figure 16. Lag and lead intervention effects (rate ratios and 95% confidence interval bands). Intervention observed in year t (2007/06)

We also examined whether the effect of the intervention may have differed by early versus late physician adoption. We separated the treatment group of physicians according to the fiscal year they switched to group practice (i.e. 2007/08, 2008/09, 2009/10 and

2010/11). The same group of control physicians was used in each analysis. We did not find evidence of either early or late adopter effects as demonstrated by the non-significant results in Table 17.

Table 17. Results from sensitivity analyses examining early versus late adopter effects

Specification	Number of observations	Estimate (95% CI)
Year of physician switch		
2007	18,144	1.00 (0.95, 1.17)
2008	13,031	1.01 (0.91, 1.10)
2009	12,200	1.02 (0.89, 1.15)
2010	11,759	0.96 (0.81, 1.15)

A barrier to accessing care from optometrists was the ability to pay for services. Only certain groups in Quebec (individuals under 18 years old, those 65 years and older, and recipients of last-resort financial assistance) were publicly covered for complete eye exams and, since 2009, dilated eye exams. To examine whether ability to pay confounded our estimate of intervention impact, we conducted a sensitivity analysis on a sub-sample of individuals aged 65 and over who had public coverage for optometry services throughout the study period. The result remained non-significant (RR = 0.99; 95% CI = 0.95, 1.03) suggesting that our initial estimate of intervention impact was robust to confounding by ability to pay.

5.10 Discussion

Our results indicate that physician membership in a group practice in which financial incentives are offered for sharing enrolled vulnerable patient caseloads produced no significant change in the rate of diabetic patients screened for retinopathy. Despite the stated intention behind the reform to facilitate continuity of care, physicians may have been reluctant to engage in routine case management of a diabetic patient enrolled with another physician in the group. Furthermore, this null effect may reflect the limited extent to which an omnibus incentive primarily aimed at patient enrolment can influence physician behavior and improve chronic disease management. Indeed, according to survey results from the Commonwealth Fund in 2009, only 63% of physicians in Quebec reported systematically following clinical guidelines for diabetes care versus 89% in

Ontario and 83% in Canada as a whole.[140] Omnibus financial incentives may be rewarding physicians that were already delivering recommended care while offering bonuses to those that did not change their practice, as appeared to be the case with the FMGs according to the Auditor General report.[7]

A number of jurisdictions have introduced pay-for-performance incentives to improve diabetes care.[141,142] Within Canada, the province of Ontario has experimented with different pay-for-performance policies. In 2002, a fee code was introduced to incentivize physician adherence to diabetes clinical practice guidelines. In a study examining changes in diabetes related service delivery, the authors noted minor increases in the quality of care as defined by the receipt of blood glucose and cholesterol tests, and retinopathy screening.[78] Furthermore, given that proper diabetes management is dictated by frequency of tests within a one-year period (eg. 4 blood glucose tests per year), the pay-for-performance strategy was criticized for failing to reflect whether care was delivered consistently over appropriate time frames.[77] Accordingly, in 2006, the Diabetes Management Initiative (DMI) was introduced to reward physicians for ongoing diabetes management in the previous 12 months. Yet, this model appears to be moderated by the physician remuneration method, as a study examining differences in quality of care delivered after the introduction of the DMI showed that those practicing in the blended capitation model were more responsive to the DMI than those in the enhanced fee-for-service model.[77] The success of incentive payments in achieving health system objectives is indeed influenced by the overarching method of remuneration and the degree of supply-side cost-sharing.[77,143] Unlike in a prospective payment system, physicians in traditional fee-for-service models bear no risk in the cost of treating patients, which may dull the effect of incentive payments if they are not carefully designed. A number of studies examining the effect of pay-for-performance on physician behavior and patient outcomes revealed mixed results,[144] which highlights the importance of devising incentive payments in conjunction with the remuneration model.[77,143,144]

Payment models are often discussed as important mechanisms for achieving health system objectives. Physicians in Canada are increasingly paid through blended models

where the base remuneration remains fee-for-service but it is complemented by other forms of payment (eg. bonuses, capitation, and pay-for-performance).[145] While blended payments have made inroads in Quebec, introducing capitation to these mixed remuneration models as a means of promoting preventive and population focused care has been met with a great deal of resistance.[5] Ontario is the exception to this trend whereby capitation makes up a third of the income for 51% of physicians.[145] Similar to the comments made regarding pay-for-performance incentives, if payments models are intended to improve the quality of service delivery, they must be designed with specific aims in mind.

Despite efforts to inform patients and physicians on the importance of diabetic retinopathy screening, persistent variation and minimal increases in adherence to retinopathy screening guidelines suggest that alternative measures should be considered.[146] Other levers to improve diabetes care in Quebec have been proposed. Developing greater infrastructure support for using electronic medical records (EMRs) could facilitate sharing information between providers. Only 20% of physicians in Quebec use EMRs.[140] Although the evidence on their effectiveness from controlled trials is mixed, findings suggest that the degree of sophistication of EMRs and how they are used are as important as their availability to physicians.[47] EMRs that incorporate tools to facilitate patient population management and reminder systems were found to improve performance on process indicators of care for diabetic patients.[47]

In 2008, the province's health technology assessment (HTA) agency released a report recommending the introduction of a province wide retinopathy screening program in response to low screening rates across the province.[147] Reasons for low screening rates may reach beyond physician control. For instance, financial barriers could be a deterrent to fulfilling a retinopathy requisition should patients be required to pay for their examination.[148] Geographic barriers also likely play an important role particularly in rural areas where individuals must travel distances to access specialized health professionals. Tele-ophthalmology projects and mobile retinopathy screening units implemented across Canada have demonstrated encouraging results in both remote and urban communities.[149]

Other barriers to accessing retinopathy screening may be due to the discomfort associated with pupil dilation and the inability to drive for up to 3 hours after the procedure which may complicate transportation arrangements for patients. Drawing on evidence from other jurisdictions such as Scotland,[150] Quebec's HTA agency has proposed a staged mydriasis protocol whereby non-mydriatic cameras are used to identify any presence of retinopathy before using a procedure requiring pupil dilation.[147] Non-mydriatic procedures induce less discomfort for the patient but maintain sensitivity and specificity percentages comparable to the mydriatic cameras.[147] Although non-mydriatic approaches have been implemented in Quebec's university health networks, it has yet to be adopted on a widescale.[149] Finally, wait times to see an ophthalmologist can also pose barriers to accessing care. In a study from Quebec, 14% of diabetic respondents who did not comply with guidelines indicated that this was due to difficulties in obtaining appointments.[146]

Our findings indicated no significant change in quality of care for diabetic patients. The change in the incentive fee structure to support group practice may be more conducive to increasing access when a patient's main provider of care is unavailable on a given day. Indeed, results from a study in Ontario found that group practice models were associated with increases in access to primary care.[125] Our results are relevant to current policy initiatives in Quebec that focus exclusively on timely access to care within group practice models and raise awareness for the need to balance access to and quality of care. Based on Murray's model for reducing wait times by re-organizing appointment booking systems,[151] formal training sessions have been offered since 2012 to physicians in the province who wish to implement the advanced access model.[152] The advanced access model in Quebec seeks to provide patients with appointments with their physician within 2 weeks of their initial request. This seeks to "do today's work today"[151] and phases out the tendency for scheduling annual check-ups for healthy individuals. However, concerns regarding the balance between timely access and quality of care have been raised in the literature.[153] Chronically ill patients are high users of services that may benefit from pre-booking systems. Without careful implementation, the emphasis on immediate access to avoid a backlog of appointments risks shifting the focus to acute care needs rather than chronic disease management.[154,155] In a study from the U.S., the authors observed poorer

performance on diabetes processes of care in advanced access clinics compared to traditional appointment booking models.[155] Given the lack of improvement in diabetes quality of care from the group practice intervention that sought to increase continuity of services, it is unclear what the effect of advanced access will be on chronic disease management.

5.11 Limitations

Among the limitations of this study was the use of a virtual roster algorithm to assign patients to physicians. Although patient enrolment is now an integral feature of Quebec's primary care system, our database did not contain this information. Instead we implemented a previously validated algorithm applicable to fee-for-service claims in Canada. This method is useful when a physician patient population is assumed to be stable over time. In comparison to rural regions, this assumption may be more difficult to uphold in urban contexts. An unstable patient population denominator would likely produce estimates biased toward the null.

We were also unable to control for the practice size as measured by the number of physicians making up the group. Previous research in Canada has identified practice size in relation to shared physician income as a potentially important variable that could confound the effect of group status on quality of care. Previous research on group practices and shared revenues in Canada suggests that their effects on quality of care is U-shaped (i.e. small or large physician groups are less effective). The non-significant results may be attributed to a notable number of very small or large practices in the treatment group that were ineffective with regard to changing retinopathy screening rates.

Given incomplete public coverage of the costs associated with retinopathy exams, patients' ability to pay may have biased our results. Firstly, patients who paid for their exams out-of-pocket would have been misclassified as non-events in our data. Relatedly, patient ability to pay may have acted as a confounder if it predicted patient population membership in the treatment or control group, and receipt of a retinopathy exam. To

address this concern, we conducted a sensitivity analysis in a sub-sample of diabetic patients aged 65 and over who had public coverage for optometry services for the entire duration of the study. Our result [RR = 0.99; 95% CI = 0.95, 1.03] was similar to our initial estimate in the full sample [RR = 1.00; 95% CI = 0.95, 1.05] thereby suggesting that ability to pay was not a key confounder of our main estimate.

Additionally, this study provided evidence on the impact of group practice membership in relation to only one aspect of diabetes management. We might have observed significant impacts for other aspects of care. Nonetheless, our study raises two important points. Firstly, despite the use of the less conservative 2-year time window, retinopathy screening rates have remained low in Quebec as is also the case elsewhere in Canada.[156] Diabetic retinopathy has important implications on an individual's quality of life. Early detection can reduce the risk of vision loss and legal blindness.[137,156] Secondly, omnibus, untargeted interventions are unlikely to induce change in specific aspects of care, despite stated reform goals of improving continuity of care.

Our study was also limited by the extent to which we could account for heterogeneity of practice types, particularly in the control group. While the data allowed us to clearly identify the intervention group, we could not distinguish between the physicians in the control group that were working in team-based practices (eg. FMGs and network clinics) or single-provider clinics. Team-based clinics have the potential to offer superior diabetes management and therefore bias our results toward the null. However this was not a large concern given that results from a previous study examining the effect of FMGs on diabetes management showed non-significant results.[124] By extension, we were also unable to identify the providers in solo practices who could not have obtained group status. Previous findings from patient surveys reported superior patient care experiences in single provider models suggesting that relational continuity of care is easier to achieve in this practice type.[157] However, over the years this model has consistently declined in popularity among physicians.[157] The DD design addresses these concerns when the common trends assumption is met: our analysis revealed no serious deviations in

outcome trends between the intervention and control groups in the pre-reform period suggesting that the threat of bias from this heterogeneity in the control group was small.

Finally, given the staged implementation of patient enrolment in Quebec, we recognize that the intervention in 2007 was correlated with previous interventions in 2002 (vulnerable and non-vulnerable patient enrolment in FMGs) and 2003 (expanding vulnerable patient enrolment to non-FMG physicians). As such, estimating the effects of the intervention in 2007 may be confounded with the lasting results of past interventions. However, previous research by Diop et al.[124] examining the impact of FMGs on diabetic retinopathy screening also showed non-significant effects and therefore lasting changes are not believed to be a source of bias. This was also confirmed by our examination of common trends between the treatment and control groups in the pre-intervention period.

5.12 Conclusion

Although the introduction of group practices had the potential to facilitate a collaborative approach to chronic disease management promoting continuity of care, our study finds no significant change in adherence to diabetic retinopathy screening guidelines among physicians who obtained group practice status. This raises questions regarding how financial incentives are implemented as a means of achieving the government's health system objectives and their effectiveness when implemented in isolation of other components of reform models.

CHAPTER 6

Discussion

6.1 Summary of research findings

This thesis project aimed to evaluate the effect of primary care reform in Quebec on indicators of access to and quality of care in the province's diabetic patient population. A systematic review was conducted to fulfill the first objective of synthesizing the evidence on the effects of primary care reform in Canada on 3 domains of health system performance: health service utilization, processes of care and physician productivity. In recognition of the fact that the FMG model's implementation was a policy diffusion process, the second objective was to provide evidence on whether the model's expansion across the regions over time produced changes in avoidable use of the ED. Finally, using changes in financial incentive structures as the basis for a natural experiment, the last objective was to determine whether physician uptake of group practice models led to changes in diabetes quality of care as measured by adherence to retinopathy screening guidelines.

Manuscript 1 presented the first systematic evidence synthesis of the peer-reviewed literature on the effects of recent Canadian primary care reforms on measures of performance. The review focused on longitudinal studies from Alberta, Ontario and Quebec where system-wide organizational reforms were implemented that included the introduction of group practices and/or new payment models. The body of evidence on the effects of interdisciplinary team-based practice models from Quebec and Alberta on indicators of health service utilization was deemed of moderate quality. Results pointed to a reduction in ED use but the findings were mixed with regard to hospital admissions (i.e. no effect or a decrease in admissions). Low quality evidence was found pertaining to the effects of team-based models, blended capitation models and pay-for-performance incentives on processes of care whereby small and non-significant improvements were

recorded in the delivery of screening and prevention services, and chronic disease management. The collection of studies on new payment models in Ontario and their effects on physician costs and productivity were deemed of high methodological quality and provided a coherent body of evidence to assess the changes produced by reforms. These findings showed that shifting from an enhanced FFS to blended capitation reduced the number of patients seen per day however the number of enrolled patients and days worked per year were equivalent. Our review highlighted two key implications for policymakers and researchers. Firstly, interventions that were targeted, tangible and well defined tended to be more successful in meeting health system objectives. Secondly, the nature of the intervention was key to assessing the impact of reforms. In comparison to payment reforms, measuring the effects of group practice models was more difficult as different versions of the intervention may have been implemented by each group practice that in turn may have changed over time with evolving iterations of the reform. The measure of effect would therefore have reflected an average effect of the proportion of individuals exposed to each implementation version of the intervention.

Using FMG patient enrolment as an indicator of model performance, the analyses in Manuscript 2 conceptualized changes in regional level of enrolment as a marker for the policy's diffusion process. The study sought to examine: (1) whether increases in the percentage of individuals enrolled in FMG practices reduced avoidable use of the ED by diabetic patients; (2) whether effects of enrolment differed according to individuals' regular or infrequent use of the ED; and (3) whether certain regions were driving FMG reform performance. Results from the fixed effects model and the MSM indicated that for every 10-percentage point increase in FMG enrolment at t - 1, there was a 7% [RR = 0.93; 95% CI = 0.91, 0.95] and a 3% [RR = 0.97; 95% CI = 0.95, 0.99] decrease in the rate of avoidable ED visits among diabetic patients, respectively. In the sub-analysis examining whether diabetic patients were sporadic or frequent ED users, results from the MSM indicated that significant rate decreases for every 10-percentage point increase in FMG enrolment at t – 1 only pertained to infrequent ED use with at most 1 visit per year [RR = 0.97; 95% CI = 0.95, 0.99]. The final sub-analysis showed that within low enrolment regions, every 10-percentage point increase in FMG enrolment at t – 1 led to

an 18% decrease in the rate of avoidable ED visits [RR = 0.82; 95% CI = 0.78, 0.87]. When the analysis was restricted to high enrolment regions, the effect was null [RR = 1.00; 95% CI = 0.92, 1.09]. The results of this analysis suggest that although there was evidence of a protective effect of FMG enrolment on avoidable use of the ED, this appeared to be diluted over time in regions where enrolment levels remained above the provincial average over the follow-up period. These findings contribute to recent work citing the need for greater governance and support for re-organizing primary care practice in Quebec.[7,40]

Manuscript 3 examined the effects of a change to financial incentive structures introduced in 2007 on physician adherence to diabetic retinopathy screening guidelines. The empirical approach used a propensity score matched DD model to address issues of selection bias and confounding due to secular trends. The final model indicated that compared to the control group, there was no change in the rate of guideline recommended retinopathy screening within the diabetic patient populations of physicians in the treatment group [RR = 1.00; 95% CI = 0.95, 1.05]. Sensitivity analyses were conducted to verify the robustness of results. In the first analysis, findings revealed no indication of any anticipatory or delayed policy effects as shown by non-significant lead and lag model terms. A second sensitivity analysis was conducted to examine whether the effect of treatment varied by the year in which the physician switched to the treatment group. The analyses showed no evidence of a treatment effect by physician cohort. These findings raise some questions regarding the government's design of financial incentives and their ability to achieve health system objectives.

6.2 Limitations

This thesis project presents a body of evidence that is informative to ongoing developments in Quebec's policies for primary care. Yet as discussed in detail in each manuscript, the studies were not without their limitations. This section will summarize the overarching issues, explain how they were addressed, and suggest steps for future research.

The primary purpose of the QICDSS is to provide data for chronic disease surveillance using population medical administrative databases. Beyond this function, the surveillance system is also used to build indicators for mortality, prescription medication consumption, specific complications from chronic illness, and health service utilization. Although medical administrative data offer researchers the chance to conduct population-based studies that are robust to some of the limitations of survey driven data collection, the extent to which researchers can answer specific questions is constrained by the initial purpose for which the data were collected. Additionally, given the sensitive nature of health data, important and necessary safeguards are in place to protect the public. Accordingly, the creation of the QICDSS and access to its data meet stringent standards of security and privacy procedures. This affected the type of variables released by the RAMQ to the QICDSS. In April 2013, a list of variables pertinent to the development of primary care indicators was submitted to the RAMQ with the aim to enhance information related to chronic disease monitoring. To this day, the request remains under review by RAMQ.

The absence of FMG enrolment data that could identify which physicians and patients participated in the reform was one of the main limitations of this thesis project. This precluded a pre/post analysis to measure the impact of the reform on avoidable use of the ED. Given that previous research identified systematic differences in the physicians and patients that joined the FMG model in the early reform period,[43] the inability to observe and control for these factors posed a risk of bias. To address this issue, aggregate level data on the percentage of individuals enrolled in an FMG practice by region were used to model the diffusion process. As such, within region variation in enrolment as opposed to physician or patient take-up, was used to define treatment status. Including fixed effects for each health and social services region provided a safeguard for the persistent unobserved differences between physicians and patients that participated in the reform. Additionally, the consistently low enrolment levels in more suburban and urban regions relative to others allowed for a stratified analysis to decipher whether effects differed by regional take-up. Furthermore, given recent media interest[92] in ranking high and low performing regions with regard to compliance with the FMG model and holding

government and physicians accountable to taxpayers, attributing change in avoidable visits to the ED to regional levels of enrolment offered a tangible empirical approach to a question of public interest. Individual level exposure data would have brought greater precision to the estimate of effect. However, given the narrow 95% confidence intervals produced from the analysis, it would likely have remained unchanged. Nonetheless, future research using individual level exposure data would be useful to confirm these inferences.

The unavailability of enrolment data also had implications for measuring changes in the quality of care delivered by physicians. Measuring this performance domain requires a stable patient population in order to fairly attribute outcomes to physician chronic disease management. More precisely, it would be inappropriate to count patients seen only once as part of a physician's patient population when assessing quality of care. To address this issue, a patient roster algorithm that was initially validated in Ontario medical claims data was used to assign diabetic patients to physicians. Another important limitation was the inability to distinguish between practice types (i.e. single provider clinics, FMGs, and network clinics). In Manuscript 3, this raised questions regarding the appropriateness of the control group that was made up in part by single provider clinics who by their very nature could not obtain group status. The control group was also comprised of FMG clinics, network clinics, and regular multi-provider clinics that did not seek group status. Practice type plausibly influenced participation in the intervention and quality of care. The direction of bias due to heterogeneity in the control group was difficult to predict since it would depend on the dominant practice model. However, the ability to distinguish, at the individual physician level, membership in the treatment and control group allowed for a study design that could provide some insight on whether this heterogeneity was likely to be an important source of bias. Indeed, the common trends between the treatment and control groups in the pre-intervention period relieved some these concerns. Future studies would benefit from being able to distinguish between practice types since this is correlated with many outcomes that are of relevance to health system performance.

The observations drawn from the results of the systematic review in Manuscript 1 apply to some of the limitations identified in Manuscripts 2 and 3. Namely, the nature of primary care reform in Quebec has implications for relying on observational studies to measure intervention effects. Unlike changes to payment which are 'fixed' in their implementation (i.e. a physician receives the payment or does not), identifying the effects of team-based practice is more difficult since the nature and scope of its actual implementation is multifactorial, and this complexity was not captured in the data. Furthermore, the extent of implementation is influenced by an array of physician factors including, but not limited to, receptivity to organizational change, practice styles, and professional peer-pressure to adopt change. This likely resulted in multiple versions of the intervention and indeed, results from Manuscript 2, in addition to the Auditor General's report, suggested this was a possibility. Without data on specific versions of treatment, the possibility that measures of effect were driven by which was the most dominant must be taken into consideration.

Relatedly, unlike reforms in Ontario that targeted specific processes of care or patient sub-populations (eg. the Diabetes Management Initiative), the objectives of reforms to primary care in Quebec were broad, making the selection of appropriate performance indicators difficult. Furthermore, the use of administrative data limited the selection of the types of indicators available to evaluate the interventions. Other indicators of the accessibility and quality of care that would have been useful to examine include patient-based measures such as perceptions and experiences of care, and self-rated health. As such, an important limitation of this project is that it provides only a narrow view of the effects of interventions as they pertain to the diabetic patient population. The generalizability of these findings to the non-diabetic population of Quebec remains to be answered. Nonetheless, the growing prevalence of diabetes is not a trivial concern and is important for the planning and distribution of resources particularly since this disease is largely managed in primary care settings.

6.3 Key messages

Three key messages were drawn from the results of the studies in this thesis project:

1. *The FMG model's early success in decreasing avoidable visits to the ED was driven by high performing adopters and diluted over time as average practices took part in the intervention.*

Using avoidable visits to the ED as a proxy for access to and quality of care, the study's findings provided evidence of a policy that was limited in scope and implementation and did not fully succeed in reorganizing primary care practice. Observed decreases in avoidable visits were likely due to a composition effect where by changes in outcome trends were attributed to the physicians' decision to adopt the FMG model. This may be due to heterogeneity in the type of physician participating in the reform through time: in regions with higher take up, early innovating physician adopters would become the minority over time with a dilution effect occurring as the proportion of late adopters grew. This assumes that high performing early adopters were concentrated in low enrolment regions in which protective effects of the reform could be isolated and observed. If this were indeed the case, the FMG reform succeeded in elevating the level of already above average practices without invoking as much change in the remaining majority who were starting from a lower performance baseline. These assertions are supported by this study's findings in conjunction with previous results that found significant decreases in ED use among patients enrolled in the first generation of FMG practices.[41] The inability to shift the entire distribution of performance could have resulted in a regression to the mean over time. While recognizing and rewarding high performers for their efforts was critical, given the founding premise of the FMG model as a population intervention, these findings should flag policymakers on current implementation strategies, oversight and resource use.

2. *Incentives introduced to support group practice by introducing a change in the incentive fee structure were limited in their ability to alter the status quo in diabetes management, as measured by levels of retinopathy examinations.*

The study's findings suggested that the financial incentives offered to physicians with the aim of promoting changes to the organization of primary care had null effects on quality improvements for diabetic patients. Although revenue sharing has the potential to support cohesive group practices and increase quality of care, an important and difficult to measure dimension is the extent to which groups can function as teams. Group practice had the potential to improve access to services for patients who could not be seen by their main provider of care. Under the assumption that physicians in the same group practice met the ideals of the intervention with regard to sharing and updating patient files, and held meetings to discuss cases, then group practice also had the potential to improve the continuity and coordination of services thereby producing favorable change in quality of care. Group practice was identified as the main vehicle in recent calls to providers by the government to increase the volume of services delivered to patients via advanced access booking systems. The results of this study raise concerns regarding the structures in place that support quality of care and are particularly relevant to the current pressures faced by physicians to increase access to services. Proposals to reform payment models are frequently put forth as a means of holding providers accountable to the amount and quality of service delivered. Yet given the rejection of a blended capitation payment model when FMGs were initially introduced,[5] it is unlikely to be implemented in the near future. Rather than overhaul existing overarching payment structures, transitional approaches could provide physicians with the necessary support as shifts toward high performing primary care are pursued. This implies moving away from an inflexible and fixed incentive scheme that is not appropriate for all physicians who are willing to take on change.[158] For instance, inflexible incentives risk restricting high performing practices from pursuing the innovative changes they are motivated to undertake while not allowing lower performing practices to meet their potential for improvement. Although the transaction costs of implementing this strategy would be higher, it offers the possibility of sustained and desired change over the long term.

3. *Specific levers must be in place to support reform implementation. This includes defining clear indicators to guide efforts on the ground, facilitate performance measurement, and establish accountability frameworks.*

The quality of evidence produced by a study is influenced by the extent to which the intervention can be clearly defined in the data. This is in large part dictated by the nature of the intervention and by the availability of the data. Results from the systematic review in this thesis project indicated that unlike payment alterations that only have one version of treatment (eg. the physician is either remunerated through blended capitation or FFS), identifying the effects was more challenging for reforms that focused on altering physician labor within practices since impacts would differ by how each clinic implemented the change. Another systematic review of the effects of the PCMH on patient and staff experiences, clinical quality of care, and economic outcomes, revealed wide variation in the implementation strategies adopted by practices.[159] The medical home was found to have small positive effects on patient care experiences and small to moderate effects on the delivery of preventive care services.[159] A recent review on approaches to implementing primary care reform in 5 Canadian provinces identified legislation and government commitments to substantial financial resources as key policy levers for supporting change and facilitating partnerships with professional bodies.[66] These were highlighted as particularly important measures for adequately supporting the integration of allied health professionals in team-based practices. While there remains an openness to change among physicians in light of increasing workloads and complex patient cases, large-scale reorganization of practices has been difficult to pursue.[66] Defining a set of indicators would not only facilitate the reform's performance measurement, it would also serve as series of markers for guiding change and increase accountability to the public.

Evaluating reforms demands a degree of foresight at the onset of implementation. For instance, given that population-based administrative data is increasingly used to answer these questions, introducing specific codes to distinguish between providers and practices in the treatment or control groups would facilitate before-and-after impact assessment studies. Additionally, staged implementation whereby the intervention is introduced in

certain regions that have a suitable control group would also facilitate impact evaluations. At the core of these suggestions is the need for data that not only clearly identifies a treatment and control group, but also contains information on the year in which the practice, provider or patient switched into the treatment group.

6.4 The future of primary care in Quebec

In 2014, the provincial government put forth Bill 20 as a means to increase physician productivity and access to care by imposing patient quotas and salary cuts of up to 30% for physicians that did not meet these standards. On May 25, 2015, an agreement was struck between the FMOQ and the MSSS that suspended patient quota clauses in favor of FMOQ initiatives to re-organize physician practices. Under this agreement, 85% of Quebecers will have a family physician by December 31, 2017. Currently, 70% of the population is reported to have a family doctor.[160] If the goal is not met, physicians may be subject to the patient quotas outlined in Bill 20. Key to meeting the agreement is re-organizing physician workload away from hospitals so that more time is spent seeing patients in family practice.[100,161]

Since 2012, the FMOQ has committed to an advanced access model of primary care in order to improve service delivery with training sessions offered to physicians who wish to implement it.[152,161] Advanced access refers to re-organizing practices so that patients are able to consult physicians on the same day or within a couple of days. It seeks to decrease long wait times for appointments, crowded waiting rooms, physician dissatisfaction with working conditions, the amount of time teams can meet to discuss cases, and reduce use of walk-in clinics and EDs.[162] Similar to comments regarding the FMG model, this represents an important paradigm shift that would require commitment and receptivity to changes in approaches to practice. The research on FMGs can provide some insights to the shift toward advanced access that is currently underway. Namely, support for implementing fundamental changes to how physicians have approached their practice will be required. Alleviating hospital commitments is an important step in this process. Phasing out routine annual check-ups for healthy individuals has also been

proposed.[163] However concerns have been raised regarding the strategy's potential to balance timely access with quality of care.[153] In the absence of pre-booking systems, it will be important to enact safeguards to ensure that high service users with chronic care needs do not experience decreases in their disease management. While the FMG model is conducive to an advanced access practice it remains to be seen whether these additional measures will improve performance on indicators of access to and quality of care.

In this context, the findings from this thesis suggest that the nature of primary care reform from 2002 onward in Quebec may have been too broad to have an impact on improving access to and quality of services for diabetic patients. Given the absence of a framework to support chronic disease management amidst profound organizational change, these results are plausibly generalizable to other chronic illnesses. Initiatives in Alberta that have focused on primary care-based chronic disease management programs (mostly for diabetic patients), and the pay-for-performance incentives in Ontario, show evidence of positive results. While the strategies adopted in other provinces can offer some guidance for Quebec, shifting too much emphasis toward improvement on performance indicators related to specific chronic diseases risks fragmenting primary care services and weakening the patient-centered model. Indeed, a multi-faceted approach that incorporates targeted incentives to support population health strategies offers potential for achieving accessible comprehensive care both in terms of the scope of services that are appropriate for a patient's needs, and maintaining a whole-person perspective that recognizes the impact of social context on patient health.

Concluding remarks

This thesis project contributes to the evidence base on the effectiveness of primary care reforms in Quebec. Notably, findings from other provinces, particularly Ontario, can offer guidance for policymakers and physicians who are currently facing pressures to change approaches to primary care practice. Furthermore, the results suggest that although patient enrolment in FMGs has contributed to reductions in avoidable ED use, there is heterogeneity in implementation that appears to correlate with early versus late

physician adoption. Additionally, the effect of group practice, as defined by changes in incentive fee structures, on diabetes quality of care appeared to have no effect. These findings align with the literature in suggesting that greater implementation support is required for shifting practices towards a medical home model. This is particularly relevant given current calls by the government and the FMOQ for physicians to meet patient enrolment targets and expand access to care by increasing the volume of service delivery.

APPENDIX A

Manuscript 1

The following lists the search terms and search strategies used for identifying the studies in the systematic review:

Keyword search terms:

Family Medicine Group*
Group de médecine familiale
Network clinic*
Integrated network clinic*
Clinique* réseau*
Clinique* réseau* intégrée*
Family Health Team*
Family Health Organization*
Family Health Group*
Primary Care Network*
Comprehensive Care Model*
Primary Health Care Initiative

Search strategies:

Canad* AND ("family medicine group*")
Canad* AND ("integrated primary care network*")
Canad* AND ("family health team*")
Canad* AND ("family health organization*")
Canad* AND ("family health group*")
Canad* AND ("primary care network*")
Canad* AND ("comprehensive care model*")
Canad* AND ("enhanced fee for service")
Canad* AND ("capitation") AND ("payment")
Canad* AND ("pay for performance")

APPENDIX B

Manuscript 2

The following provides details on aspects related to the methodology for Manuscript 2. It will outline:

- the definition and identification of the study outcome (avoidable ED visits);
- a description of the model building process; and
- additional analyses

Definition and identification of avoidable ED visits

a) Defining distinct ED visits

The RAMQ medical service claims database was used to identify visits to a hospital ED by diabetic patients over the study period. Visits were identified based on a practice site code specific to EDs. According to RAMQ billing guidelines this code must be recorded for every ED visit. Visits occurring between April 1, 2004 and March 31, 2012 were ascertained from the database to cover the study period.

In many instances, physicians administer a number of billable procedures on a single patient. A procedure code is attributed to each act and appears as a separate record in the medical service claims database. Multiple records per patient on the same day therefore appear in the data and must be collapsed into a single record to avoid over-counting the number of ED visits. Patients with more than one procedure performed on the same day and in the same emergency department (identified using a hospital identification number), were isolated and their records were collapsed into a single observation. Collapsed records contained information on each diagnostic code attributed to the procedure codes. These records were subsequently stacked with the dataset containing the single procedure claims (i.e. one observation per individual per year).

In the 1980s, the *Régistre de la salle d'urgence* (RSU) was created to track the utilization of the ED particularly in the Montreal and Quebec city regions where over-crowding was a problem.[164] The RSU contains information on the patient's age and sex, the date, time and location of arrival, how the patient got themselves to the ED (eg. by ambulance), the destination following the visit (eg. released or admitted to hospital), and the date of departure designating the end of an ED visit.[164] Although the RSU is a rich source of information, there is no unique patient identification number and therefore it cannot be linked to other administrative databases including medical service claims, hospital admission records, pharmaceutical claims, or the death registry.

While it is possible to identify care received in the ED using medical service claims, the database does not contain information on the time of arrival or departure from the ED. This is problematic for visits that occur close in time to one another, specifically, for patients who left and returned to the ED, or for single visits that span more than one day. Medical service claims data contain the date for each procedure that was administered to the patient. A previously validated algorithm was used to identify ED visits for billing sequences falling within two consecutive days.[164,165] Table 18 provides an example of how distinct ED visits were identified.

Table 18. Identifying distinct visits to the ED from medical service claims

Id	Date	Hospital Id	Note
1	15MAR2007	10	Single ED visit: multiple procedures performed on the same patient in the same hospital ED
1	15MAR2007	10	
1	15MAR2007	10	
2	08JUN2009	22	Single ED visit: made in quick succession by the same patient in the same ED or an ED visit spanning more than one day
2	09JUN2009	22	
3	22AUG2011	10	Two ED visits made by the same patient on the same day but in different hospital EDs
3	22AUG2011	22	

b) Identifying complication-specific visits to the ED

The outcome of interest was a visit to the ED for acute diabetes related complications. Each billing record in the medical claims data is associated with a single four-digit ICD-9-CM diagnosis code. The first three digits of the code broadly indicate the type of illness and typically, though not always, identify the organ system that is affected. For instance, ICD-9-CM codes 249 to 259 refer to diseases of the endocrine

system. Within this classification range, code 250 denotes diabetes mellitus (type 1 and type 2). The fourth digit indicates the specific complication attributed to diabetes. For instance, diabetes with ketoacidosis resulting from hyperglycemia would be coded 250.1. For diabetes, the fifth digit of the code refers to both the type of diabetes and whether or not it is under control. For example, code 250.10 refers to diabetes with ketoacidosis [type 2, not listed as uncontrolled], whereas code 250.13 refers to diabetes with ketoacidosis [type 1, uncontrolled].[166]

Quebec has adopted a version of the ICD-9-CM with small yet important deviations from the original coding system. Although these differences did not affect variable measurement for this study, these dissimilarities would need to be taken into account in any cross-provincial studies. In addition, any conversion from ICD-9-CM to ICD-10-CA (the Canadian version of ICD-10) would need to consider these deviations. The Canadian Institute for Health Information (CIHI) has released conversion files from 2006 onward. However, the conversion files do not take into account the modifications to ICD-9-CM in Quebec.[167] Table 19 compares the ICD-9-CM codes (four digits only) between Quebec and Canada.

Table 19. Comparison between diabetes ICD-9-CM codes in Quebec and Canada

ICD-9-CM (Quebec)	ICD-9-CM
250.0 = Diabetes mellitus without mention of complication	250.0= Diabetes mellitus without mention of complication
250.1 = Diabetes mellitus with ketoacidosis	250.1 = Diabetes with ketoacidosis
250.2 = Diabetes mellitus with coma	250.2 = Diabetes mellitus with hyperosmolarity
250.3 = Diabetes mellitus with renal manifestations	250.3 = Diabetes mellitus with other coma
250.4 = Diabetes mellitus with ophthalmic manifestations	250.4 = Diabetes mellitus with renal manifestations
250.5 = Diabetes mellitus with neurological manifestations	250.5 = Diabetes mellitus with ophthalmic manifestations
250.6 = Diabetes mellitus with peripheral circulatory disorders	250.6 = Diabetes mellitus with neurological manifestations
250.7 = Diabetes mellitus with other specified manifestations	250.7 = Diabetes mellitus with peripheral circulatory disorders
250.8 = Non-existent	250.8 = Diabetes mellitus with other specified manifestations
250.9 = Diabetes mellitus with unspecified complication	250.9 = Diabetes with unspecified complication

Although diabetes is considered an ambulatory care sensitive condition, this study considered only acute diabetes-related complications that could more plausibly be linked to inadequate access to and quality of primary care. A low frequency count of visits to the ED coded for long term complications, such as neurological or renal manifestations, were expected since pathways to hospital care likely differ from more acute complications resulting from poor blood glucose control. Furthermore, as the number of years since diagnosis with diabetes increases, patients are likely to develop associated conditions that are part of the natural course of disease, regardless of its management. These conditions were therefore excluded from the outcome definition.

The list of ambulatory care sensitive conditions was originally developed in the United States by the Agency for Healthcare Renewal and Quality as a means of assessing access to and quality of primary care. The American health care system is unique in comparison to those of other developed countries because it is primarily privately financed. This

raises questions regarding the appropriateness of the same indicator when applied in a different health system context. A recent study sought to answer this question using the Delphi survey method on a panel of medical experts. In publicly financed systems, the consensus was that primary health care was important for both the early treatment and prevention of diabetes.[168] CIHI's list of ICD-9-CM codes for acute diabetes-specific avoidable complications was used to identify preventable ED visits.[103]

Validation study for identifying avoidable visits to the ED using medical service claims data

The selection of the ICD-9 codes for identifying avoidable visits to the ED for diabetes-related complications was based on the list of recommended codes provided by the Canadian Institute for Health Information (CIHI).[103] Table 20 lists the codes and their description. As part of preliminary work for this thesis, a validation study was conducted comparing the ICD-9 codes recorded in the emergency department (medical service claims database) with the ICD-9 codes recorded in the hospital admissions database (Med-Echo). The ICD-9 codes in the medical service claims were converted to their ICD-10 equivalent to reflect the change in coding in the Med-Echo data after 2006. In order to conduct this study, a subset of patients who were admitted to hospital immediately following a visit to the ED was identified along with the corresponding hospital records. The diagnostic codes in the hospital admissions data were compared to corresponding patient medical charts by archivists for accuracy and were therefore considered a 'gold standard' in this study. Table 21 outlines the interpretations for sensitivity, specificity, positive predictive value (PPV), and negative predictive value (NPV).

Table 20. List of recommended ICD-9 and ICD-10 codes for identifying acute diabetes related complications

ICD Version	ICD Codes
ICD-9-CM	250.0, 250.1, 250.2, 250.7
ICD-10	E10.0, E10.1, E10.63, E10.64, E10.9, E11.0, E11.1, E11.63, E11.64, E11.9, E13.0, E13.1, E13.63, E13.64, E13.9, E14.0, E14.1, E14.63, E14.64, E14.9

Table 21. Definition of parameters for validation study

Property	Definition
Sensitivity	Probability of identifying an avoidable ED visit in the medical service claims data given the presence of the same ICD-9 code (or ICD-10 equivalent) in the hospital admissions data.
Specificity	Probability of identifying a non-avoidable ED visit in the medical service claims data given that the designated code did not appear in the hospital admissions data.
Positive Predictive Value	Probability of identifying the specific ICD-9 code (or ICD-10 equivalent) in the patient's hospital admission file given that the same code identifying an avoidable ED visit appeared in the medical services claims record.
Negative Predictive Value	Probability of not identifying the specific ICD-9 code (or ICD-10 equivalent) in the patient's hospital admission file given that the same code did not appear in the medical service claims record.

The results align with what is generally reported in the literature: medical service claims data are very specific however their sensitivity is often low. In a study examining case definitions for illnesses, Wilchesky et al. reported sensitivities that ranged between 0% and 60%.[169] Similar observations were drawn from this avoidable ED visit validation study. While the sensitivity varied according to specific codes (eg. 26% for code 2501 versus 11% for code 2500, and 13% overall) the specificity was consistently above 95% for all codes with an overall specificity of 98%. While the low sensitivity indicates that the identification strategy undercounts avoidable ED visits in the medical service claims data, the high specificity suggests a very low number of false positives (i.e. the identification strategy was successful at ruling out instances of avoidable ED visits). As such, this approach provides conservative estimates of the number of avoidable ED visits as identified using the medical service claims data. To probe these results further, the PPV was calculated. The high reported PPV of 89% indicates that if a medical service claim contained one of CIHI's diagnostic codes, the probability of the same code appearing in the hospital admission data was 89%.

The identification strategy therefore represents a trade-off that is not without limitations: while the number of missed cases ('true positives') produces an information

bias, there is confidence that if the relevant codes appeared for a patient in the medical service claims data, then there is a very high likelihood that they also appeared in the hospital admissions records.

Nonetheless, given the low sensitivity, there is concern that a different trend would have been observed had the false negative visits actually been identified as avoidable. Examining the trends in the total visits to the ED can give some insight to the extent to which these missed cases would have contributed to a different inference. However the trends in the number of patients with diabetes making avoidable visits to the ED versus the number of patients with diabetes visiting the ED (all cause) are very comparable (Figures 17 & 18). This indicates that there were overarching processes affecting all types of ED visits similarly, regardless of whether they were avoidable. The presence of these global processes suggests that misclassification of the diagnostic codes would be non-differential by exposure status (regional levels of FMG enrolment) and therefore estimates of effects were conservative and biased toward the null.

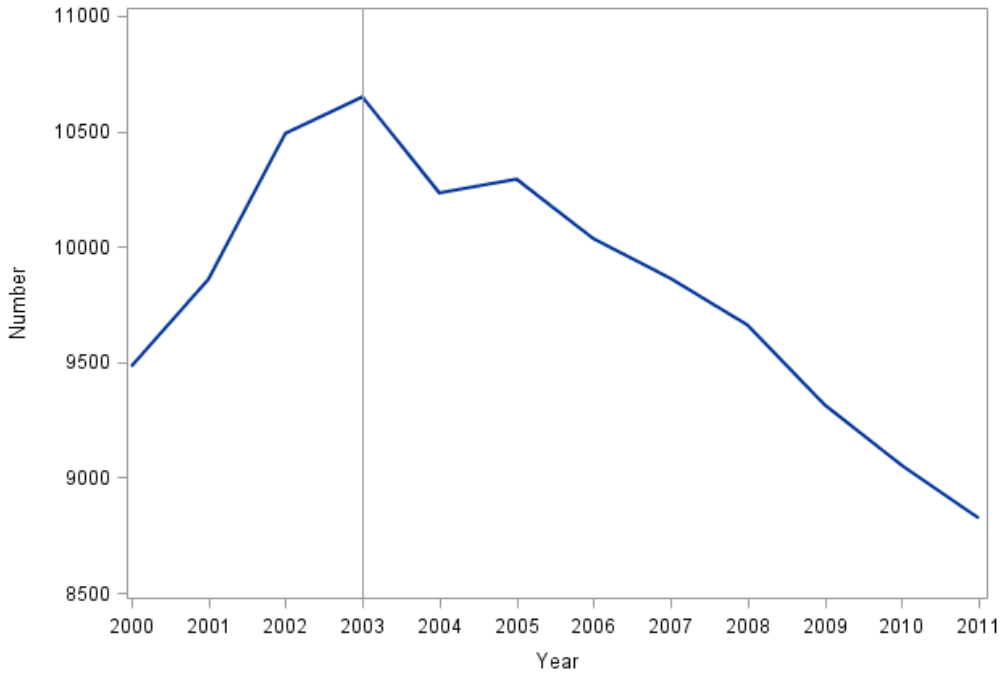


Figure 17. Number of patient with diabetes visiting the ED in Quebec between 2000/01 and 2011/12 (ICD-9 codes: 2500, 2501, 2502)

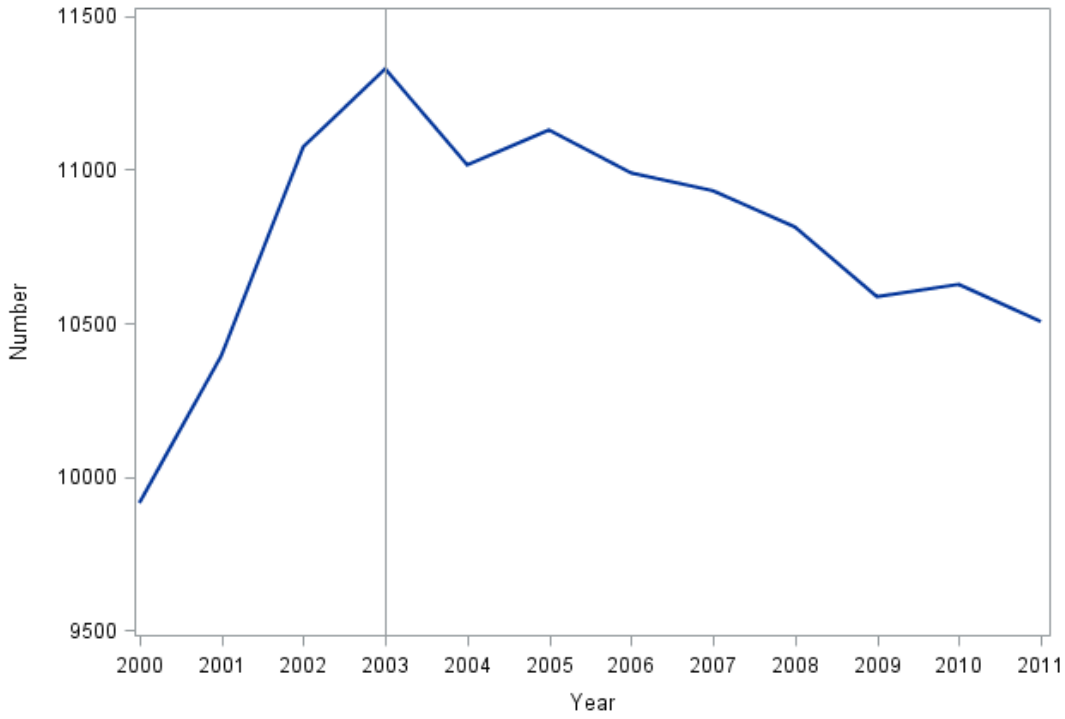


Figure 18. Number of patients with diabetes visiting the ED (total visits) in Quebec between 2000/01 and 2011/12

Construction of inverse probability weights

Identification of potential confounders was based on a review of the literature and the use of DAGs to consider the nature of the relationships between variables. To construct the weights, models for exposure and censoring were identified. Different models were built before deciding which specification would make up the final model. The bias variance trade-off was assessed informally by looking at the change in estimates and average weights across the models. Table 20 provides details of this process while also presenting results of analyses when a categorical exposure was specified. Health and social services regions were grouped into tertiles for each fiscal year with regions in the top tier containing territories with the greatest levels of enrolment and those in the bottom tier containing the territories with the lowest levels of enrolment. To note, the definition of exposure determined the model used to derive the inverse probability of treatment weights. For the continuous exposure, the probability density function was estimated using a log-normal distribution. However when the exposure was categorized into tertiles

for each fiscal year, a logistic regression model was run specifying the link for a generalized logit model.

Selection of confounders for the models was based on a previous study that assessed the differences between FMG enrollees and non-enrollees.[43] To facilitate the reading of the table, the variables were added in blocks according to patient characteristics and factors related to the utilization and availability of health services. Dummy variables for territory and fiscal year were included in Model 4. Truncating the weights was a means to exploring the bias-variance trade-off. In all models, the weights were truncated at the 99th percentile. Moving down the last column in the table, the estimates shift toward the null and the 95% confidence intervals become narrower. Truncation succeeded in bringing the mean weight closer to 1.0 indicating no notable outliers in the study population. Although this table displays the mean weight pooled across time points, the mean of 1.0 should hold for each time point as well, as shown in Figure 19 for Model 4.[170] The estimates from Model 4 indicate that in reference to regions ranked in the lowest enrolment tertile, individuals in the regions with mid and top-level enrolment experienced an average decrease of 14% [RR= 0.86; 95% CI= 0.84, 0.88] and 10% [RR= 0.90; 95% CI= 0.87, 0.93] in the rate of avoidable ED visits, respectively.

Table 22. Assessment of different model specification for categorical exposure

Specification	Description	Estimated weights	Model	Truncation		Weighted truncated model
		Mean	Estimate (RR)	Truncation percentile	Mean	Estimate (RR)
1	Model contains covariates for patient characteristics: *age, sex, Charlson comorbidity score, material deprivation, region of residence*	1.01	Low = reference Mid = 0.75 (0.64, 0.87) Top = 0.70 (0.54, 0.91)	99	0.99	Low = reference Mid = 0.86 (0.83, 0.88) Top = 0.89 (0.87, 0.92)
2	Model contains covariates for health service utilization: *number of consultations (total, family physician and specialist), number of different providers, usual provider of continuity, number of hospitalizations, number of hospitalizations for ACSCs, affiliation with FMG, past ED use, proportion of family physicians delivering services to diabetic patients in EDs*	1.01	Low = reference Mid = 0.84 (0.82, 0.86) Top = 0.86 (0.82, 0.89)	99	1.00	Low = reference Mid = 0.84 (0.82, 0.86) Top = 0.88 (0.85, 0.91)
3	Model contains covariates from (1) and (2)	1.02	Low = reference Mid = 0.78 (0.73, 0.83) Top = 0.81 (0.75, 0.88)	99	1.00	Low = reference Mid = 0.79 (0.76, 0.81) Top = 0.85 (0.81, 0.88)
4	Model contains covariates from (1) and (2) and indicator variables for fiscal year and territory	1.06	Low = reference Mid = 0.79 (0.67, 0.94) Top = 0.87 (0.78, 0.96)	99	0.99	Low = reference Mid = 0.86 (0.84, 0.88) Top = 0.90 (0.87, 0.93)

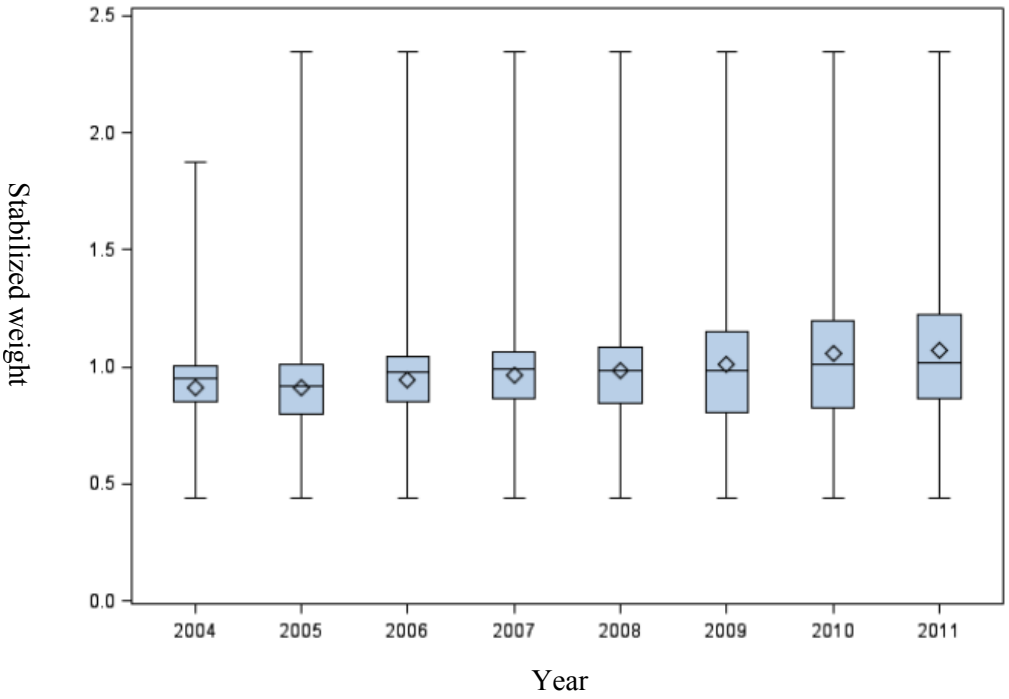


Figure 19. Mean weights across time point after truncation at the 1st and 99th percentiles

Marginal structural model assumptions

Causal effects are identifiable under 4 strong assumptions: consistency of exposure, exchangeability between exposed and non-exposed groups, positivity (non-zero probability of exposure at every level of a confounder), and correct model specification. In the case of the FMG model that was driven by voluntary uptake by physicians, consistency and exchangeability are closely related. Physicians who chose to partake in the reform versus those who did not, have been shown to differ from each other.[43] Similar observations apply to enrolled and non-enrolled patients.[43] This is a problem for the exchangeability assumption whereby the non-exposed group may not have been an adequate representation of the counterfactual. Additionally, within the group of implementers, those who decided to join the reform later in the intervention period may have differed from those who did so earlier. The analysis in Manuscript 2 suggested this could have been the case. Consequently, FMG practices made up of early implementers believed to be innovators in their field may have differed from the FMG practices established by late adopters who may have been more reluctant to accept certain

principles of the new model. In short, heterogeneity between FMG practices produced multiple versions of the model and therefore an inconsistent exposure. If the data become available, future analyses should assess the differences between physicians who subscribed to the FMG model early versus later in the reform period since heterogeneity in FMG implementation (lack of consistency) is likely to be linked to differences between physicians joining early or late (lack of exchangeability).

Records identifying which physicians and patients joined FMGs and when they did so were not available for this project. As such, while the MSM addressed the important issue of time-varying exposure and confounders related to avoidable use of the ED among individual diabetic patients, physician and practice characteristics could have also confounded the exposure and outcome. Despite the limited availability of data, a fixed effects model was specified to estimate the within-region effect of FMG expansion over time. Although this strategy did not address the problem of unmeasured time-varying physician and practice factors, it did control for stable differences between regions at the physician and practice levels (eg. a greater preference among family physicians in rural areas to work in teams due to more limited resources).

Additional analyses

The manuscript contains one of the analyses that was conducted to examine whether the effect of FMG enrolment differed according to the level of regional adoption. Low adopter regions were defined as those in which the percentage of population enrolment remained consistently below the provincial average throughout the study period. Another approach to examining this question was to model the continuous exposure variable as a series of spline terms to allow for greater flexibility in the model's assumptions.

In order to maintain ease of interpretation, piecewise linear splines were fit to the data. A number of models were tested whereby the location of the knot was specified at different levels of FMG enrolment ranging from 20% to 50%. If for instance the knot was specified at 30%, two exposure terms would be included in the model: the first would

quantify the exposure's effect on the outcome up to 30% enrolment, and the second would pertain the exposure's effect beyond 30% enrolment. The piecewise linear spline is therefore simply a dummy variable with a continuity restriction at the known value.[171] This maintains a continuous regression line yet allows for different slopes. Table 21 displays the results of these analyses. However there are limitations to this strategy because the effects are structurally tied to time. This is particularly relevant in later years when higher levels of coverage only occurred late in the post-reform period. For instance, regions only began reaching 50% enrolment around 2009. This raises questions about the extent to which the effect of higher levels of coverage can be separated from the fact that they only occur in later years (i.e. there is no region that reaches 50% in early years of the reform to which a late high adopter can be compared to).

Table 23. Results from an MSM using a piecewise linear spline to model non-linear effects of FMG enrolment

Level of population enrolment	RR (95% CI)*
20%	Range [0 to 20%]: 0.91 (0.86, 0.96) Range [20 to 100%]: 1.20 (1.11, 1.30)
30%	Range [0 to 30%]: 1.00 (0.96, 1.04) Range [30 to 100%]: 1.08 (1.00, 1.16)
40%	Range [0 to 40%]: 1.01 (0.97, 1.04) Range [40 to 100%]: 1.13 (0.99, 1.29)
50%	Range [0 to 50%]: 1.01 (0.98, 1.04) Range [50 to 100%]: 1.43 (0.95, 2.16)

* RR = rate ratio; RR reflects a 10 percentage point increase in exposure

Nonetheless, the results provide some further insight into the non-linear effects of exposure reported in the manuscript, particularly in the lowest levels of enrolment. Notably, up to 20% enrolment, there was a 9% reduction in the rate of avoidable ED visits among diabetic patients for every 10-percentage point increase in population enrolment in FMG practices (RR = 0.91; 95% CI = 0.86, 0.96) at $t - 1$. Assuming that the level of patient enrolment at the regional level was a proxy for how much uptake occurred at the physician level, then observing protective effects at low levels of enrolment lends support to the idea that early adopter physicians drove the effects of the

reform in the early period. Given that they would be the minority of primary care physicians, as the number of late physician adopters increased, a dilution effect would occur assuming there was lower adherence to the practice model among later adopters.

APPENDIX C

Manuscript 3

The following provides details on aspects related to the methodology for the study in Manuscript 3. It will outline:

- the definition and identification of the study outcome (retinopathy screening events);
- the rationale and process for defining a primary care patient population;
- descriptive analyses, and;
- a sensitivity analysis

Outcome ascertainment

The outcome definition was based on the guidelines recommended by the Canadian Diabetes Association (CDA) for diabetes management. Only certain process indicators could be used in this study since the data did not allow for distinguishing between type 1 or type 2 diabetes, nor for the severity of the condition since biomarker information was not available in the administrative data. This study focused on adherence to guideline recommended retinopathy screening as an intermediate outcome of the process of diabetes care. CDA guidelines are released every 5 years. Accordingly, the consistency of the guideline for retinopathy screening over the study period was verified to ensure that changing guidelines would not be a source of bias. The CDA recommended physicians to begin screening 5 years after a type 1 diabetes diagnosis among patients 15 years or older, and at the time of a type 2 diagnosis. If the patient was found to have retinopathy, then monitoring intervals should span no more than a year. Among those with no clinical indication, screening intervals of 1 year were advised for type 1 diabetic patients and every 1 to 2 years for type 2 diabetic patients.[134-137]

Outcome identification from administrative data for this study followed similar processes as those adopted by the Institute for Clinical Evaluative Sciences (ICES) in Ontario, the INSPQ, and the Direction de santé publique de Montréal whereby a visit to

the optometrist or ophthalmologist was used as an indicator of the event. This assumes that retinopathy screening would have taken place during each visit. The data were also searched for relevant billing codes for specific procedures that would involve retinopathy screening (Table 22). The frequency of each code was plotted by year to ensure changes in trends were unlikely to be due to shifts in the use of billing codes.

Table 24. Retinopathy screening codes used for outcome ascertainment

Billing code	Source (manual)	Procedure*	Description
00576 Examen au verre de contact au fundus sous dilatation	RAMQ omnipraticiens (section for ophthalmologists)	Dilated eye exam	Includes a dilated eye exam to view the back of the eye (retina). Visual acuity testing is also normally performed.
00555 Étude du fond de l'œil avec dessin détaillé	RAMQ omnipraticiens (section for ophthalmologists)	Ophthalmoscopy (fundoscopy)	Views the back of the eye (fundus). Used to detect changes in the retina, cataracts, etc.
00543 Gonioscopie	RAMQ omnipraticiens (section for ophthalmologists)	Gonioscopy	Test performed when glaucoma is suspected however, also indicated for diabetic retinopathy. Verifies whether the area where fluid drains out of the eye (drainage angle) is open or closed.
00537 Étude de circulation intra-oculaire par injection intraveineuse de fluoréscine (incluant rétino-photographie)	RAMQ omnipraticiens (section for ophthalmologists)	Optical coherence tomography (macula edema)	Verifies the fluid in the retina. Fluorescein is injected to view leakage from blood vessels which can lead to a swelled retina.
00536 Électrorétinographie	RAMQ omnipraticiens (section for ophthalmologists)	Electro-retinography	Screening method for retinopathy that relies on electrical responses from cells in the retina.
00553 Rétinophotographie	RAMQ omnipraticiens (section for ophthalmologists)	Retinophotography	Screening tool to diagnose retinopathy
9001 Examen complet	RAMQ optometrists	Complete eye exam	Includes a dilated eye exam to view the back of the eye (retina). Visual acuity testing is also normally performed.
9020 Examen sous dilatation du ségment postérieur	RAMQ optometrists	Dilated eye exam	Note: this is a new code introduced in 2009 for optometrists who treat diabetes patients

**Some procedures are more general than others (eg.: dilated eye exam and full exam for the optometrists). The other procedures listed are considered more specific means of diagnosing retinopathy. However, we might expect most to be coded more generally (00576 and 9001). Other codes included to limit misclassification (eg.: practitioners may favor some procedures over another).*

Selecting appropriate intermediate outcomes for quality improvement assessment

Quality indicators can be framed in terms of the structures, processes, and outcomes of care.[172] This objective highlighted a specific process to gain insight on diabetes management. Quality of care assessed through service delivery is informative when processes are closely linked to primary health outcomes. The Quality of Outcomes Framework in the English National Health Service was among the earliest diabetes quality improvement initiatives linking target indicators to pay-for-performance.[173] Process indicators are frequently used as measures of performance since they are considered standardized care for all diabetic patients, regardless of type 1 or type 2 status.[172,174] Treatment indicators were not included given the difficulty in setting population benchmarks for what is considered appropriate which is often determined on a case-by-case basis. In a study reviewing the evidence on standardized evaluations of type 2 diabetes management and quality improvement, the authors noted a lack of consensus among Canadian experts with regard to indicators related to treating diabetes.[172] Notably, treatment indicators are useful to the extent that they are accompanied by information on treatment intensity which in turn is informed by control of intermediate outcomes such as glycemic levels (HbA1c), blood pressure, and cholesterol.[172] Pharmacotherapy depends on diabetes management and co-morbidities and therefore is difficult to standardize. Anti-hyperglycemic medication (usually metformin) is prescribed among those who are unable to reach HbA1c targets in combination with other classes of drugs depending on the presence of conditions like congestive heart failure, metabolic bone disorder, pancreatitis, history of pancreatitis, and the patient's level of renal functioning, in addition to the level of hyperglycemia serverity.[175,176] Similarly, statin therapy is prescribed to those with difficulties lowering their low-density lipoprotein cholesterol.[177] The administrative data did not contain this information. Although the QICDSS contains the prescription medication database for those aged 64 years and older, without information on glycemic, blood pressure and cholesterol levels, the appropriateness of pharmacotherapy could not be inferred.

There are certain limitations when using medical claims data for identifying process indicators. For instance, measurement of glycated hemoglobin is considered central to proper diabetes management and would have ideally been included as a study outcome. Although there is a billing code specific to a blood glucose test, it is limited to measuring the patient's current blood glucose levels for that point in time in the physician's office (code 0113: 'glycémie capillaire') which is akin to what home monitoring kits produce. As evidenced in Figure 18, the frequency of the code has steadily decreased since 2000. This is likely in large part attributed to greater emphasis on patient self-management and advancements in home monitoring kits. Patients get sent to have blood drawn and tested for HbA1c but no billing code exists to indicate whether this test has been ordered. Therefore, it was not possible to provide a valid measure of this process indicator.

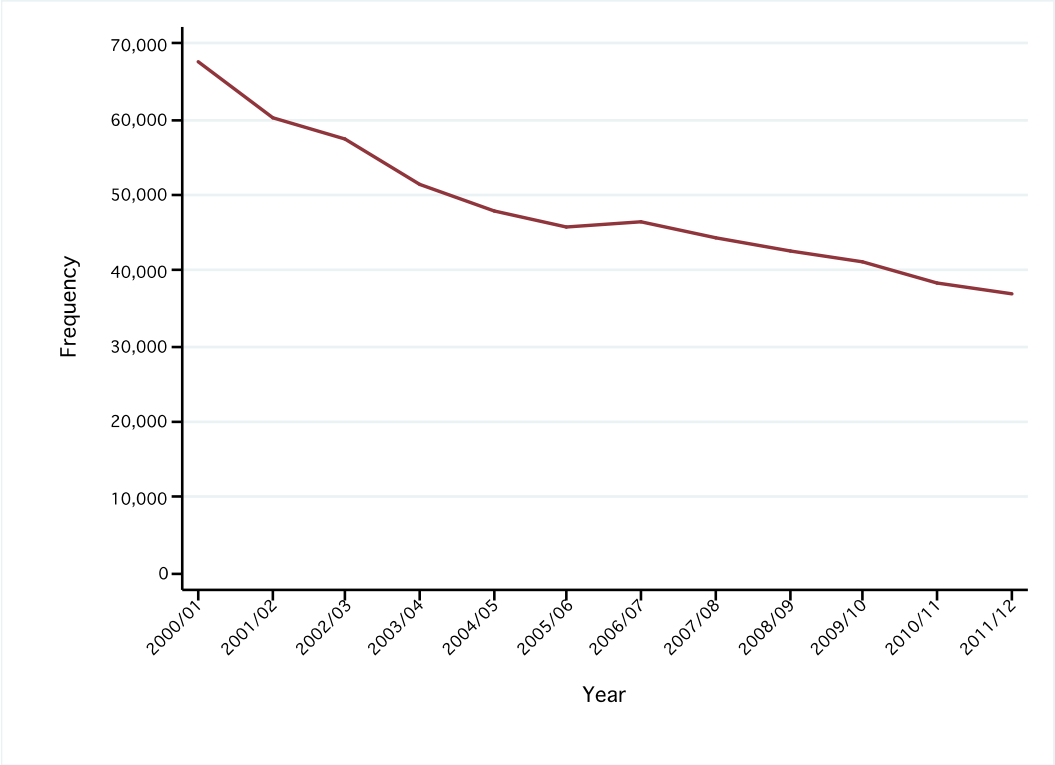


Figure 20. Billing code frequency for blood glucose measurement

Defining a provider patient population

Primary care research is beset by the 'denominator problem' particularly in health systems where capitation payment for physicians does not exist. As such, while defining

the number of outcome events in the numerator is relatively straight forward, determining the denominator in order to derive measures of occurrence is difficult when patient lists do not exist or are unavailable. Defining the patient population (i.e. population at risk) was identified as a problem as far back as the 1970s however efforts to develop integrated sentinel systems in the European Community in the 1990s further raised its importance.[178] The practice population includes individuals in a community who would seek care from a specific practice on any given day should the need to do so arise,[179] suggesting that one's inclusion in the patient population is both possible and plausible.[133] The denominator therefore consists of both observed and unobserved patients (the so called 'zero-class').[178] A provider's practice population will likely be a biased sample of the community within which she practices.[180] Patient selection factors into certain practices can be based on geography, age, sex, and various preferences for types of providers.[180]

Attempts to enumerate the patient population can be classified into two strategies: direct and indirect methods. Direct methods focus on patient registration and indirect methods estimate it through mathematical models.[178] Manuscript 3 of this thesis used a direct method to estimate the population at risk based on a defined time window using medical service claims data that attempted to address, to a certain extent, the zero-class problem while accounting for patient re-location and mortality. The method relies on documented encounters within the medical service claims database with a given provider. This method therefore assumes a de-facto registration with a physician based on the frequency and timing of the encounters.[178] One of the key limitations of this approach is the failure to account for orphan patients that do not have a regular provider of care. As such, under-counting the denominator can lead to bias in the numerator if orphan patients are at greater risk of poor health outcomes (and inadequate processes of care). Nonetheless, the de-facto registration method is relatively straightforward to understand. It requires patient linkages to providers between fiscal years of data and has been validated[133] and implemented in Canadian primary care research studies.[181]

An alternative direct method for enumerating the patient population is the yearly contact group (YCG) calculation that was adopted by the Canadian Primary Care Sentinel Surveillance Network (CPCSSN).[182] It consists of determining the number of patients frequenting a physician on an annual basis while allowing for a correction factor for utilization by age and sex based on the Canadian Community Health Survey.[182] The YCG method has also been adopted by European sentinel systems.[183]

The provider patient population in Manuscript 3 was defined according to Hutchison's algorithm for enumerating the population at risk using a 3-year window of medical service claims data to capture attendees and non-attendees.[133] Accordingly, the definition includes:

- Individuals who visited the physician at least once in the previous year (Year A), and;
- Individuals for whom there was at least one billing record linked to the same physician in each of the two years preceding Year A

If the criteria were met for more than one physician in a fiscal year of data, the physician with the most number of contacts with the patient had that individual included in her patient population. If the individual visited different physicians an equal number of times, then the physician who had the last encounter with the patient would have that individual included in her patient population.[133] The 3-year time window was deemed sufficient in capturing attending and non-attending patients since the number of years elapsed since a patient's last visit with a provider is generally an indicator of whether or not the patient is part of a physician's population at risk.[133]

Given that this thesis project specifically targets a disease group, a small modification was made to the algorithm in order to make it more appropriate for diabetic patients. Year A was defined as the current reference year rather than the previous one. 'Reference year' identified the year in which the outcome was being ascertained. For example, if the rate of retinopathy screening was calculated for fiscal year 2004/05, events would be searched for in fiscal years 2004/05 and 2005/06. This therefore included events for both incident and prevalent cases of diabetes. In the original methodology, defining the patient

population for 2004/05 would mean applying the algorithm to years 2003/04, 2002/01 and 2001/00.

The assumption in adopting this approach was that incident cases were part of the patient population of the physician they received care from in the reference year. This could have led to misclassification within the patient population since attribution of incident cases to physicians could only be made based on the reference year since medical claims for non-diabetic patients were not available. However, this misclassification was unlikely to differ by treatment status and therefore estimates would be biased toward the null. Given the similar trends in retinopathy screening by prevalent or incident status excluding incident cases would not have changed the study's non-significant findings. Figure 21 illustrates how the patient population and outcome definitions were applied to the data in each fiscal year.

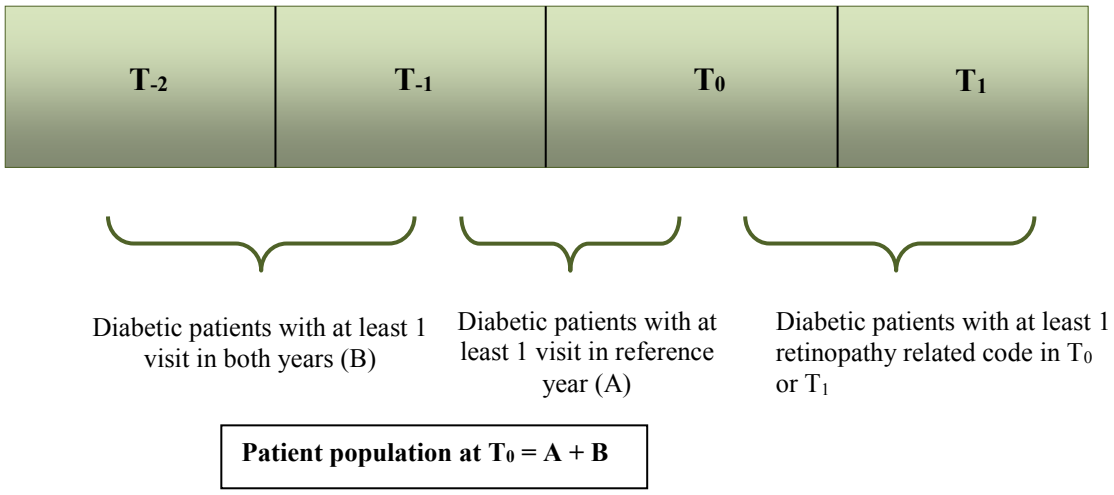


Figure 21. Application of patient population and outcome definitions for a reference year

Descriptive data

Table 23 shows how the cohort of diabetic patients was defined and its size over the study period. After identifying the population between 2000/01 and 2011/12 using the algorithm described in Chapter 2, exclusions were applied to the insured persons'

database. The data were then linked to the medical services claims. The following exclusions were applied:

- diabetic patients under 20 years old;
- regions: Outaouais, Nord-du-Québec, Nunavik, and Terres-Cries-de-la-Baie-James, and;
- diabetic patients who died in the fiscal year of interest: those who appeared in the death records for the same fiscal year were removed from the population (this was done to avoid inflating the denominator with deceased cases who would not have been able to receive a retinopathy screening)

Table 25. Diabetic patient population

Year	Prevalence (before exclusions)	Incidence (before exclusions)	After age exclusion	After regional exclusions	After deaths removed	Final Incidence	Final Prevalence
2000/01	293, 726	38, 373	290, 792	277, 609	266, 160	34, 389	266, 160
2001/02	319, 467	38, 366	316, 465	302, 075	289, 633	34, 477	289, 633
2002/03	346, 189	40, 507	343, 038	327, 488	314, 277	36, 491	314, 277
2003/04	371, 763	40, 349	368, 489	351, 686	337, 555	36, 159	337, 555
2005/06	422, 272	40, 869	393, 577	375, 605	361, 290	36, 944	361, 290
2006/07	448, 275	41, 720	444, 632	424, 400	408, 880	37, 706	408, 880
2007/08	472, 010	41, 055	468, 262	446, 957	431, 181	37, 073	431, 181
2008/09	496, 522	42, 061	492, 663	470, 275	453, 746	38, 184	453, 746
2009/10	521, 276	43, 034	517, 357	493, 759	476, 599	38, 861	476, 599
2010/11	544, 129	41, 867	540, 117	515, 442	496, 987	37, 885	496, 987
2011/12	564, 973	41, 258	560, 949	535, 484	517, 035	37, 515	517, 035

Prior to assigning patients to primary care providers, descriptive analyses were performed on the general diabetic population. Figure 22 shows the percentage of diabetic patients receiving a screening within a 1-year or 2-year period. Depending on the type of diabetes, age, time since diagnosis and presence of complications, the CDA advises a 1 to 2-year window for retinopathy screening to occur. Given that Type 1 and 2 diabetes could not be distinguished from the data, a less conservative 2-year window was used. A 1-year time window also holds physicians and patients to a strict requirement that may not be a fair measure of performance if for instance there are wait times for appointments with ophthalmologists. Widening the time window leads to roughly a 15-percentage point increase. Figure 23 shows differences in the percentage of diabetes patients receiving retinopathy screening by incident and prevalent cases. The curve for incident cases was

consistently lower than the curve for prevalent ones. This may be due prevalent cases being older and therefore consuming a greater volume of health services. Older diabetic patients may also be under greater medical surveillance. The trends are similar in both groups over time. There is a subtle decrease in the trend for females and males with a higher percentage of screening occurring among females (Figure 24). Finally, Figure 25 indicates that the percentage of diabetic patients receiving a retinopathy screening was similar across quintiles of material deprivation.

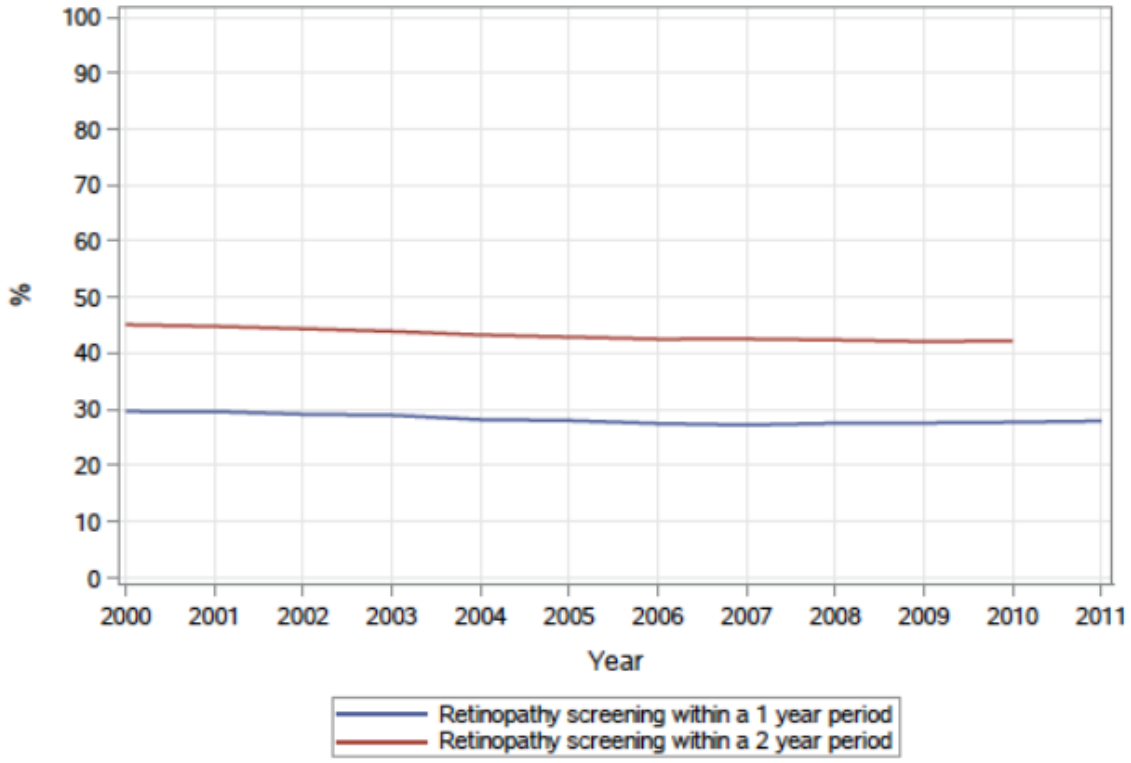


Figure 22. Percentage of diabetes patients receiving a retinopathy screening between 2000/01 and 2011/12

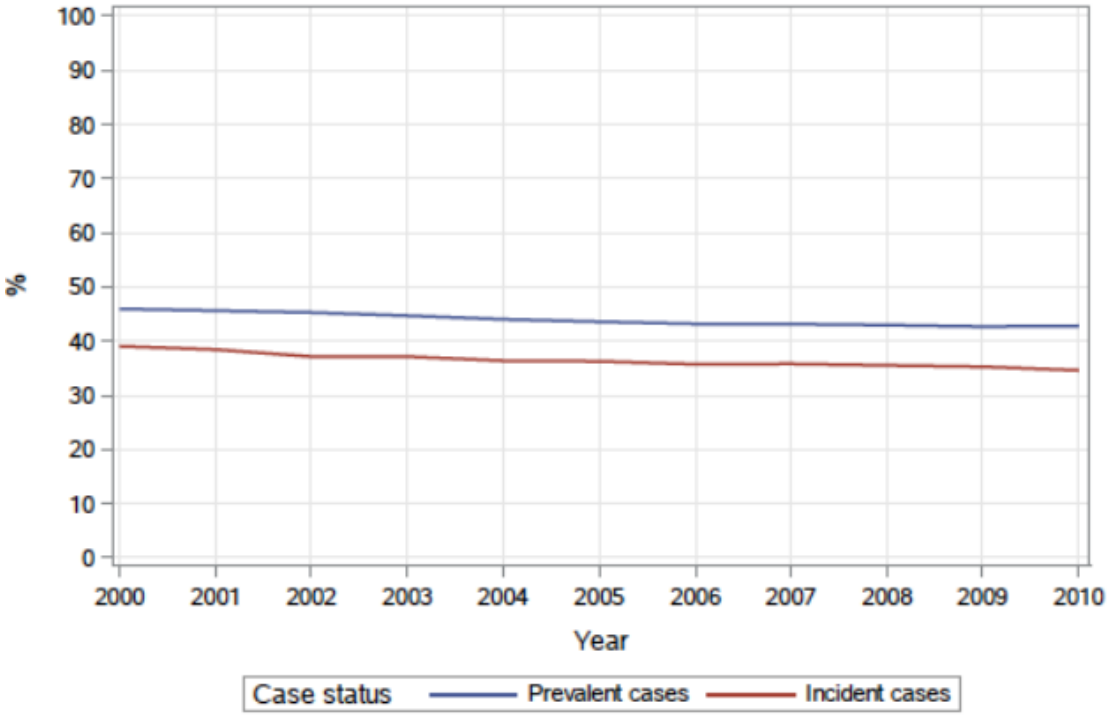


Figure 23. Percentage of diabetes patients receiving a retinopathy screening within a 2-year period, stratified by incident and prevalent case status

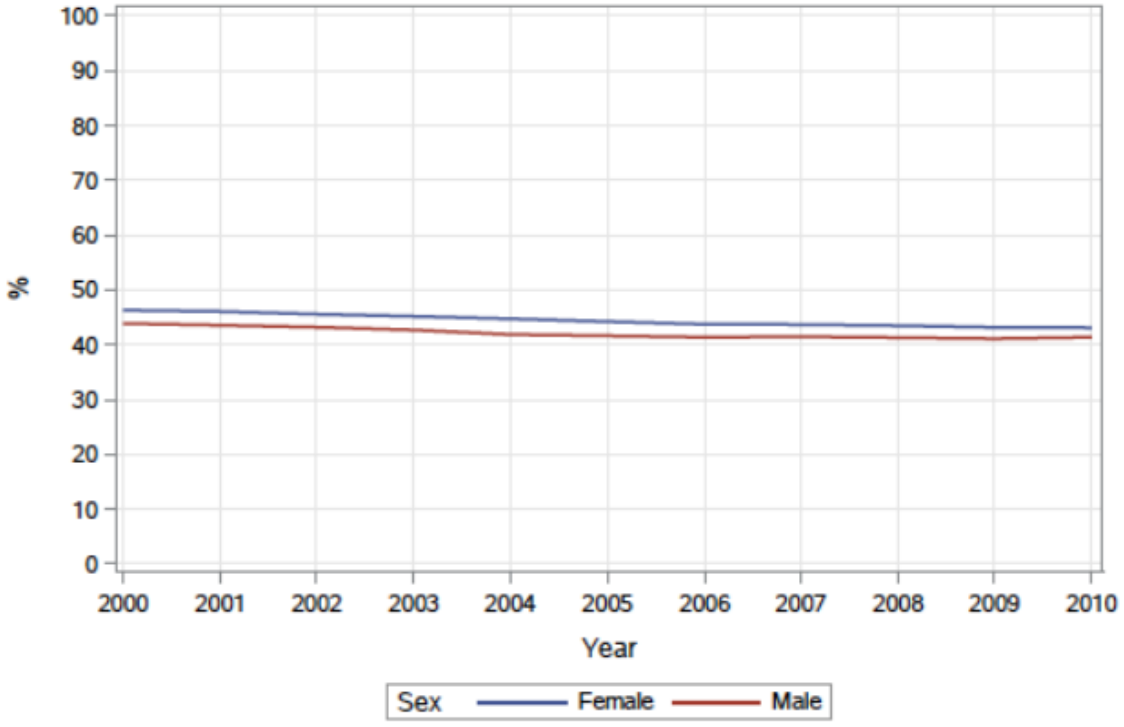


Figure 24. Percentage of diabetes patients receiving a retinopathy screening within a 2-year period, stratified by sex

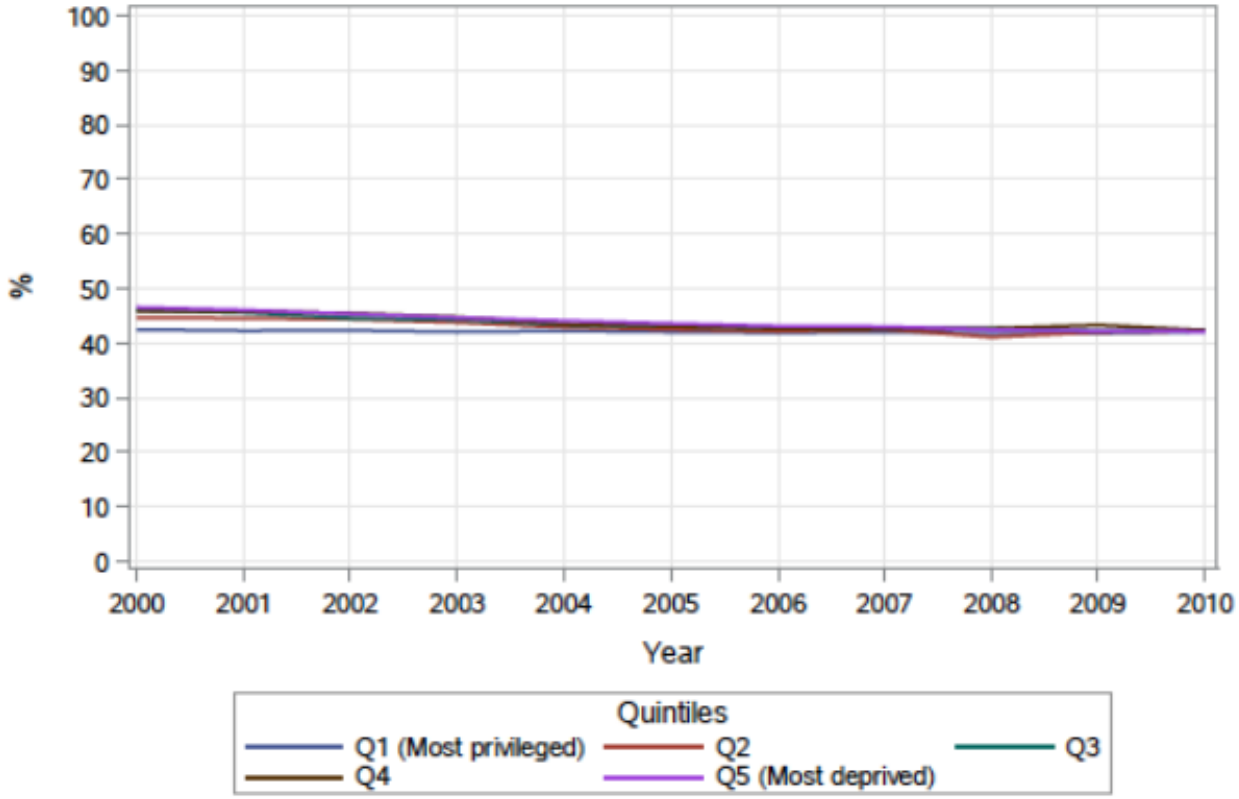


Figure 25. Percentage of diabetes patients receiving a retinopathy screening within a 2-year period, stratified by material deprivation index

Sensitivity analysis

To address concerns regarding whether ability to pay for retinopathy exams delivered by optometrists confounded our results, a sensitivity analysis was conducted on a sub-sample of the diabetic population aged 65 years and older. The propensity score matched DD analysis was redone on this group to verify the robustness of the initial estimate [RR = 1.00; 95% CI = 0.95, 1.05]. Over time, the proportion of diabetic patients screened for retinopathy was notably higher in older age groups (Figure 26). These trends support the observations drawn from the graph for prevalent and incident diabetes cases: elderly patients were more likely to be under greater medical surveillance thereby supporting greater adherence to retinopathy screening guidelines. Balance between the treatment and control groups was achieved after 1:1 nearest neighbor matching on propensity scores (Table 24 & Figure 27). The graph plotting the common trend assumption displays

overlapping and nearly indistinguishable treatment and control group curves throughout the study period (Figure 28). The final model contained the indicator for treatment group, the interaction term for treatment in the post-intervention period, fixed effects for year and fixed effects for health and social services region. The result from the sensitivity analysis (Table 25) was similar to the initial estimate [RR = 0.99; 95% CI = 0.95, 1.03]. The descriptive output and model results are presented below.

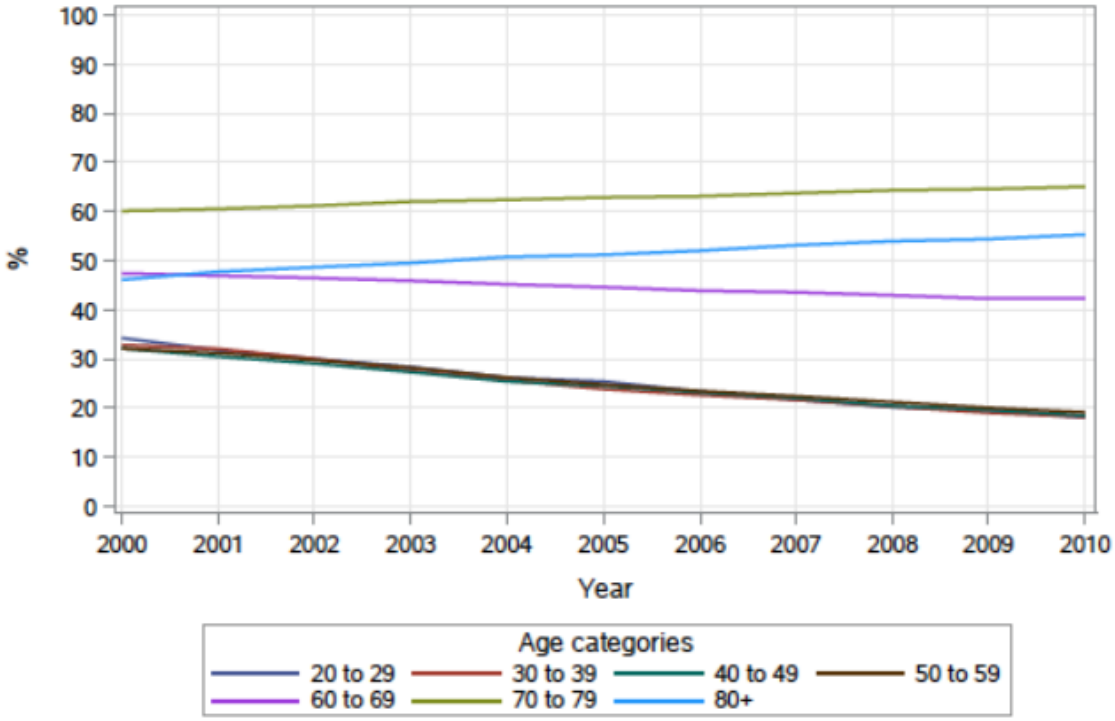


Figure 26. Percentage of diabetes patients receiving a retinopathy screening within a 2-year period, stratified by age categories

Table 26. Physician, practice and patient population characteristics at baseline (2006/07)

	Unmatched			Matched*		
	Treatment	Control	Standardized difference	Treatment	Control	Standardized difference
Number of physcians	1056	3444		1056	1056	
Physician and practice level covariates						
% of physicians in each regional category						
University	31.3	40.8	-0.19	31.3	31.3	0.00
Peripheral	44.5	36.2	0.16	44.5	44.8	-0.01
Intermediate	20.2	17.0	0.08	20.2	20.2	0.00
Remote	3.7	5.7	-0.09	3.6	3.5	0.01
% of physicians treating diabetic patients in the ED						
No patients	87.1	83.9	0.11	87.1	86.6	0.02
1 or more patients	12.9	16.1	-0.08	12.9	13.4	-0.01
% of physicians treating diabetic patients in hospital-based clinic						
No patients	71.8	70.5	0.02	71.8	72.8	-0.02
1 or more patients	28.2	29.5	-0.02	28.2	27.2	0.02
% of physicians treating diabetic patients in office-based practice						
≤ 19 patients	15.8	27.8	-0.30	15.8	15.2	0.02
20-49 patients	31.1	24.7	0.15	31.1	32.4	-0.02
50-79 patients	22.2	16.8	0.15	22.2	20.8	0.03
80+ patients	30.7	30.6	0.002	30.7	31.4	-0.01
% of physicians treating diabetic patients in outpatient clinics						
No patients	92.0	84.7	0.25	92.0	93.5	-0.03
1 or more patients	7.9	15.3	-0.25	7.9	6.4	0.02
Average number of years since graduating from medical school	22.7 (8.8)	24.7 (10.2)	-0.04	22.7 (8.8)	22.7 (9.7)	0.00
% of physicians with diabetic patient population						
Under 49 patients	57.7	58.3	-0.01	57.7	57.0	0.01
Over 50 patients	42.2	41.6	-0.02	42.2	42.9	-0.01
Patient level covariates						
Average age of diabetic patient population over 65 years old	73.7 (2.7)	74.0 (3.1)	-0.10	73.7 (2.7)	73.7 (2.7)	0.00
Average comorbidity score	6.2 (0.7)	6.2 (0.7)	0.00	6.2 (0.7)	6.2 (0.9)	0.00
Average deprivation score	3.1 (0.8)	3.0 (0.8)	0.12	3.1 (0.8)	3.0 (0.8)	0.12

*Nearest neighbor 1:1 matching (without replacement)

Covariates for the propensity score model included: practice region, patients seen in the ED, patients seen in hospital clinic, patients seen in office-based clinic, patients seen in outpatient clinics, average number of years since medical school, average diabetic patient population age, average comorbidity score, average material deprivation score

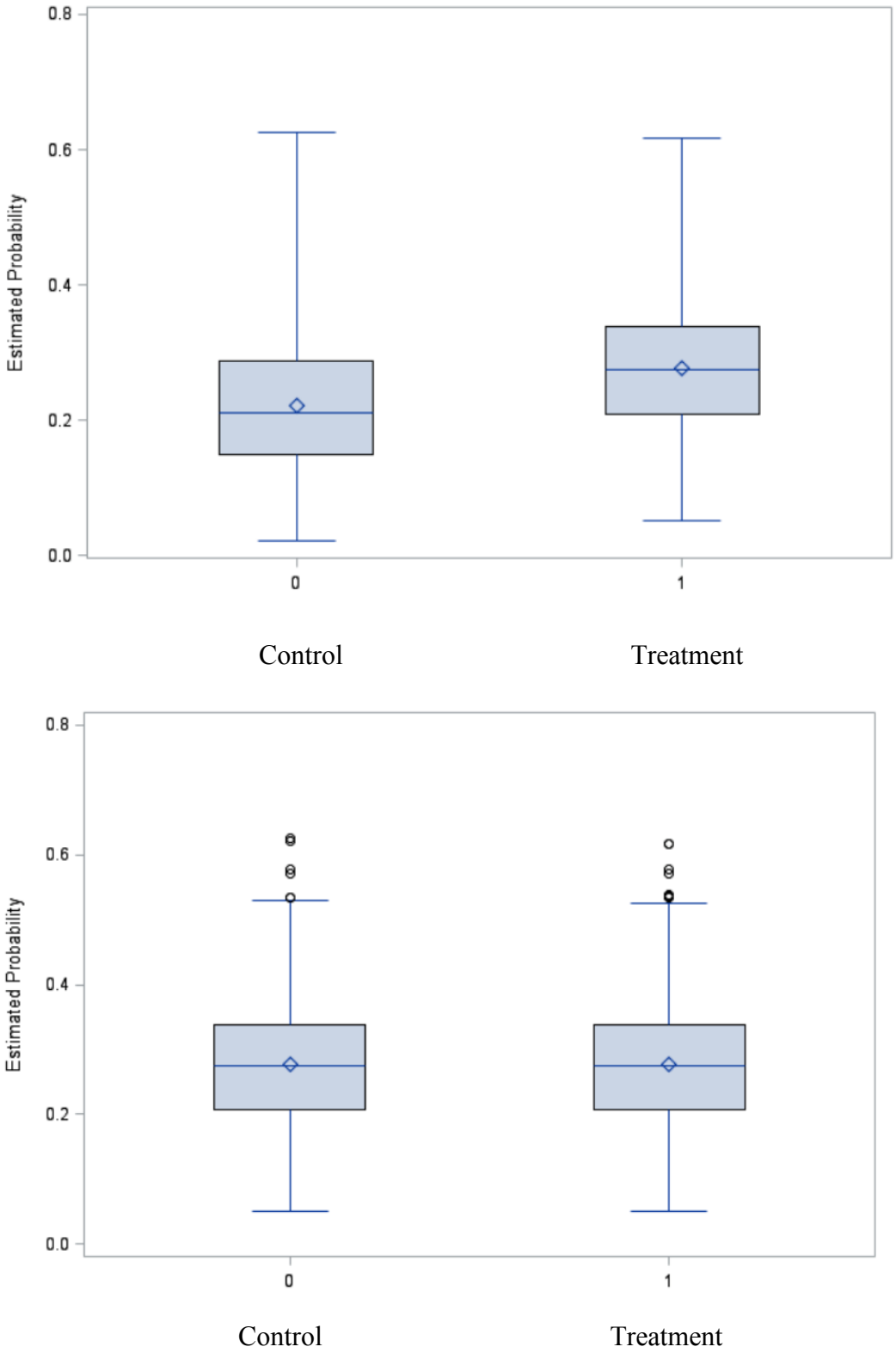


Figure 27. Distribution of the probability of treatment between the treatment and control groups before (panel A) and after (panel B) matching on propensity scores

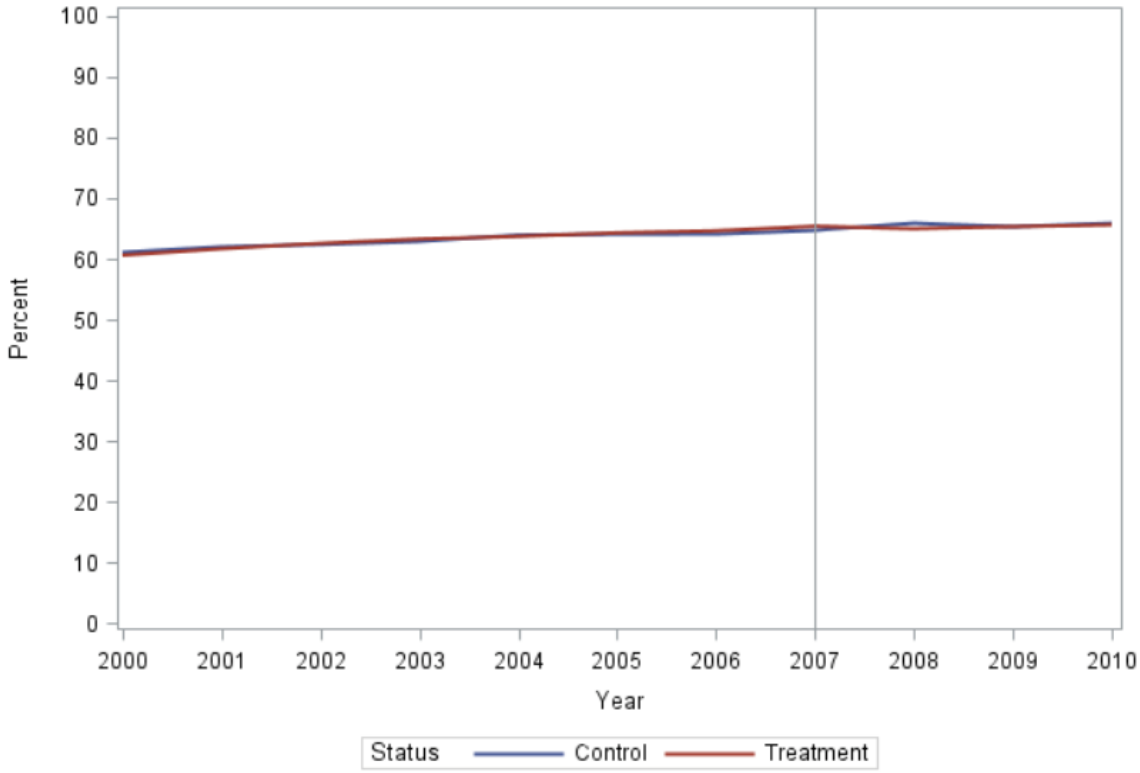


Figure 28. Assessing DD assumptions: common trends between the treatment and control groups in the pre-intervention period (percent of diabetic patient populations screened for retinopathy within a 2-year timespan)

Table 27. Main results from pooled and fixed effects difference-in-differences models

Specification	Number of observations	Estimate (95% CI)
Pooled DD model[1]	21,151	0.99 (0.95, 1.04)
DD model with fixed effects[2]	21,151	0.99 (0.95, 1.03)

[1] Simple DD model that pools the years into 2 time periods: pre and post intervention

[2] DD model that allows multiple time periods and fixed effects for region of practice. This translates into 10 indicator variables for year and 13 indicator variables for region.

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