Primary Health Care Reform:

Who joins a Family Medicine Group?

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Abstract

Reorganization of primary health care is being actively pursued and new models of primary health care delivery are being developed in the U.S. and in several Canadian provinces. In Quebec, Family Medicine Groups (FMGs) were created in 2002 in order to provide enhanced access and better coordination of care through a team based approach to primary care. Previous research on new models of primary health care has often failed to evaluate their effects within a causal inference framework, and little attention has been paid to the type of physicians and patients that voluntarily join them. Understanding who is attracted to new models is not only important to adjust for selection bias, but it may affect future reforms by helping to elucidate what would happen if FMGs were implemented on a population level.

This thesis attempts to understand the voluntary selection of patients and physicians into Family Medicine Groups in Quebec, Canada. A longitudinal administrative dataset of vulnerable patients (elderly or chronically ill) from the Régie de l'assurance maladie du Québec (RAMQ) has been divided between FMG and non-FMG users, and includes information on demographic characteristics, chronic illnesses and ambulatory and tertiary health service use before the advent of FMGs. Physicians of these patients are characterized by their FMG status, demographics, and practice and patient characteristics before FMGs are in place. Multivariate regression is used to identify key predictors of joining a FMG among both patients and physicians. Lastly, comparable physician and patient populations are created using propensity scores in order to set up the evaluation of health outcomes, utilization of services and costs in the years after joining a FMG. The distribution of propensity scores and their ability to balance key covariates after different matching and weighting techniques was investigated.

Results of the analysis reveal that geographic location, socio-economic status, visits in an ambulatory setting, emergency room visits, hospitalizations and having a usual provider of care are all factors which affect the probability of a patient joining a FMG. Specifically, residents of remote regions, low socio-economic status and those who use emergency rooms and hospitals more often are more likely to be enrolled, whereas patients that use ambulatory services and have a usual provider of care are less likely to be enrolled. Similarly, it is shown that factors that affect a physician's likelihood of joining a FMG include time since graduation, geographic region and revenue from traditional fee-for-service vs. other sources. Younger physicians and those who practice in a local community centre (CLSC) and short term/acute inpatient hospital care (CHSCD) are more likely to participate. Propensity scores were able to balance the pre-treatment differences, and this finding is robust across different mechanisms of adjusting for the propensity score.

Overall, it was shown that participation in a FMG is not a random process and any further research on the effect of FMGs, or any other type of primary health care reform, should consider this. Accounting for the type of patients that join different models, by using propensity score analysis for example, will be critical to forming evidence based policy recommendations. Particular consideration for geographic location, patients' morbidity, socio-economic status, health service use, as well as physicians' age and experience working in other settings is needed.

Abrégé

La réorganisation des soins de santé primaires est un objectif qui suscite un intérêt considérable au moment où de nouveaux modèles de prestation de soins de santé primaires sont mis en place aux États-Unis et dans plusieurs provinces canadiennes. Au Québec, les Groupes de médecine de famille (GMF) sont créés en 2002 afin de fournir un accès aux soins élargi et une meilleure coordination grâce à une approche des soins de santé primaires favorisant le travail en équipe. Les études antérieures sur les nouveaux modèles de soins de santé primaires n'incluaient généralement pas d'évaluation de leurs effets sous l'angle de l'inférence causale et peu d'attention a été accordée au type de médecins et de patients qui y participaient volontairement. Cerner le profil des personnes qui sont attirées par ces modèles est important, pas seulement pour ajuster les biais de sélection, mais cela peut aussi affecter les réformes à venir en permettant d'établir ce qui se passerait si les GMF étaient mis en place au niveau de la population entière.

Cette thèse cherche à comprendre le principe de la sélection volontaire des patients et des médecins dans les Groupes de médecine de famille au Québec. Un ensemble de données administratives longitudinales sur des patients vulnérables (personnes âgées ou malades chroniques), émanant de la Régie de l'assurance maladie du Québec (RAMQ) a été divisé entre les inscrits dans les GMF et les non-inscrits. Les données comportent des informations sur les caractéristiques démographiques, les maladies chroniques ainsi que sur l'utilisation de services de santé ambulatoires et tertiaires avant la mise en place des GMF. Les médecins de ces patients sont caractérisés par leur statut de GMF, leurs données démographiques ainsi que par les spécificités de leur cabinet et de leurs patients avant la mise en place des GMF. Une régression multidimensionnelle est utilisée afin de définir les prédicteurs clés à l'inscription aux GMF à la

fois pour les patients et pour les médecins. Enfin, des populations comparables de médecins et de patients sont créées en utilisant des scores de propension afin de mettre au point l'évaluation des résultats pour la santé, de l'utilisation des services et des coûts dans les années suivant l'inscription à un GMF. La distribution des scores de propension et leur capacité à équilibrer les covariables à la suite de différentes techniques de regroupement et pondération, a été examinée.

Les résultats de l'analyse révèlent que la situation géographique, le statut socio-économique, les visites dans un service ambulatoire, les visites dans les salles d'urgence, les hospitalisations et le fait d'avoir un prestataire de soins habituel sont tous des facteurs qui affectent la probabilité d'inscription à un GMF.

De façon plus spécifique, les résidents de régions éloignées, à faible statut socio-économique et ceux qui se rendent plus souvent dans les salles d'urgence et dans les hôpitaux ont plus de chance d'être inscrits, tandis que les patients qui utilisent des services ambulatoires et qui ont un prestataire de soins habituel sont moins susceptibles de l'être. Il est aussi démontré que les facteurs qui affectent la probabilité qu'un médecin soit membre d'un GMF incluent le nombre d'années écoulées depuis l'obtention du diplôme, la situation géographique et le revenu des traditionnelles rémunérations à l'acte par rapport à celui d'autres sources. Les plus jeunes médecins et ceux qui exercent dans un Centre local de services communautaires (CLSC) ou dans un Centre d'hébergement et de soins de courte durée (CHSCD) sont plus susceptibles d'en faire partie. Les scores de propension ont permis d'équilibrer les différences avant traitement, ce résultat est robuste par rapport à différents mécanismes d'ajustement du score de propension.

Dans l'ensemble, il est démontré que la participation à un GMF ne relève pas du hasard, ce que toute recherche additionnelle sur l'effet des GMF ou toute autre réforme des soins de santé

primaires, devrait prendre en considération. La comptabilisation du type de patients qui s'inscrit dans les différents modèles, par exemple en utilisant les scores de propension, sera critique dans l'élaboration de recommandations basées sur des faits établis. La prise en compte particulière de la situation géographique, de la morbidité des patients, du statut socioéconomique, de l'utilisation des services de santé ainsi que de l'âge des médecins et de leur expérience de travail dans divers environnements apparaît nécessaire.

CHAPTER 1: Overview of Primary Health Care Literature and Causal Inference

1.1. *Primary Health Care Theory: What should primary care look like?*

1.1.1. What is Primary Health Care: Definitions and Objectives

In recent years, most developed countries have put a focus on making primary health care the nucleus of a country's health care system and examining the potential it has to improve population health, ensure access to care and control costs. However, the evolution of primary health care has been slow and there has been confusion over what it actually means, how one should implement it and what the actual benefits will be. White first popularized the idea of primary, continuing medical care in North America in the 1960's (1961). The International Conference on Primary Care in 1978, the first of its kind, showcased some of the benefits of primary health care and laid the foundation for what primary health care should be. It was broadly defined there as " the first contact of individuals, family and the community with the national health care system, bringing health care as close as possible to where people live and work, and constitutes the first element of a continuing health care process (World Health Organization, 1978). The idea that a health care system should be centered around primary health care gained popularity and has been toted by most health policy makers and politicians in recent years. This sentiment is echoed in Quebec, as it has been recommended that "the organization of a primary care network constitute the main foundation of the health and social services system" (Clair, 2001).

An important distinction to be made is between primary care and primary *health* care, the latter that will be the focus of this thesis. Primary care is often used to refer to the situation where individuals with a medical issue will be diagnosed and treated by a physician in a clinical setting,

such as a family medicine office, a drop in clinic or the emergency room. It is the individual's first contact with the medical system, but the services may be provided by someone that is not the usual provider of care, and there is often no focus on prevention or management of illnesses. Primary care is thought to be a sub component of the larger primary healthcare, which is much broader in its definition and is provided at the community level. Primary health care usually refers to the medical home concept where physicians, nurses and allied health workers all contribute to the management of their patient's illness, provide health promotion and prevention activities and help to address the broader determinants of disease. (Marriott and Mable, 2002; Health Canada, 2006; Primary Care in Ontario, 2006)

There is a growing recognition that primary health care addresses the broader determinants of health by coordinating and integrating population based approaches to health and disease prevention. This holistic approach to care "includes the diagnosis, treatment and management of health problems; prevention and health promotion; and ongoing support, with family and community intervention where needed" (Canadian Medical Association, 1994). At the highest level, primary health care philosophy encompasses an understanding of social, political and economic and cultural determinants of health. Therefore, primary health care should embody the inter-connecting principles of equity, access, empowerment, community and inter-sectoral collaboration (Primary Care in Ontario, 2006). It appears then that at the most basic level the idea of primary health care is not only reasonable, but it has the potential to transform the way healthcare is delivered and improve the health of a nation.

1.1.2. Attributes of Primary Health Care

It should also be noted that the pillars of effective primary health care have been generally agreed upon, and include general principles like accessibility, patient-centeredness, continuity

and coordination of care. The Institute of Medicine (IOM) in the US specifically defined the core of primary care as accessible, comprehensive, coordinated and continual care delivered by accountable providers (IOM, 1978). Other essential elements of primary health care organizations include citizen choice and participation, information systems (including electronic health records) and comprehensive core services, including health promotion and sickness prevention, diagnosis and treatment, urgent care, 24/7 coverage, and management of chronic illness (Marriott and Mable, 2002). The Romanow Report noted that the four building blocks of primary health care are continuity and coordination of care, early detection and action, better information on needs and outcomes and new stronger incentives. Continuity and coordination of care is the number one priority, according to the Romanow Report, and is especially important for providing ongoing care for individuals with chronic health conditions. To help individuals properly manage their conditions, networks or teams of healthcare professionals could be used to help guide patients through the system and coordinate different aspects of their care, such as ensuring they get proper medical treatments, and providing preventive and educational activities and knowledge (Romanow Report, 2002).

1.1.3. Importance of Primary Health Care: Opportunities and Predicted Benefits

The potential for primary health care to transform the way the health care system works, in theory, is tremendous. The majority of policy experts and health care professionals agree that primary health care could improve health and reduce system inefficiencies and costs. From a population health perspective, it could provide more coordinated and better quality care, ultimately preventing illness and injury. It would mean helping patients navigate through the system more effectively and providing them with support to change unhealthy behaviors, manage or treat their illnesses, and monitor use of prescription drugs. From an economic perspective,

effective primary health care would reduce unnecessary use of hospital and emergency services, which are among the most expensive aspects of the health care system, thereby increasing the overall efficiency of the system. If it effectively reduced preventive or lifestyle-related illnesses it could reduce the need for expensive hospital treatments or at the very least reduce the propensity for readmission through coordinated outpatient care. (Kirby, 2002; Romanow, 2002; Starfield et al., 2005)

Overall, the level of agreement and excitement for effective primary health care delivery is remarkable. As the Romanow Report noted, the "issue, then, is not whether primary health care is the right approach to take but, rather, removing the obstacles and actually making it happen." The public too appears to support primary health care change. In opinion polls, Canadians echoed the reoccurring themes of wanting better access to services, improved quality of care, more health promotion and disease preventive services, and that reformed primary health care could give them this (Pollara, 2006). Given the overall consensus and positive atmosphere, it would seem that there is no question in the path that lies ahead for policy makers, but the question should be asked whether all of this support and enthusiasm is based on strong evidence regarding primary care's impacts. In the next few sections, however, it will be demonstrated that there is an overall lack of strong evidence supporting one model of primary health care delivery and the above claims on the benefits of primary health care may not be as crystal clear as some advocate they are.

1.2. *Primary Health Care Reform: What does primary health care actually look like and what current reforms are underway?*

Despite the broad consensus on the principles of primary health care, there is plenty of debate and discussion about how to specifically deliver high quality primary care. Furthermore,

it has been noted that many delivery systems are not delivering the expected results. For example, in comparison to other O.E.C.D countries, many Canadians do not have a primary care physician and have difficulties obtaining care without using emergency services (Schoen et al., 2004). In response, many countries, including Canada, have implemented reforms to primary care delivery, known as integrated delivery systems. These newer models often include one or many of the following components: enhanced access through extended hours and/or telehealth; teams of health professionals (including nurses, social workers and dieticians); rostering or patient enrollment with a physician or clinic; gatekeeping or referral to specialists by the primary care physician; implementation of electronic medical records; and physician remuneration methods that involve a blend of capitation, salary, fee-for-service and pay-for-performance (Kirby, 2002; Romanow, 2002; Hutchison et al., 2011).

1.2.1. The Canadian Context

In Canada, primary health care reform has taken a slow, voluntary and incremental approach to change. Reform has also had to develop within the context of the Canadian health care system and the fact that although the system is publicly financed, most primary health care organizations are privately owned by physicians. The power that the physicians and physician medical associations have in halting or rerouting reform has been noted as a major barrier and/or facilitator of change (Hutchison et al., 2001, 2011). But starting in the early 2000's, a new climate for primary health care emerged and federal and provincial governments got behind the movement by giving each of the provinces funds for innovative primary health care delivery (Hutchison et al., 2001). Only in recent years though has real transformation taken place across the various provinces (Hutchison et al., 2008, 2011).

In Ontario, Community Health Centres and Family Health Teams are the main innovative primary health care model, however, there also exists a range of other models implemented since 2000. As a result, the total number of family physicians practicing in multidisciplinary teams has increased from 176 in 2002 to more than 2500 in 2011 (Hutchison et al., 2011). The Community Health Centres are not a new model though, as they were established in 1979. They employ clinical, health promotion and community development professionals to help integrate clinical care with health promotion and disease prevention. Their mandate is to serve high-risk or disadvantaged populations, and there is a unique focus on addressing all of the determinants of health, including diet, poverty, housing and education (Health Force Ontario). Ontario introduced Family Health Teams in 2004, in an effort to help support other ministry initiatives, including improving chronic disease prevention and management, supporting the Ontario Diabetes Strategy and enrolling previously unattached patients (Ontario Ministry of Health and Long Term Care, 2011). The Ontario Ministry set out the following key objectives for the teams to embrace: enhanced access, interdisciplinary teams, extended hours, system navigation, patient-centered care, health promotion, disease management, integrating information technology, and community linkage (Ontario Ministry of Health and Long Term Care, 2011). There are currently 162 teams in operation across the province, employing more than 2100 family physicians and 1400 other health professionals (Hutchison et al., 2011). It has been suggested that this model may be the most promising currently in Canada, especially since it is most closely aligned with the concept of the patient-centered Medical Home (Glazier and Redelmeier, 2010).

In a similar fashion to Ontario, Quebec introduced an innovative reform project in the early 1970's by creating the *Centre Local de Services Communautaires* (CLSC). CLSC's provide primary health care and social services to a geographically defined population in a community

governed, interdisciplinary organization. However, this reform was met with strong opposition from the medical associations, especially around the issue of paying physicians on a salary basis, instead of the traditional fee-for-service (Breton et al., 2011). Taking the policy lessons and legacies from the last few decades, Quebec established Family Medicine Groups (FMG) or Groupes de Médecine de Famille in 2002. A FMG consists of a group of physicians that work with nurses to provide services to patients that have enrolled with the group. An average group consists of 10 physicians, 2 nurses, 2 administrative support staff and provides services to about 15,000 patients (Breton et al., 2011). As of late 2010, there were 219 groups across the province employing 3177 family physicians and covering 25% of the province's population. (Breton et al., 2011; Hutchison et al., 2011).

Participation in a FMG is voluntary for the physicians and patients, however there are some small monetary incentives for physicians to join and register patients. There is direct public funding to cover operational costs, including hiring administrative support staff, renting additional office space, travel and educational activities. Furthermore, there is an additional fee per patient registered and a set package to ensure 24/7 telephone access for patients. However, other than these small financial bonuses, physicians in a FMG are paid fee-for-service. This is a significant difference between other models seen across Canada and other OECD countries. In fact, it has been suggested that if FMGs implemented other payment methods, such as capitation or elements of pay-for-performance, then it could mitigate the negative side effects of fee-for-service and help to better address the health and needs of the population. (Breton et al., 2011)

Lastly, FMGs are unique in that they require contractual agreements between the physicians and the ministry (Ministère de la santé et des services sociaux). In general, physicians that practice in a traditional fee-for-service private setting have no formal contract or obligations,

except being accountable for the services that they are paid for. However, in order for a FMG to acquire accreditation, the group must commit to extended office hours, working in a group with other physicians and nurses and improve continuity of services (Breton et al., 2011). In exchange for signing this contract with the ministry the physicians are guaranteed financial and human resources, as discussed in the previous paragraph. This an ongoing process and the FMG are only accredited for 3 years, after which point they have to follow steps to get re-certified (Breton et al., 2011).

Although primary health care has been most widespread in Ontario and Quebec, other Canadian provinces and territories have begun to follow suit. Alberta introduced Primary Care Networks in 2005 and 75% of the province's family physicians are now practicing within this model. Primary Care Networks allow for a lot of variation in their implementation based on the local geography and community needs, but overall there is a multidisciplinary group of health workers that are linked within a single site or across multiple sites providing care for a roster of patients. Other provinces, such as British Columbia and Manitoba, have implemented changes to payment schemes with a focus on targeted payments for meeting performance thresholds, usually based on preventive and screening recommendations. Although other provinces and territories have not implemented wide spread reform, most have introduced or expanded the role of other health care workers into the primary health care system, such as registered nurses, midwives, social workers and dieticians. (Health Council of Canada, 2009; Hutchison et al., 2011)

1.2.2. The American Context

It should be noted that primary care reform and these integrated delivery systems are not unique to Canada. In fact, the U.S. may have a keen interest in the evaluation of these models given the similarity to the Patient-Centered Medical Home model. The Patient-Centered Medical

Home is an approach to providing comprehensive care and consists of the following attributes: personalized and whole person orientated care, so that each patient has an on going and trusted relationship with their physician; coordinated care across all the levels of the health system; enhanced access to services via extended hours and open scheduling; improved quality and safety via evidence-based medicine, performance measurement, information technology and other quality improvement activities and measures; and a payment structure that recognizes the added value of the patient-centered model (American Academy of Family Physicians, 2007; Rosenthal, 2008). Given that reforms to primary care have been generally well described and that implementation processes has been monitored, the next step in the evolution of primary care research is to really understand the impact that these systems have on population health, service use and costs.

1.3. *Impacts and Evaluation of Primary Health Care: What are the effects on access, quality of care and health outcomes?*

Some of the existing research on primary health care focuses on the relationship between the supply of primary health care and population health, with inference often made at the ecologic level. For example, a systematic review showed that a greater number of primary care physicians per 10,000 people in the population is positively associated with a multitude of health outcomes, including a lower all cause mortality, greater birth weight and better self-reported health (Starfield et al., 2005). This relationship was robust, even after controlling for population level socio-demographic characteristics and time trends, and was consistent across many different types of health outcomes. When non-urban and urban areas were examined separately, non-urban areas with a greater density of primary care physicians also experienced lower all cause mortality, lower heart disease mortality and lower cancer mortality (Shi et al., 2003). However, the opposite

was seen within urban areas; counties with fewer primary health care physicians experienced better outcomes (Shi et al., 2003). This discrepancy could be due to several reasons, such as the non-exchangeability of urban and rural areas in terms of their other characteristics such as racial composition, socio-economic levels and the health status of the population. Other reasons suggested by the authors include the hypothesis that the effect of primary health care physicians is only seen in areas where there is a high level of risk factors that are amenable to primary care intervention. The relationship between primary care supply and positive health outcomes has also been demonstrated in England, where it was shown that a higher GP supply was associated with a decrease in hospital admissions for acute and chronic conditions (Gulliford, 2002).

The previous research provides important preliminary evidence on the overall impact of primary care on health outcomes, but it is not able to address the effect that policies aimed at reforming primary care delivery have on improving health outcomes. Researchers in the U.S. have been fairly prolific in documenting the reforms to primary care, especially in regards to the effect that the medical home model is having on patient outcomes. It was shown that adults who have access to a medical home, have improved access to care, better management of chronic diseases, and have better doctor-patient communication (Schoen et al., 2007). Furthermore, racial and ethnic disparities in access and quality of care are substantially reduced within the medical home model. It was found that within a medical home, minorities are as likely to have their chronic conditions properly managed and receive timely preventive screening, as non-minorities (Rosenthal, 2008). The improved patient outcomes are likely due to the models affect on physicians and the quality of care that they provide, as it was shown medical homes have fewer duplicate tests, lower rates of medical errors and a better flow of information across providers (Schoen et al., 2007). A systematic review of patient centered medical homes across

multiple settings and countries showed that the more attributes of a medical home a practice had, the more likely their patients would have timely screening, immunization, disease prevention counseling, and the less likely their patients would be to use emergency services (Rosenthal, 2008). Lastly, evaluations on specific medical home models also show promising results. For example, a pre-post analysis on the medical home model, ProvenHealth Navigator (PHN), in Pennsylvania showed an 18% reduction in inpatient admissions and a 36% reduction in readmissions after implementation (Gilfillan et al., 2010).

Several studies in Ontario have evaluated new models of primary care in relation to organizational aspects and changes to remuneration. A large, multi-model comparison study in Ontario found that the rate of health promotion, chronic disease management and community orientation was significantly higher in Community Health Centres than in other models (Hogg et al., 2009; Russell et al., 2009; Muldoon et al., 2010). Most of the work done in Ontario has been on evaluating the changes to remuneration and the effects on physician productivity and patient health outcomes. For example, a recent study examined whether the type of physician payment model affected screening, treatment, and control rates for hypertension and found that the capitation model (Primary Care Network) performed the best (Tu et al., 2009). Similarly, it was found that emergency department use was lower among patients from a capitation-based model, compared to an enhanced fee-for-service model and traditional fee-for-service practices (Howard et al., 2008). There are conflicting findings about the effect under capitation though, and a recent population based evaluation found that patients in a capitation practice had a greater number of visits to emergency departments (Glazier et al., 2009). There has also been some evidence on the effect of new payment models on physician behavior. It was found that physicians in a Family Health Group (enhanced fee-for-service model) are more productive then physicians in a

traditional practice, as demonstrated by the greater number of services provided, patients seen, fewer referrals made and their treatment of more complex patients (Kantarevic et al., 2011). Lastly, there has been some evidence on the general effect of primary care teams on access, health promotion and chronic disease management. Based on the Canadian Survey of Experiences with Primary Health Care, individuals with access to a primary health care team have better care coordination, whole person-care, and are more likely to receive health promotion and disease prevention, and this is particularly true for those with chronic conditions (Khan, 2008). The pathways through which primary care teams exert their affect on patient outcomes were also explored. It was found that access to a team reduces uncoordinated care and unmeet needs and this reduces the risk of hospitalization and emergency room use (Khan, 2008).

In Quebec, most of the research has focused on organizational factors and their effect on physician satisfaction, patient experiences with care, access to services and continuity of care. For example, a study that looked at dimensions of job satisfaction and how they relate to organizational models found that physicians experienced greater satisfaction from longer consultations, treating harder and sicker cases, and from formal and informal interaction with other health professionals within the CLSC model (Geneau, 2007). Others have looked at primary care from the patient's perspective. Several studies have looked at accessibility of care, continuity and coordination of primary and specialty care, and the overall level of care from the patient's experience (Haggerty et al., 2007; Haggerty et al., 2008; Tourigny et al. 2010). The evidence and research on Family Medicine Groups (FMGs) has been very limited in scope given the recent implementation of the model. A case study of five FMGs found that there were improvements in accessibility of care outside and during regular hours, comprehensiveness of care and patient knowledge (Beaulieu, 2006). It was also shown that preventive care delivery was

greater in Family Medicine Groups, as compared to traditional fee-for-service models (Provost et al., 2010). The existing research on primary care, abroad and in Quebec, constitutes an important first step in identifying factors associated with quality of care and accessibility of services. However some of the limitations of this work should be explored, thereby setting the stage and providing motivation for future research agendas.

1.4. *Causal Inference and key considerations for policy evaluation*

Existing research on primary health care reform, as demonstrated in previous sections, focuses on individual's perception of access and quality of care or the ecologic relationship between physician supply and population health outcomes. While these provide an important first step in examining factors that are associated with health outcomes and utilization, they are not sufficient to be interpreted as the effects of primary care. Overall, the previous research has been descriptive or observational in nature, but has lacked any formal causal model, or at the very least an attempt to understand the causal framework.

First of all, the counterfactual outcomes and average causal effect needs to be well defined. An important distinction to note, is that "*association* is defined by a different risk in two disjoint subsets of the population determined by the subjects actual treatment value, whereas causation is defined by a different risk in the entire population under two different treatment values" (Hernán and Robins, 2012). Often studies on primary care make concluding statements like "increasing primary physician supply could be one way to address the health needs of rural populations." (Shi et al., 2003), without addressing whether their methods allow for such a statement. An association between primary care supply and population health was observed, but this does not mean that increasing the supply would *cause* better health outcomes.

In order to estimate a causal effect of primary care on an individual's health, one would need to observe the effect of primary care on an individual, while at the same also observing the effect of no primary care on that same individual. Of course, only one of those outcomes is observed for that individual- the one corresponding to the treatment value actually experienced by that person. However, one can get the average causal effect in a population of individuals if one thinks about imposing a level of treatment on a random subsample of the whole population (assuming extremely large sample sizes) and contrasting this with a random subsample of non-exposed individuals. The only catch is that the two groups must be exchangeable or treatment assignment must be independent of the future outcome.

Many studies are not specific about the causal model in terms of exchangeability and identifying potential factors that are confounders and/or intermediate variables on the causal pathway. Exchangeability refers to the independence between the counterfactual outcome and the observed treatment, meaning that the treated and the untreated would have experienced the same risk of the outcome if they had actually received/been given the same treatment (Hernán and Robins, 2012). Exchangeability in this context would mean that the group of patients and providers that eventually receive the exposure (joining a new primary care model or having more access to primary care) could be exchanged with the group of patients and providers that did not eventually receive the exposure, and the same health outcomes would develop under the particular primary care exposure. In many of the previous studies, the probability of receiving the exposure (joining a particular organizational form) could depend on many unmeasured predictors of the outcome (health outcomes), thereby, making the groups un-exchangeable. For example, in studies that show an association between a particular organizational form and improved health outcomes, it is difficult to know whether the improved health outcomes are actually a result of

the organization form or if the types of patients or providers, who voluntarily join a particular model, are driving this relationship. In studies investigating the supply of primary care physicians on mortality in a US state, there is also lack of exchangeability and presence of confounding, since there are unobservable factors that affect physician supply and mortality rates, such as neighborhood level characteristics, the socio-demographic makeup of the population and the health needs of the population. This is a good example of confounding, defined structurally as the bias that results from the presence of common causes of the treatment and the outcome (Hernán and Robins, 2012). Furthermore, previous models have failed to take into consideration time varying confounders, which is an issue because many of the time-varying potential confounders are also affected by prior quality of primary care, and are thus in the causal pathway between the exposure of interest and the outcome, at the same time that they affect the types of care a person seeks out. As a final note on confounding, exchangeability can be verified if the conditional probabilities of being assigned to each treatment level are known or can be consistently computed from the data, although in reality this is rarely possible (Hernán and Robins, 2012).

There are two reasons why the treated and untreated groups may be unexchangeable: confounding or the presence of common causes of the treatment and outcome, and selection bias or conditioning on a common element of two variables, the treatment or cause of treatment and the outcome or a cause of the outcome (Hernán and Robins, 2012). Selection bias creates an association between the treatment and the outcome as a result of the process by which individuals were selected or recruited into the study. One pertinent form of selection bias that is relevant to this field is self-selection bias or volunteer bias. If individuals sitting in a waiting room of a CLSC are sicker than individuals sitting in a waiting room of a traditional practice, then it may appear that the CLSC models performs worse in a survey of patients in the waiting room.

Without properly addressing this selection, conclusions may be drawn and policy enacted that is not in line with the actual effect of these primary care models. Within the Canadian health care context this is particularly important to address as individuals have free choice in the provider or setting they choose to receive care. There are also relatively few financial barriers to care as most services within the hospital or primary care setting are fully covered by the provincial health care plan, and therefore the effect of selection bias could be staggering.

Lastly, previous studies are not specific about the causal hypothesis under study and the fundamental condition of consistency. The condition of consistency refers to the idea that the treatment levels correspond to well-defined interventions. Often in this context the intervention is not well defined, as it is unclear what the treatment "primary health care reform" means, as there are many aspects to primary care reform and it is unclear what aspect of the reform they are measuring. This implies that the counterfactual outcomes are ill defined. For example, a patient seeking care at a particular primary care group might have cardiac failure if the reform had mostly focused on physician remuneration. But that same patient seeking care at a particular primary care group might not have experienced cardiac failure if the reform had focused on patient coordination through a team of health professionals. Therefore, the question "Does primary health care reform have a causal effect health outcomes?" is vague in the sense that it depends on how one intervenes on a primary care organization. The same argument is valid in cases when one wants to look at the effect of the supply of primary care physicians on morbidity or mortality. The idea of consistency is not only pertinent to causal inference, but also to policy evaluation. Since many primary health care reforms are multi-faceted interventions, it is often not easy to identify the key piece and relay this to policymakers. It may not be feasible or cost-

effective to implement reforms in other provinces or on a wider scale if researchers cannot be sure which aspect of the reform is causing the changes.

In summary, previous research is not specific about identifying the casual hypothesis, fails to address important confounders, selection bias and the overall concept of exchangeability, and does not consider the condition of consistency.

1.5. *Thesis Overview*

Reorganization of primary health care is reaching a tipping point in Canada, as well as in other O.E.C.D. countries. New models of primary health care delivery have been developed in the U.S. and in several Canadian provinces. In Quebec, Family Medicine Groups have been implemented to improve access, continuity of care and the quality of services delivered. However, previous research often fails to evaluate primary care or new models within a causal inference framework, often relies of ecologic or cross-sectional designs and/or focuses only on patient's experiences. In order to begin to properly evaluate these models, careful attention needs to be given to the type of physicians and patients that are voluntarily joining them. The issue of selection bias is important from not only a methodological point of view, but also from a policy perspective. Understanding who is attracted to new models will affect future reforms, as well as helping to elucidate what would happen if FMGs were implemented on a population level. Therefore, this thesis will examine the following questions:

- Are there important differences between patients that voluntarily join a Family Medicine Group in Quebec and patients who do not join? Similarly, are there important differences between physicians that voluntarily join a Family Medicine Group in Quebec and physicians who do not join?

- Are these differences between participants and non-participants likely to confound the predicted effects of FMGs on health care system outcomes if implemented at the population level?

CHAPTER 2: Methodology

2.1. Introduction

As was previously demonstrated in the last chapter, past evaluations of primary health care have often failed to consider their causal framework and the limitations of their methods. The data used to evaluate the selection of patients and physicians into Family Medicine Groups (FMGs) and the performance of these groups has been constructed specifically to evaluate their impact.

The following methodological chapter is comprised of three sections: description of the data selection process, the theoretical background for the statistical methodology and the analytic design.

2.2. Cohort Data

2.2.1. Structure

The data for this thesis come from administrative sources and has been specifically developed, validated, and managed by the Population Health and Health Services Group at the Montreal Public Health Department and Agency for Health and Social Services (Équipe santé des populations et services de santé, Direction de santé publique de l'Agence de la santé et des services sociaux de Montréal). Since physicians in Quebec receive their income from the provincial health insurance plan, Régie de l'assurance maladie du Québec (RAMQ), almost all physician-provided medical services are recorded by the RAMQ. Furthermore, the RAMQ is the only health insurance plan for Quebec residents in terms of "medically necessary services"[1], and

[1] The Canadian Health Act of 1985 states that the provincial plan "must insure all insured health services provided by hospitals, medical practitioners or dentists, and where the law of the province so permits, similar or additional services rendered by other health care practitioners."

so almost every time an individual interacts with the medical system it is recorded by the RAMQ. Furthermore, it is possible to identify which services are provided in different settings, including the hospital, the Emergency Room, specialty clinics and family medicine offices. Most importantly, it is possible to identify which physicians practice in a Family Medicine Group (FMG) and which patients belong to a FMG. It is also possible to identify services in all of the following settings: primary care (including FMGs), secondary care (specialty services) and tertiary care (hospital and ER). This provides researchers a unique and comprehensive view of the medical system, including the way that services are used across different populations and settings within the province.

For the purposes of the thesis, and the larger project developed by the Population Health and Health Services Group at the Montreal Public Health Department and Agency for Health and Social Services (Équipe santé des populations et services de santé, Direction de santé publique de l'Agence de la santé et des services sociaux de Montréal), the population of patients encompasses any vulnerable individual in the province, as recorded by the RAMQ. The definition of vulnerable is any patient that is 5 years old or younger, over 70 years old, or has one or more of the following chronic conditions: cancer, diabetes, substance abuse, HIV/AIDS, mental health disorders, chronic obstructive pulmonary disorder (COPD), moderate or severe asthma, pneumonia, atherosclerotic vascular disease, degenerative central nervous system diseases, and chronic inflammatory disease. This definition was also used because as of April 2003, physicians receive a small income bonus for registering vulnerable patients under this definition (RAMQ Communiqué, 2003a). The idea behind the inclusion criteria is that these are the patients who will use the majority of health care services and would be most likely to benefit from primary

health care interventions. From an economic perspective, these patients are also the most costly to treat and consume a large portion of the health care budget.

Two cohorts of these vulnerable patients have been designed to represent the treated and control groups and create a valid comparison in the evaluation of FMGs. All patients that have been enrolled in a FMG as vulnerable between November 1st, 2002 and January 31st, 2005 comprise cohort 1 or the treated group. It should be noted that FMG's were accredited at different times and are heterogeneous in terms of the number of physicians, nurses and patients followed. Thus, each FMG may have a different process in which they reach working capacity. In order to account for these differences, only FMG's who had been in operation for at least 4 months and have at least 300 vulnerable patients by January 2005 were retained. There were 79 FMG practices comprising 123,187 patients that fell within these parameters (See Appendix Section 1-Table 2). The control group or cohort 2 includes every other patient that is not in a FMG but is registered as vulnerable by their primary care physician during the study period (see Figure 1). The control group contains 677,466 patients and this large sample size will be important for the statistical component of the analysis. Each patient receives a "time zero", defined as the date that they were registered as vulnerable in a FMG (cohort 1) or just as vulnerable (cohort 2). For cohort 1, time zero represents the start of their exposure to the FMG. Pre-exposure data is then obtained 2 years prior to this date and 5 years of follow-up after the time zero date comprises the post-exposure data. It should be noted that payment for FMG registration started in January 2003, although the first FMG was created in November 2002, and the payment for vulnerable registration started in April 2003 (RAMQ Communiqué, 2003a and RAMQ Communiqué, 2003b). Therefore, there is not a long period of time in which the treated FMG group could be

observed but the control group is not. Furthermore, since we have two years of pre-classification data, it is possible to examine the same health patterns in both groups.

Similarly, a treated and control group of physicians has been defined to help make valid inferences about the FMGs at the physician level (see Figure 1). The physicians that register the patients in the treated FMG group/cohort 1 become the treated physicians (n=906). All the physicians that treat and register the patients in the control group/cohort 2 become the control physicians (n=3,968). In order to be consistent, a "time zero" is also assigned to each physician based on the date they register their first vulnerable patient. Data on the physician's demographics, practice characteristics and billing schedule is obtained for 2 years prior to the "time zero" and 5 years after.

Normally one might be worried about the accuracy of the date and type of vulnerable registration, given that some types of physicians might be more or less likely to report this measure. However, as was mentioned in the previously, physicians receive a small, targeted income bonus for reporting which patients are vulnerable[2]. Thus there is an incentive for the physician to report this measure, and report it accurately. Furthermore, most of the data comes from physicians submitting their claims in order to receive payment for their services. Since the physician's income depends on this process, it is likely that most of these claims are fairly accurate. In recent Quebec studies assessing the accuracy of the claims for identifying surveillance related syndromes, it was found that the positive predictive value (PPV) was moderate to high, and the specificity and negative predictive value (NPV) was almost perfect, but

[2] As of 2003, physicians working in a FMG received $7 per person/per year for registering a patient as vulnerable. Physicians working in a CLSC or UMF, as well as a FMG, also received $7 per person/per year. Physicians working in a CLSC or UMF, but not a FMG, received $22 per person/per year. Physicians not working in a CLSC, UMF or FMG received $9 per person/per year.

the sensitivity was weak (Cadieux and Tamblyn, 2008; Cadieux et al., 2011). The accuracy of specific indicators used in this thesis is discussed in the indicator section.

Lastly, ethics approval was obtained from the Commission d'accès à l'information du Québec (CAI), and measures were taken to protect the privacy of the individuals in the dataset. All of the identification numbers were encrypted by the RAMQ, and only the encrypted dataset was given to the researchers at the Montreal Agency for Health and Social Services. Furthermore, variables that could be used to identify individuals, such as age, gender and postal code, were aggregated to categories, such as the 5-year age range.

2.2.2. Variables of Interest

The dependent variable in this analysis is an indicator of belonging to a Family Medicine Group (FMG) at time zero. It has been derived from the physician claims, as previously described in the cohort selection.

2.2.2.1. Patient-level Variables

The independent variables in the patient level analysis can be sub-divided into 3 conceptual categories: demographics, chronic illnesses and health service utilization. These variables were chosen because they were identified as potential confounders of the relationship between FMG enrollment and future health outcomes.

2.2.2.1.1. Demographic Information

Basic demographic information obtained from the RAMQ includes the patients' age, sex, geographic location and socioeconomic status. Age was defined in terms of categorical 5-year age groups for the privacy reasons previously mentioned. Location of residence was defined at four administrative hierarchal levels: CLSC, CSSS, RSS and administrative regions (régions

administratives). The finest level of detail is provided at the CLSC (*Centre Local de Services Communautaures* or local community service centers) level with 166 CLSC territories defined across the province as of 2011. The level above that with 95 territories is the CSSS (Centre de santé et de services sociaux or Health and Social Services Centers), followed by the RSS (régions sociosanitaires) level with 18 regions. The National Public Health Institute of Quebec (Institut national de santé publique du Québec) has also recently combined the 18 RSS into five geographic groups based on the socioeconomic makeup of the population in those regions and the type of medical services available (Gauthier , 2009). The five administrative regions are fairly homogenous within, and yet distinct enough from each other (Appendix Figure 1). This administrative region was the primary variable used to operationalize the local geographic context, however, sensitivity analysis were performed using the other geographic constructs. The fifth "northern region" was not used, as patients or physicians were not sampled from the RSS regions 10 (Nord-du-Québec), 17 (Nunavik) or 18 (Terres-Cries-de-la-Baie-James).

Lastly, socioeconomic status was constructed at the ecological level using the Pampalon material. Deprivation is a broad construct in that it captures many aspects of socioeconomic conditions, and can be defined in terms of material deprivation (access to goods and services) or social deprivation (social support and cohesion) (Townsend, 1987). The Pampalon index is based on 3 census level variables, and thus measures socioeconomic position at the neighborhood level (Pampalon and Raymond, 2000). The material deprivation index is based on the employment level (in relation to population size), the average income of residents and the percentage without a high school diploma.

2.2.2.1.2. Chronic Illnesses

In an attempt to measure the health status and morbidity of patients, several

administratively defined variables were created. A specific set of chronic illness indicators were developed by the Population Health and Health Services Group at the Montreal Public Health Department and Agency for Health and Social Services (Équipe santé des populations et services de santé, Direction de santé publique de l'Agence de la santé et des services sociaux de Montréal) using the current literature on how to create indicators from administrative data, including diabetes (Blanchard et al., 1996), hypertension (Lix et al., 2006), COPD (Lix et al., 2006) and heart failure (Lix et al., 2006). Furthermore, a variable was created to represent the overall morbidity burden using The Johns Hopkins ACG Case-Mix System (The Johns Hopkins University ACG Case-Mix Adjustment System; Reid et al., 2001). The Resource Utilization Band (RUB) is a categorical variable indicating whether a patient has no use of health care services, is a healthy user of services, has light morbidity, moderate morbidity, high morbidity or very high morbidity (The Johns Hopkins University ACG Case-Mix Adjustment System; Reid et al., 2001).

2.2.2.1.3. Health Service Utilization

The RAMQ claims data provide information on primary and specialty outpatient care, including the number and type of services. From these claims, the total number of physicians (and the number of generalists and specialists) seen in an ambulatory setting and the number of consultations has been totaled. Furthermore, in an attempt to address continuity of care, a binary variable indicating whether a patient had a usual provider of care (UPC) was created. The usual provider of care (UPC) index is commonly used in the literature when dealing with administrative data and is a measure of concentration of care with one physician (Breslau and Reeb, 1975; Haggerty et al., 2003; Tousignant et al., 2011). For the purposes of the thesis, UPC was defined as a binary variable where a patient has a usual provider of care if they receive 75%

of their services from the same physician, conditional on receiving at least 3 services. To control for the fact that patients with less than 3 visits would be coded as having no UPC, an indicator variable was created to represent these patients. Therefore, patients could be coded as having less than 3 visits, more than 3 visits without a usual provider of care, or more than 3 visits with a usual provider of care. Sensitivity analyses were also carried out with other definitions, including changing the minimum number of services and the percentage of services with one physician to 50%.

The Med-Echo database provides information on the services that take place in an inpatient care setting. From the service codes, the number of emergency room (ER) visits for all causes, heart failure, COPD, hypertension, diabetes and ambulatory care sensitive conditions have been totaled. Ambulatory care sensitive conditions related to ER visits include otitis, cystitis, respiratory illness other than pneumonia or flu, and conjunctivitis (Altmayer et al., 2005). Similarly, the number of hospitalizations for all causes, heart failure, COPD, hypertension, diabetes, pregnancy and ambulatory care sensitive conditions has been totaled from the billing service codes. Ambulatory care sensitive conditions related to hospital admissions include epilepsy, COPD, asthma, cardiac insufficiency and pulmonary edema, hypertension, angina, and diabetes (INSPQ le Portrait de santé du Québec, 2006).

2.2.2.2. Physician-level Variables

Data on the physicians can also be thematically categorized under the headings of demographics, practice patterns (including practice type) and their patient profile. These variables identified as potential confounders of the relationship between participating in FMG and future productivity and health of the patients cared for.

2.2.2.2.1. Demographic Information

Basic demographic information is limited to sex and geographic location. Geographic location for the physicians was created using the patient information, namely in which CLSC, CSSS and RSS region the majority of their patients receive their services. Training information has been gathered on the cohort of physicians, including where they attended university for their medical training and what year they graduated from medical school. The time since graduation is a measure of the time spent in clinical practice and is used as a proxy for age, as I hypothesized that age will play a large role in whether a physician will be interested in joining a FMG.

2.2.2.2.2. Practice Patterns

Each of the physicians' total medical practice characteristics has been compiled from the RAMQ and is representative of all of their patients, not just the vulnerable cohort. The total number of billable services (acts), number of patients, days worked and the share of revenue has been totaled for each year in the various health care contexts or locations. Information is provided on the total number of acts, days, patients and percent of income per year in the emergency department, external contexts (outpatient or hospital clinic), CHSCD (Centre d' hébergement et de soins de courte durée or short term/acute inpatient hospital care), CHSLD (Centre d'hébergement de soins de longue durée or long term care facility), CLSC (*Centre Local de Services Communautaires)*, private practice, and homecare.

2.2.2.2.3. Patient Profile

The age distribution of the physicians' total patient roster, including the vulnerable patients in the cohort study and the non-vulnerable patients that a physician also sees, has been provided. The age of their patients is captured as the percentage of patients in the following age categories:

0-18, 19-64, 65-74, and 75 years and older. In order to get a more complete picture of the patients in the physicians practice, the patient level variables from the cohort study have been summarized for each physician. This includes information on the patients' average socioeconomic status (Pampalon material deprivation index), percentage with various chronic conditions, and the average RUB score. All of this information is only provided for the vulnerable patients that are part of the administrative cohort.

2.3. Creating a Natural Experiment

The structure of this data has been carefully constructed with the ultimate goal of comparing traditional service provision with the FMG model. While the FMG reform possesses characteristics of a natural experiment that can be leveraged in attempting to identify causal relationships from observational data, the voluntary participation by patients and physicians means that statistical methods are necessary to adjust for selection bias. Addressing the voluntary participation decision with statistical methods, one can attempt to emulate the setting of a randomized treatment assignment. Given the large sample sizes, especially for the control group, it is possible to create statistically equivalent groups based on key exogenous factors. By making comparisons between the treated and control group that are similar in their observed characteristics, it is possible to ultimately make inferences about the effect of FMGs on health outcomes, utilization and costs. The next section will describe how to create the statistically equivalent groups, and what this means for getting closer to the true causal effect.

2.4. Propensity Score Methods

2.4.1. Theoretical Rationale

Given the natural experiment setting and large sample sizes, certain statistical methods can be used to help address some of the issues related to selection bias and confounding.

Specifically, propensity score methods are useful in settings in which there is observational data and one wants to draw causal inferences about the effect of a specific treatment on a defined outcome (Rosenbaum and Rubin, 1983). This approach is based on treatment assignment being unconfounded with potential outcomes, conditional on a set of observed covariates (Rosenbaum and Rubin, 1983).

A common issue with observational studies is that many background characteristics need to be controlled for. Propensity score methods simply reduce these background characteristics into a single composite score, which effectively summarizes them. The propensity score then is just the likelihood to receive treatment over control, and acts like a single composite predictor. This allows one to make a straightforward estimation of treatment versus control effects that reflect adjustment for differences in all observed background characteristics.

The idea behind this method is that it tries to emulate a randomized controlled trial that would provide an unconfounded treatment effect. In some of the early work on propensity scores, it was noted that by simply carrying out subclassification of the propensity score into about five groups, the covariates that went into the propensity score estimation would be adjusted for (Rubin, 1997; Rosenbaum and Rubin, 1983). For example, if two people had the same propensity score, but one was exposed and the other was not, then the only thing differing between them is their treatment status (given the assumption that there is no unobserved confounding). Based on the observed covariates, it was as if there was a coin toss or there was random chance that either person received the treatment. This illustrates how the method attempts to emulate a randomized controlled trial, the gold standard of causal inference.

The resulting propensity score also serves an important function beyond controlling for confounding. It also allows one to carry out an assessment of whether the treated and control groups overlap sufficiently in their background characteristics to allow a sensible estimation of the treatment effect. When the overlap on particular covariate(s) is too limited, the database cannot address any causal conclusions, no matter how large it is. For example, if the treatment and control groups do not overlap in terms of age (i.e. one is entirely young and the other entirely elderly), causal comparisons should not be made as the groups are fundamentally not comparable. However, this will not be obvious from standard regression output, as the software will simply interpolate or smooth over the missing data. This is also known as "structural confounding", which is a violation of the positivity assumption and where data sparseness is a structural issue, not a sampling error (Oakes, 2006). In contrast, if the groups do not adequately overlap on age, this would be clearly visible in a graph of the propensity score distributions of the two groups. Rubin discusses this further and illustrates by a simple example: "comparing the 5-year survival rates among 70 year old smokers and 40 year old smokers gives essentially no information for either 70 year old or 40 year old persons" (Rubin, 1997).

To implement this method, each subject has a computed probability of becoming treated (the propensity score), that is a function of his or her covariate values. Predicting treatment membership based on the confounding covariates is usually done by a logistic regression analysis. It is critical that outcome play no role in the prediction model. To estimate a causal effect, one compares observations with similar propensity scores and this can be carried out through matching, stratifying or weighting by the inverse-probability of treatment. Weighting involves individual weights equal to the probability of belonging to the opposite treatment group that is based on the calculated propensity score. Propensity score matching involves comparisons

between FMG participants and non-participants with the same propensity score. While this often means reducing the size of the analysis sample, it will be feasible in this case given that the sample of control patients is approximately 7 times that of the treated FMG patients in the cohort database. However, weighting may be the ideal method given that the entire sample can be used and it has been shown to balance observed characteristics well in previous health services data (McWilliams et al. 2004). Both methods will be used to show balance in the key covariates between the FMG treated group and the control non-FMG group. Demonstrating that key covariates are balanced between the two groups is an important step to show that the propensity score method is working. Analogous to the Table 1 in a randomized controlled trial, this will show that the groups are unconfounded in terms of observable factors.

An important consideration in the implementation of propensity scores is how to select which variables will be used in the propensity score model. In general, it is advantageous to lean towards over-parameterization and allow for a flexible model, as there is no cost in terms of power for extra parameters. The ultimate goal of the propensity score model is to have balance between the covariates across treatment groups within each propensity score stratum. This does not mean having the most predictive model. It has been noted that it is best to include factors that affect the outcome and are correlated with the receipt of treatment, the classic definition of a confounder, as this will reduce bias (Brookhart, 2006). However, it may also be beneficial to include factors that affect the outcome and are not correlated with the receipt of treatment, as this can increase precision (Brookhart, 2006). The opposite scenario (factors that do no affect outcome but are correlated wit the treatment) can be harmful to include in that this will decrease precision (Brookhart, 2006). Several step-wise procedures have been suggested (Dehejia and

Wahba, 2002), but in general, there appears to be little consensus on how to select variables in practice. Further details on the approach taken in this analysis are in Section 2.5.3.

Several advantages should be highlighted in relation to traditional multivariate regression models that also attempt to control for confounding. The propensity score model is non-parametric, it easily captures interactions among covariates without a loss of power, and it can be fairly broad in the number and type of variables used in the model without any statistical penalty. This is a significant advantage when dealing with large administrative datasets, as there are often many variables that predict treatment assignment. Furthermore, it is possible to reuse a single propensity score in the analysis of the effect of an exposure on more than one outcome that a researcher may be interested in. Again, this is particularly valuable in this case, as there are many possible health and economic outcomes of interest. In contrast to traditional matching on one observed confounder, propensity score matching is multi-dimensional, and thus there are a limited number of potential treated persons who would not be matched and would have to be dropped from the analysis.

2.4.2. Assumptions and Limitations

Although this method has several advantages and has become fairly popular in the literature, several limitations should be noted. Possibly the most important assumption is that although this method adjusts for observed factors, it does not control for unobserved covariates. Unlike a properly conducted randomized controlled trial, treatment assignment is not actually randomized and therefore the possibility remains that some unmeasured factors are confounding the relationship and biasing the results. Unobserved factors for patients that are associated with both the participation in a FMG and the outcomes include things like health-seeking behavior and the relationship or level of trust with the registering physician. There is also the possibility that

there is residual confounding with improperly measured or defined variables. For example, there may remain differences in the physician's practice style even after controlling for training, patient characteristics and income sources.

From a statistical perspective, this method also requires large sample sizes. This is often not feasible in many epidemiological or public health settings. Even with large sample sizes, balance may not be achieved between the treated and control groups. When covariates only predict the treatment then the overlap between the two groups may be quite minimal. If this is the case, then only descriptive results about the lack of exchangeability between the groups can be discussed and conclusions regarding the effect on an exposure should not be drawn. The application of this method to non-binary treatment can also be inconvenient and lack an easy interpretation.

Lastly, there are assumptions regarding the generalizability of the findings. When interpreting the effect estimate from the propensity score model, it is only possible to do so for comparable units. When matching, only the people with comparable propensity scores are kept. This means that any inferences made are about the particular people in the matched analysis, not about the whole population. While propensity score analysis can improve the internal validity, it may do so at the expense of external validity.

Overall, this method has very promising applications and is well suited to the data and question being evaluated in this thesis. The next section will describe the specific implementation of the propensity score model and other statistical analyses.

2.5. Analytic Design

2.5.1. Descriptive Analysis

Initially, descriptive statistics were calculated for each continuous and categorical potential confounding variable. The distribution of the data was viewed graphically using boxplots and histograms, and numerically by examining means, medians, minimum and maximum values. Descriptive statistics were then stratified by FMG status in order to observe how each predictor varies by treatment.

The outcome variable, whether the physician or patient joins a FMG or not, is binary, so I used a logistic model. I ran a univariate logistic regression for each predictor variable, which produced the odds ratio and associated confidence interval. This allowed for the evaluation of the effect size of each unadjusted variable on the likelihood of joining a FMG practice. However, it has been noted the interpretation of the odds ratio is not intuitive (Greenland, 1987) as it is defined as the odds of having the outcome for the subpopulation with treatment value=1 compared to the odds of having the outcome for the subpopulation with treatment value=0. Given its mathematical properties, it also tends to over-estimate the effect size and does have not a natural causal interpretation (Greenland, 1987; Walter, 2000). Therefore, I report the risk ratio and risk difference.

2.5.2. Multivariate Model Building

After the univariate descriptive statistics were analyzed, the relationship between variables and their overall effect on FMG participation was examined by evaluating different multivariate models. I generated the regression models based on a forward selection procedure, whereby groups of variables were progressively added and the point estimates and confidence intervals were examined for changes. The groups were based on conceptual dimensions. For patients this included demographics (age, socioeconomic status, geography, sex), chronic illness and burden (chronic health indicators, RUB), ER and/or hospital utilization, ambulatory care use

(number of consultations or number of MDs seen) and whether the patient had a usual provider of care. For physicians this included demographics (graduation year, medical school university, geography, sex), income sources, the number of days worked in various settings, the number of acts performed in various settings and the number of patients. Evidence for confounding was demonstrated if variables' beta coefficients changed as other variables entered or exited a model.

I also examined model fit and diagnostics. First, a Likelihood Ratio test was carried out to test whether the second model was a statistically significant improvement (p-value < 0.15.) from the first model. Since the model was predictive in nature, the pseudo-R^2 and area under the curve (AUC) was also examined. However, since the ultimate goal is to have a good propensity score model (i.e. sufficient overlap of propensity score distributions) and not the best predictive model, the model fit diagnostics were interpreted in this context.

2.5.3. Propensity Scores

For the patient analysis, the propensity score model is based on demographic characteristics, health status and baseline service use. For physicians, the propensity score model is based on demographic characteristics, patient panel characteristics and the types of practices worked in. The goal of a propensity score evaluation is to show balance within the propensity score strata. If balance is poor then other variables or interactions can be added to the model. Key models from the model selection process were examined in relation to the propensity score overlap between the FMG and non-FMG groups, as well as the balancing of key covariates by matching and weighting. Interaction terms were also added to the models to help achieve balance and these were decided *a priori* based on which variables were thought to possibly modify the effect between the other independent variables and joining a FMG. The model that was best able to balance all of the key covariates with 1:1 matching, 1:2 matching, matching with and without

replacement and inverse probability of treatment weighting was kept as the final model (see Appendix Section 2 for the physician and patient final propensity score models and the accompanying statistical code). When constructing the inverse probability weights, I checked the weights for extreme values. There is a bias-variance tradeoff between including a large number of flexibility modeled potential confounders and the construction of well behaved weights (Cole and Hernán, 2008). This bias-precision tradeoff is highlighted in weight truncation, such that there is a growing bias as one progressively truncates weights, and a simultaneous increase in precision. Therefore, extreme weights were truncated in favour of obtaining reasonable precision, without compromising a lack of bias.

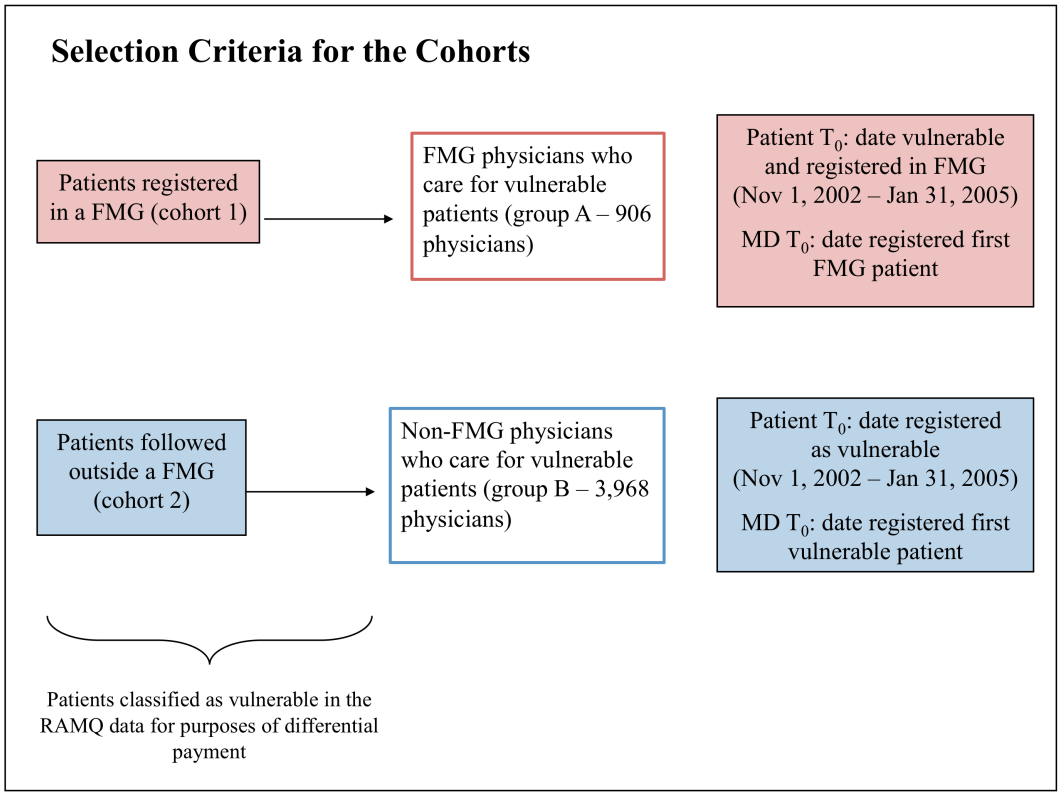

Figure 1: Selection criteria and structure of the patient and physician cohort

CHAPTER 3: Profile of Physicians Attracted to Family Medicine Groups

3.1. Introduction

The last two chapters have demonstrated the methodological and policy reasons why the selection of participants into a particular program is extremely important to investigate. This chapter describes the types of physicians that eventually joined a Family Medicine Group (FMG) in terms of their demographic characteristics, the clinical context in which they practiced and the type of patients they cared for. This information was then used to create propensity scores.

3.2. Results

3.2.1. Descriptive Analysis

The entire sample of physicians included only primary care doctors, and 81.4% (n=3968) were non-FMG physicians and 18.6% (n=906) belonged to the FMG group. There were approximately four times as many non-FMG physicians as FMG physicians, which was important for the propensity score matching in section 3. Descriptive statistics for the entire sample was generated for each independent variable and the distribution was examined for normality (results not shown). Practice-level variables, including the total number of patients are quite right-skewed (Figure 2).

Each independent variable was stratified by FMG status to determine whether differences existed between FMG and non-FMG physicians. Furthermore, I ran univariate logistic regressions for each independent variable against FMG status and the odds ratios (OR), risk ratios (RR) and risk differences (RD) are reported in Table 1. The following characteristics are

based on the two years prior to the creation of the new FMG model - therefore not be affected by the exposure (joining a family medicine group) - and are averaged across the two years to reduce statistical noise. Table 1 shows the proportions and means for all the demographic, training information, practice and patient panel characteristics. The patient panel characteristics are comprised of two sections; the total patient roster, including both vulnerable and non-vulnerable patients, and the vulnerable patient cohort comprised of the patients in the study population.

3.2.1.1. Demographics

The proportion of physicians graduating from a Quebec university was very similar between the FMG and non-FMG physicians (Table 1). Physicians graduating from a Quebec university are 1.31 times more likely to join a FMG as physicians graduating from a non-Quebec university, although by looking at the confidence interval it is apparent that this result is inconclusive (RR=1.31, 95% CI [0.89-1.92]). Geography, however, did show some interesting results, and the proportion of FMG physicians in each region is shown in Table 1. It appears that only a limited number of physicians in the large university-centered urban areas joined a FMG in the programs first two years (Table 1) and this is particularly true for the Montreal area (Appendix Section 1- Table 1). The odds ratio, risk ratio and risk difference for each geographic region is shown in comparison to the university area. As shown in Table 1, physicians in the intermediate area have a risk ratio of 1.39 (95% CI 1.16-1.63), in comparison to the university area. This means that there is a 39% greater risk or chance that physicians in the intermediate region will join a FMG, in comparison to the university area of Quebec. Sex also showed some effect, with men being less likely to join a FMG practice (RR=0.89, OR=0.87, RD=-0.022).

Another variable that showed considerable effect on FMG participation was the year that the physician graduated from medical school or the time since graduation. It is apparent from

Figure 2 that the probability for joining a FMG increases across the decades of graduation. Time since graduation is indicative of the time spent in medical practice, and is likely to be highly correlated with age. This indicates that younger, less-experienced physicians are more likely to join a FMG. Testing for a trend of odds based on the chi-squared test showed that there was a "significant" linear trend with decade of graduation for the log odds of joining a FMG, at the $p<0.01$ significance level. However, this conclusion should be taken with caution as the test for a trend conflates magnitude of slope with sample size. In order to investigate this further, I calculated the effect estimate for each successive decade of graduation by comparing to the baseline category and with being in a given category relative to being in the adjacent lower category (Figures 3 and 4, respectively). Figure 3 shows the log (OR) and confidence intervals for joining a FMG as a function of decade of graduation. Note that it appears approximately linear, but the lower limit of the confidence interval does not cross the null until the 1970-1979 decade. To view this relationship another way, the incremental odds ratios are calculated for each decade where contrasts are made against the previous category. Note that it appears approximately constant after 1970 and it is a monotonically increasing trend (Figure 4). The tendency for the estimated odds ratio to be above the null (OR=1) suggests there is a nearly uniform increasing probability of joining a FMG with each increase in decade of graduation. Overall, for each increase in decade of graduation (ex. 1970-1979 to 1980-1989) physicians have 1.29 greater chance of joining a FMG, and this result is clinically and statistically interesting (95% CI 1.20-1.38) (Table 1). Expressed another way, for every 5 year increase from the time of graduation there is a risk ratio of 0.91 (95% CI 0.89-0.93). In conclusion, it appears that the time spent in the medical field, expressed as either the year of graduation or time since graduation,

greatly affects the likelihood that a physician will join a FMG, and this is clear across all of the different ways of expressing this association.

3.2.1.2. Practice Patterns

There are several ways to describe physicians' practice style in terms of the clinical setting in which they work, including the number of patients seen, the number of services performed, the percentage of days worked and the percentage of income received from each setting. However, for each clinical setting these variables are highly correlated and represent the same theoretical construct. For example, the number of patients seen in private practice and the number of acts performed in private practice have a correlation of 0.84. Furthermore, the number of days worked in private practice and the percentage of income from private practice have a correlation of 0.82. Therefore, while each type of practice variable (acts, days, income, patients) was explored separately, only the results for the number of patients seen in each setting are shown. The results for the number of acts performed, days worked and percent of income were very similar and the same conclusions were drawn.

As seen in Table 1, FMG physicians provided services to more patients in short-term acute hospitals (CHSCD), ERs and local community service centres (CLSCs) in the 2 years prior to registering their first vulnerable patient and joining the FMG. They also have slightly more patients aged 0-18 than non-FMG physicians. Non-FMG physicians provide more services to more patients in the private practice setting, as well as having more patients aged 19-64 and 65-74 years old in the 2 years prior to registering their first vulnerable patient (Table 1). The effect estimates show that for an increase in 50 patients in the term acute hospital (CHSCD) setting, there is a risk ratio of 1.08 (95% CI 1.06-1.1) of joining a FMG.

Very consistent patterns emerged in terms of physicians' practice location and FMG status. Physicians were more likely to join a FMG (expressed as an odds ratio or risk ratio >1) if they have more patients, days worked and a greater percentage of income in the ER, short-term acute hospital (CHSCD) and local community service centres (CLSC) in the 2 years prior to registering their first vulnerable patient (results not shown). They were less likely to join a FMG (expressed as an odds ratio or risk ratio <1) if they had more patients, days worked and percentage of income in private practice (results not shown).

3.2.1.3. Vulnerable Patient Panel Characteristics

Lastly, I analyzed patient-level characteristics by physicians' FMG status based on physicians' cohort of vulnerable patients in our dataset (Table 1). FMG physicians saw vulnerable patients with a lower SES status (ie, greater deprivation index) in the two years prior to becoming a FMG physician, in comparison to the control non-FMG physicians. FMG physicians also treated patients that had much lower morbidity and consumed fewer health care resources, as indicated by the lower RUB scores.

This descriptive section has provided preliminary evidence on the types of physicians attracted to a FMG practice. However, these results should be interpreted carefully as they only provide unconditional effect estimates. It is likely that many of these variables are correlated with one another and the effect estimates may change when holding other variables constant. The next section explores different multivariate models and how estimates change as variables enter or exit the model.

3.2.2. Model Building

To begin to understand the multiple, correlated factors that affect a physician's likelihood to join a FMG, different multivariate models were explored. First, only conceptually similar variables were combined. Model 1 includes only the physicians' demographic characteristics and is similar to the univariate analysis in terms of overall conclusions (Table 2). Geographic location and time since graduation remain as significant predictors, however, sex is no longer significant. The effect estimates for geography were similar to the results seen in the descriptive section, with the intermediate region having a risk ratio of 1.34 (95% CI [1.11-1.57]), compared to the university region. The effect estimate for the time since graduation was almost exactly the same as the univariate estimate; with every 5 year increase from the time of graduation showing a risk ratio of 0.91 (95% CI 0.88-0.95).

Model 2, which includes all of the variables on the number of patients seen in various settings, shows that seeing more patients in the CHSCD and CLSC setting increases the risk that a physician will join a FMG practice. The effect estimates are similar to the univariate analysis and show that for an increase in 50 patients in the short term acute hospital (CHSCD) setting, there is a risk ratio of 1.10 (95% CI 1.06-1.14), and for an increase in 50 patients in the local community centre (CLSC) setting, there is a risk ratio of 1.05 (95% CI 1.01-1.09) of joining a FMG. The number of patients cared for in an emergency room (RR=1.03, 95%CI [0.99-1.07]) and private practice (RR=1.03, 95%CI [0.99-1.07]) are no longer predictive of FMG participation.

Model 3 includes information on the physicians' total patient (including both vulnerable and non-vulnerable patients) rosters' age profile and the vulnerable patient cohort in terms of demographic characteristics and health service use (Table 2). Having vulnerable patients with a lower deprivation index score increases the likelihood that physicians will join a FMG, although

the effect estimate for material deprivation were somewhat attenuated in relation to the results seen in the descriptive section (RR=1.05, 95%CI [1.00-1.11]). This model also showed a greater effect of patient age then the descriptive statistics, with patients aged 19-64 (RR=0.93, 95%CI [0.87-0.99]) and 65-74 (RR=0.89, 95%CI [0.81-0.98]) reducing the likelihood of joining a FMG. Furthermore, having vulnerable patients with higher morbidity or higher Resource Utilization Band (RUB) scores drastically reduces the likelihood that physician's will participate, although this effect was somewhat attenuated from the descriptive statistics (RR=0.70, 95%CI [0.65-0.74]).

I then combined the three previous models to get an overall picture. Model 4, which combines the demographic information and the practice characteristics, shows that rural geography, a later graduation year and seeing more patients in CHSCD setting increases the chances that a physician will join a FMG practice (Table 2). All other variables are non-informative, and this is a departure from the descriptive univariate statistics and model 2, where the number of patients seen in a private setting, emergency room and CLSC played a significant role in prediction. Lastly, model 5 incorporated all of the variables, including the physician demographics, number of patients seen in various clinical settings and the health and demographic profile of the physicians' vulnerable patients (Table 2). This model shows that seeing more patients in the CHSCD setting increases the probability of participating in a FMG, whereas, having patients with higher Resource Utilization Band (RUB) scores decreases the probability of participating in a FMG. When odds ratios are examined, instead of risk ratios, geographic location, years since graduation and patients aged 65-74 are also predictive (results not shown).

The same process was carried out for the number of acts, percent of days worked and percent of income received in various settings. These variables are getting at the same construct as the number of patients seen in each setting, namely where physicians are working, and overall, the same conclusions are seen; the number of practice setting variables that are predictive of participation in a FMG is reduced in the multivariate analysis. However, rural geographic location, more years in medical practice and working more in the CHSCD setting increase the risk/odds of participating in a FMG. On the other hand, working in a private practice setting and having vulnerable patients with higher resource use decreases the odds of participating in a FMG.

3.2.3. Propensity Score Methods

The previous sections showed that physicians who joined the FMG differed markedly from their Quebec primary care colleagues who did not join FMGs. I attempted to address this selection issue by implementing propensity score methods. First, the conditional probability of joining a FMG, over not joining, was estimated based on the characteristics that were found to be predictive in the previous two sections. As mentioned in Chapter 2, the evaluation of a propensity score model is based on balancing key covariates, and not on having the most predictive model. Several different models were evaluated in terms of propensity score overlap and balancing of key covariates. The model that fulfilled these requirements and made intuitive sense was kept as the final model (see Appendix Section 2 for the full model and statistical code). Since there is also no penalty in terms of statistical power for including other terms, all practice variables (acts, days, income, patients) were included.

Balancing of the key covariates was assessed after stratification, matching and weighting. Overall, adjusting for the propensity score significantly reduces the imbalances between the treatment FMG and comparison non-FMG physicians. The matched and weighted sample of

physicians is very similar with respect to the pre-treatment covariates. Table 3 shows the summary statistics for some of the key variables before and after propensity score analysis. The before propensity score analysis statistics include the full sample (described in section 3.2.1) and the sample with no missing covariates (used to generate the propensity score). The after propensity score analysis statistics include nearest neighbor 1:1 matching with the replacement option (re-using controls), 1:1 matching without the replacement option (not re-using controls) and inverse probability of treatment weights.

The full sample and the non-missing appear to be very similar and indicate the same conclusions; namely that there are imbalances in years since graduation, sex, geographic location, number of patients seen in the private practice setting, CHSCD setting, CLSC setting, the deprivation index of the vulnerable patients and the RUB of the vulnerable patients. After nearest neighbor matching, with and without the replacement option, I achieve very good balance between the treatment and control groups. Moreover, none of the remaining differences observed are statistically significant. Propensity score weighting also achieves balancing, both substantially and statistically, as the means are very close and there are no statistically significant differences. Therefore, I conclude that the propensity scores were able to achieve the desired goal and balance the pre-treatment differences between FMG physicians and non-FMG physicians.

The propensity score adjustment techniques and the population that they are generalizable to should be highlighted. When looking at the means of the covariates post-propensity score adjustments (Table 3), two patterns emerge in terms of whom the matching and weighting techniques are representative of. The matching, both with and without replacement, seem to bring the FMG treated group and the matched control non-FMG group closer to the original FMG group. This makes intuitive sense since the matching technique is only keeping control non-FMG

physicians that are similar to the original treated FMG physicians. Thus when making conclusions with this matched sample, one must be cognizant of the fact although the sample is internally valid, it may lack externally validity to the general physician population. Conversely, weighting does not reduce the sample size of the control group and appears to push the weighted means closer to the original control non-FMG sample before propensity score weighting. Therefore, inverse probability of treatment weighting may be the ideal method, as it is both internally valid (balances the propensity scores) and externally valid (keeps the original sample size). Although when making conclusion with the weighted sample, one must be aware of the fact that it is very similar to the original control group.

Furthermore, I examined how the covariates vary within and across propensity score strata. Although all variables were explored in this manner, time since graduation and the number of patients seen in a CHSCD setting are highlighted. Figure 5 shows how there is balance within the propensity score strata, which is the goal of propensity score evaluation. But there is a decreasing trend across the propensity score (or predicted probability of becoming a FMG) in terms of the number of years since graduation. This is consistent with the evidence from the previous sections in that physicians with more years since graduation were less likely to join a FMG. Similarly, Figure 6 shows that there is balance within the propensity score strata, but with an increasing trend in the number of patients seen in a short-term acute (CHSCD) setting across the strata. This is also consistent with the evidence from the univariate and model building section.

Lastly, the distribution of the propensity scores for the FMG physicians and non-FMG physicians shows that there is moderate overlap between the groups (Figure 7). It appears that the propensity score distributions are reasonably different between the treatment and control groups,

but not completely deterministic that no comparisons could be drawn between the two groups (ie, no structural confounding).

3.3. Discussion

3.3.1. Key Findings

The primary objective was to understand the type of physician that joined a FMG, in an attempt to contextualize the early impacts of the FMG program. Means and univariate logistic regression showed that rural geographic location, fewer years in medical practice, being female, practicing in the CHSCD setting, practicing in the CLSC setting and having vulnerable patients that are more materially deprived increases the chance of joining a FMG. Conversely, it was shown that urban geographic location, more years in the medical field, being male, practicing in the private practice setting, and having vulnerable patients that have higher morbidity decreases the chance of joining of participating in a FMG. After controlling for physician and patient panel characteristics, the multivariate model showed that geography, graduation year, practicing in a CHSCD setting, patient age and the morbidity/resource utilization of the vulnerable patients still affects the likelihood of a physician participating in a FMG practice or not.

These results clearly indicate that physicians self select into this new primary care model in a non-random way. The effect of geographic location on whether or not a physician joins a FMG practice was particularly notable. The fact that physicians working in the university area were less likely to join a FMG practice could suggest a few things. First of all, it appears that FMG practices were set more quickly in the areas outside of the university region (see Appendix Section 1- Figure 2 and Table 2). If more practices were available for physicians to join in the areas outside of the university urban setting, then this could explain the geographic differences. Alternatively it could suggest that physicians that work in urban areas are different from

physicians working outside the major urban and academic medical settings with respect to their preferences for group practice. Alternatively, perhaps the structural, financial or social incentives created to encourage FMG participation affected physicians differently by region. An Ontario-based study that used the equivalent form of provincial administrative billing data found geographic differences when comparing physicians who joined a Family Health Network practice (capitation funded) and Family Health Groups (enhanced fee-for-service) (Glazier et al., 2009). Although this study was mainly focused on the mode of remuneration, it demonstrated that physicians who join a less traditional capitation model were more likely to be in the rural and non-urban areas, compared to urban areas. Moreover, they found that physicians in rural areas were more likely to be male and Canadian born, as well as enrolling fewer patients. Rural areas also had higher rates of emergency departments visits and lower after hour visits, after adjusting for patient and physician characteristics, suggesting that there are structural medical system differences across geography. Two other Ontario studies did not find any geographic effect, but they were based on much smaller, cross-sectional samples, suggesting they are not directly comparable with this analysis (Tu et al., 2009; Hogg et al., 2009). Furthermore, the extent to which similarities can be drawn between Ontario and Quebec may be limited. Ontario focused their primary care reform on financial incentives and changes to the payment structure, and it was found that one of the greatest predictors in determining whether Ontario physicians would join a new model was their "expected gain" income (Kantarevic et al., 2011). Conversely, there was very limited financial incentive for the family physicians in Quebec to join a FMG.

Another notable finding was that less experienced physicians (in terms of number of years since medical school) were more likely to join. This makes intuitive sense as younger physicians may be more proactive, enthusiastic and have more time or willingness to invest in a new, FMG-

style practice than older physicians with established practice styles. Another hypothesis for this "age effect" is that the policy context in which the implementation of these FMGs is taking place can constrain or affect the decisions of physicians. Specifically, each health and social agency, in conjunction with the regional department of general medicine (DRMG), specifies that younger family physicians (less than 15 years of experience) perform specific medial activities or Activités médicales particulières (AMPs). AMPs include delivering care in specific practices, such as the Emergency Department, the Obstetrics Department within a specialized hospital (CHSGS), a CLSC, a CHSCD or short-term care, a long-term care facility (CHSLD) or rehabilitation centre. Furthermore, there is a stipulation that if resources are full in any of the previously mentioned settings then "continuity of care with respect to vulnerable clientele" also counts as an AMP. Given this stipulation, some physicians may choose to work in an FMG and treat vulnerable patients there to qualify for an AMP within their given region. (Federation des Medecins Residents du Quebec, 2011). This could generate the correlation between physician age and FMG status. However, since family physicians can also care for vulnerable patients outside of FMGs and such care is a secondary AMP category available after other priority services are satisfied, I do not expect AMPs to explain all of the physician age effect. .

According to a study by the Ministry of Health and Social Services, the FMG model is effectively able to recruit and retain new physicians (Ministère de la santé et des services sociaux, 2008). Since our population is based on early adopters, it reasons that this age effect would be particularly strong. The Ontario study that specifically focused on the different types of physicians who join different types of practices found only small differences in age and years since graduation (Glazier et al., 2009). The Ontario cross sectional chart abstraction study (Tu et al., 2009) and the Comparison of Models of Primary Care in Ontario (COMP-PC) study (Hogg et

al., 2009) also did not find any age differences across models (Tu et al., 2009). However, an Ontario study about family physician views of primary health care reform found that physicians in practice for fewer years were more likely to expect to join the new network (Hunter et al., 2004).

A third important finding was that physicians who had a more varied practice, especially in terms of working in the Emergency Room (ER), short-term acute hospital (CHSCD) and local community service centres (CLSC) were more likely to join a FMG. This may indicate that physicians who are highly engaged in the medical system and community are more likely to hear about the benefits of working in a FMG and encouraged to join. It may also be due to personal characteristics and preferences, such that these physicians already work with multidisciplinary teams and like to be engaged and challenged in new ways. It should be noted the concept of working in a specific setting (CLSC, ER, CHSCD, etc.) was based on the number of patients seen in that setting, not as discrete category. For example, physicians who join a FMG tend to see more patients in a CLSC setting than physicians who do not join a FMG, however, they can also see patients in other settings. Therefore, this does not imply that there are more CLSC-related physicians joining in absolute numbers. The similar Ontario study that focused on physician selection, also showed that enhanced fee-for-service physicians had a higher percentage of visits in office-based care and physicians in the new capitation model had a higher percentage of visits in inpatient settings and slightly more in emergency department settings (Glazier et al., 2009). The other recent Ontario study by Tu and colleagues (2009) showed very significant differences in the percentage of physicians who had hospital privileges, indicating that the newer Primary Care Network physicians were much more likely to be involved in the hospital than traditional fee-for-service based physicians.

The finding that physicians who care for vulnerable patients with higher resource utilization scores or overall morbidity were less likely to participate was somewhat surprising. While we originally thought that patients with more complicated health needs would be more likely to join, from the physician's perspective those caring for many vulnerable complex patients may already be burdened with enough work and have little time or energy to invest in the start up of a new clinic. Glazier and colleagues (2009) also showed that the more traditional enhanced fee-for-service group was more likely to have patients with high morbidity (as measured by the RUB), compared to the patients cared for by physicians in the capitation group.

3.3.2. Policy Implications

Policy makers interested in understanding the impacts of FMGs on the health of the population, and on how to implement FMG practices in the future, should take into consideration the type of physicians that select into a FMG practice. Particular consideration for physicians' age or medical experience, geographic location and experience working in other settings is needed. These results could be taken in two different directions; targeting the younger, more varied physicians and rural areas to rapidly increase the number of participating physicians or by focusing on the older, traditional physicians and urban areas and why they are not joining.

If the Quebec government's primary objective is to get as many physicians joining in a short period of time, then targeting medical schools and recent graduates may help to achieve this goal. However, if the health ministry decided to fully implement this model across the province, then special attention would need to be paid to older physicians, those in urban areas and those with more traditional practice styles. The reasons why this type of physician is not joining should be further explored, both in terms of qualitative and quantitative research. Incentives may need to be introduced in the urban areas or for the older physicians. This may include financial

incentives, such as the way Ontario has tried to recruit physicians through major pay increases (Kantarevic et al., 2011). However, other incentives could be used or promoted, such as the better work-life balance, supportive work environment, reduced stress and more available resources. Research has shown how several dimensions of job satisfaction relate to organizational factors, most the formal and informal interaction with other health professionals within the CLSC model (Geneau et al., 2007).

A major implication of this work is that participating in a FMG is not a random process and any further research on the effect of FMGs, or any other type of primary health care reform, should consider this. Accounting for the type of physicians that join different models, such as the propensity score analysis set up in this chapter, will be critical to forming evidence based policy recommendations. Since self-selection appears to be towards physicians that already like multidisciplinary group practice, then any evaluation of the impacts of these models on the health care system or population health needs to account for that selection. Future studies should also be cognizant of geography, physician age, and the overall morbidity of the physicians' patient panel when adjusting for confounding variables.

3.3.3. Limitations

Overall, there has been careful consideration to study design, data collection, abstracting informative variables and statistical methodology. However, certain variables may be limited in terms of the way they were defined or collected. The geographic variable used in this analysis was defined as the average geographic location of the physician's vulnerable patient cohort, and was not collected directly. There is likely measurement error in this variable, and the patient analysis using geography (Chapter 4) may give a better indication of the effect of geography on participation in a FMG. The same is true for the average RUB score and the material

disadvantage score, and so careful attention to these variables in Chapter 4 is warranted. Although there is likely measurement bias in terms of obtaining a physician's geographic location, and their patient rosters' SES and overall morbidity, it is most likely non-differential measurement bias. For example, since these variables are defined administratively it is hard imagine a scenario where the proxy geographic variable would capture the true physician's geographic location differential between the future FMG physician and the non-FMG physician. The same reasoning can be applied to the patient roster's SES and overall morbidity. Lastly, we did not have the physician's actual age, only the year of graduation from medical school, and so we cannot say for certain whether younger physicians join a FMG, only less experienced physicians.

Moreover, certain variables were not obtained, and these could significantly affect the results demonstrated. The methods used do not control for unobserved variables and thus there is always the possibility for confounding or selection bias to affect the results. For example, there was no practice level information in terms of which FMG a given physician joins or which physicians work together. This may an important source of where physicians obtain information on the FMG practices, and whether or not they are encouraged to join. This type of variable can also affect many of the practice variables, including the number and type of patients each physician sees. Lastly, there may be other factors determining whether a physician participates in a FMG that could never be obtained from administrative databases. These include things like the social network of a physician and the knowledge and passion for primary health care reform. These factors ultimately may be what are important in predicting participation, and the variables we have collected only roughly capture that.

3.3.4. Future Work

Although it appears that selection bias is a critical issue in relation to evaluating the FMG model, it is not clear why physicians choose one practice over another. Administrative data can only begin to answer these questions and a qualitative piece would help to elucidate some of these unanswered questions. Particular attention needs to be paid to the major factors that go into the decision of joining a new program or not, including financial, structural or personal incentives. There could also be different practice contexts that could help to provide some insight in explaining these findings, such as the requirements involved in joining a FMG, which could only be gathered through surveys or qualitative interviews. Administrative data can only begin to describe the type of physician that joins a FMG, but cannot explain the complex decision making pathway and the ultimate reason why a particular physician joins a practice, or not. Lastly, whether these decision processes differ between younger vs. older physicians and physicians in urban vs. rural areas should also be considered.

Now that the propensity scores have been created and evaluated, the final step is to use them to address the question of whether the new FMG practices had any effect on physician productivity, population health, health care utilization and costs. It seems that matching control physicians to their most similar FMG physician is best for creating a balanced sample, although weighting would also be sufficient. When selecting a propensity score adjustment technique generalizability should also be considered, and it appears that matching limits the external validity and allows for conclusions to be drawn mainly on the population of physicians that will become treated. Weighting may allow for better external validity, as all of the physicians are kept in the adjustment. Overall, the results from this chapter set the stage for the next wave of primary health care reform research.

Table 1: Characteristics of study physicians in the two years prior to joining a FMG practice

Characteristics	Mean (95% CI) FMG	Mean (95% CI) Non-FMG	Odds Ratio (95% CI)	Risk Ratio (95% CI)	Risk Difference (95% CI)
Demographics					
Male (%)	52.4* (49.2-55.7)	56.0 (54.5-57.6)	0.87 (0.75-1.00)	0.89 (0.78-0.99)	-0.022 (-0.044-0.000)
Attended a Quebec Medical School (%)	96.3 (95.1-97.6)	95.3 (94.6-96.0)	1.31 (0.89-1.92)	1.25 (0.84-1.65)	0.038 (-0.013-0.090)
Years Since Graduation[1]	18.7*** (18.1-19.3)	20.9 (20.7-21.2)	0.88 (0.85-0.92)	0.91 (0.89-0.93)	-0.025 (-0.034- -0.016)
Geographic location (%)					
University Region	30.1*** (27.1-33.1)	38.1 (36.5-39.6)	Reference	Reference	Reference
Peripheral Region	43.1* (39.9-46.4)	39.1 (37.6-40.7)	1.40 (1.18-1.65)	1.31 (1.13-1.50)	0.049 (0.024-0.073)
Intermediate Region	20.7* (18.0-23.3)	17.4 (16.2-18.6)	1.50 (1.22-1.85)	1.39 (1.16-1.63)	0.061 (0.029-0.093)
Remote Region	6.1 (4.5-7.6)	5.4 (4.7-6.1)	1.43 (1.04-1.98)	1.34 (0.99-1.69)	0.053 (0.001-0.104)
***Practice Patterns** (number of patients seen in each setting)*[2]					
Emergency Room	284.1* (239.2-329.1)	231.2 (209.9-252.5)	1.01 (1.00-1.01)	1.00 (1.00-1.001)	0.001 (0.000-0.002)
External	38.2 (30.1-46.2)	32.4 (27.9-37.0)	1.01 (0.99-1.04)	1.01 (0.99-1.03)	0.002 (-0.002-0.006)
CHSCD	113.2*** (103.8-122.7)	72.8 (68.4-77.1)	1.10 (1.07-1.13)	1.08 (1.06-1.1)	0.013 (0.010-0.016)
CHSLD	6.7 (4.3-9.1)	6.3 (5.4-7.2)	1.02 (0.90-1.15)	1.02 (0.92-1.12)	0.003 (-0.015-0.022)
CLSC	71.3* (50.5-92.2)	41.5 (33.4-49.5)	1.02 (1.01-1.03)	1.01 (1.00-1.02)	0.003 (0.001-0.004)
Private Practice	1412.1** (1330.4-1493.7)	1564.9 (1527.6-1602.2)	0.99 (0.99-1.00)	1.00 (0.99-1.00)	-0.001 (-0.002-0.000)
Total Patient Panel					
Total Number of Patients[2]	1895.5 (1809.7-1981.3)	1936.0 (1896.0-1976.0)	1.00 (1.00-1.00)	1.00 (1.00-1.00)	0.000 (-0.001-0.000)
Patients Age (%)					
0-18 years old	18.9*** (18.2-19.6)	17.2 (16.8-17.6)	1.01 (1.01-1.02)	1.01 (1.00-1.01)	0.001 (0.001-0.002)
19-64 years old	59.5*** (58.6-60.5)	62.5 (62.1-63.0)	0.98 (0.98-0.99)	0.99 (0.99-0.99)	-0.004 (-0.005--0.002)
65-74 years old	9.0* (8.6-9.4)	9.5 (9.3-9.7)	0.98 (0.97-1.00)	0.99 (0.98-1.0)	-0.003 (-0.005-0.000)
75 years and older	10.9 (10.0-11.8)	10.0 (9.6-10.3)	1.00 (1.00-1.01)	1.01 (1.00-1.01)	0.001 (0.000-0.002)
Vulnerable Patient Panel					
Material Deprivation Score[3]	3.06* (3.01-3.11)	2.99 (2.96-3.01)	1.11 (1.02-1.22)	1.10 (1.01-1.18)	0.014 (0.005-0.023)
Morbidity (Resource Utilization Band)[4]	3.09*** (3.08-3.10)	3.13 (3.13-3.14)	0.46 (0.34-0.63)	0.75 (0.73-0.78)	-0.177 (-0.210--0.145)

[1] Odds ratio, risk ratios and risk differences are based on an increase in 5 years
[2] Odds ratio, risk ratios and risk differences are based on an increase in 50 patients
[3] A higher score indicates more disadvantaged (1=least disadvantaged, 5=most disadvantaged)
[4] A higher score indicates higher morbidity (0=no use of health care services, 5=very high morbidity)
Note: *p<0.05, **p<0.01, ***p<0.001

Table 2: Multivariate models demonstrating which characteristics are predictive of joining a FMG (Risk Ratios and 95% Confidence Intervals)

Characteristics	Model 1	Model 2	Model 3	Model 4	Model 5
Demographics					
Percent Male	1.02 (0.88-1.16)			0.97 (0.82-1.13)	1.01 (0.95-1.06)
Attended a Quebec Medical School	1.23 (0.84-1.61)			1.27 (0.83-1.71)	1.08 (0.92-1.23)
Years Since Graduation[1]	0.91 (0.88-0.95)			0.93 (0.89-0.98)	0.98 (0.95-1.00)
Geographic location					
University Region	Reference			Reference	Reference
Peripheral Region	1.23 (1.05-1.40)			1.28 (1.07-1.48)	1.07 (0.98-1.16)
Intermediate Region	1.34 (1.11-1.57)			1.34 (1.09-1.59)	1.08 (0.97-1.18)
Remote Region	1.10 (0.80-1.41)			1.01 (0.69-1.23)	0.99 (0.86-1.11)
***Practice Patterns** (number of patients seen in each setting)*[2]					
Emergency Room		1.03 (0.99-1.07)		1.02 (0.98-1.07)	1.1 (0.99-1.02)
External		1.03 (0.99-1.07)		1.03 (0.99-1.08)	1.01 (0.99-1.03)
CHSCD		1.10 (1.06-1.14)		1.08 (1.04-1.13)	1.02 (1.00-1.05)
CHSLD		1.06 (0.94-1.17)		1.09 (0.97-1.22)	1.02 (0.97-1.06)
CLSC		1.05 (1.01-1.09)		1.04 (1.00-1.08)	1.01 (0.99-1.03)
Private Practice		1.03 (0.99-1.07)		1.02 (0.98-1.07)	1.01 (0.99-1.02)
Total Patient Panel					
Total Number of Patients		0.97 (0.93-1.01)	1.06 (1.00-1.12)	0.97 (0.93-1.02)	1.01 (0.97-1.06)
Patients Age (n)					
0-18 years old			0.95 (0.90 -1.01)		0.99 (0.95-1.03)
19-64 years old			0.93 (0.87-0.99)		0.97 (0.93-1.02)
65-74 years old			0.89 (0.81-0.98)		0.95 (0.89-1.01)

75 years and older	0.98 (0.94-1.03)	1.00 (0.96-1.04)
Vulnerable Patient Panel		
Material Deprivation Score	1.05 (1.00-1.11)	1.01 (0.98-1.05)
Morbidity (Resource Utilization Band)	0.70 (0.65-0.74)	0.73 (0.64-0.81)

[1] Odds ratio, risk ratios and risk differences are based on an increase in 5 years
[2] Odds ratio, risk ratios and risk differences are based on an increase in 50 patients

Table 3: Characteristics of study physicians in the two years prior to joining a FMG practice, before and after propensity score matching

	BEFORE				**AFTER**					
Characteristics	**Full Sample**		**Non-Missing Sample**		**Nearest Neighbour Matching[1]**		**Nearest Neighbour Matching[2]**		**Weighting[3]**	
	FMG	Non-FMG	FMG	Non-FMG	FMG	Non-FMG	FMG	Non-FMG	FMG	Non-FMG
Number of Physicians	906	3968	797	3334	797	592	797	797	795	3334
Demographics										
Percent Male	52.4*	56.0	54.0*	58.8	54.2	55.7	54.2	54.6	57.6	58.0
Years Since Graduation	18.7***	20.9	19.0***	20.9	19.0	19.1	19.0	19.0	20.4	20.5
Geographic location (%)										
University Region	30.1***	38.1	27.7***	36.9	27.7	26.5	27.7	27.5	32.4	34.8
Peripheral Region	43.1*	39.1	44.8*	39.9	44.8	47.9	44.8	44.4	41.1	40.9
Intermediate Region	20.7*	17.4	22.1**	17.8	22.1	20.3	22.1	22.3	21.1	18.7
Remote Region	6.1	5.4	5.4	5.4	5.4	5.3	5.4	5.8	5.4	5.6
***Practice Patterns** (number of patients seen in each setting)*										
Emergency Room	284.1*	231.1	273.3	234.7	273.3	276.2	273.3	279.6	232.1	239.7
CHSCD	113.2***	72.8	114.1***	74.7	114.1	121.2	114.1	112.3	79.1	81.8
CLSC	71.3**	41.5	71.1**	40.6	71.1	79.8	71.1	75.8	43.1	45.3
Private Practice	1412.1**	1564.9	1418.7**	1555.8	1418.7	1483.2	1418.7	1401.4	1481.8	1525.9

Vulnerable Patient Panel										
Material Deprivation Score	3.06*	2.99	3.06*	2.98	3.06	3.07	3.06	3.07	3.1	3.0
RUB score	3.09***	3.13	3.10***	3.14	3.10	3.08	3.10	3.10	3.11	3.13

*p<0.05, **p<0.01, ***p<0.001
[1]with replacement (re-using controls)
[2] without replacement (not re-using controls)
[3] weights were truncated for extreme weight values (weights>800)

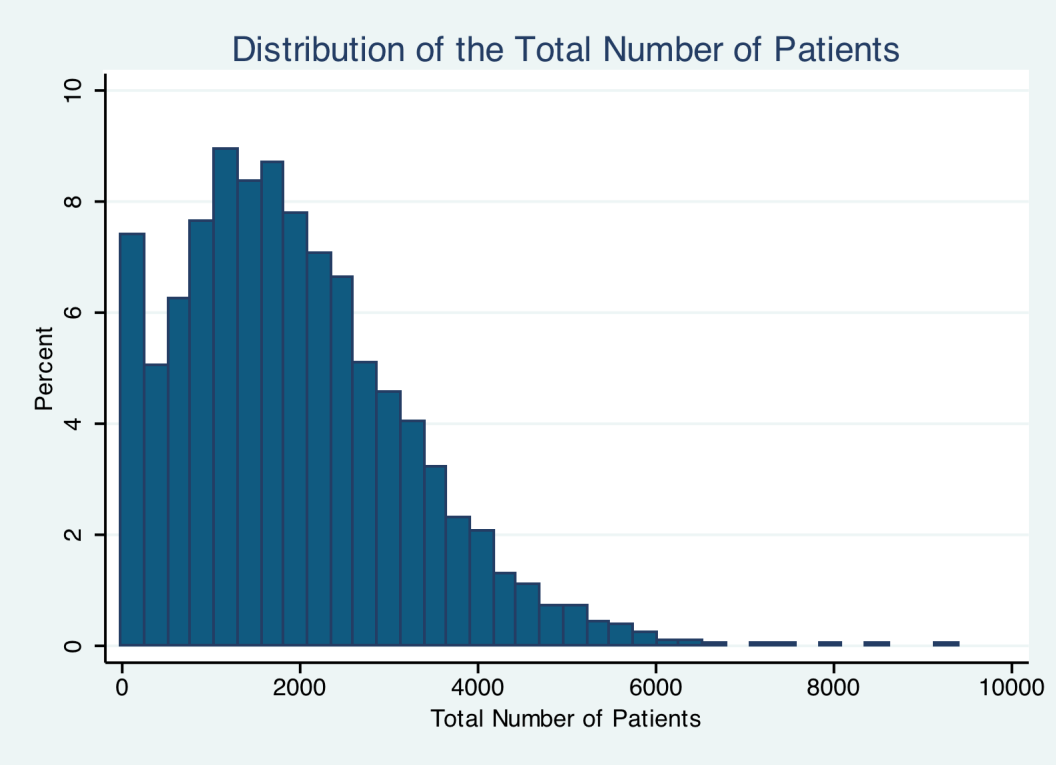

Figure 2: Distribution of the total number of patients

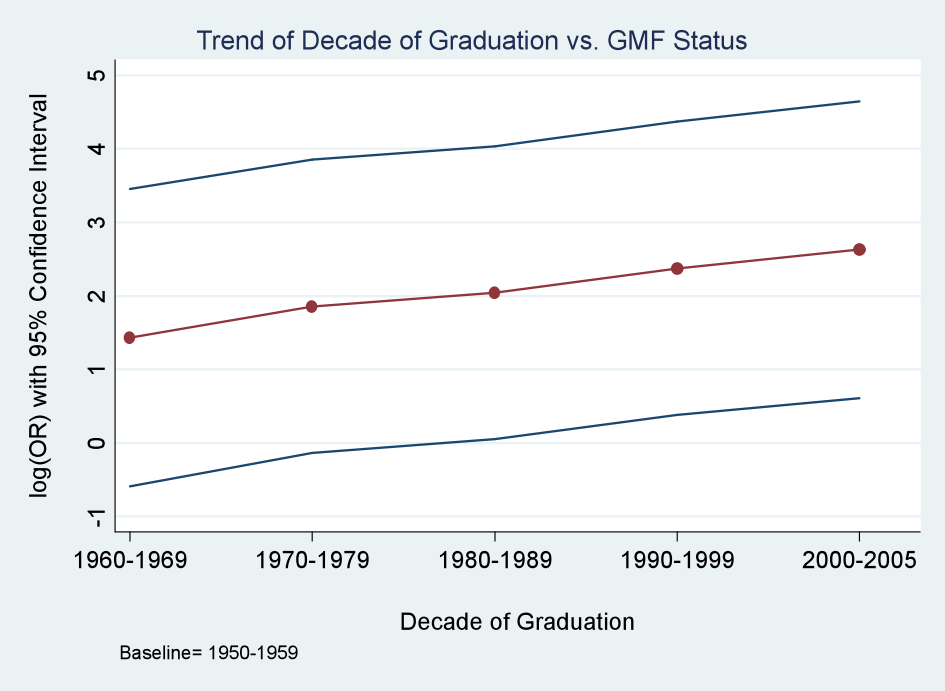

Figure 3: The log(OR) and confidence intervals for joining a FMG as a function of decade of graduation.

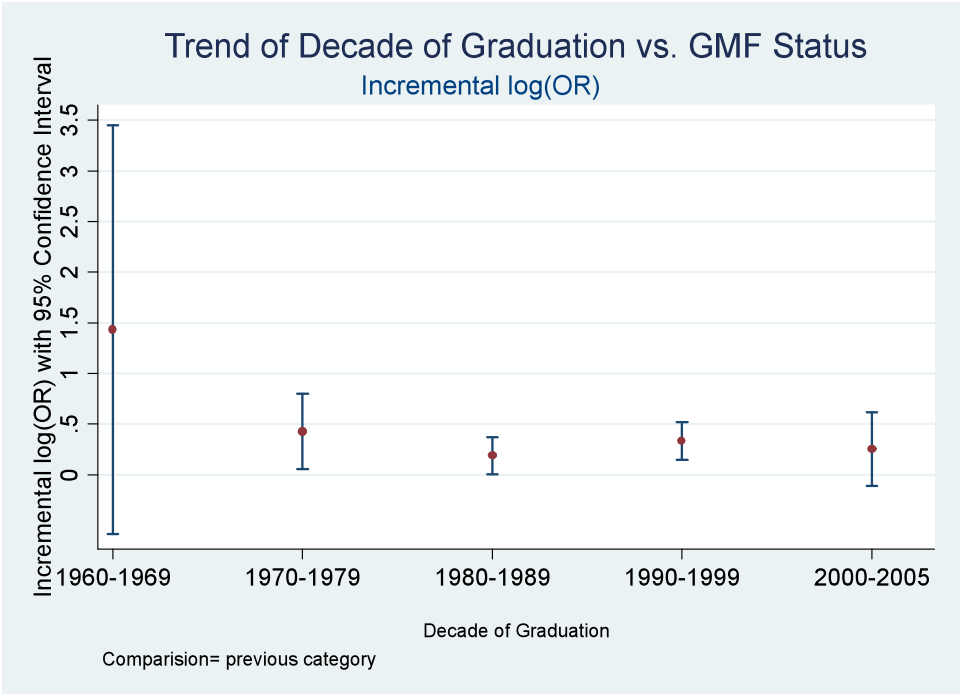

Figure 4: The incremental log(OR) and confidence intervals for joining a GMF as a function of decade of graduation.

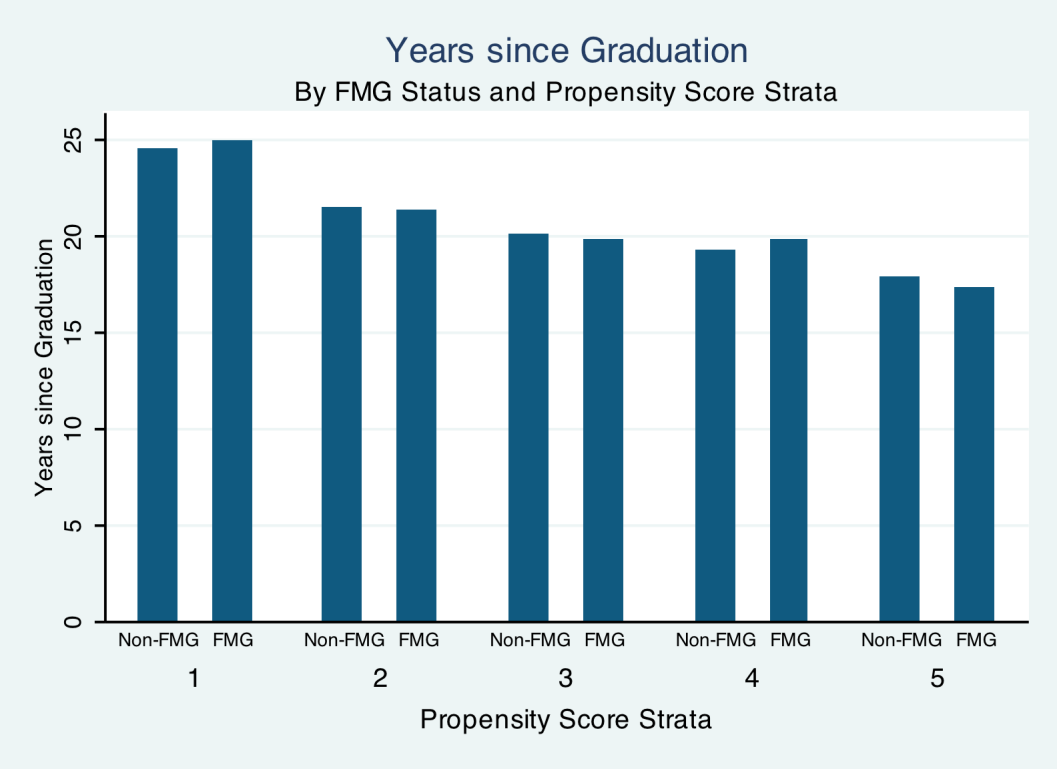

Figure 5: Years since graduation across propensity score strata

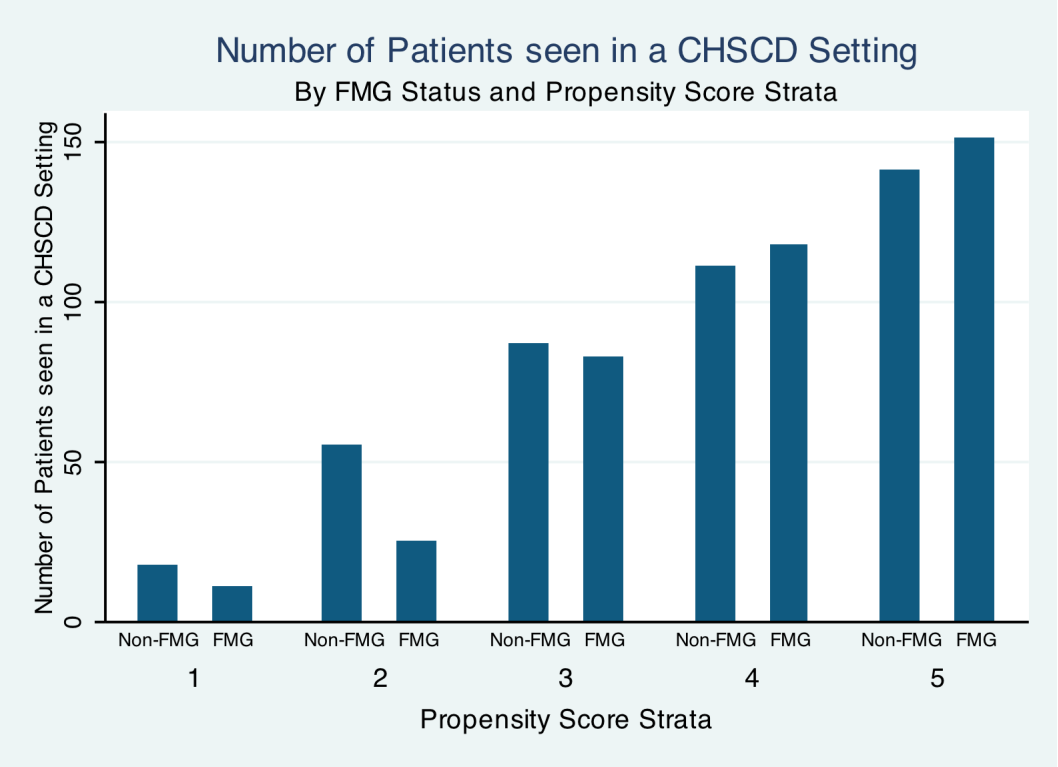

Figure 6: Number of CHSCD Patients across propensity score strata

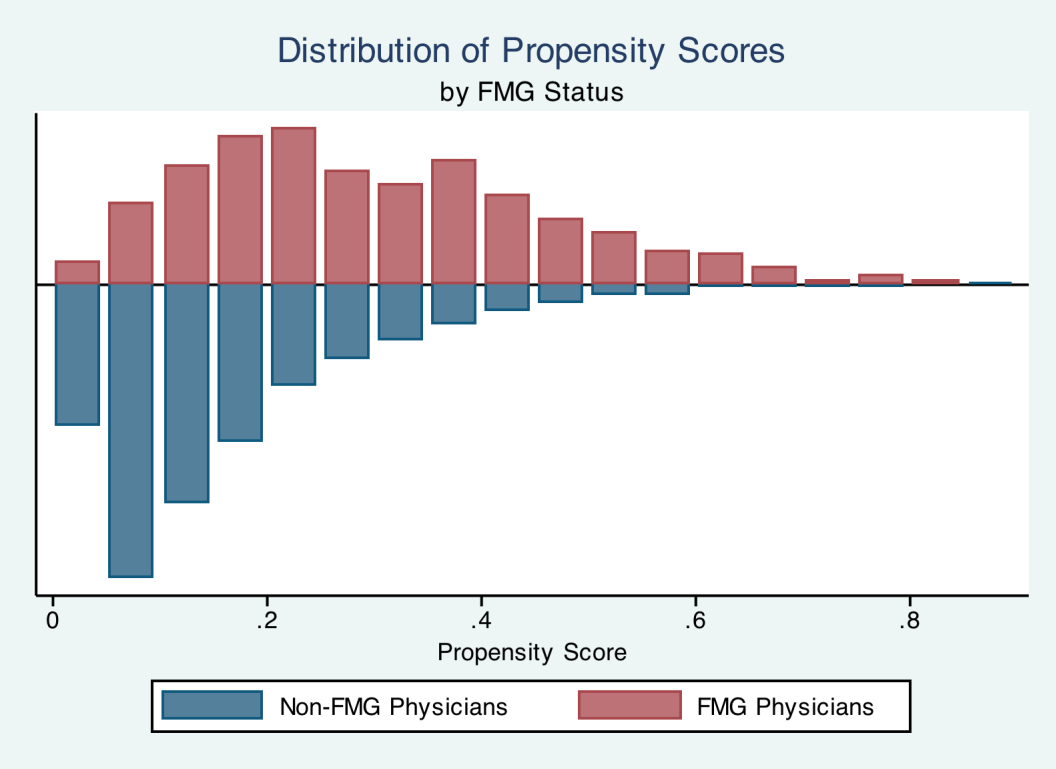

Figure 7: Distribution of Propensity Scores by FMG Status

CHAPTER 4: Profile of Patients Attracted to Family Medicine Groups

4.1. Introduction

The last chapter demonstrated that selection existed at the physician level. This chapter describes the types of patients that eventually joined a Family Medicine Group (FMG) in terms of their demographic characteristics, their chronic illnesses, their overall morbidity, and their tertiary and ambulatory health service utilization. This information was then used to create propensity scores, which were evaluated using different matching and weighting techniques.

4.2. Results

4.2.1. Descriptive Analysis

4.2.1.1. Distribution of key variables

Descriptive statistics were generated for each independent variable and the distribution was examined for normality (results not shown). Overall 84.6% (n=677,466) of the patients are non-FMG patients and 15.4% (n=123,187) belong to the FMG group. I found that the health service utilization variables were extremely right skewed, especially the number of visits to the emergency room (ER) and the number of hospitalizations. The distribution for the total number of ER visits and for the number of hospitalizations is highlighted (Figure 8 and 9 respectively).

4.2.1.2. Distribution of key variables by FMG status

I began evaluating whether patients differentially selected into a FMG practice by examining the distribution of key covariates stratified by FMG status and the associated odds ratio (OR), risk ratio (RR) and risk difference (RD) (Table 4). The following characteristics are from the year prior to joining to the new model, and therefore cannot be affected by the exposure, joining a Family Medicine Group.

It was found that basic demographics, including age and sex, were fairly balanced across the FMG and non-FMG groups (Table 4). However, non-FMG patients are slightly more advantaged, as measured by the material component of the deprivation index developed by Pampalon and Raymond (2001) (Table 4). Patients that were in the most deprived category were 1.28 times more likely to join a FMG, than patients in the most advantaged category (RR=1.28, 95% CI [1.26-1.31]). A major difference between the two groups was where the patient lived and received services. I found that there are many fewer FMG patients in the major university urban centers and more in the surrounding areas (Table 4). Patients that live in the intermediate area are twice as likely to join a FMG, in comparison to the urban area (RR=2.02, 95% CI [1.99-2.05]). There is a corresponding absolute difference in the risk of joining a FMG between the intermediate region and the university region of 10.3% (RD=0.103, 95% CI [0.101-0.105]). The remote region also shows a greater proportion of FMG patients than the university region, with a risk ratio of 1.76 (95% CI [1.72-1.81]).

Surprisingly, the presence of diabetes, COPD and congestive heart failure did not predict whether a patient joined a FMG. There were, however, differences noted in the percentage of patients with hypertension (Table 4). Patients with hypertension have a risk ratio of 0.88 (95% CI 0.87-0.89) and a risk difference of -0.019 (-0.021 — -0.018) of joining a FMG. Furthermore, there were differences noted in the percentage of patients in each Resource Utilization Band (RUB) and the overall mean RUB score. It appears that patients that had very high morbidity levels were less likely to join a FMG, in comparison to patients that had no health service use (RR=0.82, OR=0.79, RD=-0.033).

An interesting result that required careful interpretation was that hospital and emergency room use is greater in future FMG patients (Table 4). However, effect sizes were very small,

indicating the possible lack of clinical relevance. FMG patients have more all cause ER visits and slightly more ER visits for ambulatory care sensitive conditions in the year prior to joining. They also have slightly more total hospitalizations and hospitalizations for ambulatory care sensitive conditions. The effect estimates are extremely small though. For example, an increase of one visit to the ER increases the chance that a patient will join a FMG practice by 1% (RR 1.01, 95% CI[1.00-1.01]) and an increase of one hospitalization increases the chance that a patient will join a FMG practice by 2% (RR 1.02, 95%CI[1.01-1.02]). The number of visits for ambulatory sensitive conditions are slightly more interesting, with a risk ratio of 1.07 (95% CI [1.03-1.11]) for the ER and a risk ratio of 1.03 (95% CI [1.01-1.05]) for hospitalizations (Table 4). As demonstrated in Figure 10, the distribution for the number of ER visits is barely shifted to the right for future FMG patients. Figure 11 shows the same type of pattern for the number of hospitalizations, and the future FMG patient distribution is slightly shifted to the right.

Lastly, service use in an ambulatory setting differed between the two exposure groups (Table 4). Future non-FMG patients had a greater number of consultations in an external/private clinic with any physician, as well as more consultations specifically with a generalist and a specialist. In total, non-FMG patients also saw a greater number of physicians in an ambulatory setting in the year prior to becoming registered (Table 4). This pattern also exists for the number of different generalists and specialists. Therefore, non-FMG patients had greater ambulatory service use as measured by the number of consultations and the number of different physicians seen. Future non-FMG patients were also more likely to have a usual provider of care (UPC) before becoming registered (Table 4). Patients that had a usual provider of care are 18% less likely to join a FMG (RR 0.85, 95% CI[0.84-0.86]).

4.2.2. Model Building

It appears that patients that eventually join a FMG are different in several of their characteristics, compared to patients that do not join a FMG practice. However, many of the associations may be spurious and just a result of other factors confounding the relationship to joining a FMG. Different multivariate models were analyzed to see if this was the case.

The first model combined all of the demographic variables and demonstrated that age, geographic region and material deprivation were still predictors of participating in a FMG (Table 5). Sex was no longer a predictor as the confidence interval crosses the null (RR=0.99, 95%CI [0.97-1.00]). The effect estimates for geography were similar to the results seen in the descriptive section, with the intermediate region having a risk ratio of 1.98 (95% CI [1.95-2.01]) compared to the university region, and the remote region having a risk ratio of 1.76 (95% CI [1.72-1.81]) compared to the university region. The effect estimates for material deprivation were somewhat attenuated in relation to the results seen in the descriptive section, as the most deprived group had a risk ratio of 1.07 (95% CI [1.05-1.10]), compared to the most advantaged group.

The second model combined all of the information on the health status of the patients and demonstrated that hypertension and the overall morbidity level (RUB) were still predictors of not participating in a FMG (Table 5). The effect estimate for the mean RUB level was similar to the result seen in the descriptive section, with a risk ratio of 0.97 (95% CI [0.97-0.98]) for a one unit increase in the RUB score. Also similar to the descriptive section, patients that had hypertension had a risk ratio of 0.89 (95% CI [0.88-0.90]) for joining a FMG. Interestingly, the other chronic illnesses that showed no effect in the descriptive section were predictive of joining a FMG after controlling for other health status measures. Diabetes (RR=1.02, 95%CI [1.01-1.04]), COPD (RR=1.03, 95%CI [1.01-1.05]) and congestive heart failure (RR=1.05, 95%CI [1.02-1.07]) all positively predict participating in a FMG, as demonstrated by the risk ratios greater than one.

The third model combined all of the health service utilization variables and demonstrated that ER visits (RR=1.01, 95%CI [1.01-1.02]), ER visits for ambulatory sensitive conditions (RR=1.07, 95%CI [1.03-1.10]), hospitalizations (RR=1.06, 95%CI [1.05-1.07]), number of consultations in an ambulatory setting (RR=0.98, 95%CI [0.98-0.99]) and having a usual provider of care (RR=0.84, 95%CI [0.83-0.85]) were still predictors of participating in a FMG (Table 5). The effect estimates for all of the previously mentioned variables were similar to the result seen in the descriptive section. However, unlike the univariate results, hospitalizations for ambulatory sensitive conditions (RR=0.99, 95%CI [0.97-1.01]) and the number of different doctors seen in an ambulatory setting (RR=1.00, 95%CI [1.00-1.00]) were no longer significant.

The previous models were then combined to get an overall picture. The fourth model, which combined the demographic information and the health status variables, showed similar conclusions and effect sizes to model 1 and model 2 (Table 5). Like model 1, residing in the remote region over the university region (RR=1.74, 95%CI [1.69-1.78]) and being in the most deprived category over the most advantaged category (RR=1.08, 95%CI [1.06-1.10]) increased the chances that a patient would join a FMG practice. However, now being male slightly, but significantly, decreased the likelihood of joining a FMG practice (RR=0.98, 95%CI [0.97-0.99]). Like model 2, having diabetes (RR=1.01, 95%CI [1.00-1.03]) and having congestive heart failure (RR=1.05, 95%CI [1.02-1.08]) increased the chances that a patient would join a FMG practice. Furthermore, having hypertension (RR=0.89, 95%CI [0.88-0.90]) and being in the higher morbidity or RUB category (RR=0.98, 95%CI [0.98-0.99]) decreased the likelihood that a patient would join a FMG. The only difference observed was that COPD was no longer significantly predictive (RR=1.00, 95%CI [0.98-1.02]).

The fifth model then combined all of the variables and also showed similar results to all of the other models (Table 5). Notable factors that increased the chances of a patient joining a FMG included being in a remote region over the university region (RR=1.65, 95%CI [1.60-1.69]), being in the highest deprivation group over the most advantaged group (RR=1.07, 95%CI [1.04-1.09]), having diabetes (RR=1.07, 95%CI [1.05-1.08]), having visits to ER for ambulatory sensitive conditions (RR=1.05, 95%CI [1.00-1.09]) and being hospitalized (RR=1.02, 95%CI [1.00-1.03]). Notable factors that decreased the chances of a patient joining a FMG included having hypertension (RR=0.95, 95%CI [0.94-0.97]) and having a usual provider of care (RR=0.82, 95%CI [0.81-0.84]). Interestingly, the effect size for hypertension was diminished in this final model. Furthermore, the overall morbidity level as measured by the RUB became predictive of joining a FMG (RR=1.04, 95%CI [1.03-1.05]), switching directions from previous models.

4.2.3. Propensity Score Methods

I attempted to address the non-random selection of patients into FMG practices by implementing propensity scores. The conditional probability of joining a FMG, over not joining, was estimated based on the characteristics that were found to be predictive in the previous two sections. Since there is also no penalty in terms of statistical power for including other terms, interaction terms were added between all variables and geography, sex and SES (material deprivation index), as well as squared terms for the number of emergency visits and the number of consultations in an ambulatory setting. Many different model combinations, both with and without interaction terms, were explored for balance and propensity score overlap. The final model used was best able to achieve balance and had the same covariates as model 5 from section 4.2.2, including the demographic, chronic illnesses and health service utilization, but with the

added interaction and squared terms (see Appendix Section 2 for the full model and statistical code).

The goal of a propensity score evaluation is to show balance within the propensity score strata or after weighting or matching. Overall, there appears to be reasonable balance across the different matching and weighting methods. Table 6 shows the summary statistics for some of the key variables before and after propensity score analysis. The before propensity score analysis statistics include the full sample (described in section 4.2.1.2) and the sample with no missing covariates (used to generate the propensity score). The after propensity score analysis statistics include nearest neighbor 1:1 matching with the replacement option (re-using controls), 1:1 matching without the replacement option (not re-using controls) and inverse probability of treatment weights.

The full sample and the non-missing are very similar and indicate the same conclusions; namely that there are imbalances in geographic location, material deprivation, presence of hypertension, overall morbidity or RUB scores, the number of consultations in ambulatory setting, the number of different providers seen in an ambulatory setting and the percent with a usual provider of care. After matching, with and without replacement, and weighting the mean values between FMG patients and non-FMG patients were very similar. There was no statistical difference noted for most of the geographic regions, the percentage of male patients and the percentage in each material deprivation group. Given the extremely large sample sizes, some statistically significant differences remained after matching, including the percent with hypertension, the overall morbidity or RUB scores, the number of consultations in ambulatory setting, the number of different providers seen in an ambulatory setting and the percent with a usual provider of care. However, the differences noted are unlikely to be substantively or

clinically relevant. No statistically significant differences were noted after weighting. Both matching techniques significantly reduced the sample size of the sample and the final covariates had means that were very close to the original treated FMG sample (Table 6). This was particularly noticeable in covariates that differed significantly and substantially before propensity score analysis, such as the percentage in the university region, the mean overall RUB score, the number of ambulatory consultations and the percentage with a usual provider of care. Conversely, inverse probability of treatment weighting did not reduce the sample size and the weighted means were very close to the original non-FMG sample. This is an excellent illustration of how the different propensity score methods use different samples and how they affect the generalizability of the results. Overall, I conclude that the propensity scores were able to achieve the desired goal and balance the pre-treatment differences between FMG patients and non-FMG patients, and this finding is robust across different mechanisms of adjusting for the propensity score.

Furthermore, I examined how the covariates vary within and across propensity score strata. Although all variables were explored in this manner, geography and UPC are highlighted. Figure 12 shows how there is balance within the propensity score strata, which is the goal of propensity score evaluation. But there is a decreasing trend across the propensity score (or predicted probability of becoming a FMG) to have a greater proportion of patients from the university region. This is consistent with the evidence from the previous sections in that patients in the university region were less likely to join a FMG, and thus would have a lower propensity score. Similarly, Figure 13 shows that there is balance within the propensity score strata, but with a decreasing trend in the proportion with a usual provider of care across the strata. This is also consistent with the evidence from the univariate and model building section.

The distribution of the propensity scores for the FMG patients and non-FMG patients shows that there is moderate to excellent overlap between the groups (Figure 14). It appears that there is no structural confounding, such that the propensity score distributions are not completely deterministic. It also appears that the overlap is sufficient for matching to occur and is even better than the physician distribution seen in the last chapter in terms of comparing similar individuals.

4.3. Discussion

4.3.1. Key Findings

The primary objective of this chapter was to understand the type of patient that joined a FMG, in an attempt to contextualize the early impacts of the FMG program from the patient and population health perspectives. Means and univariate logistic regression showed that being male, residing outside of the university urban region, having a higher material deprivation score, visiting the ER for any cause, visiting the ER for ambulatory sensitive conditions, being hospitalized for any cause and being hospitalized for ambulatory sensitive conditions increased the chances that a patient would join a FMG. Conversely, it was shown that residing in the university urban geographic location, being female, being material disadvantaged, having hypertension, having a higher morbidity RUB score, visiting an ambulatory clinic, seeing many different physicians in the ambulatory setting and having a usual provider of care decreased the chances of enrolling in a FMG. After controlling for demographic, health and service use characteristics, the multivariate model showed that geography, sex, material deprivation, the presence of hypertension, the presence of diabetes, overall morbidity levels, visits to the ER, visits to the ER for ambulatory sensitive conditions, hospitalization, the number of consultations in an ambulatory setting and having a usual provider of care still affects the likelihood of a patient enrolling in a FMG practice or not. Furthermore, the effect estimates maintained their

magnitude and direction in the multivariate model, with the exception of the morbidity RUB score, which reversed to being predictive of joining a FMG in the multivariate model.

Like the previous chapter on physicians, there is evidence that patients join this new model of primary care in a non-random way. Even after controlling for patient demographic, health and service use variables, residing outside of the urban university region was a predictor of joining a FMG. The lack of participation in the urban university region could be indicative of two processes. Either patients outside of the university urban area have a greater preference for group practice or patients outside of the university urban areas follow their physician into the FMG. Given our sample of early adopters to the FMG model and that it appears that FMG practices took off faster in the intermediate, peripheral and remote regions (Appendix Section 1- Table 2), it is possible that patients in the non-university region had more choice in whether they wanted to enroll or not. Ontario-based studies on new models of primary health care reform have shown mixed results in terms of whether there are geographic differences between models (Glazier et al., 2009; Kantarevic et al., 2011) or not (Tu et al., 2009; Hogg et al., 2009). There is evidence that rural areas are significantly different in terms of overall health and health service use. For example, it was shown that individuals in rural areas were more likely to have chronic conditions, less after hours care, better continuity of care, a higher proportion of after hours visits that were to the enrolling physician, higher rates of emergency department use and a higher proportion of visits that were less urgent than patients in urban areas (Glazier et al., 2009). Patients in rural areas in Canada face greater geographic barriers to care, higher rates of disease and fewer available health services, than urban areas (Tepper et al., 2005). Lastly, it has been shown that in rural areas primary care is heavily tied to tertiary service provision, as physicians tend to provide more hospital- and emergency-based services (Chan, 2002; Hutten-Czapski et al., 2004). It is also

possible that physicians in rural areas provide primary care services in hospital and emergency department settings, and therefore it appears that hospital and emergency visits are higher. Therefore, it is not surprising that geography played a significant role in predicting whether a patient joined a FMG practice, as the overall medical structure, type of care and health issues are drastically different in different geographic regions.

Another interesting demographic characteristic that was predictive of whether a patient would join a FMG was the material deprivation score. It should be noted that this is a socio-economic status measure based on where the patient lives, and is therefore an ecologic measure, not an individual one. Since this is a neighborhood level measure, and geography was captured on a larger scale, this could represent residual geographic differences. This could also be due to the fact that CLSCs are particularly receptive to the needs of deprived groups, they offer programs targeting deprived groups and reducing inequalities is part of their mission (Philibert et al., 2007). This combined with the fact that physicians in a CLSC are more likely to join a FMG, could indicate why patients that are more deprived are more likely to join a FMG. In Ontario, the capitation-based practice had patients with slightly lower neighborhood income, although the difference was minimal (Glazier et al., 2009). In a survey based study, it was found that Community Health Centres (which are very similar to the Quebec CLSCs) had patients with significantly lower household income, a higher proportion on non-white patients, slightly more immigrant patients and patients with lower rates of education above high-school than fee-for-service practices (Hogg et al., 2009). In general, the effect of socioeconomic status on access to health care services in Canada is mixed (Hutchison, 2007). There is some evidence to suggest that higher SES is associated with greater visits to specialists and bypassing primary care to

specialists, but with little differences noted in obtaining access to primary care (McIssac et al., 1997; Glazier et al., 2009b).

Although differences in the health status of patients that eventually join a FMG compared to patients that do not join were noted, it was hard to conclude whether one group was particularly sicker. When just examining raw differences, greater rates of hypertension and greater overall morbidity decreased the likelihood of joining. After adjustment for other patient characteristics, the presence of diabetes and a higher morbidity was predicative of joining a FMG, while the presence of hypertension was protective. The fact that the estimates change degree, and sometimes direction, suggests that there is not a strong effect of chronic health on predicting FMG enrollment. Given the large sample sizes and multiple testing, the fact that some variables are statistically "significant" only seems to suggest a lack of a clear story in terms or morbidity and health on patient enrollment. In Ontario it was shown that patients in the capitation group practice were less likely to have chronic conditions, including hypertension, and less morbidity and co-morbidity compared with patients in the more traditional enhanced fee-for-service (Glazier et al., 2009).

As an integrated care model, FMGs could be expected to reduce tertiary level of care, including emergency room visits and hospitalizations (Clair, 2001; Kirby, 2002; Romanow, 2002). It is theorized that this effect would be most greatly seen in the rates of emergency room and hospitalizations for ambulatory sensitive conditions. However, pre-exposure differences need to be considered. It was found that hospital and emergency room use is greater in future FMG patients, however, the effect estimates were very small and may not be clinically informative. In Ontario, capitation practices had more visits to emergency departments and a higher proportion of visits that were semi-urgent and non-urgent than traditional enhanced fee-for-service based

practice (Glazier et al., 2009). This finding was consistent even after adjusting for patient characteristics and across geographic locations.

Lastly, an interesting result from this analysis was that patients who had a usual provider of care (UPC) were less likely to eventually join a FMG practice. The UPC index is a measure of concentration of care and it has been shown to reflect continuity of care (Haggerty et al., 2003; Tousignant et al., 2011). High continuity of care, as defined administratively, has been found to be associated with lower morbidity, and predictive of ER visits and hospitalizations in high morbidity patients and protective of ER visits and hospitalizations in low morbidity patients (Tousignant et al., 2011). An Ontario based study found that continuity of care, as defined by the usual provider of care index, was fairly similar across different models of care, although possibly slightly higher in the traditional fee-for-service practice (Glazier et al., 2009). In a survey-based study from Ontario, it was found that patients in Community Health Centre's saw their own provider less regularly than fee-for-service practices (Hogg et al., 2009).

4.3.2. Implications: Policy and Research

Given the previous findings, there are three major areas to consider for policy and research recommendations: geographic differences, socio-economic status or material deprivation differences and differences in terms of the percentage of patients with a usual provider of care (UPC).

As there is a lack of early participation in the urban university region, more attention needs to be given to understanding why there is a lack of participation and developing a specific urban strategy. The decreased participation could be due to a supply issue, such that there are not enough FMG practices per capita. If physicians in the university urban centers are not interested in joining a FMG, then patients have very limited opportunities to become involved in one. A

follow-up study to assess whether there was greater participation in the urban areas in the later years of FMG development is needed to see whether these areas eventually caught up to the enrollment levels of the more rural areas or whether they remained behind. The lack of participation could also be due to a marketing issue, such that the FMGs are not appealing enough or there is competition in terms of other types of clinics (i.e. private practice, walk-ins, CLSCs). Major urban centers have complex issues, such as transportation and cultural concerns, that also need to be considered. Specifically performing an in depth analysis of FMGs in the urban area may be needed, including understanding incentives for participation and why patients are not joining as frequently as in the other areas.

There also appears to be a lack of participation by patients that are more advantaged, or at least live in more advantaged areas. Understanding this difference from a sociological perspective may help to shed some light on this finding. This could be the result of more advantaged patients being more informed about health care issues, including new primary care reforms. Alternatively, more disadvantaged populations are seen in other types of integrative care delivery, such as CLSCs. As shown in chapter 3, physicians that work in a CLSC are more likely to join a FMG, and therefore the physician may encourage the patient to join a FMG while they are treating them in a CLSC. Teasing out these differences is an important next step. Furthermore, it should be noted that the applicability of the findings to the effect of the FMG on health outcomes may be limited to the more disadvantaged population, and thus inferences and conclusions must be careful in terms of who is in the matched or weighted propensity score sample.

Another interesting finding that was elucidated from this chapter was that patients who have a usual provider of care are less likely to eventually join a FMG. This result may be due to the fact that a patient who has a usual provider of care forms a bond with their physician,

especially since this is a vulnerable population and high users of health services, and may not want to join a multidisciplinary team where they could see any other practicing physicians or nurses. Furthermore, if the patient's usual provider of care does not join a FMG, then it is highly unlikely that the patient will separate from their usual physician to join the FMG model with all new physicians. If this is the case, and the Quebec government wanted to increase the number of participating patients, then highlighting the benefits to joining may be needed, both for patients and physicians of already attached patients. A marketing strategy to show the other appealing features of the FMG practice could be implemented, both to the patients and the physicians of these attached patients.

A major implication of this work is that participating in a FMG is not a random process and any further research on the effect of FMGs, or any other type of primary health care reform, should consider this. Accounting for the type of patients that join different models, such as the propensity score analysis set up in this chapter, will be critical to forming evidence based policy recommendations. Future studies should be cognizant of geography, SES, overall morbidity and health service use when adjusting for confounding variables.

4.3.3. Limitations

Certain variables used in this analysis may be limited in terms of the way they were defined or collected. As was previously mentioned, the socio-economic construct, material deprivation, was defined on an ecologic level and is compromised of census level variables. We were not able to obtain individual level data on a patient's education, employment status or income. Therefore, there is likely measurement bias in terms of obtaining an individual's SES, however it is most likely non-differential measurement bias. Since the variable is defined

administratively it is hard imagine a scenario where the ecological SES construct would capture the individual's SES differential between the future FMG patients and the non-FMG patients.

Furthermore, all of the health status variables were defined administratively and thus there is the possibility for measurement bias since we cannot directly ask the patient or physician whether they have a certain illnesses. However, the illnesses captured in this analysis have been previously verified (Blanchard et al., 1996; Lix et al., 2006) and it is unlikely that the measurement bias differential affects the future FMG patients and the non-FMG patients.

The usual provider of care (UPC) was also defined administratively and the limitations of this have been discussed elsewhere (Tousignant et al., 2011). Briefly, the UPC indicator is sensitive to the number of visits, is not readily applicable to patients that have less than three visits, it does not capture longitudinal care, it cannot differentiate between whether visits are concentrated in time or not and it cannot capture continuity of care offered by groups.

Lastly, the methods used do not control for unobserved variables. Therefore, there may still be confounding or selection bias present. For example, the health seeking behavior of a patient may largely determine their health, service use and whether or not they join a newer group practice. This cannot be observed using administrative information and therefore cannot be addressed using propensity score adjustment. Other research methods would have to be utilized to tackle this question.

4.3.4. Future Work

Since it appears that treatment assignment is not random, the propensity scores can be used to address the effect of the new primary care reform model on population health, service utilization and costs. Nearest neighbor matching with replacement and nearest neighbor matching without replacement achieved good balance. Both matching techniques drastically reduced the

sample size and this has implications for the generalizability of the results. When making conclusions about the effect of the FMG practice on health outcomes, one can only make concluding statements about the group of patients actually retained in the matching processes. The findings would only be applicable to the sub-set of patients that were similar enough in their characteristics to be matched, and any of the patients not on the common support or not used in the matching processes would not be accounted for. As an alternative, inverse probability of treatment weighting can be used where all patients would be used in the sample.

Similarly to the physician results, it was demonstrated that selection exists. However, it is also not clear why patients differentially end up in a FMG practice or not. A qualitative study from the patient's view would help to elucidate this question. From this data it is hard to distinguish between whether a patient chooses to join a FMG practice for their own personal reasons or whether they are passively enrolled in a practice based on their physician's choice. It is also not clear whether the patients understand what a FMG practice is, why they should or should not join it and what the potential benefits are. Understanding the patient's thoughts, beliefs and perceptions of primary care and primary care models could help to explain and better understand the selection process.

In addition to the health indicator and health service use characteristics, it may also be worthwhile to gather other physical and mental health information from the patients. Many mental health states and some physical characteristics, such as mobility in older adults, cannot be collected administratively and would have to be studied through surveys. Furthermore, patients that join a FMG practice may also have different social characteristics, such as time spent with friends or clubs, which may be impacting future health and service utilization. As mentioned in the limitations section, the health seeking behavior of a patient may affect their desire to join a

FMG and their future health outcomes. Questions pertaining to this construct could be investigated in a questionnaire format. This work could add an additional piece to understanding which type of patients join a group practice and what the effect of a new primary care model is.

Given that primary health care reform is being developed in other Canadian provinces and territories, as well as other countries, it will become increasingly important to evaluate the effectiveness of the different models in the different contexts. However, without being cognitive of non-random treatment assignment, selection bias and confounding in these observational studies, it could lead to erroneous conclusions and basing policy decisions on tenuous evidence. It will be important to evaluate whether similar selection occurs in other primary care reform models in other provinces/territories or countries, and what the effect is on overall conclusions.

Table 4: Characteristics of patients in the year prior to enrolling in a FMG practice

Characteristics	Mean (95% CI) FMG	Mean (95% CI) Non-FMG	Odds Ratio (95% CI)	Risk Ratio (95% CI)	Risk Difference (95% CI)
Demographics					
Male (%)	44.3 (44.0-44.6)	43.9* (43.8-44.0)	1.02 (1.00-1.03)	1.01 (1.00-1.02)	0.002 (0.000-0.004)
Age Group (years)					
0-19	8.2 (7.6-8.7)	7.4 (7.2-7.6)	Reference	Reference	Reference
20-59	21.8 (21.6-22.0)	20.6 (20.5-20.7)	0.96 (0.90-1.03)	0.97 (0.91-1.02)	-0.005 (-0.015-0.004)
60-74	44.0 (43.7-44.2)	44.2** (44.0-44.3)	0.90 (0.84-0.97)	0.92 (0.87-0.97)	-0.014 (-0.023- -0.004)
≥75	33.4 (33.1-33.7)	34.5*** (34.4-34.7)	0.88 (0.82-0.94)	0.90 (0.84-0.95)	-0.017 (-0.027- -0.008)
Geographic location (%)					
University Region	24.4 (24.1-24.6)	39.5*** (39.3-39.6)	Reference	Reference	Reference
Peripheral Region	44.0 (43.7-44.2)	37.4*** (37.3-37.5)	1.90 (1.87-1.93)	1.74 (1.72-1.77)	0.075 (0.073-0.077)
Intermediate Region	26.6 (26.3-26.8)	18.9*** (18.8-19.0)	2.28 (2.24-2.32)	2.02 (1.99-2.05)	0.103 (0.101-0.105)
Remote Region	5.1 (5.0-5.2)	4.3*** (4.2-4.3)	1.93 (1.87-1.98)	1.76 (1.72-1.81)	0.077 (0.073-0.081)
Material Deprivation Index					
most advantaged 1	13.1 (13.0-13.3)	17.9 (17.7-18.1)	Reference	Reference	Reference
2	17.9 (17.7-18.1)	18.2 (18.1-18.3)	1.31 (1.29-1.34)	1.27 (1.24-1.29)	0.032 (0.029-0.034)
3	23.2 (23.0-23.5)	20.5 (20.4-20.6)	1.51 (1.48-1.54)	1.42 (1.40-1.45)	0.051 (0.048-0.053)
4	23.9 (23.6-24.1)	21.9 (21.8-22.0)	1.45 (1.42-1.48)	1.38 (1.35-1.40)	0.045 (0.043-0.048)
most disadvantaged 5	21.8 (21.7-21.9)	21.8 (21.6-22.1)	1.33 (1.30-1.36)	1.28 (1.26-1.31)	0.034 (0.031-0.036)
Health Status					
Diabetes	17.5 (17.3-17.7)	17.4 (17.3-17.5)	1.01 (0.99-1.02)	1.01 (0.99-1.02)	0.001 (-0.001- 0.003)
Hypertension	34.6 (34.3-34.9)	38.0*** (37.9-38.2)	0.86 (0.85-0.87)	0.88 (0.87-0.89)	-0.019 (-0.021- -0.018)
COPD	7.3 (7.1-7.4)	7.3 (7.3-7.4)	1.00 (0.97-1.02)	1.00 (0.98-1.02)	-0.001 (-0.004- 0.002)
Congestive Heart Failure	5.1 (5.0-5.3)	5.2 (5.1-5.2)	0.99 (0.96-1.02)	0.99 (0.97-1.02)	-0.001 (-0.005- 0.002)
Resource Utilization Band (RUB)					
No use of health care services	0.11 (0.09-0.13)	0.09* (0.08-0.10)	Reference	Reference	Reference
Healthy user of services	2.8 (2.7-2.9)	2.4*** (2.3-2.4)	0.95 (0.78-1.16)	0.96 (0.81-1.11)	-0.007 (-0.036-0.022)
Light morbidity	16.4 (16.2-16.6)	15.6*** (15.5-15.6)	0.85 (0.70-1.03)	0.87 (0.74-1.01)	-0.023 (-0.052-0.005)
Moderate morbidity	57.8	58.2**	0.80	0.83	-0.031

	(57.5-58.1)	(58.1-58.4)	(0.66-0.96)	(0.70-0.96)	(-0.06- -0.003)
High morbidity	13.9 (13.7-14.1)	14.6*** (14.5-14.7)	0.76 (0.63-0.92)	0.80 (0.67-0.92)	-0.037 (-0.066- -0.009)
Very high morbidity	9.0 (8.8-9.2)	9.1 (9.1-9.2)	0.79 (0.65-0.96)	0.82 (0.69-0.95)	-0.033 (-0.061- -0.004)
Mean RUB score[1]	3.09 (3.09-3.10)	3.12*** (3.12-3.13)	0.96 (0.96-0.97)	0.97 (0.96-0.97)	-0.005 (-0.006- -0.004)
Tertiary Health Service Utilization					
Number of Emergency Room visits	0.69 (0.69-0.70)	0.68*** (0.68-0.68)	1.01 (1.00-1.01)	1.01 (1.00-1.01)	0.001 (0.000-0.001)
Number of ER visits for ambulatory care sensitive conditions	0.014 (0.014-0.015)	0.013*** (0.013-0.013)	1.09 (1.04-1.14)	1.07 (1.03-1.11)	0.011 (0.005-0.017)
Number of hospitalizations	0.22 (0.22-0.23)	0.22* (0.21-0.22)	1.02 (1.01-1.03)	1.02 (1.01-1.02)	0.002 (0.001-0.004)
Number of hospitalizations for ambulatory care sensitive conditions	0.043 (0.041-0.044)	0.040** (0.039-0.041)	1.04 (1.02-1.06)	1.03 (1.01-1.05)	0.005 (0.002-0.008)
Ambulatory Health Service Utilization					
Number of consultations (All)	7.6 (7.5-7.6)	8.8*** (8.7-8.8)	0.98 (0.98-0.98)	0.98 (0.98-0.98)	-0.003 (-0.003- -0.003)
Number of consultations (Generalist)	3.7 (3.7-3.7)	4.4*** (4.4-4.5)	0.95 (0.95-0.96)	0.96 (0.96-0.96)	-0.007 (-0.007- -0.007)
Number of consultations (Specialist)	3.9 (3.8-3.9)	4.3*** (4.3-4.3)	0.99 (0.99-0.99)	0.99 (0.99-0.99)	-0.002 (-0.002- -0.002)
Number of different physicians seen	3.5 (3.5-3.6)	3.9*** (3.8-3.9)	0.96 (0.96-0.97)	0.97 (0.97-0.97)	-0.005 (-0.005- -0.005)
Number of different generalists seen	1.4 (1.4-1.4)	1.4 (1.4-1.4)	0.95 (0.95-0.96)	0.96 (0.96-0.97)	-0.006 (-0.007- -0.005)
Number of different specialists seen	2.2 (2.1-2.2)	2.4 (2.4-2.4)	0.96 (0.96-0.96)	0.97 (0.97-0.97)	-0.005 (-0.006- -0.005)
Usual Provider of Care (% that have one)	53.6 (53.3-53.9)	62.2*** (62.1-62.3)	0.82 (0.81-0.84)	0.85 (0.84-0.86)	-0.024 (-0.026- -0.022)

[1] A higher score indicates higher morbidity (0=no use of health care services, 5=very high morbidity)

Table 5: Multivariate models demonstrating which characteristics are predictive of enrolling a FMG (Risk Ratios and 95% Confidence Intervals)

Characteristics	Model 1	Model 2	Model 3	Model 4	Model 5
Demographics					
Male (%)	0.99 (0.97-1.00)			0.98 (0.97-0.99)	0.96 (0.95-0.97)
Average Age Group[1]	0.99 (0.99-0.99)			1.00 (1.00-1.00)	1.00 (1.00-1.00)
Geographic location (%)					
University Region	Reference			Reference	Reference
Peripheral Region	1.74 (1.72-1.76)			1.75 (1.72-1.77)	1.74 (1.72-1.77)
Intermediate Region	1.98 (1.95-2.01)			1.97 (1.94-2.00)	1.96 (1.93-2.00)
Remote Region	1.76 (1.72-1.81)			1.74 (1.69-1.78)	1.65 (1.60-1.69)
Material Deprivation Index					
most advantaged 1	Reference			Reference	Reference
2	1.15 (1.12-1.17)			1.15 (1.13-1.17)	1.15 (1.13-1.18)
3	1.25 (1.22-1.27)			1.25 (1.23-1.28)	1.26 (1.24-1.29)
4	1.19 (1.17-1.21)			1.20 (1.17-1.22)	1.20 (1.17-1.22)
most disadvantaged 5	1.07 (1.05-1.10)			1.08 (1.06-1.10)	1.07 (1.04-1.09)
Health Status					
Diabetes		1.02 (1.01-1.04)		1.01 (1.00-1.03)	1.07 (1.05-1.08)
Hypertension		0.89 (0.88-0.90)		0.89 (0.88-0.90)	0.95 (0.94-0.97)
COPD		1.03 (1.01-1.05)		1.00 (0.98-1.02)	1.01 (0.98-1.03)
Congestive Heart Failure		1.05 (1.02-1.07)		1.05 (1.02-1.08)	1.03 (1.00-1.06)
Resource Utilization Band (RUB)[2]		0.97 (0.97-0.98)		0.98 (0.98-0.99)	1.04 (1.03-1.05)
Tertiary Health Service Utilization					
Number of Emergency Room visits			1.01 (1.01-1.02)		1.00 (1.00-1.01)
Number of ER visits for ambulatory care sensitive conditions			1.07 (1.03-1.10)		1.05 (1.00-1.09)

Number of hospitalizations	1.06 (1.05-1.07)	1.02 (1.00-1.03)
Number of hospitalizations for ambulatory care sensitive conditions	0.99 (0.97-1.01)	0.99 (0.96-1.01)
Ambulatory Health Service Utilization		
Number of consultations (All)	0.98 (0.98-0.99)	0.99 (0.98-0.99)
Number of different physicians seen	1.00 (1.00-1.00)	1.00 (1.00-1.01)
Usual Provider of Care (% with one)	0.84 (0.83-0.85)	0.82 (0.81-0.84)

[1] Risk ratios are based on an increase in 5 years
[2] A higher score indicates higher morbidity (0=no use of health care services, 5=very high morbidity)

Table 6: Characteristics of patients in year prior to joining a FMG practice, before and after propensity score matching and weighting

Characteristics	BEFORE				AFTER					
	Full Sample		Non-Missing Sample		Nearest Neighbour Matching[1]		Nearest Neighbour Matching[2]		Weighting	
	FMG	Non-FMG	FMG	Non-FMG	FMG	Non-FMG	FMG	Non-FMG	FMG	Non-FMG
Number of Patients	123,187	677,466	111,352	619,844	111,352	98,841	111,352	111,352	111,352	619,844
Demographics										
Percent Male	44.3	43.9*	44.2	43.9	44.2	43.9	44.2	43.8	44.0	43.9
Geographic location (%)										
University Region	24.4	39.5***	23.9	39.1***	23.9	23.9	23.9	23.9	36.9	36.8
Peripheral Region	44.0	37.4***	45.1	37.8***	45.1	45.5	45.1	45.4	38.9	38.9
Intermediate Region	26.6	18.9***	25.9	18.8***	25.9	25.9	25.9	25.9	19.9	19.9
Remote Region	5.1	4.3***	5.1	4.3***	5.1	4.7***	5.1	4.8**	4.4	4.4
Material Deprivation Index										
most advantaged 1	13.1	17.9	13.3	17.6***	13.2	13.4	13.2	13.4	17.0	17.0
2	17.9	18.2	18.0	18.3*	18.0	18.0	18.0	18.0	18.2	18.2
3	23.2	20.5	23.3	20.5***	23.3	23.3	23.3	23.4	20.9	21.0
4	23.9	21.9	23.8	21.9***	23.8	23.7	23.8	23.7	22.1	22.2
most disadvantaged5	21.8	21.8	21.6	21.7	21.6	21.6	21.6	21.4	21.8	21.7
Health Status										
Hypertension	34.6	38.0***	36.4	39.7***	36.4	35.7***	36.4	35.8**	39.4	39.2
Resource Utilization Band (RUB)	3.12	3.09***	3.09	3.12***	3.09	3.04***	3.09	3.05***	3.12	3.12*
Ambulatory Health Service Utilization										
Number of consultations (All)	7.6	8.8***	8.0	9.1***	8.0	7.6***	8.0	7.7***	9.1	9.0
Number of different physicians seen	3.5	3.9***	3.8	4.0***	3.8	3.6***	3.8	3.6***	4.0	4.0
Usual Provider of Care (%)	53.6	62.2***	56.2	64.3***	56.2	56.8*	56.2	56.7*	63.0	63.1

*p<0.05, **p<0.01, ***p<0.001 [1]with replacement (re-using controls) 2 without replacement (not using controls)

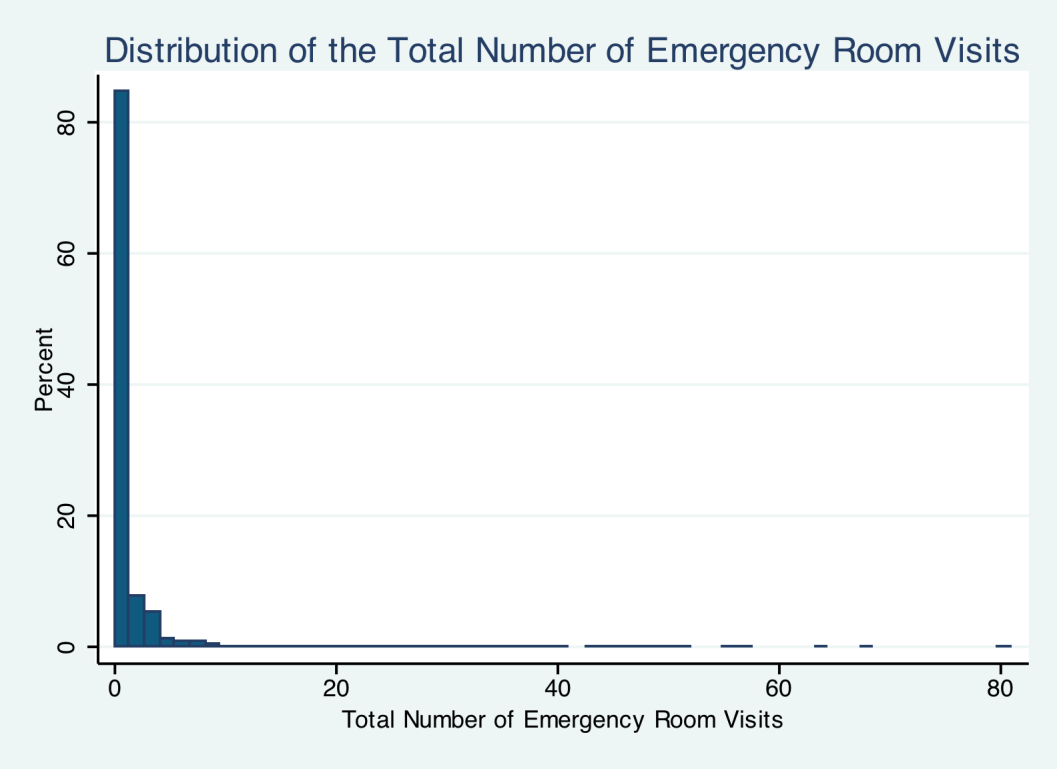

Figure 8: Distribution of the number of ER visits in the year prior to time zero

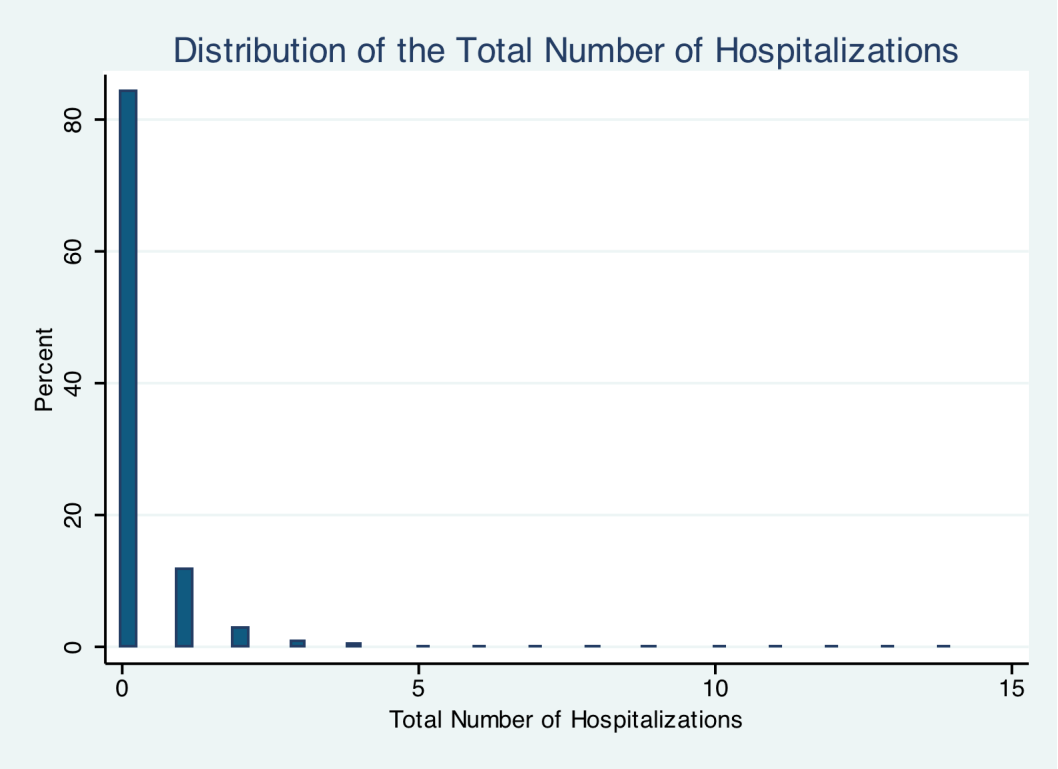

Figure 9: Distribution of the number of hospitalizations in the year prior to time zero

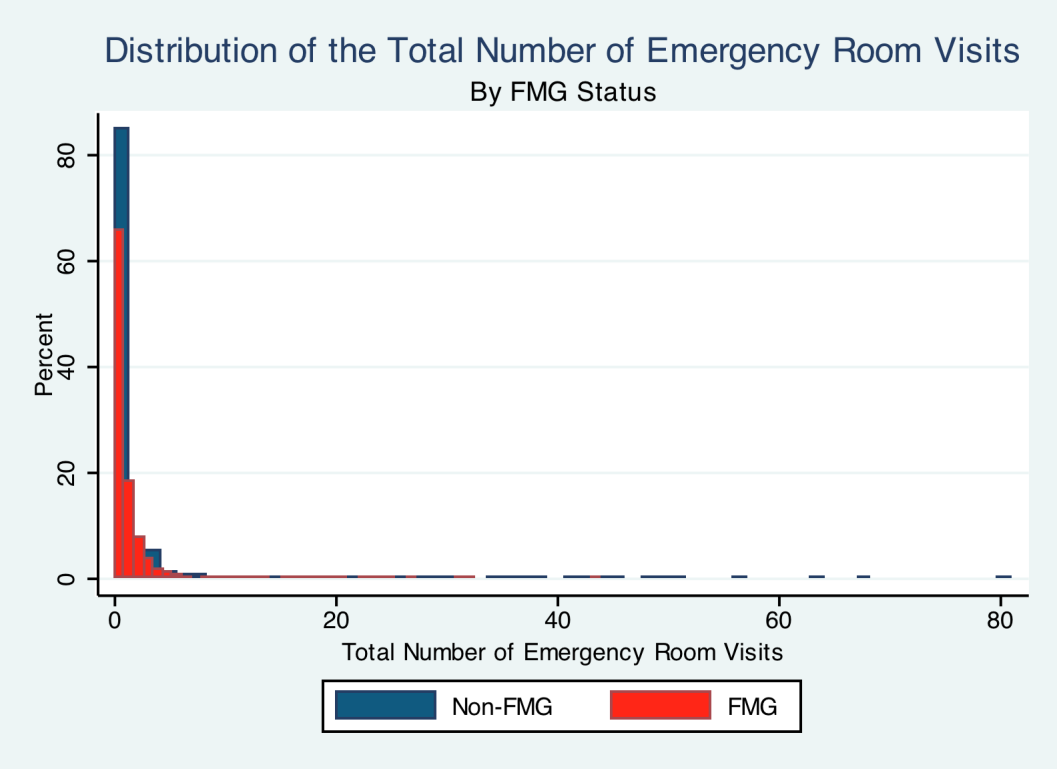

Figure 10: Distribution of the number of ER visits in the year prior to time zero, stratified by FMG status

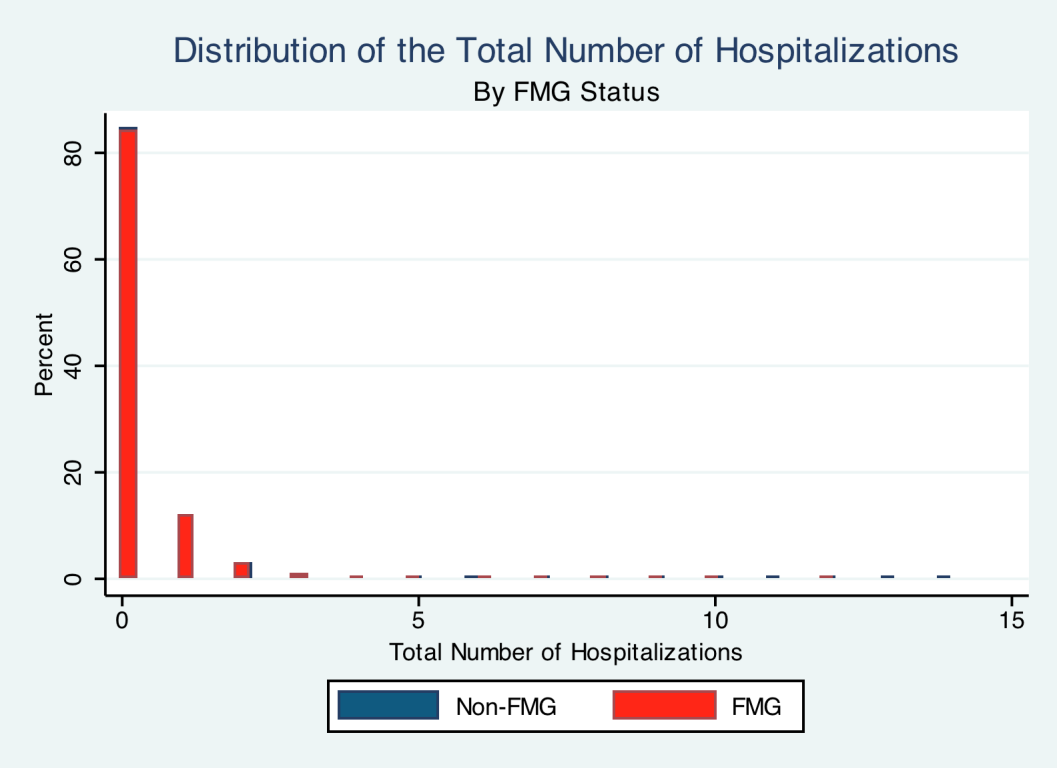

Figure 11: Distribution of the number of hospitalizations in the year prior to time zero, stratified by FMG status

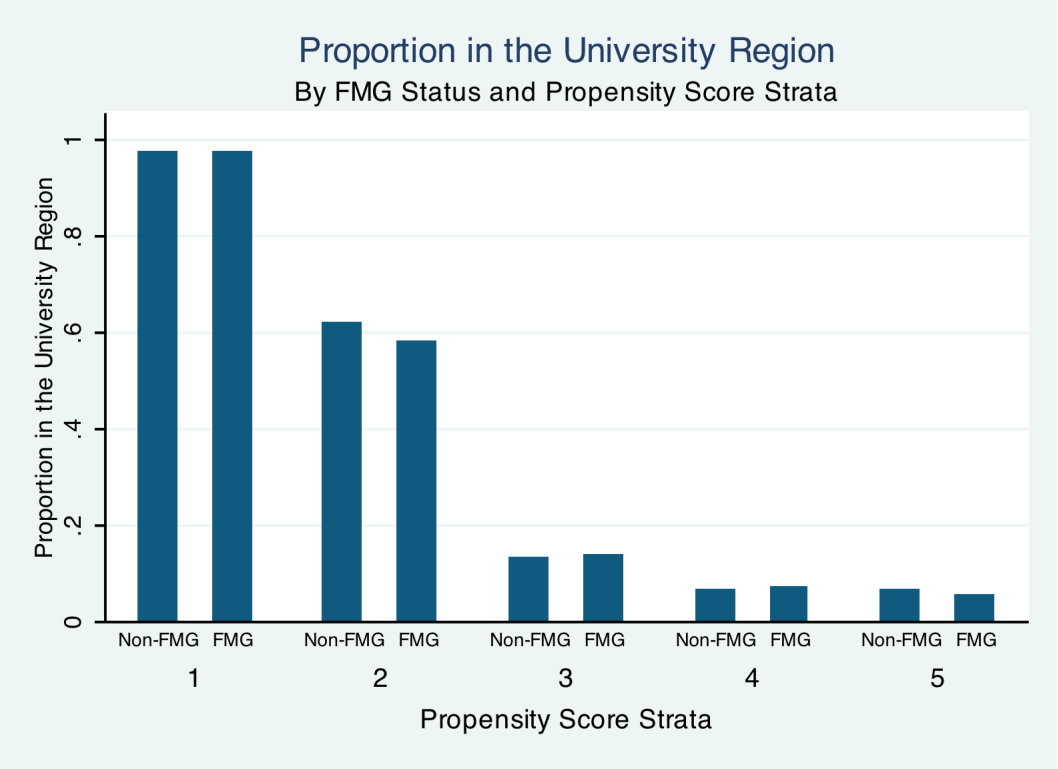

Figure 12: Proportion of patients in the INSPQ university region across propensity score strata

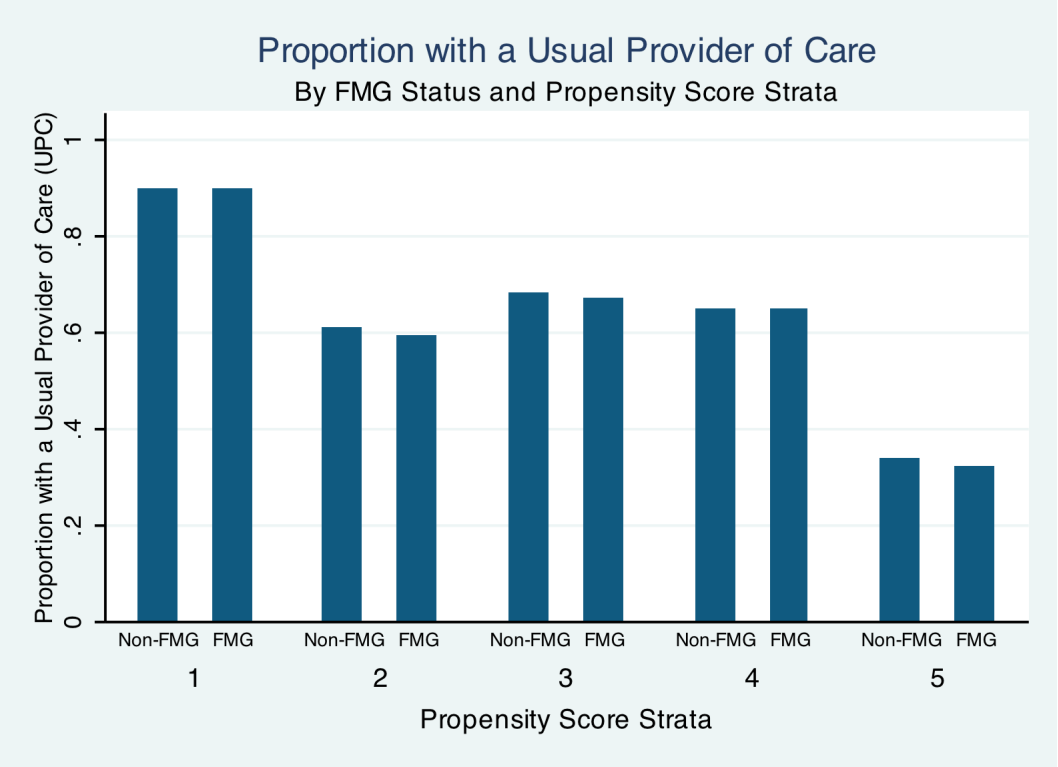

Figure 13: Proportion of patients with a usual provider of care (UPC) across propensity score strata

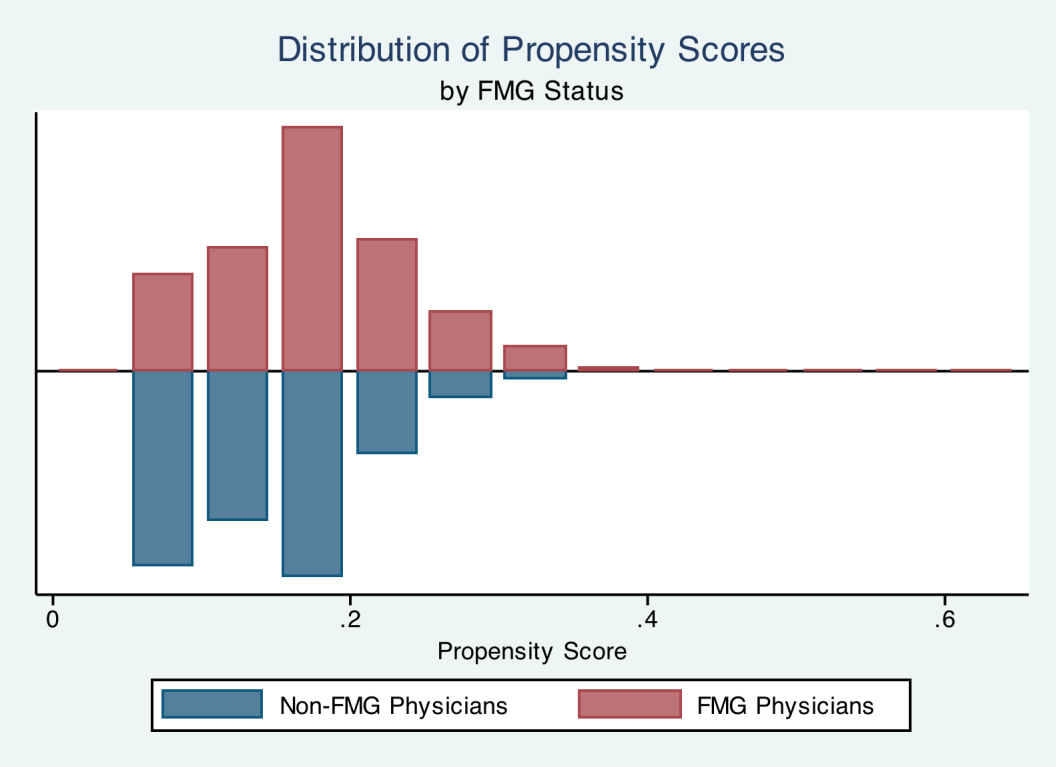

Figure 14: Distribution of Patient Propensity Scores by FMG Status

CHAPTER 5: Conclusions

The extent to which physicians and patients self select into different models of primary care has become evident. The major factors that predict participation in a Family Medicine Group (FMG) in Quebec were examined from the patients' perspective and the physicians' perspective. Furthermore, propensity score methods were investigated as a method for controlling for this selection bias and explicitly demonstrating the population in which inferences could be made.

Chapter 3 examined physician characteristics from the two years prior to FMG participation and elucidated several findings. After controlling for physician and patient panel characteristics, rural geographic location, fewer years in medical practice and practicing in the short term acute care (CHSCD) setting increased the chances that physicians would join a FMG. Conversely, it was shown that having patients with higher morbidity decreased the chances that physicians would participate in a FMG.

Chapter 4 followed a similar format to chapter 3, and showed which pre-enrollment characteristics were predictive of patient FMG participation. After controlling for demographic, health and service use characteristics, being male, residing outside of the university urban region, having a higher material deprivation score, visiting the ER for any cause, visiting the ER for ambulatory sensitive conditions and being hospitalized for any cause increased the chances that a patient would join a FMG. Factors that decreased the probability that a patient would join a FMG included the presence of hypertension, visiting an ambulatory clinic and having a usual provider of care.

The interaction of these patient and physician characteristics deserves further discussion and investigation. Overall, it appears that geography plays a strong role in determining whether a

patient or physician will join a FMG, and the direction and magnitude of this association was similar in both groups. Given that the sample was primarily based on early adopters and FMGs seemed to catch on quicker in the intermediate and peripheral regions (see Appendix Section 1-Table 2), it is possible that there was simply more practices to join in those areas, both for physicians and patients. It is also possible that the structural, financial or social incentives created to encourage FMG participation affected physicians differently by region or that physicians working outside the major urban and academic medical settings have different preferences for group practice. If patients simply follow their physicians into the practice that they choose, then it follows that geography would show a differential effect on patients. Overall, it is not surprising that geography played a significant role in predicting whether a physician or patient joined a FMG practice, as the overall medical structure, type of care and health issues, and incentives for different types of care models can vary across different geographic regions.

There also may be a combined effect between where physicians choose to work and the type of patients they see in these locations. It was shown that physicians who had a more varied practice, especially in terms of working in the Emergency Room (ER), short-term acute hospital (CHSCD) and local community service centres (CLSC), were more likely to join a FMG. This may indicate that physicians who are highly engaged in the medical system and community are more likely to hear about the benefits of working in a FMG. It may also be due to personal characteristics and preferences, such that these physicians already work with multidisciplinary teams and like to be engaged and challenged in new ways. Furthermore, patients followed in a CLSC are likely to be sicker or from a more disadvantaged neighbourhood. Therefore, the reason we see more disadvantaged individuals participating in a FMG may be because their physician decides to join one and encourages the patients from CLSCs to follow suit.

In terms of the overall morbidity of patients, slightly different results were demonstrated in the physician and patient analysis. In the physician descriptive statistics and multivariate models, physicians with vulnerable patients with higher resource utilization scores or overall morbidity were less likely to participate. Likewise, in the patient descriptive statistics, patients with higher resource utilization scores or overall morbidity were less likely to be enrolled. When the different models were combined, the models that combined the health information and then health and demographic information, also showed this association. Only when the health service utilizations was added in the final model did the association actually reverse, such that, conditional on utilization levels, patients with greater morbidity were more likely to participate. Since the health service utilization patterns of patients were not captured in the physician models it makes sense that this reversal was not seen there. In general, it is hard to draw definitive conclusions about whether future FMG patients had greater morbidity or not.

For both the patients and physicians, the generated propensity scores for each group were effectively able to balance covariates after matching and weighting. The respective distribution for the patient propensity scores and the physician propensity scores also demonstrated good overlap, such that inferences would still be possible (i.e. no structural confounding). Furthermore, it was noted that the matching techniques bring the treatment and control groups closer to the original treated FMG group, which makes sense since the matching technique matches each control to a treated observation. The weighting method brought the treatment and control groups closer to the original control group, which makes sense since the weighting keeps the original sample and just up or down weights based on the inverse probability of receiving the treatment (or control) that they actually receive, and since most of the sample is comprised of control observations it follows that they look more like the control group. This issue of generalizability is

important to highlight for future analysis, as one needs to be careful which population their conclusions are based on.

The primary objective of this thesis was to understand the type of physician and patient that joined a FMG, in an attempt to contextualize the early impacts of the FMG program. Future analysis should focus on using the propensity score to evaluate the effects of FMGs on changes in health conditions, service use, costs and overall physician productivity. Given some of the results demonstrated here, it may be worthwhile to look at the effect of FMGs within the subgroups of urban geographic location vs. rural, deprived vs. advantaged groups and the different vulnerable populations (young and chronically ill vs. elderly and chronically ill vs. healthy elderly).

Lastly, understanding these findings in relation to personal, financial or other system level factors will help form evidence-based and informed policy. Being able to distinguish whether a patient chooses to join a FMG practice for their own personal reasons or whether they are passively enrolled in a practice based on their physician's choice will become critical to understand why there is differential selection. Furthermore, understanding the patients' and physicians' thoughts, beliefs and perceptions of primary care and primary care models could help to explain the selection process.

Given that primary health care reform is being developed in other developed countries, it will become increasingly important to evaluate the effectiveness of the different models in the different contexts with a causal inference approach. Being aware of non-random treatment assignment, selection bias and confounding in these observational studies is ever important as policymakers seek to design effective primary health care systems.

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APPENDIX

Section 1: GEOGRAPHIC INFORMATION

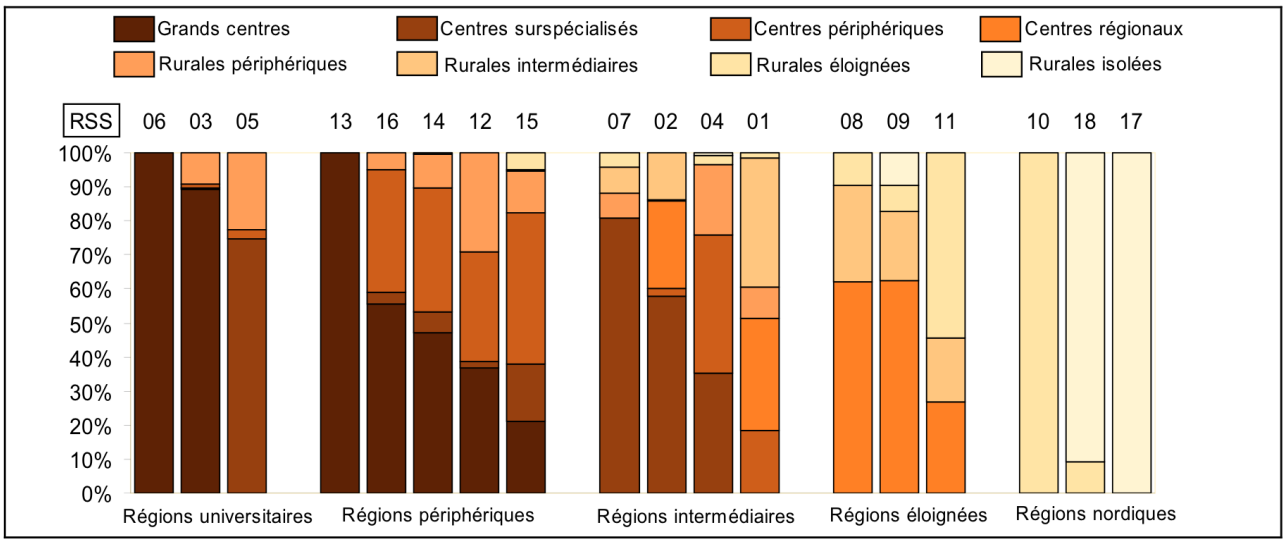

Figure 1: INSPQ administratively defined regions (Source: Gauthier, 2009. Figure 1 "Répartition de la population (%) en fonction des contextes géographiques selon les 18 régions sociosanitaires (RSS) et les types de régions administratives"

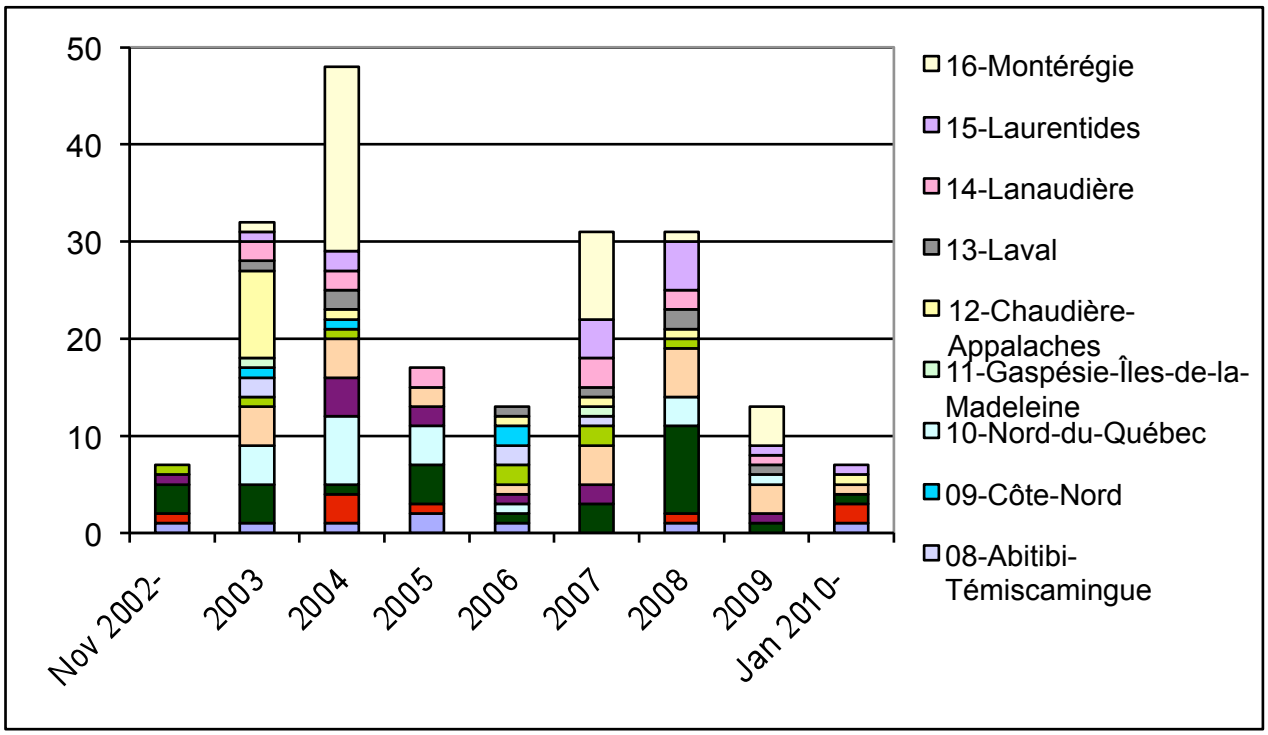

Figure 2: Number of New FMGs, by Date and Geographic Region (Source: Équipe santé des populations et services de santé, Direction de santé publique de l'Agence de la santé et des services sociaux de Montréal)

Table 1: Physician Descriptive Statistics, by RSS Region

RSS location	Number of FMG MDs	Number of Non-FMG MDs	Odds	OR[1]	OR[2]	OR[3]
1	33	120	0.28	*Baseline*	2.11*	N/A
2	34	167	0.20	0.74	1.56	0.74
3	87	412	0.21	0.77	1.62	1.04
4	95	191	0.50	1.81*	3.81*	2.36*
5	66	162	0.41	1.48	3.12*	0.82
6	119	912	0.13	0.47*	*Baseline*	0.32*
7	25	202	0.12	.045*	0.95	0.95
8	20	103	0.19	0.71	1.49	1.57
9	29	40	0.73	2.64*	5.56*	3.73*
11	6	67	0.089	0.33	0.69	0.12*
12	97	187	0.52	1.89*	3.98*	5.79*
13	61	177	0.34	1.25	2.64*	0.66
14	36	213	0.17	0.61	1.30	0.49*
15	27	292	0.092	0.34*	0.71	0.55*
16	169	658	0.26	0.93	1.97*	2.78*

OR[1] represents the odds ratio for that geographic region where contrasts are made against the baseline (RSS 1 Bas-Saint-Laurent).

OR[2] represents the odds ratio for that geographic region where contrasts are made against the baseline (RSS 6 Montreal-Centre).

OR[3] represents the odds ratio for that geographic region where contrasts are made against the previous category.

* $p<0.05$

Table 2: FMGs included in the study cohort, by RSS location and registration date

Région Nom du GMF	Date d'adhésion	Date de 1ère inscription	Médecins partenaires	Personnes désinscrites	Personnes inscrites	Personnes inscrites et vulnérables	Ratio vuln. / inscr.
01 BAS-SAINT-LAURENT - Total			33	398	19 439	5 189	27%
GMF des Basques	2002-11-29	2003-01-05	13	178	5 982	1 903	32%
GMF Lafontaine	2003-07-25	2003-11-13	8	193	9 076	2 302	25%
GMF de la Matapédia	2004-01-06	2004-01-10	12	27	4 381	984	22%
02 SAGUENAY - LAC-SAINT-JEAN - Total			25	386	17 929	4 127	23%
GMF de Jonquière	2002-11-29	2002-11-29	7	317	5 962	1 371	23%
GMF de la Clinique médicale d'Alma	2004-01-06	2004-01-10	11	28	6 958	1 316	19%
GMF Clinique de médecine familiale Montcalm	2004-03-15	2004-05-05	7	41	5 009	1 440	29%
03 CAPITALE-NATIONALE - Total			79	1 193	45 741	12 779	28%
GMF du Centre médical Beauport	2002-11-14	2003-01-03	9	335	10 881	2 952	27%
GMF Saint-Vallier	2002-11-14	2002-11-14	8	271	6 466	2 245	35%
GMF de l'unité de médecine familiale de l'Enfant-Jésus	2002-11-29	2002-11-29	15	83	4 120	725	18%
GMF Saint-Louis	2003-07-25	2003-08-20	15	220	9 202	3 025	33%
GMF du Carrefour	2003-07-25	2003-07-30	9	119	5 288	1 526	29%
GMF Centre de Santé Orléans mission CLSC secteur Beauport	2003-07-25	2003-09-30	10	65	3 320	646	19%
GMF Clinique médicale Pierre-Bertrand	2003-07-17	2003-10-20	13	100	6 464	1 660	26%
04 MAURICIE ET CENTRE-DU-QUEBEC			95	1 361	72 609	18 254	25%
GMF de Saint-Léonard	2003-01-15	2003-02-09	5	74	4 098	773	19%
GMF des Bois-Francs #3	2003-02-24	2003-03-08	6	233	8 671	2 357	27%
GMF des Bois-Francs #1	2003-02-24	2003-02-24	19	388	15 840	3 336	21%

Région Nom du GMF	Date d'adhésion	Date de 1ère inscription	Médecins partenaires	Personnes désinscrites	Personnes inscrites	Personnes inscrites et vulnérables	Ratio vuln. / inscr.
GMF des Bois-Francs #2	2003-02-24	2003-02-24	18	425	13 118	4 062	31%
GMF Clinique médicale de Shawinigan-Sud	2004-01-06	2004-01-12	7	25	4 248	1 418	33%
GMF Centre de santé	2004-02-17	2004-02-17	11	96	8 789	2 391	27%
GMF Centre médical AJC	2004-02-17	2004-04-08	6	37	5 405	792	15%
GMF Clinique médicale de Nicolet	2004-01-06	2004-02-23	9	43	4 449	1 940	44%
GMF Centre Médical Saint-François	2004-02-17	2004-02-27	8	33	6 650	821	12%
GMF Haut-Saint-Maurice	2004-07-16	2004-10-04	6	7	1 341	364	27%
05 ESTRIE			52	812	22 665	4 940	22%
GMF des Grandes-Fourches	2002-12-18	2003-01-05	22	158	8 244	1 144	14%
GMF de Vimy	2004-01-06	2004-01-07	7	41	4 427	1 369	31%
GMF Plateau Marquette	2004-02-17	2004-03-12	16	35	7 408	1 489	20%
GMF des Cantons	2004-02-17	2004-03-17	7	578	2 586	938	36%
06 MONTREAL			129	500	24 867	7 802	31%
GMF de Verdun	2003-03-19	2003-03-19	21	254	3 966	1 542	39%
GMF des Faubourgs	2003-03-25	2003-07-10	14	94	2 010	607	30%
GMF Notre-Dame	2003-03-25	2003-08-12	15	56	2 608	774	30%
GMF de Herzl	2003-06-25	2003-11-17	19	55	5 299	1 700	32%
GMF Centre médical Saint-André	2004-01-06	2004-01-19	8	17	2 078	575	28%
GMF Côtes-des-Neiges	2004-01-06	2004-01-14	23	9	2 055	348	17%
GMF du Sud-Ouest	2004-07-16	2004-09-19	15	12	5 358	1 841	34%
GMF Saint-Louis-du-Parc	2004-07-16	2004-09-09	14	3	1 493	415	28%
07 OUTAOUAIS			26	101	12 358	2 667	22%
GMF d'Aylmer	2002-11-29	2003-01-06	7	45	5 410	1 091	20%
GMF de Hull	2003-07-11	2003-07-12	9	26	2 945	799	27%

Région Nom du GMF	Date d'adhésion	Date de 1ère inscription	Médecins partenaires	Personnes désinscrites	Personnes inscrites	Personnes inscrites et vulnérables	Ratio vuln. / inscr.
GMF de Wakefield	2004-01-06	2004-01-23	10	30	4 003	777	19%
08 ABITIBI-TEMISCAMINGUE			20	73	7 137	1 760	25%
GMF du Centre de santé Témiscamingue	2003-07-02	2003-09-24	5	17	2 220	367	17%
GMF des Aurores Boréales	2003-07-23	2003-10-09	15	56	4 917	1 393	28%
09 COTE-NORD			29	115	13 253	3 232	24%
GMF de la Polyclinique Boréale	2003-03-28	2003-06-26	12	72	5 696	1 080	19%
GMF de Sept-Îles	2004-01-06	2004-01-13	17	43	7 557	2 152	28%
11 GASPESIE - ILES-DE-LA-MADELEINE			6	36	2 759	874	32%
GMF de Haute-Gaspésie	2003-04-07	2003-11-21	6	36	2 759	874	32%
12 CHAUDIERE-APPALACHES			96	1 648	58 393	13 094	22%
GMF des Etchemins	2003-01-24	2003-02-20	9	190	3 285	1 383	42%
GMF Clinique médicale de Lauzon	2003-07-17	2003-07-22	8	464	6 906	1 694	25%
GMF Lévis-Métro	2003-07-02	2003-07-02	10	184	6 290	1 751	28%
GMF Clinique médicale du Vieux-Fort	2003-07-17	2003-09-02	6	49	3 345	776	23%
GMF Clinique médicale de Lévis	2003-07-17	2003-09-06	11	205	9 390	2 440	26%
GMF de Montmagny	2003-07-23	2003-08-24	17	164	10 659	2 237	21%
GMF Sainte-Croix / Saint-Patrice	2003-07-17	2003-09-06	5	92	4 557	1 215	27%
GMF Clinique médicale Saint-Étienne	2003-07-23	2003-08-10	11	265	6 886	614	9%
GMF Centre Médical Saint-Rédempteur	2003-08-28	2003-12-03	7	32	5 835	577	10%
GMF de Laurier-Station	2004-07-16	2004-10-06	12	3	1 240	407	33%
13 LAVAL			59	222	28 455	6 771	24%
GMF de Laval	2003-04-04	2003-11-04	16	91	2 969	575	19%
GMF Centre médical Laval	2004-02-17	2004-02-17	17	85	13 228	2 962	22%

Région Nom du GMF	Date d'adhésion	Date de 1ère inscription	Médecins partenaires	Personnes désinscrites	Personnes inscrites	Personnes inscrites et vulnérables	Ratio vuln. / inscr.
GMF Concorde	2004-03-15	2004-04-17	26	46	12 258	3 234	26%
14 LANAUDIERE			35	587	24 578	5 307	22%
GMF de Lavaltrie-Lanoraie	2003-01-21	2003-01-21	13	396	9 147	1 554	17%
GMF de l'Assomption	2003-06-25	2003-08-29	8	154	9 011	2 196	24%
GMF de Mascouche	2004-01-06	2004-01-11	9	17	4 044	767	19%
GMF de Saint-Donat	2004-03-15	2004-04-02	5	20	2 376	790	33%
15 LAURENTIDES			28	483	20 201	3 984	20%
GMF de Mont-Tremblant	2003-04-11	2003-04-11	7	256	9 100	1 624	18%
GMF de la Rouge	2003-04-11	2003-04-15	13	213	6 386	1 988	31%
GMF de Lorraine	2004-02-17	2004-03-11	8	14	4 715	372	8%
16 MONTEREGIE			144	600	79 634	21 374	27%
GMF de Salaberry	2003-07-02	2003-07-02	9	81	7 231	1 746	24%
GMF du Haut-Saint-Laurent	2004-01-06	2004-01-17	5	26	2 781	936	34%
GMF Richelieu Saint-Laurent	2004-01-06	2004-01-06	8	44	7 423	1 875	25%
GMF Centre de médecine familiale de Granby	2004-03-15	2004-06-08	12	43	5 473	1 942	35%
GMF Sutton-Cowansville	2004-02-17	2004-02-17	12	37	5 939	1 515	26%
GMF Bedford	2004-02-17	2004-03-25	9	48	4 484	1 086	24%
GMF Lac Brome-Cowansville	2004-02-17	2004-03-11	9	79	7 531	1 609	21%
GMF Vaudreuil-Dorion	2004-03-15	2004-03-22	7	23	3 621	1 184	33%
GMF Médicentre Pincourt	2004-03-15	2004-04-03	7	27	4 146	1 203	29%
GMF Rigaud	2004-03-15	2004-04-22	5	15	1 728	797	46%
GMF Centre médical Robinson	2004-03-15	2004-03-29	11	48	7 050	2 378	34%
GMF Waterloo-Bromont	2004-02-17	2004-02-26	10	18	3 775	962	25%

Région Nom du GMF	Date d'adhésion	Date de 1ère inscription	Médecins partenaires	Personnes désinscrites	Personnes inscrites	Personnes inscrites et vulnérables	Ratio vuln. / inscr.
GMF Clinique Centrale	2004-03-15	2004-04-05	7	30	4 806	657	14%
GMF du Centre médical Saint-Jacques	2004-03-15	2004-04-28	6	24	3 906	1 002	26%
GMF Farnham	2004-02-17	2004-02-17	17	47	5 377	1 050	20%
GMF du Lac Saint-François	2004-07-16	2004-09-21	10	10	4 363	1 432	33%
TOTAL PROVINCIAL			856	8 515	450 018	112 154	25%

Section 2: PROPENSITY SCORE INFORMATION

2.1 Physician Propensity Score Code (STATA)

```
xi: pscore GMF i.rss yrgrad que_univ MD_male pre_meanPATTOTAL
pre_meanPATURGENCE pre_meanPATEXTERNE pre_meanPATCHSCD
pre_meanPATCHSLD pre_meanPATCLSC pre_meanPATCABPRIV pre_meanPAT0_18_
pre_meanPAT19_64_ pre_meanPAT65_74_ pre_meanPAT75_PLUS_  pre_meanquintilem
pre_meanrub pre_meanACTETOTAL pre_meanACTEURGENCE pre_meanACTEEXTERNE
pre_meanACTECHSCD pre_meanACTECHSLD pre_meanACTECABPRIV
pre_meanJRSTOTAL percent_JRSURGENCE percent_JRSEXTERNE percent_JRSCHSCD
percent_JRSCHSLD percent_JRSCLSC percent_JRSCABPRIV pre_meanPREVACTE
pre_meanPREVSALAIRE pre_meanPMNTURGENCE pre_meanPMNTEXTERNE
pre_meanPMNTCHSCD pre_meanPMNTCHSLD pre_meanPMNTCLSC
pre_meanPMNTCABPRIV, pscore(psvar1) blockid(blockvar) level(0.05) numblo(20) comsup
logit

*Matching
        *re-using controls
psmatch2 GMF, pscore(psvar1)  neighbor(1) logit common

pstest MD_male yrgrad geo1 geo2 geo3 geo4 pre_meanPATTOTAL pre_meanPATURGENCE
pre_meanPATCHSCD pre_meanPATCLSC pre_meanPATCABPRIV pre_meanquintilem
pre_meanrub

        *exact 1:1 matching
psmatch2 GMF, pscore(psvar1)  neighbor(1) common noreplacement

pstest MD_male yrgrad geo1 geo2 geo3 geo4 pre_meanPATTOTAL pre_meanPATURGENCE
pre_meanPATCHSCD pre_meanPATCLSC pre_meanPATCABPRIV pre_meanquintilem
pre_meanrub

*Create inverse prob of treatment weights
gen psvar1weight= psvar1
replace psvar1weight = psvar1*GMF + (1-psvar1)*(1-GMF)
gen psvar1inverprobtreat = 1/psvar1weight

mean MD_male yrgrad geo1 geo2 geo3 geo4 pre_meanPATURGENCE pre_meanPATCHSCD
pre_meanPATCLSC pre_meanPATCABPRIV pre_meanquintilem pre_meanrub [pw=
psvar1inverprobtreat], over(GMF)

*Test Weighting Balance
 foreach var of varlist MD_male yrgrad geo1 geo2 geo3 geo4 pre_meanPATURGENCE
pre_meanPATCHSCD pre_meanPATCLSC pre_meanPATCABPRIV pre_meanquintilem
pre_meanrub {
logistic GMF `var' [pw=psvar1inverprobtreat]
}
```

2.2 Patient Propensity Score Code (STATA)

```
xi: pscore GMF i.geo_group male grage i.quintilem rub diabete hta mpoc icardiaq nburg nburg2
nburgamb nbhosp nbhospambul nbconsult_amb nbconsult_amb2 nbconsult_amb3 nbmd_amb
i.UPC grage_male  quintilem2_male quintilem3_male quintilem4_male quintilem5_male
rub_male diabete_male hta_male mpoc_male icardiaq_male nburg_male nbhosp_male
nbhospambul_male nburgamb_male nbconsult_amb_male nbmd_amb_male UPC2_male
UPC3_male grage_geo2 grage_geo3 grage_geo4 male_geo2 male_geo3 male_geo4
quintilem2_geo2 quintilem2_geo3 quintilem2_geo4 quintilem3_geo2 quintilem3_geo3
quintilem3_geo4 quintilem4_geo2 quintilem4_geo3 quintilem4_geo4 quintilem5_geo2
quintilem5_geo3 quintilem5_geo4 rub_geo2 rub_geo3 rub_geo4 diabete_geo2 diabete_geo3
diabete_geo4 hta_geo2 hta_geo3 hta_geo4 mpoc_geo2 mpoc_geo3 mpoc_geo4 icardiaq_geo2
icardiaq_geo3 icardiaq_geo4  nburg_geo2 nburg_geo3 nburg_geo4  nbhosp_geo2 nbhosp_geo3
nbhosp_geo4 nbhospambul_geo2 nbhospambul_geo3 nbhospambul_geo4 nburgamb_geo2
nburgamb_geo3 nburgamb_geo4  nbconsult_amb_geo2 nbconsult_amb_geo3
nbconsult_amb_geo4 nbmd_amb_geo2 nbmd_amb_geo3 nbmd_amb_geo4 UPC2_geo2
UPC2_geo3 UPC2_geo4 UPC3_geo2 UPC3_geo3 UPC3_geo4 grage_ses2 grage_ses3
grage_ses4 grage_ses5 diabete_ses2 diabete_ses3 diabete_ses4 diabete_ses5 hta_ses2 hta_ses3
hta_ses4 hta_ses5 mpoc_ses2 mpoc_ses3 mpoc_ses4 mpoc_ses5 icardiaq_ses2 icardiaq_ses3
icardiaq_ses4 icardiaq_ses5 nburg_ses2 nburg_ses3 nburg_ses4 nburg_ses5 nburgamb_ses2
nburgamb_ses3 nburgamb_ses4 nburgamb_ses5   nbhosp_ses2 nbhosp_ses3 nbhosp_ses4
nbhosp_ses5 nbhospambul_ses2 nbhospambul_ses3 nbhospambul_ses4 nbhospambul_ses5
nbconsult_amb_ses2 nbconsult_amb_ses3 nbconsult_amb_ses4 nbconsult_amb_ses5
nbmd_amb_ses2 nbmd_amb_ses3 nbmd_amb_ses4 nbmd_amb_ses5 UPC2_ses2 UPC2_ses3
UPC2_ses4 UPC2_ses5 UPC3_ses2 UPC3_ses3 UPC3_ses4 UPC3_ses5, pscore(ps15) logit
level(0.05) numblo(5) comsup

*Matching
        *re-using controls
psmatch2 GMF, pscore(ps15)  neighbor(1) logit common

pstest male grage geo1 geo2 geo3 geo4 quintilem quintilem1 quintilem2 quintilem3 quintilem4
quintilem5  rub diabete hta mpoc icardiaq nburg nburgamb nbhosp nbhospambul UPC2 UPC3
nburg_binary nburgamb_binary nbhosp_binary nbhospambul_binary nbconsult_amb nbmd_amb


        *exact 1:1 matching
psmatch2 GMF, pscore(ps15)  neighbor(1) common noreplacement

pstest male grage geo1 geo2 geo3 geo4 quintilem quintilem1 quintilem2 quintilem3 quintilem4
quintilem5  rub diabete hta mpoc icardiaq nburg nburgamb nbhosp nbhospambul UPC2 UPC3
nburg_binary nburgamb_binary nbhosp_binary nbhospambul_binary nbconsult_amb nbmd_amb

*Create inverse prob of treatment weights
gen weight= ps15
```

```
replace weight = ps15*GMF + (1-ps15)*(1-GMF)
gen inverprobtreat = 1/weight


*Test Weighting Balance
foreach var of varlist male grage geo1 geo2 geo3 geo4 quintilem quintilem1 quintilem2
quintilem3 quintilem4 quintilem5  rub diabete hta mpoc icardiaq nburg nburgamb nbhosp
nbhospambul  UPC2 UPC3 nburg_binary nburgamb_binary nbhosp_binary nbhospambul_binary
nbconsult_amb nbmd_amb {
mean `var' [pw=inverprobtreat], over(GMF)
logistic GMF `var' [pw=inverprobtreat]
}
```