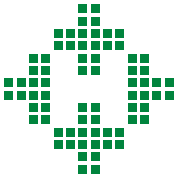
Profiling Primary Care Physician Practice in Manitoba

August 2006



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The Manitoba Centre For Health Policy

The Manitoba Centre for Health Policy (MCHP) is located within the Department of Community Health Sciences, Faculty of Medicine, University of Manitoba. The mission of MCHP is to provide accurate and timely information to health care decision-makers, analysts and providers, so they can offer services which are effective and efficient in maintaining and improving the health of Manitobans. Our researchers rely upon the unique Population Health Research Data Repository to describe and explain patterns of care and profiles of illness, and to explore other factors that influence health, including income, education, employment and social status. This Repository is unique in terms of its comprehensiveness, degree of integration, and orientation around an anonymized population registry.

Members of MCHP consult extensively with government officials, health care administrators, and clinicians to develop a research agenda that is topical and relevant. This strength along with its rigorous academic standards enable MCHP to contribute to the health policy process. MCHP undertakes several major research projects, such as this one, every year under contract to Manitoba Health. In addition, our researchers secure external funding by competing for other research grants. We are widely published and internationally recognized. Further, our researchers collaborate with a number of highly respected scientists from Canada, the U.S. and Europe.

We thank the University of Manitoba, Faculty of Medicine, Health Research Ethics Board for their review of this project. MCHP complies with all legislative acts and regulations governing the protection and use of sensitive information. We implement strict policies and procedures to protect the privacy and security of anonymized data used to produce this report and we keep the provincial Health Information Privacy Committee informed of all work undertaken for Manitoba Health.

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TABLE OF CONTENTS

EXECUTIVE SUMMARY vii

1.0 INTRODUCTION AND BACKGROUND 1
- 1.1 Introduction 1
- 1.2 Background 2

2.0 METHODS 5
- 2.1 Overview 5
- 2.2 Data Sources 5
- 2.3 Physician Inclusions and Exclusion Criteria 6
- 2.4 Defining Practice Populations 7
- 2.5 Variables 8

3.0 INDICATORS: DESCRIPITON AND RESULTS 11
- 3.1 Indicator of Service Provision: Scope 11
  - 3.1.1 Atypical Diagnostic Coding Index (ADCI) 11
- 3.2 Indicators of Service Provision: Volume 15
  - 3.2.1 Visit Index (VI) 15
  - 3.2.2 Referral Index (RI) 18
- 3.3 Indicators of Service Provision: Quality 24
  - 3.3.1 Continuity of Care Index (COCI) 24
  - 3.3.2 Preventive Care Index (PCI) 26
- 3.4 Summary of Findings 30

4.0 DISCUSSION 31
- 4.1 Strengths and Uses of the Indicators 31
- 4.2 Limitations 33
  - 4.2.1 Potential Underbilling by APP Physicians 33
  - 4.2.2 Identification of Group Practices 34
- 4.3 Overall Results 36
- 4.4 Physician Characteristics 38
  - 4.4.1 Practice Characteristics 39
- 4.5 Summary 41

5.0 KEY POINTS 43

REFERENCES 45

GLOSSARY 49

APPENDIX A: BI-VARIATE ANALYSES 56

APPENDIX B: CONSTRUCTING THE VISIT INDEX 77

APPENDIX C: CONSTRUCTING THE REFERRAL INDEX 79

List of Tables

Table 1: Manitoba Centre for Health Policy reports on physician care 3

Table 2: Distribution of core and occasional patients by type of remuneration 8

Table 3: Atypical Diagnostic Coding Index Model: Percentage of unique variance attributable to each variable 14

Table 4: Visit Index Model: Percentage of unique variance attributable to each variable 17

Table 5: Referral Index Model (Core Patients): Percentage of unique variance attributable to each variable 20

Table 6: Referral Index Model (Occasional Patients): Percentage of unique variance attributable to each variable 21

Table 7: Regional distributions of the Referral Index and the Consultation Index 23

Table 8: Continuity of Care Index Model: Percentage of unique variance attributable to each variable 25

Table 9: Manitoba's routine childhood immunization schedule (as of January 2001) 26

Table 10: Codes used in Preventive Care Index 27

Table 11: Preventive Care Index Model: Percentage of unique variance attributable to each variable 29

Table 12: Relationship of significant physician characteristics with indicators: Winnipeg and Rural South 30

List of Figures

Figure 1: Distribution of Diagnostic Coding Across Dino-Clusters for Primary Care Physician Visits 12

Figure 2: Distribution of Physicians' Atypical Diagnostic Coding Index Scores 14

Figure 3: Distribution of Physicians' Visit Index Scores 16

Figure 4: Distribution of Physicians' Referral Index Scores (Core Patients) 19

Figure 5: Distribution of Physicians' Referral Index Scores (Occasional Patients) 21

Figure 6 Distribution of Physicians' Continuity of Care Index Scores 25

Figure 7: Distribution of Physicians' Preventive Care Index Scores 28

LIST OF APPENDIX FIGURES

Figure A.l: Visit Index by Canadian and Non-Canadian Graduate Status 57

Figure A.2: Visit Index by Physician Workload (FTE) 58

Figure A.3: Visit Index by Proportion of Above Average Morbidity Patients in the Practice 59

Figure A.4: Referral Index by Physician Age: Core Patients 60

Figure A.5: Referral Index by Method of Remuneration (Fee-for-Service vs. Alternate Payment Plan): Core Patients 61

Figure A.6: Referral Index by Hospital Privileges: Core Patients 61

Figure A.7: Referral Index by Proportion of Above Average Morbidity Patients in the Practice: Core Patients 62

Figure A.8: Referral Index by Proportion of Above Average SEFI Patients in the Practice: Core Patients 63

Figure A.9: Referral Index by Proportion of Female Patients in the Practice: Core Patients 64

Figure A.10: Referral Index by Method of Remuneration (Fee-for-Service vs. Alternate Payment Plan): Occasional Patients 65

Figure A.11: Referral Index by Physician Age: Occasional Patients 65

Figure A.12: Referral Index by Physician Sex: Occasional Patients 66

Figure A.13: Referral Index by Proportion of Patients in the Practice Aged 0-18 Years: Occasional Patients 67

Figure A.14: Referral Index by Proportion of Patients in the Practice Aged 25-44 Years: Occasional Patient 67

Figure A.15: Referral Index by Proportion of Female Patients in the Practice: Occasional Patients 68

Figure A.16: Referral Index by Proportion of Above Average SEFI Patients in the Practice: Occasional Patients 69

Figure A.17: Continuity of Care Index by Physician Workload (FTE) 70

Figure A.18: Continuity of Care Index by Patients in the Practice Aged 65 Years or Older 70

Figure A.19: Continuity of Care Index by Proportion of Patients in the Practice Aged 0-18 Years 71

Figure A.20: Preventive Care Index by Physician Age 72

Figure A.21: Preventive Care Index by Canadian and Non-Canadian Graduate Status 72

Figure A.22: Preventive Care Index by Hospital Privileges 73

Figure A.23: Preventive Care Index by Proportion of Above Average SEFI Patients in the Practice 74

Figure A.24: Preventive Care Index by Proportion of Patients in the Practice Aged 0-18 Years 74

Figure A.25: Preventive Care Index by Proportion of Patients in the Practice Aged 25-44 Years 75

Figure A.26: Preventive Care Index by Proportion of Patients in the Practice Aged 65 Years or Older 76

EXECUTIVE SUMMARY

The Primary Health Care system (PHC) is the foundation of Canada's health care system. For most people, it is their first point of contact with the health care system, usually through a physician. In Manitoba, the government has published a policy framework that defines its vision, mission, principles and goals for PHC. Manitoba Health's strategy acknowledges that to support service delivery "… a provincial population health information and monitoring system that collects, analyzes and distributes accurate and timely information is required." This study helps to address this need.

This study deals with a central component of the PHC system: primary care as delivered by a physician. The Manitoba Centre for Health Policy (MCHP) undertook this project as part of its contract with Manitoba Health. The purposes of the study were to (a) develop indicators of primary care delivery, (b) describe current patterns of primary care physician services delivery, and (c) offer insights regarding variability in the scope, breadth, and continuity of services delivered by primary care physicians.

This is a methodological study. It builds on earlier work by MCHP and breaks new ground in developing indicators of primary care with some preliminary analyses to demonstrate how the indicators could be used. The indicators cover three dimensions of primary care: scope, volume, and quality.

1. Scope:
    a. Atypical Diagnostic Coding Index
2. Volume:
    a. Visit Index
    b. Referral Index
3. Quality
    a. Continuity of Care Index
    b. Preventive Care Index

Methods

A broad-based Working Group was established to advise on the design of the project, methodological approaches, and the interpretation of results. We selected physician services that could serve as markers of clinical activities of typical primary care practices. For each indicator, we first assessed the average, or expected, rate for the indicator among all the primary care physicians in the region. We then compared each physician's actual performance to the expected value for the patients in their practice. We examined the distribution of scores on each index, and explored patient and practice characteristics associated with variation in these scores.

The patient characteristics that were included were: age, sex, socioeconomic status (SES) and level of illness. The provider characteristics that were analyzed were age, sex, being a Canadian graduate or not, having hospital privileges (for Winnipeg only since most rural physicians do have hospital privileges), years in practice, payment method, and physician workload.

Patients were allocated to physicians based on a majority-of-care rule. That is, the primary care physician that provided the most services for that patient was defined as the most responsible physician, and the patient was one of the physician's core patients. An occasional patient of a given physician was one that had a different most responsible physician. Our cohort comprised 593 physicians, 347 in Winnipeg and 246 in the Rural South. Physicians who submitted claims for fewer than 1,000 visits in 2001/02, who moved during the year, who practiced in Brandon or the North, or who appeared to have specialized practices were excluded.

The study used administrative data from the Population Health Research Data Repository (Repository) housed at MCHP. The Repository is a comprehensive research resource developed to describe and explain patterns of care, and profiles of the population's health and illness. The Repository contains records for all Manitobans' contacts with physicians, hospitals, home care, personal care homes, and pharmaceutical prescriptions. The Repository records are anonymous, as prior to data transfer Manitoba Health processes the records to encrypt all personal identifiers and remove all names and addresses. The most recent files readily available at the start of the study (2001/02) were used for all analyses. Since this is a methodological or feasibilit, study, we did not update the work with more recent years of data.

The Indices

Atypical Diagnostic Coding Index (ADCI): The ADCI identifies physicians whose practice is atypical compared to their colleagues. The first step in constructing the ADCI was to use the Johns Hopkins Expanded DIagNOsis Clusters (EDCs), or Dino-Clusters grouper to group the range of services provided by primary care physicians into 27 clusters of diagnoses, based on physician billings. The top six reasons for visits, accounting for 57% of all visits were cardiovascular, musculoskeletal, ear-nose-and-throat, psychiatry, respiratory and skin. The distribution of these diagnostic codings was used to identify the usual pattern of physician diagnoses, a necessary step in the identification of 'atypical' physicians.

The ADCI compared each physician's coding in the 27 diagnostic groups to the regional distribution or average; the higher the score, the more narrow the set of conditions a physician sees, e.g., sports medicine. Winnipeg

physicians scored higher on average, indicating a more narrowly focussed practice. This finding implies a greater tendency for Winnipeg physicians to pursue special interests, which may not be possible when practicing in a rural area. Furthermore, it suggests that primary care physicians in Winnipeg may be less available to provide general primary care.

Visit Index (VI): The VI is the ratio between the actual number of visits provided and the expected number given the age, sex, SES and level of illness of each physician's core patients. With the exception of a very few outliers, the highest scorers on the VI saw their patients about 40% more often than the average physician. The lowest scorers saw their patients half to two-thirds as often as the average. The range between lowest and highest scorers on the VI was bigger for Winnipeg compared to Rural South. The VI, like the Referral Index (next), could be used to monitor changes in visit patterns that might accompany primary care reform.

Referral Index (RI): The RI is the ratio between the actual number of patients a physician referred to another physician (usually a specialist), and the expected number given the age, sex, SES and level of illness of patients. Two RIs were constructed, one for core patients (RI_{core}) and one for occasional patients (RI_{occ}). Rural South physicians were more likely to make referrals to non-specialist physicians. Physicians in both regions were much more likely to refer their occasional than their core patients. An increased RI for occasional patients may be due to either patient or physician behaviour: patients may seek a referral for a problem for which they did not achieve satisfaction from their most responsible provider, or physicians may be more willing to refer a patient with whom they are less familiar.

Continuity of Care Index (COCI): COCI for a patient was the number of visits to the most frequent physician divided by the total number of visits that patient had overall. COCI for the physician was the average of the COCI for each of their core patients, and represents the degree to which each physicians' patients obtain care from him or her. In both Winnipeg and Rural South, core patients received over 70% of their care from their most responsible physician. There is, however, some question about the broad applicability of this index, since we cannot identify group practices: patients may receive high COCI within the group, even if they see several different physicians.

Preventive Care Index (PCI): The PCI measures the extent to which physicians provide preventive services to their eligible patients, i.e., patients who should receive these services. Three preventive services were included: childhood immunizations, influenza vaccinations and cervical cancer screening. The scores on this Index were standardized so that the mean PCI score for the province was set at 0.0. The mean score in Winnipeg was 0.34, while in

Rural South it was -0.1. This difference cannot be explained by the greater likelihood of public health nurses providing immunizations in Rural South since all immunizations were captured and attributed back to the most responsible physician.

Discussion

The indicators we have developed should prove useful for practitioners, practitioner groups and policy-makers. Individual physicians could compare their practice styles to regional norms in terms of the scope, volume, and quality of services they deliver. Policy-makers and practitioner groups could evaluate variances from norms or standards and possibly consider actions to address any variances viewed as problematic. Policy-makers would be able to use these indicators to assess baseline characteristics of physician practices, and to stimulate and monitor changes over time. Together with previous measures produced by MCHP, there are now available a variety of measures of the care provided by primary care physicians: measures of workload and human resources, of quality, and now index measures of the volume, continuity and scope of primary care services provided.

There are several indications of the face validity of the indicators we have developed. The selection of the indicators built on previous research at MCHP, a model of primary care, and input from the Working Group. When possible, it made sense to develop indicators based on standards of care, e.g., PCI. But since standards are not available for most indicators, using regional norms permits a fair comparison among colleagues who practice under similar conditions.

The significant relationships also supported the validity of the indicators: a higher level of illness was associated with a higher VI (in Winnipeg) and RI_{core} (in both regions); working significantly more than the average full time physician was also associated with a higher VI (in Rural South); higher continuity was associated with being in practice longer (in both regions) which would enable physicians to build up a group of core patients; having lower scores on preventive care was associated with having a higher proportion of low SES patients, a finding that has been reported previously. These results support the validity of these indicators for describing primary care physician behaviour.

There are a few limitations to this study. Physicians who are not paid fee-for-service (FFS) are required to file 'shadow' claims, but they may be under-filing. Second, we could not identify group practices using the data in the Repository. Third, we do not know the 'right rate' of visits or referrals. Significant variation is found across physicians, but we cannot tell to what extent these patterns are due to physician or patient behaviour.

Key Points

- The indicators reflect different dimensions of primary care outputs: scope (Atypical Diagnostic Coding Index), volume (Visit Index, Referral Index), and quality (Continuity of Care Index, Preventive Care Index).
- The COCI may underestimate continuity: continuity provided in a group practice setting cannot be captured with our data. Having better data on group practices would allow us to extend the utility of this indicator. Therefore, we suggest that Manitoba Health conduct a survey of all physicians in the province to determine where and to what extent they practice in groups.
- The indicators are relevant to physicians, physician groups and policy-makers. They can assist in evaluating individual performance, in identifying areas requiring continuing medical education or detailing, and in assessing the effects of primary care system reform.
- Policy-makers would be able to use these indicators, along with others (workload, human resources, quality) previously developed by MCHP, to assess baseline characteristics of physician practices and to stimulate and monitor changes over time. Different groupings of physicians could be compared, for example by geographic area, by physician gender, or other attribute of interest.
- Both physician and practice characteristics are associated with variation in Index scores. Physician characteristics include age, sex, years in practice, workload, having hospital privileges (in Winnipeg), payment method and being a Canadian graduate. Practice characteristics included the distribution of patients with regard to age, sex, level of illness and socioeconomic risk.
- Practices are more likely to be focussed into specialized interest areas in Winnipeg compared with the Rural South. This could mean that fewer physicians who practice general primary care are available in Winnipeg.
- Core patients were less likely to be referred than occasional patients. An increased RI for occasional patients may be due to either patient or physician behaviour: patients may seek a referral for a problem for which they did not achieve satisfaction from their most responsible provider, or physicians may be more willing to refer a patient with whom they are less familiar.
- Referral behaviour is different in Winnipeg and in the Rural South. In the latter, more referrals are made to non-specialist physicians.
- One of the greatest differences in practice between Rural South and Winnipeg was in preventive care. Rural South mean scores were much lower. This difference cannot be explained by the greater likelihood of public health nurses providing immunizations in Rural South since all immunizations were captured and attributed back to the most responsible physician.

- While our indicators are a good first step, one would want to know the impact of these indicators on patient outcomes. This would require a longitudinal analysis over many years to trace the impact of primary care on subsequent health status.

Technical Issues

- The province will only be able to track these indicators if physicians systematically report information on patient contacts. As primary reform efforts move physicians from FFS to alternate payment plans (APP), there is a need for a mechanism to ensure adherence to shadow billing. Along with any reforms, it will be necessary to have electronic information systems in place to support complete data collection and submission.
- Group practices may be very different from solo. However, it is impossible to identify or describe group practices using the data available in the Repository. This is an area that requires further research in order to understand how group practices may be defined, how they share patients, office space and billing systems, and the impact of a group practice on patients. With primary care reform, this issue becomes an even greater priority.
- There are two different ways to measure referrals, one relying on a consult tariff by the physician receiving the referral, and the other relying on the identification of a referring physician on a claim. While these two methods should produce equal results, they do not in Rural South. This distinction is important to understand when analyzing referral patterns in Rural South compared to Winnipeg.

1.0 INTRODUCTION AND BACKGROUND

1.1 Introduction

"Primary Health Care is the first level of contact with the health system where services are mobilized to promote health, prevent illnesses, care for common illnesses, and manage ongoing health problems..." (Manitoba Health)

The **Primary Health Care (PHC)**[1] system is the foundation of Canada's health care system. For most people, it is their first point of contact with the health care system, and it is often through a physician. Across Canada, there have been substantial investments intended to improve the delivery of **primary care**. Most recently, the Primary Health Care Transition Fund, the First Ministers' Accord on Health Care Renewal, and the 10-year Plan to Strengthen Health Care (2004) include commitments to heighten and sustain renewal of this sector. These financial commitments have, to varying degrees, required that the policy, administrative and practice community monitor, guide, and report on renewal efforts. These activities require health information systems that enable people to understand and monitor changes in how physicians deliver primary care.

In Manitoba, the government has published a policy framework that defines its vision, mission, principles and goals for PHC. From the Ministry's perspective "Primary Health Care is the first level of contact with the health system where services are mobilized to promote health, prevent illnesses, care for common illnesses, and manage ongoing health problems... Primary Care includes assessment, diagnosis and treatment of common illnesses generally provided by **family physicians** and nurses. Primary Care is one of the core services provided by the PHC system. Other core PHC services include health promotion, illness prevention, health maintenance and home support, community rehabilitation, pre-hospital emergency medical services and coordination and referral." (Manitoba Health)

Manitoba Health's strategy acknowledges that to support service delivery "… a provincial population health information and monitoring system that collects, analyzes and distributes accurate and timely information is required to ensure the appropriate development and ongoing management of all levels of care within Manitoba's health care system." This study is, in part, an effort to address this stated need.

This study deals with a central component of the PHC system: primary care delivered by a physician.

This study deals with a central component of the PHC system: primary care delivered by a physician. The Manitoba Centre for Health Policy (MCHP) undertook this project as part of its contract with Manitoba Health. The purposes of the study are to (a) develop indicators of primary care delivery that have the potential for application at the individual physician, group-practice and area level, (b) describe current patterns of primary care

[1] Throughout this report, terms in **bold** typeface are defined in the glossary at the end of the report.

physician services delivery, and (c) offer insight regarding current variability in the scope, volume, and quantity of services delivered by primary care physicians.

1.2 Background

The public is increasingly worried about access to, and the quality of primary care. While 86% of Manitobans report having a family physician, 19% report difficulty accessing first contact care, and 16% report difficulty accessing routine care (Sanmartin et al., 2004).

In Canada, both physicians and the general public have expressed concerns about the primary care system. The public is increasingly worried about access to and the quality of primary care. While 86% of Manitobans report having a family physician, 19% report difficulty accessing first contact care, and 16% report difficulty accessing routine care (Sanmartin et al., 2004). In 2001, 92% of Canadians who had a regular family physician reported that the quality of care they received was good or excellent (Sanmartin et al., 2001). But in 2003, this dropped to 70%, and 51% ranked improvements in the quality of care as a top priority. In that same year, fewer than half of Canadians were satisfied with access to care in the community and the timeliness of access (48% and 43%, respectively) (Pollara Inc, 2003). In 2004, 68% of Canadians in an international survey rated the quality of care received from their primary care doctor as excellent or very good. This compares to 74% in New Zealand, 71% in Australia, 64% in the United Kingdom and 61% in the United States (Schoen et al., 2004).

From the physician's perspective, all is not well: workloads and working life are unsatisfactory. In 2004, 65% of family physicians in Canada reported that they were satisfied with their current professional life, and only 52% were satisfied with the balance between personal and professional life. Sixty percent now limit the number of new patients they see or do not take new patients at all (The College of Family Physicians of Canada et al., 2004). Further, fewer medical students are choosing a future in family medicine (Wright et al., 2004) and, those who do carry lower workloads than their predecessors (Watson et al., 2004b; Buske, 2004).

The experiences and expectations of both the public and physicians have commanded the attention of politicians, policy-makers, administrators and practitioners. The need for change is widely recognized and substantive efforts are underway to renew primary care in Canada. In order to enable these stakeholders to monitor, evaluate and guide initiatives designed to facilitate renewal, policy-relevant information is required to inform decision-making processes (Institute of Medicine, 2001; Watson et al., 2004a; Treasury Board of Canada Secretariat, 2000).

Over the last decade, researchers at MCHP have published several reports on care provided by physicians (see Table 1). In addition to the reports listed in this table, a number of others have described the use of physician services at the population level (Tataryn et al., 1994; Frohlich et al., 1994;

Martens et al., 2003; Martens et al., 2004; Fransoo et al., 2005). These reports have helped to inform the activities and decisions of policy-makers, administrators, and practitioners responsible for the delivery of primary care in Manitoba. Two recent reports included several measures or indicators of physicians' activities in the province. Watson et al. (2003) examined ten-year patterns of supply, availability and use of family physicians in Winnipeg. They developed and validated indicators of health, human resource inputs (e.g., physician-to-population ratios), clinical-level activities (e.g., workloads, scope of practice), and primary care outputs (e.g., visit rates). Katz et al.'s (2004) report on quality of care in family practice developed indicators of the provision of **preventive services** (e.g., immunizations, **cervical cancer screening**) and management of chronic disease (e.g., asthma, diabetes) in relation to recommended practice. Thus, building blocks are in place for the construction of a comprehensive overview of primary care provision by physicians.

Table 1: Manitoba Centre for Health Policy reports on physician care

Year	Title	Synopsis
1996	*Needs-Based Planning for Manitoba's Generalist Physicians* by N Roos, R Fransoo, B Bogdanovic et al.	Estimated the need for physicians, based on the population's age, gender, health and socioeconomic mix, and then compared need with supply.
1997	*Issues in the Management of Specialist Physician Resources for Manitoba* by N Roos, R Fransoo, B Bogdanovic et al.	Examined the current supply of specialist physicians in Manitoba, incorporating Statistics Canada data to help project future requirements, and analyzed access to specialists by area of residence and socioeconomic status.
1999	*Development of Physician Information Capabilities* by N Roos and R Fransoo.	Provided a variety of perspectives on physician resources, including individual physician counts, as well as full-time equivalent counts, using several approaches and data sources to ensure counts were as accurate as possible.
1999	*Measuring Morbidity in Populations: Performance of the Johns Hopkins Adjusted Clinical Group (ACG) Case-Mix Adjustment System in Manitoba* by R Reid, L MacWilliam, N Roos et al.	Explored the capabilities of the Johns Hopkins Adjusted Clinical Group system, a tool which uses demographics and ambulatory and hospital diagnostic information to measure the burden of illness in a population.
2000	*Defining Practice Populations for Primary Care: Methods and Issues* by V Menec, C Black, N Roos et al.	Explored questions such as: Who is your doctor? Is there a family physician or clinic that you go to most of the time? What does "most of the time" mean? 50% of the time? 65%? 80%?
2001	*Do Some Physician Groups See Sicker Patients Than Others? Implications for Primary Care Policy in Manitoba* by R Reid, B Bogdanovic, N Roos et al.	Assessed whether some Manitoba clinics treat healthier patients while others treat sicker ones, relevant in the consideration of alternative models of physician reimbursement.
2003	*Supply, Availability and Use of Family Physicians in Winnipeg* by D Watson, B Bogdanovic, P Heppner et al.	Looked at family physicians in Winnipeg over previous ten years to determine how Manitobans went from concerns about having too many doctors to anxieties about a possible shortage.
2004	*Using Administrative Data to Develop Indicators of Quality in Family Practice* by A Katz, C De Coster, B Bogdanovic et al.	Developed a set of thirteen indicators that were used to assess the quality of care Manitoba doctors deliver.

Source: Manitoba Centre for Health Policy, 2006

The present study reports on the development of new indicators relevant to measuring and monitoring primary care outputs. Following a model developed by Watson et al. (2004a), primary care outputs represent the interface between providers and Canadians—where patients and physicians meet to address issues related to health and illness. The indicators developed for this project reflect the different dimensions of primary care outputs: scope, volume, and quality:

1. Scope:
    a. Atypical Diagnostic Coding Index
2. Volume:
    a. Visit Index
    b. Referral Index
3. Quality
    a. Continuity of Care Index
    b. Preventive Care Index

2.0 METHODS

2.1 Overview

As is common with MCHP deliverables, a Working Group was established to advise on the design of the project, methodological approaches, and the interpretation of results. A wide variety of stakeholders were represented: Manitoba Health, the Winnipeg Regional Health Authority, the Office of Rural and Northern Health, the University of Manitoba, River East Clinic, Mount Carmel Clinic and the College of Family Physicians. (See Acknowledgements page for list of Working Group members.)

Our approach was to select physician services that could serve as markers of clinical-level activities and primary care outputs. For each indicator, we first assessed the average, or expected, rate for the given indicator among all the primary care physicians in the region. We then compared each physician's actual performance to the expected value for the patients in their practice. Therefore, each indicator represents a comparison between actual physician practice patterns compared with an expected pattern, which was based on the average of all physicians in the region. We examined the distribution of scores on each index, and explored patient and practice characteristics associated with variation in these scores. Details of indicator construction will be described further for each indicator in the following text. Data analyses were performed using SAS® statistical analysis software, version 8.2.

How should we define a primary care physician? How can we adjust for full-time or part-time physicians? How would we allocate patients to physicians, i.e., who should be included in a physician's practice? The following paragraphs describe how we addressed these and other important methodological issues.

This overview belies the complexity of developing each of the indices. Several thorny issues challenged us: How should we define a primary care physician? How can we adjust for full-time or part-time physicians? How would we allocate patients to physicians, i.e., who should be included in a physician's practice? The following paragraphs describe how we addressed these and other important methodological issues.

2.2 Data Sources

This study used **administrative data** from the **Population Health Research Data Repository** (**Repository**) housed at MCHP. The Repository is a comprehensive research resource developed to describe and explain patterns of care, and profiles of the population's health and illness. The Repository contains records for all Manitobans' contacts with physicians, hospitals, home care, personal care homes, and pharmaceutical prescriptions. The Repository records are anonymous, as prior to data transfer Manitoba Health processes the records to encrypt all personal identifiers and remove all names and addresses. The most recent files readily available at the start of the study (2001/02) were used for all analyses. Since this is a methodological study, it was not deemed critical to update the work with more recent years of data.

The primary source of data for the project was **physician claims** submitted by physicians for services rendered. The majority of physicians are reimbursed on a **fee-for-service (FFS)** basis, which ensures the submission of claims. Physicians on an **alternate payment plan (APP)** are also required to submit claims for administrative purposes. Other information about physicians came from the **Physician Resource Database**: specialty, age, sex, country of training, and years of practice in Manitoba. Additional files used in this study were: the population registry, hospital files, 2001 Census data, and the **Manitoba Immunization Monitoring System (MIMs)** files.

We included only claims for in-province **ambulatory visits** for Manitoba residents to physicians registered as general practitioners or family physicians (subsequently called "physicians"). Visits to primary care paediatricians were also included when calculating the Continuity of Care Index and the Visit Index. Claims from personal care homes and chronic care facilities were excluded from all analyses.

2.3 Physician Inclusions and Exclusion Criteria

Minimum Number of Visits: We included only physicians who had submitted 1,000 or more claims for ambulatory visits during the 2001/02 fiscal year from one or more than one setting. Some physicians practice in more than one setting; visits from all settings were attributed to the physician. Since we were concerned with characterizing the typical physician's delivery of primary care services we deemed it inappropriate to include physicians who were working on a highly reduced part-time basis. Some physicians had months with no claims; these physicians were included in the cohort if they satisfied the minimum visit criterion.

Physician Practice Location: Analyses were carried out based on the **physicians' practice location**, which was determined by the **Regional Health Authority (RHA)** in which most of their patients lived. To be included, the majority of patient visits for each physician had to be from the same RHA for each of the twelve months of the study. Thus, only physicians who appeared to practice in the same RHA for the entire year were included.

Manitoba is divided into eleven RHAs; Winnipeg and Brandon are urban and the rest are rural or northern. Following established practice at MCHP, the rural and northern RHAs were grouped into the larger geographic areas of **Rural South** (North Eastman, South Eastman, Central, Assiniboine, Interlake, and Parkland) and North (Burntwood, Churchill and Nor-Man). The Working Group for this project agreed that there are significant and important differences in the way in which primary care services are delivered in urban and rural settings, and concurred that they be analyzed separately. Brandon is too small to examine alone, and it is also too different from both Winnipeg and rural areas to be included in either region for analysis (Katz et al., 2004). Therefore, physicians practicing primarily in the Brandon RHA were excluded from this study. Physicians practicing primarily in the North were excluded from the analyses for similar reasons (i.e., small numbers and different practice styles).

The number of physicians with one or more claims for the year in question was 1,064. The exclusion of physicians from Brandon and the North reduced this number to 869, and the requirements of regional stability and at least 1,000 visits over the year further reduced the cohort to 631. Some physicians with limited scope of practice (e.g., practice limited to sports medicine) fulfilled these criteria, but were later identified as "atypical", and were therefore excluded from the statistical analyses (See Atypical Diagnostic Coding Index, Page 11). The final cohort consisted of 593 physicians, 347 in Winnipeg and 246 in the Rural South.

2.4 Defining Practice Populations

To define physicians' practices, we included Manitoba residents who received primary care services over the study period. Since patients may seek services from any family physician, many patients see more than one physician in a year. In most cases, however, patients have a 'regular' physician with whom they have more contact over time. A physician who is the principal provider of primary care to some patients may also provide occasional care to other patients who rely on a different physician for the bulk of their care. For some indicators (e.g., Continuity of Care Index) it is important to focus on the former type of patients, while for others (e.g., Atypical Diagnostic Coding Index) one may want to look at both types of patients. Accordingly, we distinguished between two groups of patients for each physician: **core patients** (those who received more visits from that physician than from any other) and **occasional patients** (those who received most of their care from other physicians). Occasional patients include patients who might be a core patient of a different physician as well as patients whose **most responsible physician** was excluded from the study cohort.

Using the **plurality approach to patient allocation** (Katz et al., 2004), we identified a patient as a 'core' patient of their most responsible physician based initially on the number of visits. In the case of a tie (i.e., a patient saw more than one physician the same number of times), plurality was determined by the costs associated first with visits, and then with the costs based on **referral** for other services attributable to that physician. An 'occasional' patient of a given physician was a patient who had a different most responsible physician. Of the 707,330 patients in our study, 91% were allocated as a core patient to a physician (434,997 in Winnipeg and 211,511 in Rural South). The remaining 9% of patients were core patients of physicians not in our cohort, but were occasional patients of at least one physician who was in our cohort.

Table 2 shows the distributions of these two patient types across Manitoba. The total number of patients is much higher than the count of unique patients because occasional patients may be counted more than once: Patient

Y may be a core patient of Dr. A, but may also be an occasional patient of Drs. B and C. Of the 682,692 unique patients allocated to FFS physicians in Manitoba, 88% were identified as core patients compared to 74% of the 61,138 unique patients allocated to APP physicians. That is, FFS physician practices had a higher proportion of core patients than APP physicians.

Table 2: Distribution of core and occasional patients by type of remuneration

	Winnipeg			Rural South			Manitoba		
	FFS*	APP*	Total	FFS	APP	Total	FFS	APP	Total
All Patients	**725,940**	**17,361**	**743,301**	**322,710**	**64,147**	**386,857**	**1,048,650**	**81,508**	**1,130,158**
Core patients	**425,237**	**9,760**	**434,997**	**175,828**	**35,683**	**211,511**	**601,065**	**45,443**	**646,508**
	(59%)	(56%)	(59%)	(54%)	(56%)	(55%)	(57%)	(56%)	(57%)
Occasional patients	**300,703**	**7,601**	**308,304**	**146,882**	**28,464**	**175,346**	**447,585**	**36,065**	**483,650**
	(41%)	(44%)	(41%)	(46%)	(44%)	(45%)	(43%)	(44%)	(43%)
Unique patients **	**479,090**	**12,548**	**487,498**	**203,602**	**48,590**	**237,983**	**682,692**	**61,138**	**725,481**

* fee-for-service (FFS), alternate payment plan (APP)

** The total number of unique patients is 725,481, not 1,130,158. Patients are counted more than once if they are the core patients of one physician and the occasional patients of one (or more) other physicians.

Source: Manitoba Centre for Health Policy, 2006

2.5 Variables

In this section, explanatory variables will be defined. Some of the patient-based variables defined below were used in both the construction of the Indices and in modelling the variation in the indices. To illustrate, when constructing the Visit Index, patient sex was one of the variables used to help calculate the expected level of visits. It was subsequently used, along with other patient and physician characteristics as a predictor in models developed to help explain variation in the Index values among physicians. As a predictor variable, patient sex was used as a way to characterize the physician's practice (i.e., as a proportion of the physician's practice that was female) because, beyond the individual patient characteristics, the make-up of the physician's practice may have an independent effect on explaining variation in physician's practice patterns.

Practice Characteristics:

Patient age: Patient age as of December 31, 2001. This was a continuous variable in the Index construction stage. In Index modelling, age was defined as the proportion of a physician's practice that was aged 0-18, 19-24, 25-44, 45-64, and 65+.

Patient sex: For Index modelling, sex was coded as the percentage of a physician's practice that was female (a continuous variable from 0 to 100).

Socioeconomic Factor Index (SEFI): The **Socioeconomic Factor Index (SEFI)** is a way of describing an overall composite socioeconomic "risk" of a population in a given area. It reflects non-medical determinants of health, such as age, single parent status, female labour force participation, unemployment, and education. SEFI is not an individual-based measure but is based on the averages for all residents in an area: for index construction, SEFI was defined at the RHA district level or Winnipeg neighbourhood level, and for index modelling SEFI was defined at the postal code level. In general, the higher the SEFI score, the greater the socioeconomic risk, the poorer the regional overall health status and the greater the need for health care services (Martens et al., 2002). In Index construction, SEFI was coded as a continuous variable. In Index modelling, we calculated the percentage of patients with higher than average SEFI (also a continuous variable from 0 to 100).

Morbidity: Patient **morbidity** (level of illness) was measured using the **Adjusted Clinical Group (ACG) System** developed by the Johns Hopkins School of Public Health (Johns Hopkins University School of Hygiene and Public Health, 2000). This is a risk adjustment tool developed to measure the illness burden of individual patients and populations. This system quantifies morbidity by grouping individuals based on their age, sex and all known medical diagnoses (both ambulatory and hospital) over a defined time period (typically one year). A **Morbidity Index (MI)** was calculated for each patient using either Winnipeg or Rural South relative costs associated with each ACG. For more information on the development of the MI and its application to Manitoba residents, please see Reid et al. (1999, 2001). At the Index construction stage, this variable was coded as a continuous variable. At the Index modelling stage, the morbidity variable was defined for each physician in terms of the percentage of patients in the practice with morbidity above the regional average (also a continuous variable from 0 to 100).

Physician Characteristics:
Based on the current literature and available data, we identified several demographic and practice pattern characteristics of physicians that could affect patterns of service delivery. These variables were only used in the Index modelling stage, not in Index construction.

Physician age: Physician age as of December 31, 2001, stratified into six age groups: <35, 35-44, 45-54, 55-64, and 65 and older

Physician sex: Male or female.

Canadian graduate: Whether a physician graduated from a Canadian medical school (yes/no).

Years of practice in Manitoba: To a maximum of 11 years as per data availability; stratified into <11 years and 11+ years.

Hospital privileges: Yes/no, determined by the presence of a specific **tariff code** used to bill for visits made in hospital. This variable is more pertinent in Winnipeg where many physicians do not have hospital privileges. Hospital privileges were not included in the multivariate models for Rural South since virtually all physicians in Rural South have hospital privileges.

Payment method: Physicians' principal type of compensation (FFS or APP) was also identified from the Physician Resource Database. Physicians under an APP may be salaried, sessional, or hired on contract. The majority of physicians in our study (84%) practiced exclusively on a FFS basis. Only 8% were solely APP, while another 8% operated under both systems. This last group was assigned into either the FFS or APP group, depending on which one was associated with the majority of their claims.

Physician workload: We used a standard measure of workload, **Full-Time Equivalent** (**FTE**) that employs measurement parameters previously established by Health Canada. This measure uses physicians' annual billings to quantify their practice relative to what is considered a full load and results in a single value for each physician. In essence, 'full-time' physicians are those whose earnings fall between the 40th and the 60th percentile of billings; their FTE value would therefore be 1. The algorithm used to calculate FTE is described fully elsewhere (Watson et al., 2003), and is highly correlated with other workload measures, such as visits per year. In this study, physicians were stratified into three groups, according to whether their workload was less than 1 FTE, 1 FTE, or more than 1 FTE.

3.0 INDICATORS: DESCRIPTION AND RESULTS

Each of the indicators used in this study (**Atypical Diagnostic Coding Index, Visit Index, Referral Index, Continuity of Care Index and Preventive Care Index**) will be described in further detail later. To make the report easier to read, the method of developing each indicator will be immediately followed by the results for that indicator. For all the indices, the distributions are shown divided into deciles: the range of the index scores is divided into 10 equal segments, or deciles, and the distribution of physicians across those deciles is depicted. Then the practice and physician characteristics that were significantly associated with variation in the index are stated. Additional figures that illustrate the more robust of these relationships can be found in Appendix A.

3.1 Indicator of Service Provision: Scope

3.1.1 Atypical Diagnostic Coding Index (ADCI)

Distribution of Diagnoses

Because a visit to a primary care physician is usually the first point of contact with the health system, primary care physicians are expected to address (through direct services or referrals to others) a full array of health states and engage in delivering a broad or comprehensive spectrum of services (Starfield, 1998). Physicians make decisions regarding the range and comprehensiveness of services they provide (Tepper, 2004).

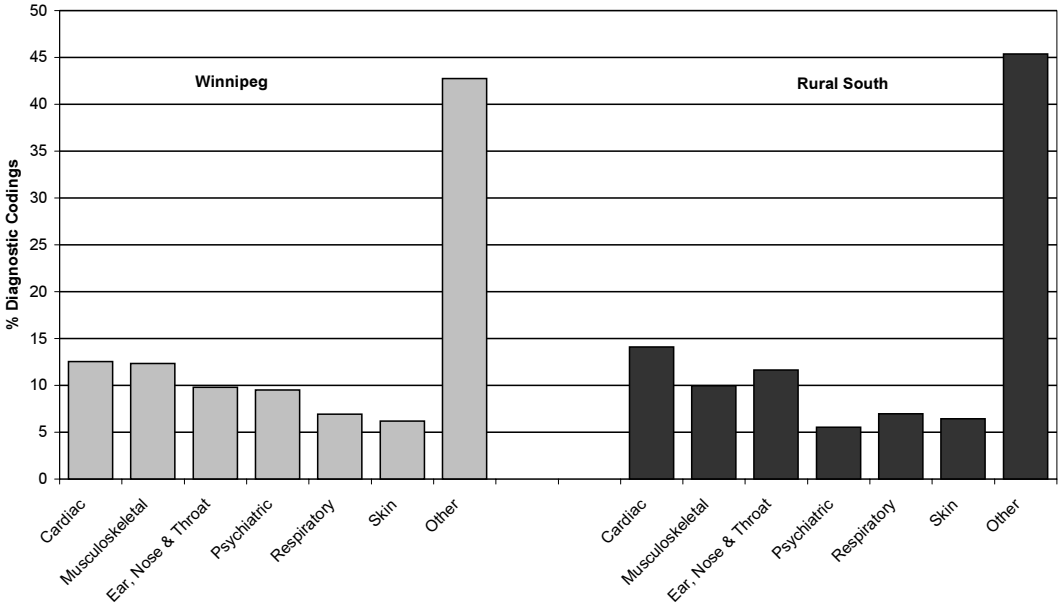
In order to profile the range of clinical areas in which physicians practice, we used a diagnostic grouper, the Johns Hopkins Expanded DIagNOsis Clusters (EDCs), or Dino-Clusters for short.

In order to profile the range of clinical areas in which physicians practice, and building on previous work conducted at MCHP in this area (Watson et al., 2005), we used a diagnostic grouper, the Johns Hopkins **Expanded DIagNOsis Clusters (EDCs)**, or **Dino-Clusters** for short. The Dino-Cluster algorithm assigns approximately 9,400 **ICD-9-CM** diagnostic codes to 190 EDCs, which can be further collapsed into 27 distinct groups. Each claim for a physician visit must have an ICD-9 code. This grouper emphasizes conditions that most commonly occur in ambulatory settings. By grouping diagnostic codes with clinical homogeneity, this method removes differences in coding practices between practitioners (Weiner and Abrams, 2001; Watson et al., 2003). We used the grouper at the level of 27 groups.[2] In this study, we chose to look at the six most frequently occurring clusters (cardiovascular, musculoskeletal, ears-nose-and-throat, psychosocial, respiratory, and skin), which together accounted for 57% of all primary care visits provided by our study cohort of 631 physicians. We combined the other 21 clusters into one group called 'Other'.

[2] We refined the Dino-Cluster coding by reallocating some of the codes that they categorized as "other" into one of the 26 specified categories that appeared relevant.

Figure 1 presents the distribution of diagnoses across the clusters, calculated separately for Winnipeg and Rural South physicians. Given that the accuracy of diagnostic codings is often viewed with some suspicion, it is remarkable that family physicians do code quite similarly to each other. For both Winnipeg and Rural South, the top three diagnostic groups were cardiovascular, musculoskeletal and ears-nose-and-throat. Winnipeg physicians recorded more visits with a Psychiatric diagnosis than did physicians in the Rural South. Respiratory and Skin diagnoses were about equal in both areas. Differences between Winnipeg and Rural South, although they were small, could be due to a combination of factors: difference in the prevalence, a difference in coding practices, or a difference in treatment rates.

Figure 1: Distribution of Diagnostic Coding Across Dino-Clusters for Primary Care Physician Visits



Source: Manitoba Centre for Health Policy, 2006

ADCI Construction

The ADCI was developed in order to see if primary care physicians are subspecializing, and would therefore be less available for generalized care. Although Dino-Clusters allow us to compare the distribution of a given reported condition in one physician's practice versus another, they do not indicate how typical the distribution of the clinical conditions of the patients in a physician's practice is in relation to expected distributions of conditions. For example, while a physician may have claims in all clusters, there may be only a few claims, or no claims in some clusters but many in one or two others. Hence, using the Dino-Clusters, we developed the ADCI. This Index allowed us to examine how atypical physicians' patterns of diagnoses were in relation to the regional norm.

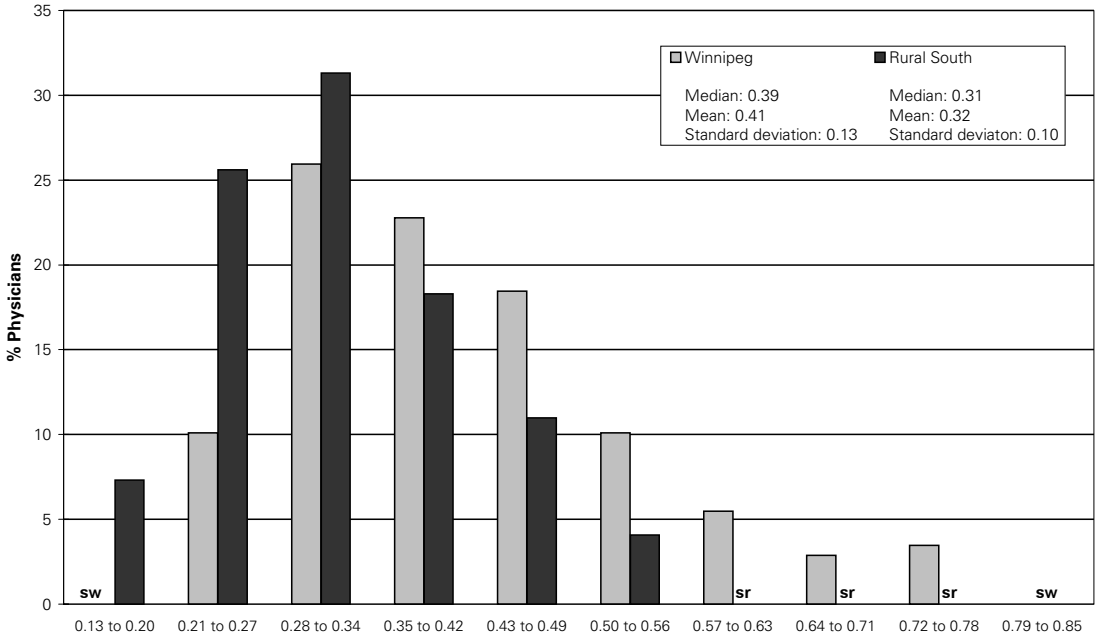
To calculate the ADCI, we first determined the 'expected coding ratio' in each Dino-Cluster, separately for Winnipeg and Rural South physicians. This was taken from the actual distribution of each of 27 Dino-Clusters in the two regions. We calculated the mean proportion of all Dino-Clusters' codings among cohort physicians in the region. This became the region's 'expected proportion of codings' per Dino-Cluster.

To understand how individual physician's codings varied from this average, for each Dino-Cluster, we computed the difference between the actual and expected proportions of codings (i.e., the difference between each physician's proportion and the regional average). To illustrate, in Rural South, as seen in Figure 1, about 10% of codings are for musculoskeletal problems. If Dr. S codes 8% of visits with a musculoskeletal diagnosis, then the difference between actual and expected is 2% (or 0.02). We did this for every Dino-Cluster, and then summed the absolute values of the differences across all the Dino-Clusters. The resulting score reflected the atypicality of the physicians' codings compared to the regional norms and ranged from 0 (absolutely typical) to 2 (most atypical). Physicians with ADCI scores of 0.9 or higher were dropped from all further analyses because it identified them as highly "atypical;" such physicians do not provide a comprehensive range of primary care services. Thirty-six physicians were dropped from the Winnipeg cohort and two were dropped from the Rural South cohort, bringing the total number of physicians to 593: 347 in Winnipeg and 246 in Rural South.

ADCI results

Physicians varied considerably in the typicality of their mix of diagnostic coding of visits. As Figure 2 shows, Winnipeg physicians tended to be a bit more atypical than their Rural South counterparts in their distribution of diagnosis codings: the mean in Winnipeg was 0.41 versus 0.32 in Rural South and there was a higher proportion of physicians in Winnipeg with scores above 0.5. (Recall that since this analysis was designed to develop indicators for generalist physicians, we excluded physicians with ADCI scores of above 0.9, presuming them to be highly specialized.)

Figure 2: Distribution of Physicians' Atypical Diagnostic Coding Index Scores



sw - data suppressed due to small n in Winnipeg only
sr - data suppressed due to small n in Rural South only

Source: Manitoba Centre for Health Policy, 2006

Patient and physician factors explained relatively little of the variance in this indicator (see Table 3). In Winnipeg, 19% of the variance was explained, while in Rural South, only 10% was explained. While we identified some statistically significant relationships, the explanatory power of the overall regressions were relatively low (especially in Rural South). The weak nature of the overall regressions and the ambiguous results obtained from almost all binary analyses of the relationship between the explanatory factors and the ADCI leads us to be cautious about placing too much weight on the importance of these factors.

Table 3: Atypical Diagnostic Coding Index Model*:
Percentage of unique variance attributable to each variable

	Winnipeg	Rural South
Physician Characteristics		
Age (<35, 35-44, 45-54, 55-64, 65+)	0.54 (ns)	
Years in practice in Manitoba	--	4.44
Female	--	1.28 (ns)
Full-time equivalent	--	0.45 (ns)
Practice Characteristics		
% Patients 65+ yrs	5.82	--
% High SEFI** patients	3.09	--
% Patients 25-44 yrs	2.18	--
% Patients 0-18 yrs	1.12	--
Model R^2	19.0	10.0

-- indicates variable was not part of the model
(ns) indicates variable was not significant in the model as a main effect

*Full model results are available upon request from the authors
**Socioeconomic Factor Index

Source: Manitoba Centre for Health Policy, 2006

3.2 Indicators of Service Provision: Volume

3.2.1 Visit Index (VI)

VI Construction

The visit is the main interface between physicians and patients and is the principal service provided by physicians. Thus, the important question is not 'how many visits do patients receive?' but 'do patients receive an expected number of visits?' A second related question is 'to what extent do visit levels across physicians vary from the norm and what factors may account for this variance?' While we cannot establish the 'correct' number of visits for any patient, we can determine the expected number of visits for a patient, based on several patient characteristics known to affect visit frequency: age, sex, socioeconomic status (SES), and level of illness (Finkelstein, 2001; Frohlich et al., 2001).

While we cannot establish the 'correct' number of visits for any patient, we can determine the expected number of visits for a patient, based on several patient characteristics known to affect visit frequency: age, sex, socioeconomic status (SES), and level of illness. This section summarizes the process of constructing the VI.

This section summarizes the process of constructing the VI. (For technical details, please see Appendix B.) We first calculated the expected number of visits for each patient using a multiple generalized linear regression conducted at the level of the patient. The results of this regression model represent how many visits a patient of a given age, sex, SES and level of illness would receive from all physicians if that patient received the average number of visits for patients with the same characteristics. Then, for each core patient, we calculated a visit ratio: the actual number of visits that patient received divided by the expected number of visits for a patient of that type (Actual Visits/Expected Visits). Many patients see physicians other than their most responsible physician; given patient mobility, we used all visits a patient received during the year from any family physician or primary care paediatrician as the actual number of visits.

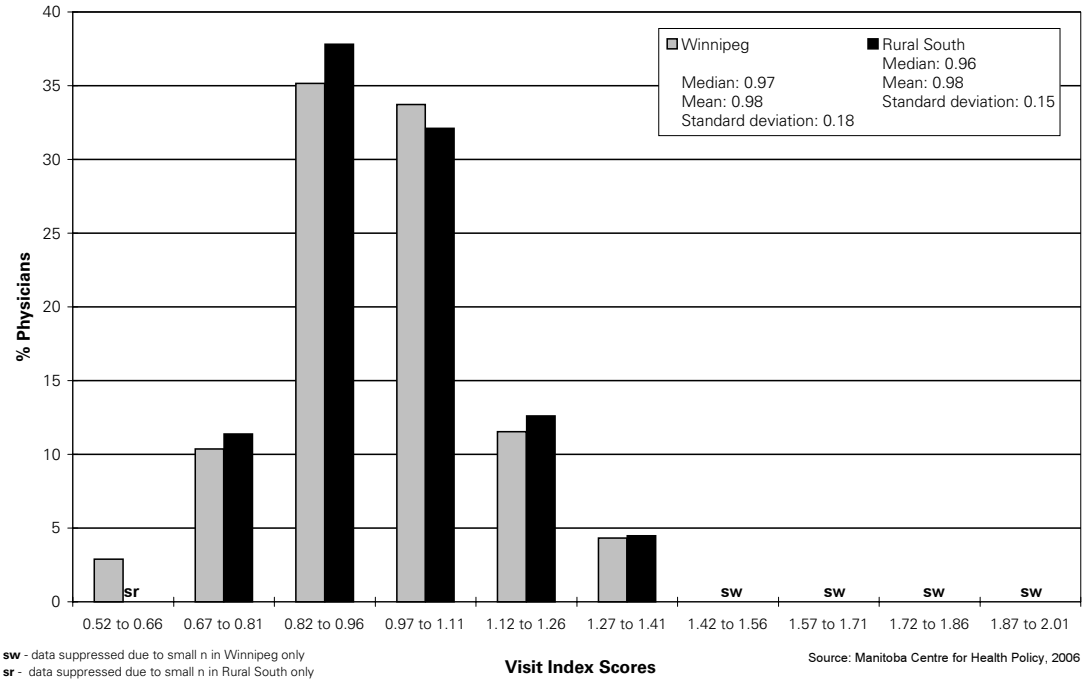
We allocated all visits received by each core patient to the most responsible physician to make the interpretation of the resulting ratio meaningful. It tells a physician how their core patients are receiving visits in relation to the regional norm. Although some of those visits are from other physicians, the physician in question is the most responsible provider. Thus, the visit ratio represents how the core patients in the practice are being treated. Moreover, by definition, the bulk of the visits for these patients are provided by that physician.

Thus, each core patient in a physician's practice had a visit ratio. The physician's VI was the average of these patient ratios for all of that physician's core patients. A physician whose core patients each received the expected number of visits would have a VI of 1. If visit levels were higher than expected, then the physician's VI score would be greater than 1, and a physician whose patients received fewer than the expected number of visits would have a VI less than 1.

VI Results

Figure 3 shows the distribution of physicians across the range of scores in the VI. The mean level of the VI in both Winnipeg and Rural South was 0.98. Winnipeg, however, had a wider range of scores (0.52 to 2.01), than the Rural South (0.63 to 1.44). In Winnipeg, the physicians with the highest VI scores had core patients whose visit levels were more than twice the expected levels of patients of comparable, age, sex, SEFI and morbidity, while the physicians with the lowest VI had patients with fewer than 50% of the expected visits. It is important to note that some of those visits were provided by other physicians, and that there were very few physicians with extreme values. In Rural South, the differences were less marked. Nevertheless, the physicians with the highest VI had core patients with 1.5 times the expected number of visits, and physicians with the lowest VI had core patients with about two-thirds the expected number of visits. Both regions showed considerable variation in the average levels of visits for patients in a practice; however, the levels were concentrated heavily within roughly 25% of the expected visit level.

Figure 3: Distribution of Physicians' Visit Index Scores



sw - data suppressed due to small n in Winnipeg only
sr - data suppressed due to small n in Rural South only

Source: Manitoba Centre for Health Policy, 2006

There is a small positive correlation between the number of core patients and the VI score (data not shown). That is, higher VI scores cannot be attributed to having fewer patients but seeing them more often; in fact, it's just the opposite: higher VI scores are associated with having more patients, not fewer.

Several physician and patient variables were significant in the multivariate regression we performed using the VI as a dependent variable (see Table 4). The model explained 20% of the variation in the Index among Winnipeg physicians. In Winnipeg, a lower than expected VI is associated with having a higher proportion of patients aged 65+ and with being a Canadian graduate. A higher than expected VI is associated with having more patients with a higher than average morbidity.

Table 4: Visit Index Model*: Percentage of unique variance attributable to each variable

	Winnipeg	Rural South
Physician Characteristics		
Canadian graduate	1.57	5.24
Full-time equivalent	1.29 (ns)	4.23
Age (<35, 35-44, 45-54, 55-64, 65+)	--	4.20
Alternate payment plan	--	0.56 (ns)
Practice Characteristics		
% High morbidity patients	7.03	--
% Patients 65+ years	2.44	--
% Patients 25-44 years	--	3.22
% Patients 0-18 years	--	1.34
Model R^2	20.0	28.0

-- indicates variable was not part of the model
(ns) indicates variable was not significant in the model as a main effect

*Full model results are available upon request from the authors

Source: Manitoba Centre for Health Policy, 2006

In Rural South, the model explained 28% of the variation in the VI. A lower than expected VI was associated with having a higher proportion of patients aged 25 to 44, and with being a Canadian graduate. A higher than expected VI was associated with a higher proportion of children and adolescents in the practice, and with working more than one FTE. This latter relationship, while apparently obvious, actually indicates something not obvious. Physicians who bill more do so, in part, by seeing their core patients more frequently, rather than by seeing more patients, less frequently. Physician age is also associated with variation in the VI but the direction is not strictly increasing or decreasing with age, but varies across age categories.

3.2.2 Referral Index (RI)

RI Construction

The RI relates to the extent to which physicians referred patients to other physicians. The question here was, given certain patient characteristics (age, sex, SES, level of illness), how likely is it that the patient will be referred? Does the likelihood of being referred vary between physicians and can we explain why?

Our second volume measure, the RI, relates to the extent to which physicians referred patients to other physicians. The question here was, given certain patient characteristics (age, sex, SES, level of illness), how likely is it that the patient will be referred? Does the likelihood of being referred vary between physicians and can we explain why?

First, to establish an expected level of referrals for a physician, given the characteristics of their patients, we conducted **logistic regressions** separately for Winnipeg and Rural South, using patient age, sex, SES, and individual level of illness. The outcome of the regression was the probability of any patient being referred given that patient's age, sex, SES and illness level.

For each patient, visits were allocated proportionally to every physician they visited. That is, we assumed that the probability of being referred by a given physician was related to the proportion of visits a patient received from that physician. Each probability was then multiplied by the proportion of visits the patient received from that physician, out of all visits that patient received over the study year. To illustrate, if Patient A's probability of being referred was 0.4 (given her sex, age, SES and level of illness) and she saw Dr. X three times and Dr. Y one time, then Patient A's total probability was allocated ¾ to Dr. X (0.4 x 0.75 (X) = 0.3) and ¼ to Dr. Y (0.4 x 0.25 (Y) = 0.1). These probabilities were then summed across all patients in each practice to yield an expected number of referred patients for each physician.

We considered different versions of the RI. Instead of looking at referrals as a yes/no variable, we considered looking at the number of referrals in a given year. However, the proportion of patients in one year with multiple referrals was very low and did not provide enough variation to analyze statistically. In our method, when calculating the probability of being referred, we included all referrals, even those provided by primary care physicians who were not part of the study cohort. There are arguments both for including and excluding these referrals; we chose to include them as they reflect what happens to patients being treated by a physician, and for whom the physician is arguably responsible. While all referrals were included for assessing the probability of being referred, when we constructed the RI, only referrals made by the physicians in the cohort were considered.

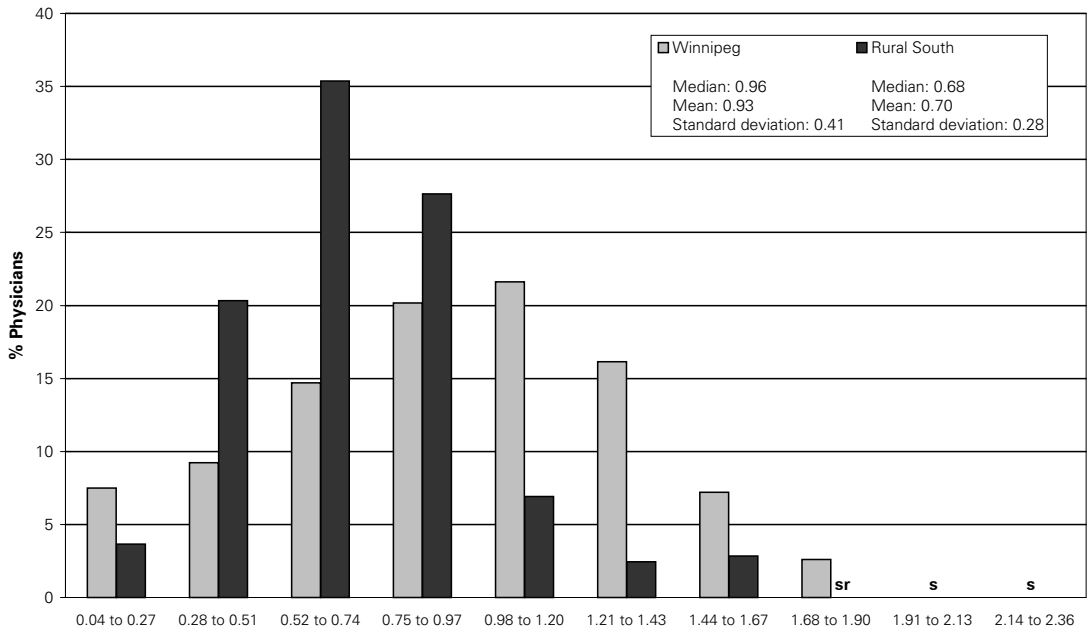
Preliminary analyses indicated that physicians had very different referral patterns for their core and occasional patients. Accordingly, we developed two RIs for each physician's practice: one for core patients (RI_{core}) and one for occasional patients (RI_{occ}). Each RI is a ratio of the actual number of patients referred to the expected number of patients referred. For each physician, an RI score greater than 1 indicates an above average rate of

referred patients compared to the norm in their region, and a number less than 1 represents a rate lower than the norm. Technical details of the construction of this Index can be found in Appendix C.

RI_{core} Results

Figure 4 shows the distribution of the RI in Winnipeg and Rural South for core patients. The mean referral level for Winnipeg was 0.93 compared to 0.70 for Rural South. The seemingly anomalous finding that RI_{core} scores were less than 1 is explained by the fact that the RI scores for occasional patients (RI_{occ}) were more than 1 for both regions. Similar to the VI, the range for the RI_{core} was broader for Winnipeg (0.04 to 2.36) compared to Rural South (0.10 to 1.70). In Rural South, 84% of physicians' RI_{core} scores were clustered around the mean (or were within three deciles of each other). A small number of Winnipeg physicians had scores double the expected levels, while more than twice as many physicians had very low RI_{core} scores, (less than 50% of the expected level).

Figure 4: Distribution of Physicians' Referral Index Scores (Core Patients)



sw - data suppressed due to small n in Winnipeg only
sr - data suppressed due to small n in Rural South only

Source: Manitoba Centre for Health Policy, 2006

The regression models for the RI explained 30% of the variation among Winnipeg physicians (see Table 5). In Winnipeg, lower than expected RI_{core} scores were associated with having a higher than average proportion of low

SES patients in the practice. Higher than expected RI_{core} scores were associated with having more female patients, having more patients with a high level of illness, being in practice more than 11 years and having hospital privileges.

Table 5: Referral Index Model* (Core Patients): Percentage of unique variance attributable to each variable

	Winnipeg	Rural South
Physician Characteristics		
Physician years in practice	1.93	--
Hospital privileges	0.96	--
Age (<35, 35-44, 45-54, 55-64, 65+)	0.48 (ns)	0.93 (ns)
Alternate payment plan	--	7.22
Full-time equivalent	--	0.04 (ns)
Practice Characteristics		
% High morbidity patients	9.51	19.90
% Female patients	6.80	4.17
% High SEFI**patients	3.82	--
Model R^2	30.0	46.0

-- indicates variable was not part of the model
(ns) indicates variable was not significant in the model as a main effect

*Full model results are available upon request from the authors
**Socioeconomic Factor Index

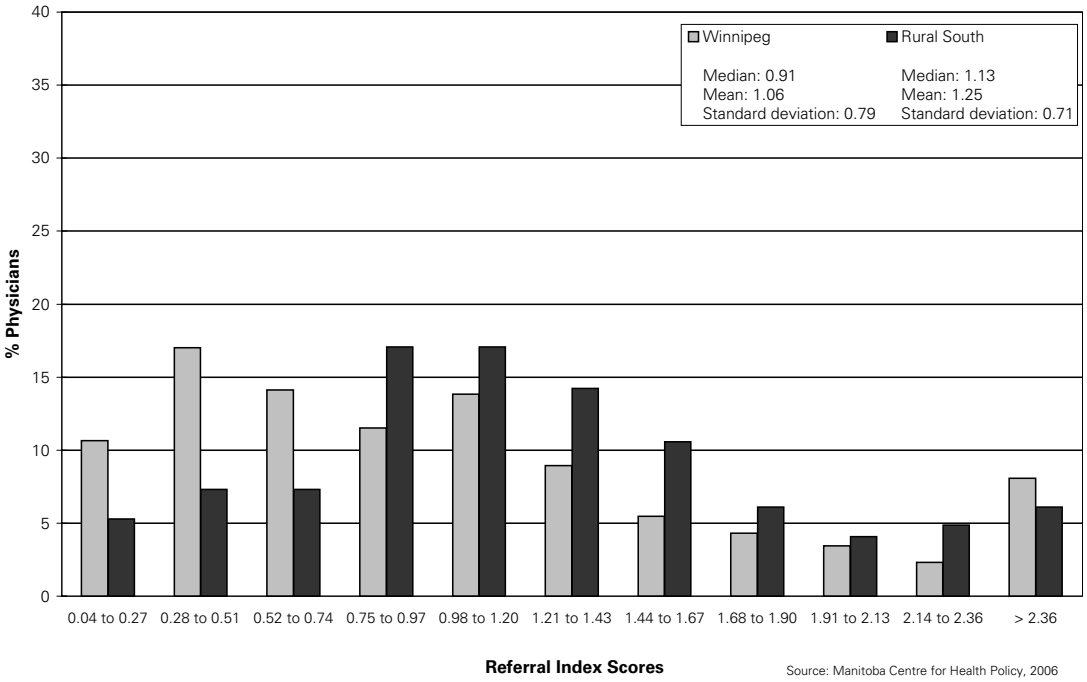
Source: Manitoba Centre for Health Policy, 2006

In Rural South, as in Winnipeg, higher than expected RI_{core} scores were associated with having more female patients, and having more patients with a high level of illness. Additionally, physicians on an APP were more likely to refer than were FFS physicians. The model was quite strong, explaining 46% of the variation in the RI_{core} among Rural South physicians.

RI_{occ} Results

Figure 5 shows the distribution of the RI in Winnipeg and Rural South for occasional patients. Winnipeg physicians had lower mean RI_{occ} scores than did their Rural South colleagues; the mean level for Winnipeg was 1.06 compared to 1.25 for Rural South. Notably, in Winnipeg, a relatively high proportion of physicians (over 26%) had an RI below 0.5. In both regions, the highest RI_{occ} scores were more than four times the average, meaning that occasional patients of some physicians were four times more likely to be referred than one would expect given their age, sex, SES and level of illness.

Figure 5: Distribution of Physicians' Referral Index Scores (Occasional Patients)



Source: Manitoba Centre for Health Policy, 2006

In Winnipeg, the regression models for RI_{occ} explained 25% of the variation among physicians (see Table 6). Lower than expected RI_{occ} scores were associated with having a higher proportion of children, adolescents and younger adults in the practice, having a lower proportion of female patients in the practice, and having a higher than average proportion of low SES patients in the practice. None of the physician characteristics were statistically significant in Winnipeg.

Table 6: Referral Index Model* (Occasional Patients): Percentage of unique variance attributable to each variable

	Winnipeg	Rural South
Physician Characteristics		
Alternate payment plan	--	8.24
Female	--	2.02
Age (<35, 35-44, 45-54, 55-64, 65+)	--	1.83 (ns)
Practice Characteristics		
% Patients 0-18 yrs	10.64	--
% Female patients	9.12	2.67
% Patients 25-44 yrs	3.14	--
% High SEFI** patients	1.02	--
% Patients 65+ yrs	--	5.89
Model R^2	25.0	26.0

-- indicates variable was not part of the model
(ns) indicates variable was not significant in the model as a main effect

*Full model results are available upon request from the authors
**Socioeconomic Factor Index

Source: Manitoba Centre for Health Policy, 2006

In Rural South, higher than expected RI_{occ} scores were associated with having a higher proportion of older adults in the practice, and having more female patients. Physicians paid on an APP were also more likely to refer their occasional patients. Female physicians in Rural South were less likely to refer their occasional patients. The model explained 26% of the variation.

When we reviewed the results of the RI, we were struck by the differences between Winnipeg and Rural South. While some differences were expected, the magnitude of the differences was surprising.

Consultation Index (CI)

When we reviewed the results of the RI, we were struck by the differences between Winnipeg and Rural South. While some differences were expected, the magnitude of the differences was surprising. To try and understand our results, we reviewed our technical definition of '**referral**' and the definition used in previous work at MCHP. Although the RI is new to this study, referrals or **consultations** have been measured before, but there are different ways to define referrals or consultations.

When a physician refers a patient to another physician, the physician who provides the consultation indicates this process in their billing to Manitoba Health in two ways: first, by including the number of the referring physician (the source of the request for the consultation), and second, by a specific consultation tariff [3] that results in a higher fee. This tariff must be accompanied by the number of the referring physician. Previous work at MCHP, primarily interested in whether a patient has received a consultation, has used only these tariffs to identify consultation visits (Tataryn et al., 1994; Martens et al., 2003) rather than the more inclusive measure of a referring physician number. In the current study, however, our focus is on the physician providing the referral. Thus, in developing the RI, we looked specifically for the presence of the referring physician number to define a referral so it could be attributed back to that physician.

If physicians consistently follow this billing process, the two methods should result in the same number of referrals and consultation visits. There is no reason for a billing to identify a physician in the "referring physician" field of the claim if the visit was not a consultation. Furthermore, if the visit was indeed a consultation, we would expect the physician to bill the higher tariff associated with a consultation. However, when we compared RI results for Rural South and Winnipeg, we found marked differences between the two regions in how the "referring physician" field was used. Specifically, in Rural South, numerous claims identified a referring physician but used the tariff for a regular regional visit, not a consultation. Thus, we developed the **Consultation Index** (CI) for Rural South, using only the consultation tariffs. This Index was calculated the same way as the RI (see Appendix C for details).

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[3] Tariff codes 8516, 8550, 8553, 8554, 8556, 8557, 8596, or 8595

Table 7 illustrates the difference in these two measures. In Winnipeg, the results of using either measure are nearly identical for both core and occasional patients. However, in Rural South the two measures yield quite different results. For core patients, the CI yields a higher mean value, very close to the results for Winnipeg. Whereas the RI had a mean value of 0.70 for Rural South (compared to 0.93 for Winnipeg), the CI has a mean value of 0.98 for Rural South and 0.96 for Winnipeg. For occasional patients, the CI was less consistent between the two regions, with mean values of 1.14 and 0.98 for Winnipeg and Rural South, respectively. These findings mean that in Rural South, physicians make referrals to other physicians, but those 'receiving' physicians do not consistently bill for a consultation. This is unlike Winnipeg. We do not know the reasons for this difference between Rural South and Winnipeg; but we know it is an important issue to consider when measuring referrals.

Table 7: Regional distributions of the Referral Index and the Consultation Index

	RI				CI			
	Mean	**Median**	**Max**	**Min**	**Mean**	**Median**	**Max**	**Min**
Winnipeg								
Core patients	0.93	0.96	2.36	0.04	0.96	0.98	2.47	0.04
Occasional patients	1.06	0.91	4.41	0.03	1.14	0.94	4.82	0.04
Rural South								
Core patients	0.70	0.70	1.70	0.10	0.98	0.96	2.88	0.20
Occasional patients	1.25	1.13	4.11	0.07	0.98	0.85	3.77	0.04

Source: Manitoba Centre for Health Policy, 2006

3.3 Indicators of Service Provision: Quality

3.3.1 Continuity of Care Index (COCI)

Continuity of care measures the extent to which patients obtain their care from their most responsible physician as opposed to visiting other physicians.

COCI Construction

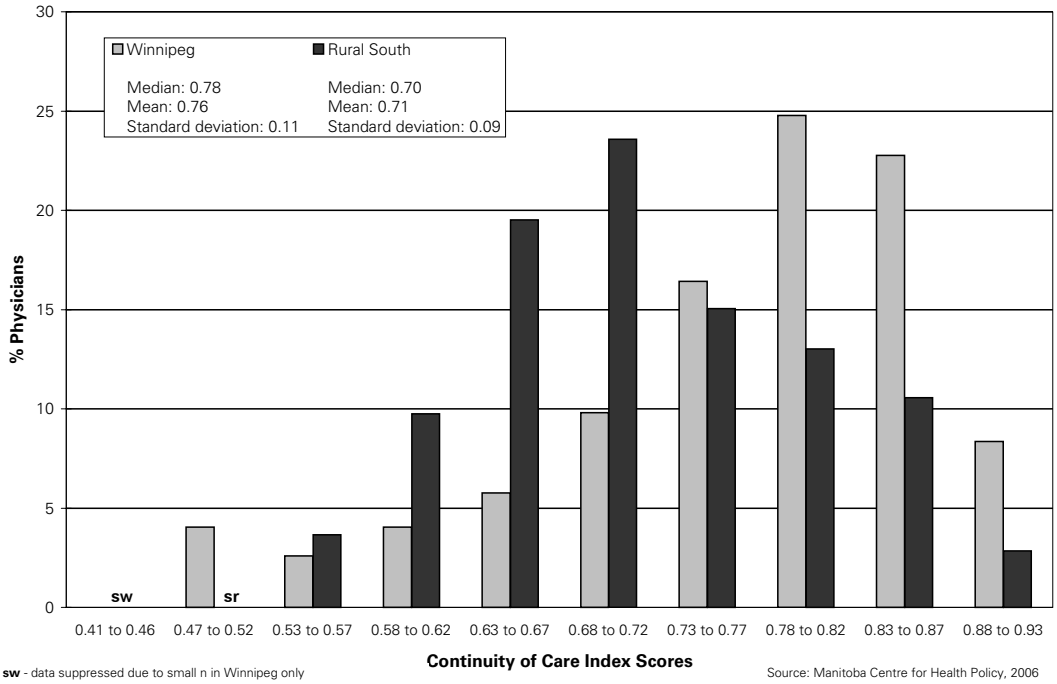
Ideally, physicians have a core base of patients for whom they provide all or most of their care. This pattern allows them to develop and implement appropriate care plans. **Continuity of care** measures the extent to which patients obtain their care from their most responsible physician as opposed to visiting other physicians. We constructed the COCI for each physician, based on core patients with two or more visits (to any physician, including primary care paediatricians, in the study year). Continuity of care for a patient was defined as the number of visits to the most responsible physician divided by the total number of visits that patient had overall. The COCI for the physician was the continuity for each of these patients averaged across all their core patients with two or more visits.

COCI Results

The mean COCI score in Winnipeg was 0.76 and in Rural South 0.71. Thus, in both regions, core patients, on average, received over 70% of their care from their most responsible physician. The distribution in Winnipeg was skewed toward the right: 72% of these physicians had COCI scores over 72% (see Figure 6). In Rural South, COCI scores were somewhat lower, and 71% of physicians had scores ranging between 62% and 82%. This result may reflect greater sharing of patients in group practices in Rural South. (Repository data do not permit us to identify group practices; for further discussion of this issue, see Identification of Group Practices, Page 34.) Notwithstanding that aggregate difference, a higher percentage of Winnipeg physicians (5%) had COCI scores under 52%, compared to only 2% in Rural South. This may be attributable to Winnipeg physicians working in walk-in clinics.

Our regressions were able to explain 49% of the variance in COCI in Winnipeg and 55% in Rural South as a function of patient and physician characteristics (see Table 8). In Winnipeg, higher continuity was associated with having more patients older than 65, working more than 1 FTE, being a female physician, being in practice longer, and having hospital privileges. Lower COCI in Winnipeg was associated with having a higher proportion of patients with high levels of illness, although this association was weak.

Figure 6: Distribution of Physicians' Continuity of Care Index Scores



sw - data suppressed due to small n in Winnipeg only
sr - data suppressed due to small n in Rural South only

Source: Manitoba Centre for Health Policy, 2006

Table 8: Continuity of Care Index Model*: Percentage of unique variance attributable to each variable

	Winnipeg	Rural South
Physician Characteristics		
Full-time equivalent	12.35	5.02
Years in practice in Manitoba	2.65	1.42
Female	2.02	1.54
Hospital privileges	1.71	--
Age (<35, 35-44, 45-54, 55-64, 65+)	--	2.66
Alternate payment plan	--	2.41
Practice Characteristics		
% Patients 65+ yrs	11.01	--
% High morbidity patients	1.98	12.56
% Patients 0-18 yrs	--	12.98
% Female patients	--	1.45
% High SEFI** patients	--	1.24
Model R^2	49.0	55.0

-- indicates variable was not part of the model
(ns) indicates variable was not significant in the model as a main effect

*Full model results are available upon request from the authors
**Socioeconomic Factor Index

Source: Manitoba Centre for Health Policy, 2006

In the Rural South, lower COCI was found in practices with a higher proportion of children and adolescents, of female patients and, as in Winnipeg, of patients with high levels of illness. Higher COCI scores were found in practices with a higher proportion of low SES patients, and among physicians in practice longer, those who worked more than one FTE, and those paid by an APP. COCI was also associated with physician age, but the direction was not consistent across age categories.

3.3.2 Preventive Care Index (PCI)

PCI Construction

The PCI measures the extent to which physicians provide appropriate preventive services to their eligible patients (i.e., patients expected to receive these services).

Preventive care services constitute an important part of a primary care physician's activities and contribute to public health. The PCI, developed by Katz et al. (2004), measures the extent to which physicians provide appropriate preventive services to their eligible patients (i.e., patients expected to receive these services). The PCI includes three indicators of quality in primary care, which are summed to provide the PCI score. **Childhood Immunization** was defined as the percentage of patients (born in 1998) who received their primary course of immunization (DPT-HiB and Polio x4, and MMR) by aged 24 months (see Table 9 for the current immunization schedule). **Influenza Vaccination** was defined as the percentage of patients, aged 65 years or older, who received at least one influenza vaccine in the previous two years. Immunizations/vaccinations provided by **public health nurses** were included in this measure. The third indicator, Cervical Cancer Screening was defined as the percentage of female patients aged 18 to 60 (excluding those who underwent a hysterectomy) who had at least one **Papaniculaou (Pap) smear** in the prior three years. The codes used to define these indicators are listed in Table 10.

Table 9: Manitoba's routine childhood immunization schedule (as of January 2001)

AGE	DaPTP*	Hib*	MMR
2 months	X	X	--
4 months	X	X	--
6 months	X	X	--
12 months	--	--	X
18 months	X	X	--

*DaPTP and Hib are given as "one needle"

D or d	-	diphtheria	M	-	measles (red measles)
aP	-	accelular pertussis (whooping cough)	M	-	mumps
			R	-	rubella (german measles)
T	-	tetanus	HBV	-	hepatitis B
P	-	polio			
Hib	-	*haemophilus influenza type B*			

Source: Routine Childhood Immunization Schedule (as of January 2001). Communicable Disease Control Unit, Manitoba Health, May 2001

Source: Manitoba Centre for Health Policy, 2006

Table 10: Codes used in Preventive Care Index

Indicator	Codes
Childhood Immunization	
DPT-HiB, Polio (X4)	**Tarriffs** 8802, 8804, 8806, 8807
MMR	**Tarriff** 8870
Influenza Vaccination	**Tarriffs** 8791, 8792, 8799
Cervical Cancer Screening	**Tarriffs** 8470, 8495, 8496, 8498, 9795

Source: Manitoba Centre for Health Policy, 2006

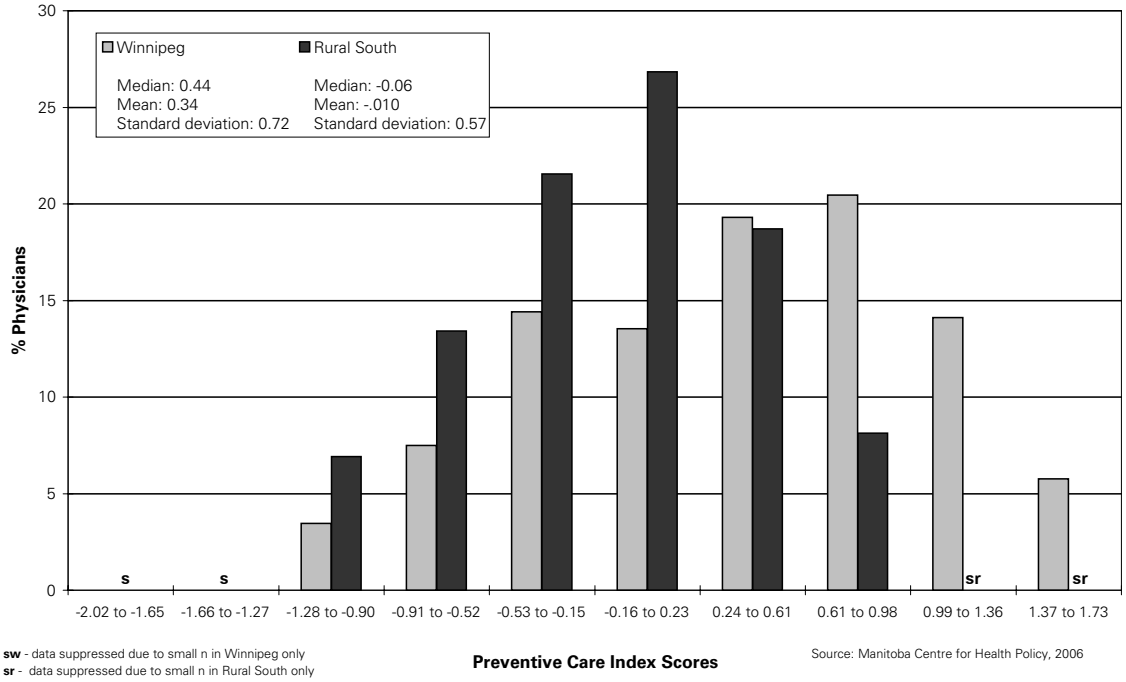
As described by Katz et al. (2004), physicians were only scored on the indicators for which they had eligible patients. The Index score was based solely on the averages of these indicators across physicians. However, to create the PCI, the raw averages of these scores could not be used: the desired clinical outcome was more likely for some indicators than for others and so an average of the three was not very representative. Thus, the indicators were equalized by transforming them to have a mean of zero and standard deviation of one, such that negative scores represent a level of care below average and positive scores indicate an above average level of care.[4] Averages of the transformed scores were calculated for each physician and then for all physicians overall; the latter score served as the standard of comparison.

PCI Results

Physicians' performance on the PCI varied between Winnipeg and Rural South and within each region, with mean values of 0.34 and -0.10, respectively. The negative value for Rural South indicates that on average, Rural South physicians provided fewer preventive services than the provincial norm of PCI=0. This difference cannot be explained by the greater likelihood of public health nurses providing immunizations in Rural South since all immunizations were captured and attributed back to the most responsible physician. As Figure 7 shows, Winnipeg physicians provided more preventive services than did their Rural South colleagues: there is a higher proportion of Winnipeg physicians in the positive side of the graph compared to Rural South.

[4] Note that the scores indicate performance above or below the regional average; however the regional average does not indicate 100% achievement on these indicators.

Figure 7: Distribution of Physicians' Preventive Care Index Scores



sw - data suppressed due to small n in Winnipeg only
sr - data suppressed due to small n in Rural South only

Source: Manitoba Centre for Health Policy, 2006

In the PCI regressions, patient and physician characteristics explained 53% and 23% of the variance in this Index across physicians in Winnipeg and Rural South, respectively (see Table 11). In Winnipeg, lower PCI scores were found in practices with a higher proportion of children and adolescents or a higher proportion of younger adults in the practice. Having a higher-than-average proportion of low SES patients also predicted a low PCI. Having a higher proportion of female patients predicted a better PCI. Physician characteristics associated with a higher PCI were being female, being in practice longer, having hospital privileges and being a Canadian graduate.

Table 11: Preventive Care Index Model*:
Percentage of unique variance attributable to each variable

	Winnipeg	Rural South
Physician Characteristics		
Age (<35, 35-44, 45-54, 55-64, 65+)	1.84	--
Hospital privileges	1.75	--
Canadian graduate	1.40	3.06
Years in practice in Manitoba	1.12	--
Female	0.63	6.13
Practice Characteristics		
% High SEFI** patients	9.89	2.32
% Patient 0-18 yrs	2.06	--
% Patients 25-44 yrs	0.86	--
% Female patients	0.85	--
% Patients 65+ yrs	--	0.27 (ns)
Model R^2	53.0	23.0

-- indicates variable was not part of the model
(ns) indicates variable was not significant in the model as a main effect

*Full model results are available upon request from the authors
**Socioeconomic Factor Index

Source: Manitoba Centre for Health Policy, 2006

In the Rural South region, the only practice characteristic that was statistically significant was SES: having a higher proportion of low SES patients was associated with a lower PCI score. Two physician characteristics predicted a higher Index score, being female and being a Canadian graduate.

3.4 Summary of Findings

The preceding discussion has described the patient and physician characteristics that explain a portion of the variation in each of the indices. Each section was accompanied by a table that indicated the proportion of the variation explained by each significant variable in the model. Table 12 summarizes these findings for Winnipeg and Rural South. The plus and minus signs indicate that the relationship was significant and the direction of the relationship. For example, looking at the VI for Winnipeg, a lower VI score was explained by having a higher proportion of patients who are 65 and older and a higher score was explained by having a higher proportion of patients with an above average level of illness.

Table 12: Relationship of significant physician characteristics with indicators*: Winnipeg and Rural South (Empty cells indicate relationship was not significant. Signs indicate direction of relationship where applicable)

WINNIPEG MODEL						
	ADCI	**VI**	**RI_{core}**	**RI_{occ}**	**COCI**	**PCI**
Practice Characteristics						
% Patients 0-18 yrs	-			-		-
% Patients 25-44 yrs	-			-		-
% Patients 65+ yrs	-	-			+	
% Female patients			+	+		+
% High morbidity patients		+	+		-	
% High SEFI patients	+		-	-		-
Physician Characteristics						
Age (<35, 35-44, 45-54, 55-64, 65+)						yes
Female					+	+
Years in practice in Manitoba			+		+	+
Full-time equivalent					+	
Hospital privileges			+		+	+
Alternate payment plan						
Canadian graduate		-				+
Model R^2	19%	20%	30%	25%	49%	53%
RURAL SOUTH MODEL						
	ADCI	**VI**	**RI_{core}**	**RI_{occ}**	**COCI**	**PCI**
Practice Characteristics						
% Patients 0-18 yrs		+			-	
% Patients 25-44 yrs		-				
% Patients 65+ yrs				+		
% Female patients			+	+	-	
% High morbidity patients			+		-	
% High SEFI patients					+	-
Physician Characteristics						
Age (<35, 35-44, 45-54, 55-64, 65+)		yes			yes	
Female				-	+	+
Years in practice in Manitoba	+				+	
Full-time equivalent		+			+	
Hospital privileges**						
Alternate payment plan			+	+	+	
Canadian graduate		-				+
Model R^2	10%	28%	46%	26%	55%	23%

* Atypical Diagnostic Coding Index (ADCI); Visit Index (VI); Referral Index, core patients (RI_{core}); Referral Index, occasional patients (RI_{occ}); Continuity of Care Index (COCI); Preventive Care Index (PCI)

**Hospital privileges not included in Rural South model.

Source: Manitoba Centre for Health Policy, 2006

4.0 DISCUSSION

We have achieved the goals that we set for this study. We have used data available in the Population Health Research Data Repository (Repository) at the Manitoba Centre for Health Policy (MCHP) to develop indicators of primary care delivery, have applied them to individual physicians, described current patterns of primary care physician services delivery, and offered insights regarding the variability in the scope, volume, and quality of services delivered by primary care physicians.

We have achieved the goals that we set for this study. We have used data available in the Population Health Research Data Repository (Repository) at the Manitoba Centre for Health Policy (MCHP) to develop indicators of primary care delivery, have applied them to individual physicians, described current patterns of primary care physician services delivery, and offered insights regarding the variability in the scope, volume, and quality of services delivered by primary care physicians. The indicators we have used were based on standards of care (e.g., Preventive Care Index (PCI)) or on regional norms that took into consideration relevant patient characteristics. We have presented the distributions of these indicators and have demonstrated how physician and patient characteristics might account for variance from the expected values.

4.1 Strengths and Uses of the Indicators

There are several indications of the face validity of the indicators we have developed. The selection of the indicators built on previous research at MCHP, a model of primary care (Watson et al., 2004), and input from the Working Group. When possible, it made sense to develop indicators based on standards of care, e.g., PCI. Since standards are not available for most indicators, using regional norms permits a fair comparison among colleagues who practice under similar conditions.

The significant relationships also supported the validity of the indicators: a higher level of illness was associated with a higher Visit Index (VI) (in Winnipeg) and Referral Index (RI_{core}) (in both regions); working significantly more than the average full time physician was also associated with a higher VI (in Rural South); higher continuity was associated with being in practice longer (in both regions) which would enable physicians to build up a group of core patients; lower scores on preventive care were associated with having a higher proportion of low socioeconomic status (SES) patients, a finding that has been reported previously (Frohlich et al., 2001; Roos et al., 1999). These results support the validity of these indicators for describing primary care physician behaviour.

The indicators provide opportunities for practitioners, practitioner groups and policy-makers. Individual physicians could compare and evaluate their practice styles to regional norms in terms of the scope, volume and quality of services they deliver. Each physician's own score could inform them about the way they practice in relation to their peers. For example, the VI provides insight into the levels of visits physicians provide their patients after controlling for the patients' age, sex, morbidity and SES. While there is wide variability in the visit levels provided in both Winnipeg and Rural

South, the bulk of physician scores on the Index are—reassuringly—concentrated heavily around its mean. Nevertheless, it may help physicians in evaluating their own behaviour to know if their score was far above or below regional norms.

We cannot tell to what extent these patterns are due to physician or patient behaviour. For instance, we found lower scores on the RI to be associated with a higher proportion of low SES patients in the practice. But we do not know if physicians are referring those patients less often to **specialists**, or if patients themselves are not as actively seeking referrals as are higher SES patients, or whether they do not follow up on referrals.

We measure quality and the degree to which care is typical relative to other physicians. Recent research elsewhere indicates that average physician care in the community often falls below standards established in clinical practice guidelines (McGlynn et al., 2003; Asch et al., 2006). Research in Manitoba on the quality of care provided by family physicians suggest that Manitoba may be no different; Katz et al. (2004) studied the extent to which primary care physicians followed recommended practice for an array of preventive care and chronic disease management indicators. There was clear room for improvement. Average performance ranged from a low of roughly 35% for anticoagulant medication monitoring and post-myocardial infarction cholesterol testing to highs of about 65% to 70% for childhood immunizations and cervical cancer screening. What these findings suggest is that using average performance as the comparator may still lead to less than optimum results.

Beyond the individual physician, score results could serve as the impetus for discussions between Manitoba Health and physician organizations such as the Manitoba College of Family Physicians, the College of Physicians and Surgeons, and the Manitoba Medical Association, regarding modalities of reporting and using index scores. Policy-makers and practitioner groups could also evaluate variances from norms or standards and possibly consider actions to address any variances viewed as problematic. Reports of preliminary results to our broadly-based Working Group elicited interest along these lines.

Policy-makers would be able to use these indicators to assess baseline characteristics of physician practices and to monitor changes over time.

The indices can also be of benefit to policy-makers. Policy-makers would be able to use these indicators to assess baseline characteristics of physician practices and to monitor changes over time. Together with previous reports produced by MCHP, there are now available a variety measures of the care provided by primary care physicians: measures of workload and human resources (Watson et al., 2003), measures of quality (Katz et al., 2004), and now index measures of the volume, quality and scope of primary care services provided. Conceivably different groupings of physicians would also be

possible, for example by geographic area, by physician sex, or other attribute of interest. However, two important issues must be addressed: possible incomplete shadow-billing by alternate payment plan (APP) physicians, and the inability to identify group practices.

4.2 Limitations

4.2.1 Potential Underbilling by APP Physicians

As stated previously, the majority of physicians are reimbursed on a fee-for-service (FFS) basis, which ensures the submission of claims. Physicians on an APP are also required to submit claims, called shadow-bills, for administrative purposes. In Rural South, proportionally more APP physicians than FFS physicians were excluded from the study cohort by our requirement that they have at least 1,000 claims in the study year. This suggests that there may be under-reporting of shadow billing in this region.[5] Inasmuch as these physicians may be different in other regards from their faithfully reporting colleagues, one must interpret the differences in service delivery cautiously. Greater confidence in the relationship between type of physician compensation and physician behaviour require high levels of compliance to shadow billing so that the data provide a more complete and accurate account of all physician activity in the Province.

An example of the possible impact of the exclusion of many APP physicians is one result that was not statistically significant but is potentially significant from a policy point of view. Although the Working Group expected the type of compensation to affect the VI—that FFS physicians would deliver more visits than APP physicians—it was not a significant explanatory factor in either Winnipeg or Rural South. Since we cannot be sure that our sample is representative, we cannot be sure about the validity of this null finding or, indeed, other findings involving payment mechanisms, although strong results are more likely to be valid. To the extent that policy-makers desire valid data upon which to base decisions in this area, there is need for a mechanism to ensure adherence to shadow billing. This is particularly relevant given primary care reform efforts, which may see an increase in alternate payment mechanisms and in the provision of primary care by other **health care providers**, such as nurse practitioners. Along with any reforms, it will be necessary to have electronic billing systems in place to support complete data collection and submission.

[5] In Winnipeg there are very few APP physicians and those who are paid this way are more likely to have automated billing systems which would assist in filing shadow claims.

4.2.2 Identification of Group Practices

All of the analyses in this study were based on the individual physician as the unit of analysis. However, physicians work in a variety of environments which may influence their practice patterns and styles. In terms of the indicators used in this study, a physician who practices in an office without sharing any aspect of the practice with one or more colleagues may differ in behaviour from physicians in a shared group practice. In order to determine differences between solo and group-based physicians, and to see how physician practice changes under differing models of primary care delivery, we need to be able to identify groups of physicians who practice together and further describe those groups.

The Repository does not include the details necessary to allow an unambiguous categorization. While we can determine which physicians share an electronic billing claims system to submit their billing data to Manitoba Health, this information is insufficient to determine the nature of the relationship between those physicians. Several different relationships may exist between physicians using the same claim submission system that may have different effects on our indicators. In some circumstances they run integrated practices where all staff and other resources are shared but patients have a strong relationship with one particular physician. Other relationships may be based on more patient-sharing within the clinic but with less resource sharing. Some physicians may practice in the same clinic, but do not share their resources, their claim submission systems or their patients.

The following illustration uses the size of the group to demonstrate the variability we need to be able to capture and represent in group-based analyses. One obvious way to describe physician groups would be in terms of their size. Size, however, is a surprisingly complex construct that can be defined several different ways, each raising several other issues. For example, it could be measured in terms of the number of visits provided or the number of patients seen. The latter measure requires further specification in terms of whether these are patients who receive all or most of their care from the particular physician or any patient the physician sees. The distinction between such core and occasional patients was discussed earlier in this report.

Another way of characterizing group practices is by workload. Although the full-time equivalent (FTE) measure used in this report to characterize workload is an accepted national algorithm, it is not particularly useful when describing groups of physicians. A group consisting of four FTEs could be made up of either four full-time physicians working five days a week or eight physicians each working halftime. The way those physicians contribute their “halftime work” to the group can vary considerably and each

possibility will affect some of our indicators, such as the Continuity of Care Index (COCI). A physician who is present five mornings per week but is unavailable in the afternoons may be covered by a colleague if a patient needs to be seen. That physician is more easily available (every day) than a physician only working Monday to Wednesday. Physician availability also depends on the size of their practice. A physician with reduced hours, who accepts responsibility for the care of a large number of patients, will offer limited access for patients compared to a physician with the same number of patients and longer working hours. Access is an important variable that affects both continuity of care and the number of visits provided to patients.

Other measures of workload that have been used to reflect practice size include number of patients seen, number of patients assigned to the physician using the plurality method of assignment, number of services (i.e., visits) provided by the physician per year, and visits provided per day of work (Watson et al., 2003; Katz et al., 2004). Although each of these can be measured for individual physicians, to consider a group of physicians by merely summing these numbers does not result in a meaningful measure. Thus, the need to combine data from several physicians working in a group, each with different hours of work and numbers of patients in their practice, makes it exceedingly difficult to define a useful measure of practice size.

The important questions examining the effect of group practices on service delivery require complex and extensive analyses—research which may be even more pressing with primary care reform, which may increase the number of group-based practices and also introduce additional health care providers such as nurse practitioners.

The important questions examining the effect of group practices on service delivery require complex and extensive analyses—research which may be even more pressing with primary care reform, which may increase the number of group-based practices and also introduce additional health care providers such as nurse practitioners. This is particularly relevant for the COCI. We found the scores in the Rural South were lower than in Winnipeg, and yet intuitively, this doesn't make sense, since many people living in the Rural South have fewer choices of physicians. Patients may in fact be obtaining high continuity of care if they receive all of their care from one group practice who shares patients. Therefore, we suggest that the COCI be used with caution until we can obtain further information on group practices. We suggest that Manitoba Health survey all physicians in the province to determine whether or not they practice in groups. A sample of what might be asked in such a survey is in the text box.

Please indicate which of the following best describes how your practice is organized:

1. Solo practice
2. Group practice: share premises only
3. Group practice: share premises and staff, have a walk-in service for any patients
4. Group practice: share premises and staff, no sharing of patients
5. Group practice: share premises and staff, physicians see each others' patients when colleague is away
6. Group practice: share premises and staff, physicians see each others' patients to facilitate an earlier appointment
7. Group practice: share premises and staff, physicians see each others' patients only in an emergency

4.3 Overall Results

A regional comparison of the distribution of physicians' diagnostic codings of visits showed that in general, primary care physicians code diagnoses quite similarly across the province.

A regional comparison of the distribution of physicians' diagnostic codings of visits showed that in general, primary care physicians code diagnoses quite similarly across the province. As to the distribution of physicians' coding according to typical patterns, we found that Winnipeg physicians scored higher on average on the Atypical Diagnostic Coding Index (ADCI), indicating a more narrowly focussed practice. This finding represents a greater tendency for Winnipeg physicians to pursue special interests, whereas this may not be possible when practicing in a rural area. This indicator can be used to assess the degree to which primary care physicians are subspecializing. It supports the perception that Winnipeg primary care physicians may be more likely to subspecialize and therefore not be available for general primary care. When we excluded primary care physicians who had highly specialized practices, 36 (9.4%) of physicians in Winnipeg were dropped, compared to two (0.81%) in Rural South.

The average RI score for core patients was lower in the Rural South (0.70) than in Winnipeg (0.93). This may be explained by geographical proximity between the referring physician and the consultant: for a rural patient, the need to travel a considerable distance to see a specialist, the vast majority of whom are located in Winnipeg, would be a significant disincentive to seeking these consultations. Physicians working in an environment with less dependence on specialist opinions would likely become more confident over time and be even less likely to seek the advice of specialists. However, when we used a different definition for referrals in the Rural South, i.e., the Consultation Index (CI), we found this difference disappeared. An impor-

tant finding therefore is that how one defines 'referrals' in the administrative data may affect the results, especially outside of Winnipeg, and the appropriate definition will depend on the question of interest.

The reasons for differences in referral rates are complex and may be classified into three areas: physician factors, patient factors and patient-physician relationship factors.

Our findings may lead policy-makers and physicians to ask why patients who saw a physician as a core patient were less likely to be referred than patients who saw a physician who was not their most responsible provider—a finding that was consistent for both Winnipeg and the Rural South. The reasons for differences in referral rates are complex and may be classified into three areas: physician factors, patient factors and patient-physician relationship factors. Possible explanations for an increased RI for occasional patients include a patient's pursuing a persistent problem, a patient specifically seeking a referral for a problem for which they did not achieve satisfaction from their most responsible provider or physicians' increased willingness to refer a patient with whom they are less familiar. There is considerable literature debating the potential benefits of continuity of care (see Reid et al., 2002). While it cannot be claimed that continuity of care and our classifications of core and occasional represent the same phenomenon, there is clearly a relationship between the two. It may be that an advantage of core patients is that the resultant patient-physician relationship is stronger and does not rely as heavily on consultation for a second opinion.

The VI is a useful indicator to evaluate not only primary care reform efforts, but also the effects of changes in the supply and mix of family physicians. The range of scores on the VI was narrower for Rural South compared to Winnipeg physicians. The highest scorers in Winnipeg saw patients twice as often as the average Winnipeg physician, however, there were very few physicians in this category and once these few outliers were removed, the highest scorers in both regions saw their patients about 40% more often than the average. The lowest scorers in Winnipeg saw patients half as often as the average and in Rural South, about two-thirds as often as the average.

Inasmuch as preventive services are deemed important and there is desire among policy-makers to improve these services, there is clearly more room for improvement in rural areas.

Perhaps one of the largest differences in the delivery of services by physicians was exhibited in the scores on the PCI. The scores on this Index were standardized so that the mean PCI score for the province was set at 0.0. The mean score in Winnipeg was 0.34, while in Rural South it was -0.1. Immunizations in rural areas are more likely to be provided by public health nurses than by physicians. However, we used data from Manitoba Immunization Monitoring System (MIMS) which includes all immunizations, regardless of provider, so the difference in rates between Winnipeg and Rural South cannot be explained by the higher reliance on public health nurses in the Rural South. Inasmuch as preventive services are deemed important and there is desire among policy-makers to improve these services, there is clearly more room for improvement in rural areas.

4.4 Physician Characteristics

Our objectives included not only constructing indices of physician service delivery, but also identifying factors which might explain variation in the physicians' performances on the indices. Table 12 summarizes the significant relationships between physician characteristics and the physicians' scores on the indicators.[6] Each of the physician characteristics is significantly related to variation in at least two indicators. The more significant of these relationships point to sub-sets of physicians for whom informational or educational initiatives may offer the possibility of improving overall service delivery.

In Rural South, physicians who were remunerated via an APP had significantly higher scores on their RIs. While we cannot determine whether the effect is due to the selection of physicians into the APP grouping, the environment in which they practice, or some other related factor, a strong effect was clearly associated with the type of compensation. This effect was not found in Winnipeg. This is most likely due to the lack of power in the statistical analysis, since the number of APP physicians in the Winnipeg cohort was small. Given our previously stated concerns about potential underbilling, these results should be interpreted with caution.

Physician workload (FTEs) was significantly related to scores on several of our indicators. Higher workload appeared generally to have been focussed more on treating patients more intensively than on expanding the patient base. This was evidenced by positive relationships between FTE scores and the COCI scores in both Winnipeg and Rural South.

In Winnipeg, whether or not the physician graduated from a Canadian medical school was associated with scores on the VI. On average, graduates of Canadian medical schools saw patients less frequently than did their foreign graduated colleagues. While one cannot establish which is the more appropriate visit rate, the difference is notable. The trend was reversed for provision of preventive services, where Canadian trained physicians provided more than their colleagues trained elsewhere. Borgiel et al. (1989) have shown that physicians with residency training are more likely to provide preventive services. Although local family medicine residency programs emphasize preventive services and relevant Canadian guidelines, internationally-trained physicians and older physicians are less likely than local, younger graduates to have had such training.

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[6] In interpreting these relationships, it is important to note that a number of the characteristics are quite highly correlated. For example, female physicians are more likely to have higher percentages of female patients, older physicians, more likely to have older and more morbid (and fewer young and less morbid) patients, etc. So the underlying relationships may be more complex than can be teased out by simple regression techniques. Nevertheless, our analyses cast light on factors which are related to service delivery.

In Winnipeg, a physician's age was associated with the scores on the PCI: there was a significant drop in the provision of preventive services for physicians in their mid-fifties and beyond. Physician sex was significantly related to a few indicators, with females providing more preventive services to their patients in both Winnipeg and Rural South than did male physicians.

Finally, insofar as physician characteristics are concerned, the number of years of practice in Manitoba was associated with significantly higher degrees of specialization by Rural South physicians as measured by the ADCI. It appears that as physicians practice more their coding of diagnoses becomes less like the normal pattern. However, we are unable to determine whether this represents a change in practice patterns or in coding habits.

4.4.1 Practice Characteristics

Although the VI and the RIs were derived on the basis of controlling for some patient characteristics (age, sex, SEFI and morbidity) it was found that physicians' scores on all but one of the indicators (ADCI – Rural South) were, in part, a function of the patient characteristics of their practices. Thus, for example, it may be that a highly morbid patient in a practice with a high number of such patients is more likely to be referred than the same patient in a practice with fewer highly morbid patients. This might be interpreted as an ecological effect within a practice, which operates in addition to the individual effect experienced at the level of the patient. Table 12 shows the significant relationships between the patient composition of a practice and the physicians' score on the indicators.

The practice characteristic with the most impact on physicians' scores on the indices was the percentage of patients with above average morbidity. Higher levels of above average morbidity patients were associated with higher scores on the RI_{core}, and lower on the COCI. Almost 10% of the variance in the RI_{core} was explained by this factor in Winnipeg and almost 20% in Rural South. Over 12% of the variance in COCI scores was explained in Rural South. In Winnipeg, having more above average morbidity patients was also associated with higher VI scores and accounted for 7% of the variance. Thus, the effect of patient morbidity on physician behaviour goes significantly beyond the individual effect of the particular patient's morbidity to the average morbidity of the practice.

The percentage of female patients in a practice also seemed to affect physicians' behaviour. Significantly higher scores on the RIs were associated with practices with more female patients in both Winnipeg and Rural South. It is unlikely that these are associated with pregnancy and other reproductive

issues since these referrals would have formed part of the RI, i.e., it would have been accounted for in identifying the expected number of referrals by age, sex, level of illness.

The percentage of high SEFI (low SES) patients in a practice was negatively related to the RI in Winnipeg, and in Rural South, to the CI. Thus, physicians were less likely to refer patients if their practices comprised a high proportion of patients who were socioeconomically at risk. This effect cannot be attributed to the physician's behaviour alone. It is important to keep in mind the patients' role in referrals; our data only capture referrals that actually result in a visit, but patients may decide against following up on referrals for various reasons. It may also be that environments in which there are more patients of high socioeconomic risk also involve other factors which inhibit patients from following through on referrals, factors like transportation, child care or ability to take time off work. Concerns for equity, however, would draw attention to this discrepancy.

Similar concerns are relevant regarding the effect of high numbers of patients of above average SEFI on provision of preventive care. While Winnipeg physicians performed much better on the PCI than their Rural South counterparts, having a higher proportion of patients of above average socioeconomic risk was still associated with providing fewer preventive services. The gradient was fairly marked. Physicians with low proportions of these patients had an average score of 0.70. Physicians with high proportions of these patients have scores of -0.29. While this reflects more than physician behaviour, inasmuch as patient behaviour may contribute to the gradient, it points directly to the possibility of improvement for physicians in the latter group. Thus, educational initiatives or promotional campaigns could be directed towards physicians with practices with high proportions of high SEFI patients, and to the patients themselves to improve these results.

Finally, the distribution of patients in a practice according to age groups also seems to have had an effect on the delivery of services. The largest effect seems to be with regard to COCI. Physicians with higher proportions of the oldest category of patients tended to provide higher levels of continuity and those with higher proportions of the youngest category the least continuity. This might well be explained by the differential mobility of patients in those two categories. The former effect, regarding older patients, explained over 11% of the variance in the COCI model in Winnipeg, while the latter explained almost 13% of the variance in Rural South. In Rural South, there was also a relationship between higher RI scores for occasional patients in practices with higher proportions of patients above 65 years of age.[7]

[7] It should be borne in mind that the age category composition of a practice is not independent. A practice with a very high proportion of over 65 year old patients must have lower proportions of younger patients. Hence the relationships identified in the categorical regression must be interpreted with some caution.

4.5 Summary

In summary, we have developed a number of indicators of service that could be used by physicians, physician groups and health care policy-makers to inform their decisions, and we have also identified factors which may materially affect the delivery of services as measured by those indices.

In summary, we have developed a number of indicators of service that could be used by physicians, physician groups and health care policy-makers to inform their decisions, and we have also identified factors which may materially affect the delivery of services as measured by those indices. We have described methodological challenges we faced when developing these indicators and our solutions to these challenges. We have highlighted some important technical issues which we think are important to solve in order to monitor primary care practice, particularly in light of ongoing reform efforts.

Our indices were developed relative to existing norms of practice. Ideally, one would want to know which level of visits and which levels of referral lead to the best outcomes for patients. Developing indicators is a first step in that much more ambitious and difficult project. It requires a longitudinal analysis over many years to trace the impact of primary care on subsequent health status. We believe the Repository available at MCHP may provide the unique resource necessary for an analysis of that scope and depth. But that is a work for another day.

5.0 KEY POINTS

- The indicators reflect different dimensions of primary care outputs: scope (Atypical Diagnostic Coding Index), volume (Visit Index, Referral Index), and quality (Continuity of Care Index, Preventive Care Index).
- The COCI may underestimate continuity: continuity provided in a group practice setting cannot be captured with our data. Having better data on group practices would allow us to extend the utility of this indicator. Therefore, we suggest that Manitoba Health conduct a survey of all physicians in the province to determine where and to what extent they practice in groups.
- The indicators are relevant to physicians, physician groups and policy-makers. They can assist in evaluating individual performance, in identifying areas requiring continuing medical education or detailing, and in assessing the effects of primary care system reform.
- Policy-makers would be able to use these indicators, along with others (workload, human resources, quality) previously developed by MCHP, to assess baseline characteristics of physician practices and to stimulate and monitor changes over time. Different groupings of physicians could be compared, for example by geographic area, by physician sex, or other attribute of interest.
- Both physician and practice characteristics are associated with variation in Index scores. Physician characteristics include age, sex, years in practice, workload, having hospital privileges (in Winnipeg), payment method and being a Canadian graduate. Practice characteristics included the distribution of patients with regard to age, sex, level of illness and socioeconomic risk.
- Practices are more likely to be focussed into subspecialized interest areas in Winnipeg compared with the Rural South. This could mean that fewer physicians who practice general primary care are available in Winnipeg.
- Core patients were less likely to be referred than occasional patients. An increased RI for occasional patients may be due to either patient or physician behaviour: patients may seek a referral for a problem for which they did not achieve satisfaction from their most responsible provider, or physicians may be more willing to refer a patient with whom they are less familiar.
- Referral behaviour is different in Winnipeg and in the Rural South. In the latter, more referrals are made to non-specialist physicians.
- One of the greatest differences in practice between Rural South and Winnipeg was in preventive care. Rural South mean scores were much lower. This difference cannot be explained by the greater likelihood of public health nurses providing immunizations in Rural

South since all immunizations were captured and attributed back to the most responsible physician.

- While our indicators are a good first step, one would want to know the impact of these indicators on patient outcomes. This would require a longitudinal analysis over many years to trace the impact of primary care on subsequent health status.

Technical Issues

- The province will only be able to track these indicators if physicians systematically report information on patient contacts. As primary reform efforts move physicians from FFS to APPs, there is a need for a mechanism to ensure adherence to shadow billing. Along with any reforms, it will be necessary to have electronic information systems in place to support complete data collection and submission.
- Group practices may be very different from solo. However, it is impossible to identify or describe group practices using the data available in the Repository. This is an area that requires further research in order to understand how group practices may be defined, how they share patients, office space and billing systems, and the impact of a group practice on patients. With primary care reform, this issue becomes an even greater priority.
- There are two different ways to measure referrals, one relying on a consultation tariff by the physician receiving the referral, and the other relying on the identification of a referring physician on a claim. While these two methods should produce equal results, they do not in the Rural South. This distinction is important to understand when analyzing referral patterns in Rural South compared to Winnipeg.

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GLOSSARY

Acronyms used in this report:

ACG – Adjusted Clinical Group
ADCI – Atypical Diagnostic Coding Index
APP – Alternative Payment Plan
CI – Consultation Index
COCI – Continuity of Care Index
EDC – Expanded DIagNOstic Clusters
FFS – Fee-for-Service
FTE – Full-Time Equivalent
ICD – International Classification of Disease
MIMS – Manitoba Immunization Monitoring System
MI – Morbidity Index
PCI – Preventive Care Index
PHC – Primary Health Care
RHA – Regional Health Authority
RI – Referral Index
SEFI – Socioeconomic Factor Index
SES – Socioeconomic Status
VI – Visit Index

Adjusted Clinical Group (ACG) System

A risk adjustment tool developed to measure the illness burden of individual patients and enrolled populations. This system quantifies morbidity by grouping individuals based on their age, gender and all known diagnoses assigned by their **health care providers** over a defined time period (typically, one year).

Administrative Data

Information collected "usually by government, for some administrative purpose (e.g., keeping track of the population eligible for certain benefits, paying doctors or hospitals), but not primarily for research or surveillance purposes" (Spasoff, 1999). MCHP's research uses administrative data from hospital discharge summaries, physician billing claims, claims for prescription drugs, and other health related data. Using these data, researchers can study the utilization of health resources over time and the variations in rates within and across the provinces.

Alternate Payment Plan (APP)

Type of compensation for physicians who are not paid on a **fee-for-service** basis but are either salaried, sessional, or hired on contract. These physicians submit claims (shadow-billings) for administrative purposes only.

Ambulatory Visits

Almost all contacts with physicians: office visits, walk-in clinics, home visits, personal care home (nursing home) visits, visits to outpatient departments, and some emergency room visits (where data are recorded). Services provided to patients while admitted to hospital, and most visits for prenatal care are excluded.

Atypical Diagnostic Coding Index (ADCI)

Developed in this study, this Index identifies the extent to which a family physician's diagnostic codings across Dino-Clusters are distributed atypically compared to their peers.

Cervical Cancer
Cancer of the uterine cervix, the portion of the uterus attached to the top of the vagina. **Papaniculaou (Pap) smears** screen for pre-cancerous changes and cancer.

Childhood Immunization
An intervention to initiate or increase resistance against infectious disease. Manitoba's recommended immunization schedule for children under two years of age is presented in Table 9. Codes used to define the vaccines are in Table 10.

Consultation Index
An Index developed for the this study to measure the extent to which a physician over or under-refers patients compared to the average physician after taking into account the characteristics of their practice population. It is the ratio of the actual number of referred patients to the expected number of referred patients identified using consultation tariffs. Separate indices were developed for core and occasional patients in a practice. These indices were compared to the corresponding **Referral Indices**.

Consultations
Visits provided by physicians as a result of referrals from another physician.

Continuity of Care (ambulatory)
The extent to which individuals see a given **health care provider** (versus one or more other providers) over a specified period of time. A provider may be defined either as an individual physician, a physician group practice, or a clinic. Continuity of care can be calculated in several different ways. In this study, visits were used to calculate continuity of care for **core patients** with at least two visits to their **most responsible physician.**

Continuity of Care Index (COCI) (physician)
An Index to measure the extent to which a physician's patients with at least two visits (to that physician) see them versus one or more other physicians over a specified period of time. It is the average of the patient's **continuity of care** and can range from just greater than zero to one.

Core Patients
Patients who are allocated to a **health care provider** because they received most of their care from that provider than from any other. These patients are considered **occasional patients** of any the other provider visited. In this study, core patients for physicians were identified through the **plurality approach to patient allocation**.

Dino-Clusters
See **Expanded DIagNOsis Clusters (EDC)**

Expanded DIagNOsis Clusters (EDCs or Dino-Clusters)

Part of the Johns Hopkins diagnosis grouping and case-mix tools, this classification tool categorizes ICD-9-CM diagnosis codes found in claims into 190 disease-specific clinical categories (EDCs or Dino-Clusters). These can then be used to identify persons with specific diseases or symptoms without the need to create algorithms. "The 190 EDCs are organized into 27 categories called Major Expanded Diagnosis Clusters (MEDCs)" (Weiner and Abrams, 2001).

Family Physician

A generalist physician who provides and coordinates personal and continuing comprehensive primary health care to individuals and families. Such physicians are identified by a code in MCHP's physician data.

Fee-For-Service (FFS)

Type of compensation whereby physicians bill for each service rendered, according to a pre-arranged schedule of fees and services. Other physicians are compensated under the **alternate payment plan.**

Full-Time Equivalent (FTE)

Standard measure of physician workload established by Health Canada that uses physician billings to quantify their practice relative to what is considered a full load and results in a single value for each physician. 'full-time' physicians (FTE=1) are those whose earnings fall between the 40th and the 60th percentile of billings. A physician with an average workload above this 'normal' level would have an FTE value greater than one and a physician whose workload is below "normal" would have an FTE value of less than one.

Generalized Linear Regression

A statistical technique that estimates values of one variable on the basis of two or more other variables; the relationship between the variables is assumed to be linear.

Health Care Provider

A person or facility providing health care services in order to identify, prevent, or treat an illness or disability. This could include physicians, nurse practitioners, pharmacists, hospitals, and clinics. This study focussed on physicians.

ICD-9-CM

The 9th version of the ICD (International Classification of Disease) coding system (with Clinical Modifications), developed by the World Health Organization (WHO) that is used to classify diseases, health conditions and procedures.

Logistic Regression

Statistical technique for estimating the probability of an event based on two or more variables.

Manitoba Immunization Monitoring System (MIMS)
A population-based monitoring system that provides monitoring and reminders to help achieve high levels of immunization. Immunization status is monitored by comparing the system record and the recommended schedule.

Morbidity
"Any departure, subjective or objective, from a state of physiological or psychological well-being (i.e. sickness or illness)" (Last et al., 2001).

Morbidity Index (ACG-based)
An Index developed at MCHP based on the **ACG System** to measure the "disease burden" of individuals and populations using diagnostic codes routinely collected in administrative data. In this study, the Index represents the sum of the "portions" of each patient's morbidity in a practice.

Most Responsible Physician
The physician who provided the majority of the patient's primary care. This may be measured in several different ways such as using visit costs or number of visits. In this study, the most responsible physician was the one who provided more of the patient's visits than any other physicians.

Nurse Practitioner
Registered nurses with advanced training that allows them to provide a full range of primary healthcare services to patients. "They work in partnership with physicians and other health care professionals to provide care in a variety of health care settings." (Nurse Practitioner Association of Manitoba, 2006).

Occasional Patients
Patients attending a **health care provider** who receive most of their care from another provider. They are considered **core patients** of the other provider. This study focussed on patient visits to physicians.

Papaniculaou (Pap) Smear
A microscopic examination of cells scraped from the cervix used to detect pre-cancerous changes in cervical cells, and cancers. See Table 10 for codes used to identify these tests.

Patient Allocation
The process of allocating all patients to their most responsible **health care provider** during the study period. This is necessary in order to define the provider's practice. In this study we used the **plurality approach** to allocate patients to their **most responsible physician**.

Physician Claims

Claims that are submitted to the provincial government by individual physicians for services they provide. **Fee-for-service** physicians receive payment based on these claims, while those submitted by physicians on **alternate payment plans** are for administrative purposes only. The physician claims data file is part of the **Population Health Research Data Repository**.

Physician Practice Location

The location of a physician's practice based on where the majority of their patients live. This may be determined in one of several ways, such as using patients' municipal code, **Regional Health Authority** (**RHA**), or **RHA district**. In this study, we used patients' RHA of residence.

Physician Resource Database

An elaboration of the basic physician information available to the **Population Health Research Data Repository** from Manitoba Health. It contains physicians' demographic data and information derived from analysis of their practice patterns. These data can be used to analyze other components of the Repository from the perspective of physicians.

Plurality Approach to Patient Allocation

A method that assigns patients exclusively to their most responsible **health care provider.** In this study, the **most responsible physician** was the one who provided more of their visits than any other physician. When more than one physician provided equal numbers of visits, the patient was assigned to the physician with the greatest visit costs and in the case of a second tie, total costs were used. Calculation of total cost included direct care (i.e., visits) and indirect care (i.e., referrals for other services and consults).

Population Health Research Data Repository (Repository)

A comprehensive collection of administrative, registry, survey and other databases primarily comprising residents of Manitoba housed at the Manitoba Centre for Health Policy (MCHP). It was developed to describe and explain patterns of health care and profiles of health and illness, facilitating inter-sectoral research in areas such as health care, education, and social services. The administrative health database, for example, holds records for virtually all contacts with the provincial health care system, the *Manitoba Health Services Insurance Plan* (including physicians, hospitals, personal care homes, home care, and pharmaceutical prescriptions) of all registered individuals. MCHP acts as a steward of the information in the Repository for agencies such as Manitoba Health.

Preventive Services
Medical services delivered by physicians that are directed at prevention or early detection of disease. This study included two levels or types of preventive care: primary preventive care (e.g., immunizations) and secondary preventive care (i.e., early detection).

Preventive Care Index (PCI)
An Index developed by Katz et al. (2004) to measure the extent to which physicians provide appropriate preventive services to their eligible patients. It includes three such services: **childhood immunizations,** influenza vaccination for seniors, and **cervical cancer** screening. The Index score for each physician reflects the proportion of their eligible patients who receive appropriate care. In this study, the score was also calculated across all physicians overall as the standard of comparison; physicians scoring above the standard were considered "below average" and those higher than the standard were deemed "above average".

Primary Health Care (PHC)
In Manitoba, "the first level of contact with the health system where services are mobilized to promote health, prevent illnesses, care for common illnesses, and manage ongoing health problems.…" (Manitoba Health)

Primary Care
"In Manitoba, one of the core services provided by the **Primary Health Care** system. It includes assessment, diagnosis and treatment of common illnesses generally provided by family physicians and nurses." (Manitoba Health)

Public Health Nurses
Nurses with expertise in areas such as communicable diseases, maternal-child and school health. They deliver services within communities using a community-based model whereby services are driven by the needs and resources of a defined community.

Referral Index (RI)
An Index developed for this study to reflect the extent to which a physician over or under-refers patients compared to the average physician after taking into account the characteristics of their practice population. It is the ratio of the actual number of referred patients to the expected number of referred patients identified using the referral field on **physician claims**. Separate indices were developed for core and **occasional patients** in a practice.

Regional Health Authority (RHA) Districts
Subdivisions of **Regional Health Authorities** defined based primarily on municpal code and some postal codes for analysis purposes. Districts were created collaboratively by individual RHAs, MCHP, and Manitoba Health.

Regional Health Authorities (RHAs)
Regional governance structures set up by the province to be responsible for the delivery and administration of health services in specified areas. In Manitoba, as of 2002, there are 11 RHAs.

Rural South
An aggregate geography which includes all of the **Regional Health Authorities (RHAs)** in the south and the mid-province of Manitoba except the two urban centres of Winnipeg and Brandon. Those RHAs include: South Eastman, Central, Assiniboine, Interlake, North Eastman, and Parkland.

Screening
A process (i.e., test, examination, or other procedure) to distinguish between well individuals who probably have (or are likely to develop) a particular disease from those who probably do not have it.

Socioeconomic Factor Index (SEFI)
An Index developed at MCHP that provides a way of describing an overall composite socioeconomic "risk" of a population in a given area. It reflects the non-medical determinants of health, such as age, single parent status, female labour force participation, unemployment, and education. The lower the SEFI score the more favourable the socioeconomic conditions.

Specialists (physician)
Physicians whose practices are limited to a specific area of medicine in which they have undergone additional training. They were identified by a code in the **Physician Resource Database**.

Tariff Code
A specific code used to identify each service provided by physicians or **nurse practitioners**, as defined in the **tariff manual**.

Tariff Manual
A manual defining the specific services and fee schedule for which a physician may bill Manitoba Health. This is updated on a regular basis.

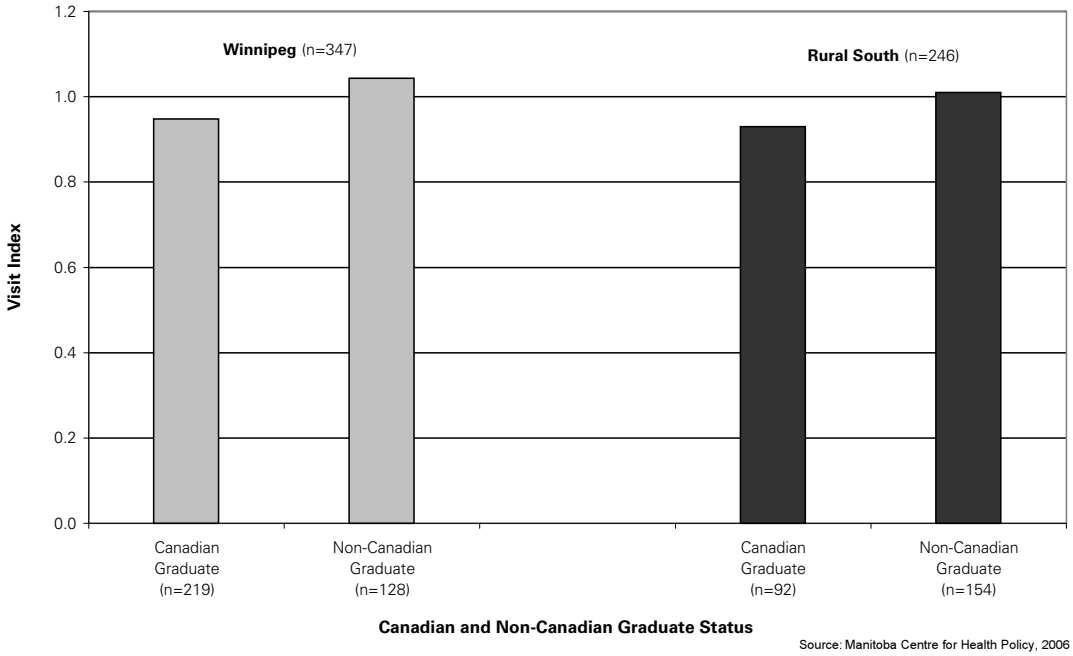
Visit Index (VI)
An index developed in this study to reflect the extent to which a physician over or under-provides visits to his/her patients compared to the average physician after taking into account the characteristics of their practice population. It is the average ratio of the actual number visits to the expected number of visits for core patients in a practice.

APPENDIX A: BI-VARIATE ANALYSES

The results of the multivariate models are reported in the text. For each of the indicators, models were developed to determine which characteristics—such as age of physician, sex of physician, age distribution of the practice, proportion of practice with higher than average level of illness, and so on—helped to explain variation in the indicator. Modeling tells us the impact of each predictor variable on the outcome, *after adjusting for all other variables*. However, it is difficult to illustrate the results of multivariate models. Therefore, we have created these bi-variate graphs which illustrate the relationship between selected predictor variables and the different indicators. These graphs show the relationship of one predictor variable with a specified outcome *without* adjusting for the effect of other variables. Following the adage that a picture is worth a thousand words, they were developed so that these relationships would be more easy to see. The selection of graphs was guided by results of the multivariate models. In the cases of some variables, which are continuous, we have converted the variables into ordinal form for purposes of illustration, but in all cases, the underlying significance of the relationships referred to is that reflected in the regressions.

Visit Index (VI)

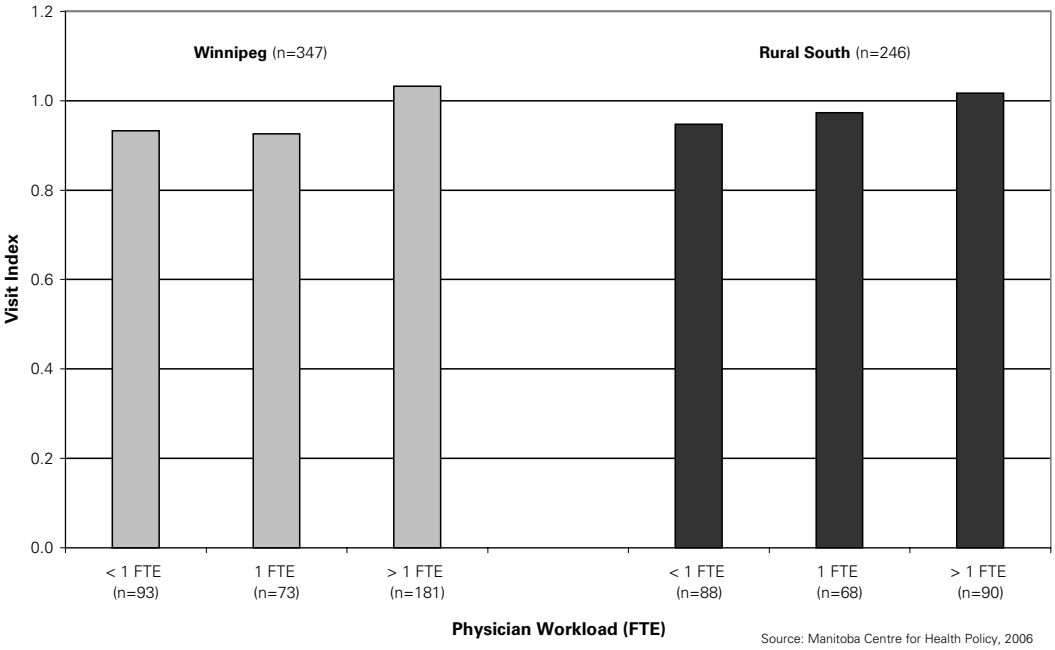
Appendix Figure A.I: Visit Index by Canadian and Non-Canadian Graduate Status



Source: Manitoba Centre for Health Policy, 2006

Several physician and patient variables were significant in the multivariate regression we performed using the VI as a dependent variable. The differences in the VI between physicians who graduated from a Canadian medical school and those who trained elsewhere are illustrated in Figure A.1. Physicians who graduated from a Canadian medical school had below average visit levels in both Winnipeg and Rural South (0.95 and 0.93, respectively) while foreign trained physicians had higher levels (1.04, and 1.01, Winnipeg and Rural South, respectively).

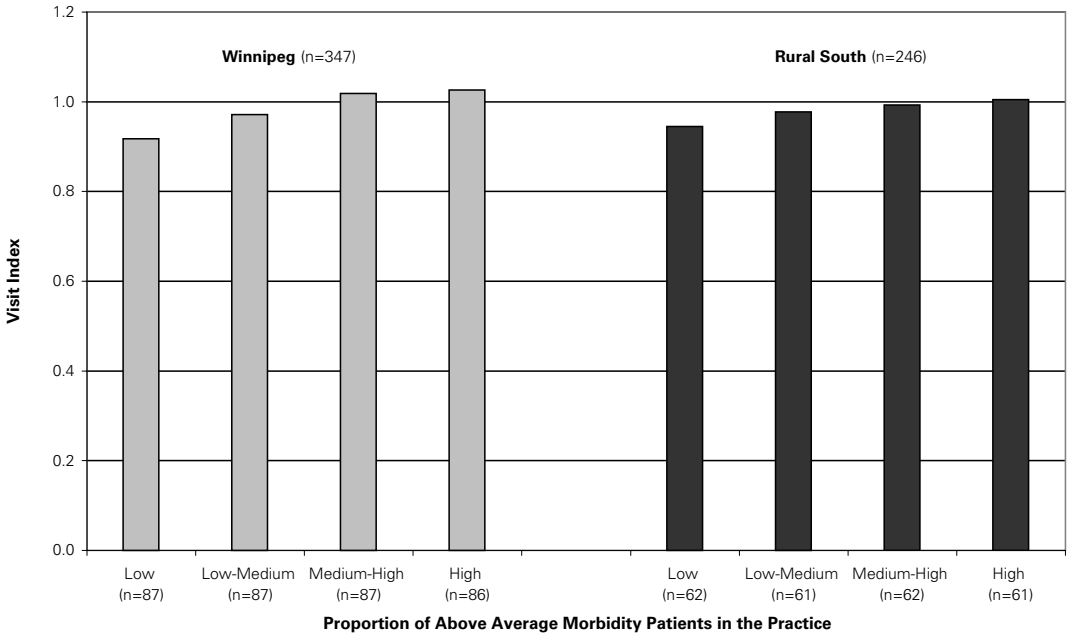
Appendix Figure A.2: Visit Index by Physician Workload (FTE)



Source: Manitoba Centre for Health Policy, 2006

The total value of a physician's billings for services (represented here as FTEs) seemed to affect the extent to which patients received higher or lower levels of visits. Not surprisingly, as shown in Figure A.2, physicians who had a high amount of annual billings generally saw patients more frequently than those with lower annual billings. The one exception was physicians who fell within the middle range of FTEs in Winnipeg. When evaluating this variable, one should note that higher activity (billing) levels by a physician could be a result of seeing *more* patients *less* frequently. Since the VI increased with FTE, it indicates that higher activity levels means that the more active physicians were providing more visits to their patients rather than seeing more patients.

Appendix Figure A.3: Visit Index by Proportion of Above Average Morbidity Patients in the Practice



Source: Manitoba Centre for Health Policy, 2006

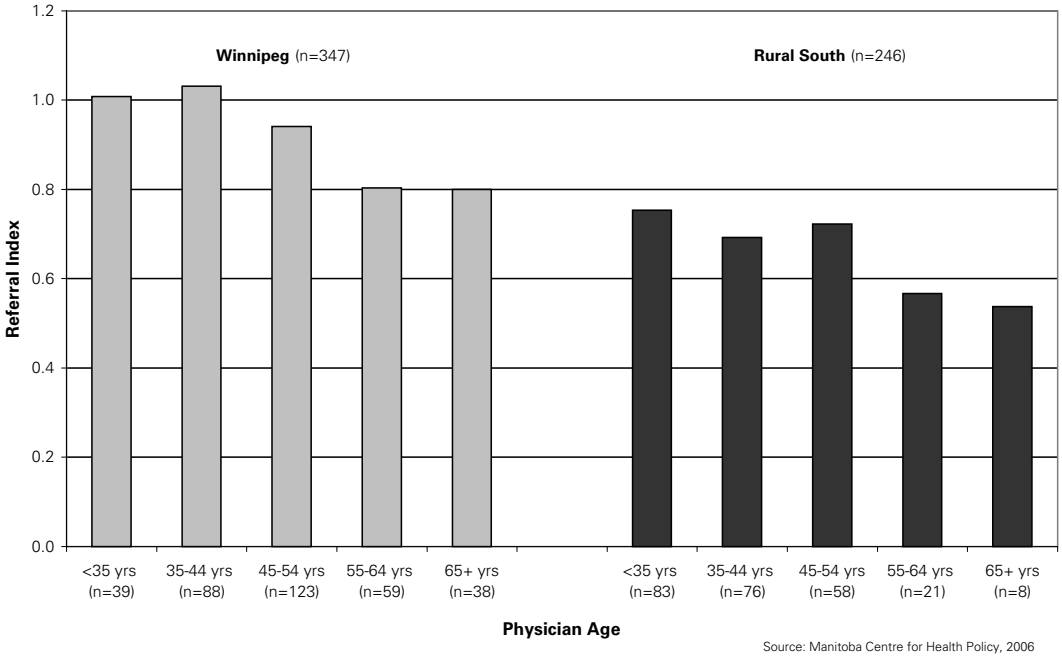
Figure A.3 shows the consistent relationship between the percentage of patients with above average morbidity in the practice and higher than expected visit rates. The trend in Winnipeg was quite pronounced, going from a VI of 0.92 (for physicians with the lowest proportion of higher morbidity patients) to 1.03 (for physicians with the highest proportion). The same trend was apparent in Rural South, but was less pronounced with a range of 0.94 to 1.01.

Atypical Diagnostic Coding Index (ADCI)

No bi-variates done.

Referral Index - Core Patients (RI_{core})

Appendix Figure A.4: Referral Index by Physician Age: Core Patients

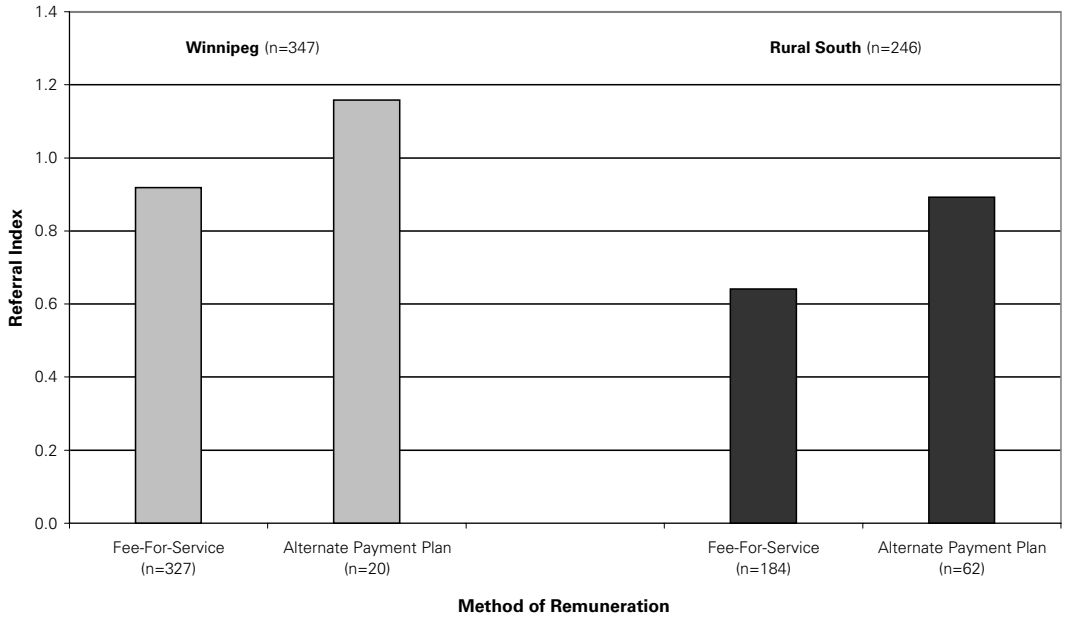


Source: Manitoba Centre for Health Policy, 2006

The RI_{core} varied with several physician characteristics. As demonstrated in Figure A.4, in Rural South, the RI_{core} generally declined across physician age, from 0.75 for physicians <35 years, to 0.54 for the the 65+ age group.[8]

[8] Although physician age was not itself significant in the Rural South regression, it entered signficantly in a number of the interaction terms.

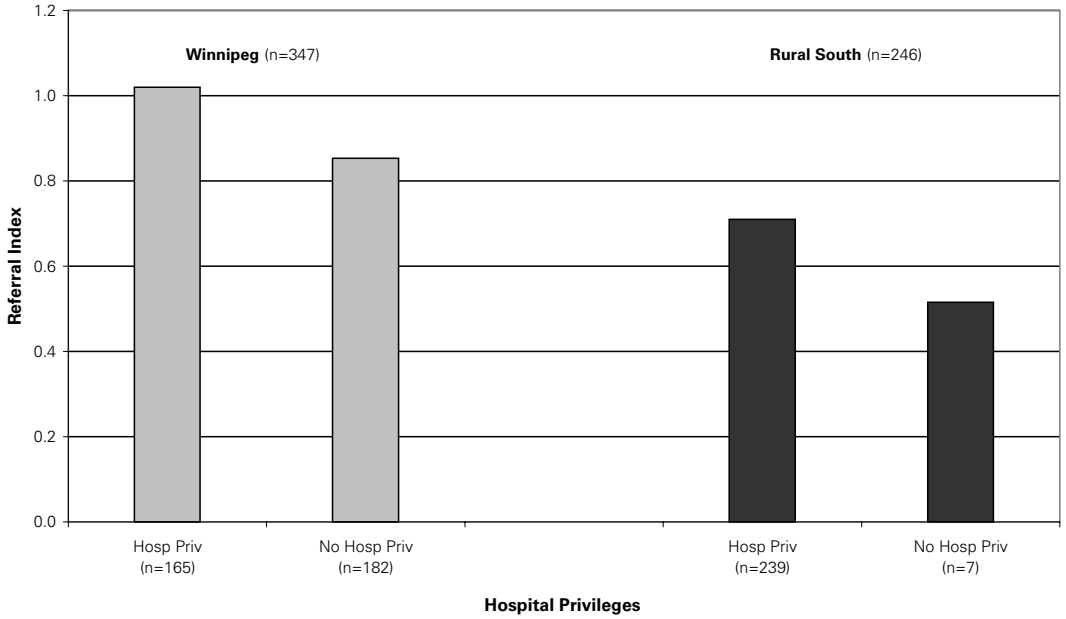
Appendix Figure A.5: Referral Index by Method of Remuneration (Fee-for-Service vs. Alternate Payment Plan): Core Patients



Source: Manitoba Centre for Health Policy, 2006

In Rural South, the RI_{core} also varied by type of compensation. As seen in Figure A.5, the RI_{core} for FFS physicians was 0.64 (below the mean of 0.70) and 0.89 for APP physicians (higher than average). There also appeared to be a similar bi-variate relationship in Winnipeg, with FFS physicians having an RI_{core} of 0.92 compared to 1.16 for APP physicians. However, in the Winnipeg regression model, after controlling for other variables, this variable was not significantly related to the RI_{core}, likely due to the low number of APP physicians.

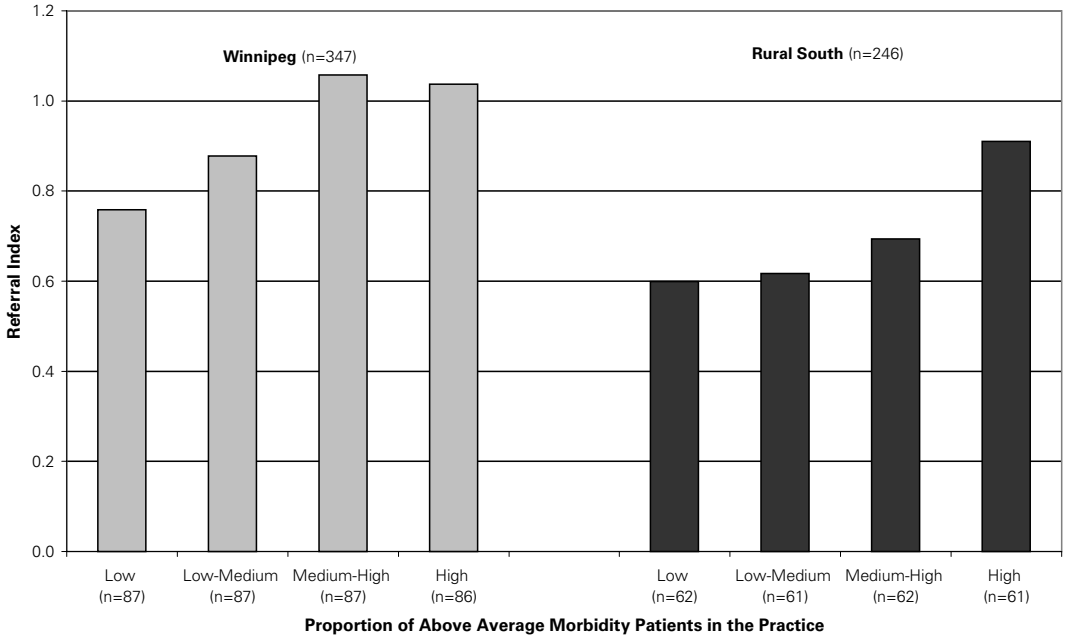
Appendix Figure A.6: Referral Index by Hospital Privileges: Core Patients



Source: Manitoba Centre for Health Policy, 2006

Hospital privileges also seemed to affect the RI_{core}. In Winnipeg, physicians without hospital privileges referred below expected levels (0.85), while those with privileges referred slightly more than would be expected (1.02) (Figure A.6). There are too few physicians without privileges in Rural South areas to make it feasible to model the relationship.

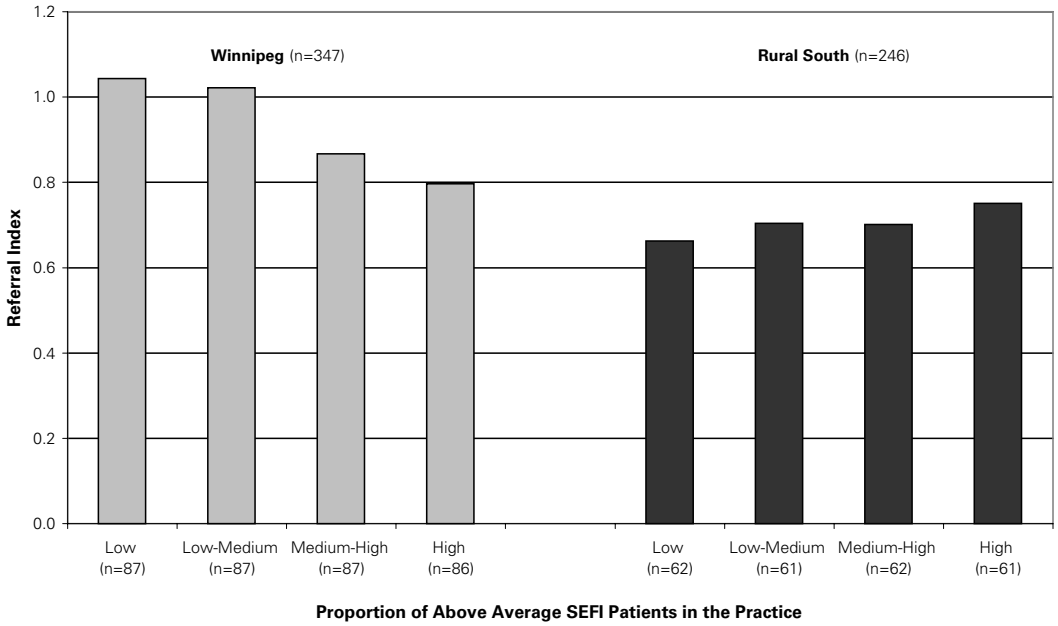
Appendix Figure A.7: Referral Index by Proportion of Above Average Morbidity Patients in the Practice: Core Patients



Source: Manitoba Centre for Health Policy, 2006

Patient morbidity was related to the physician's referral patterns in both Winnipeg and Rural South, as shown in Figure A.7; the RI_{core} rose almost consistently with increasing proportions of above average morbidity patients. In Winnipeg, RI_{core} increased from 0.75 to 1.04, over the range, while in Rural South, the RI_{core} rose from 0.60 to 0.91.

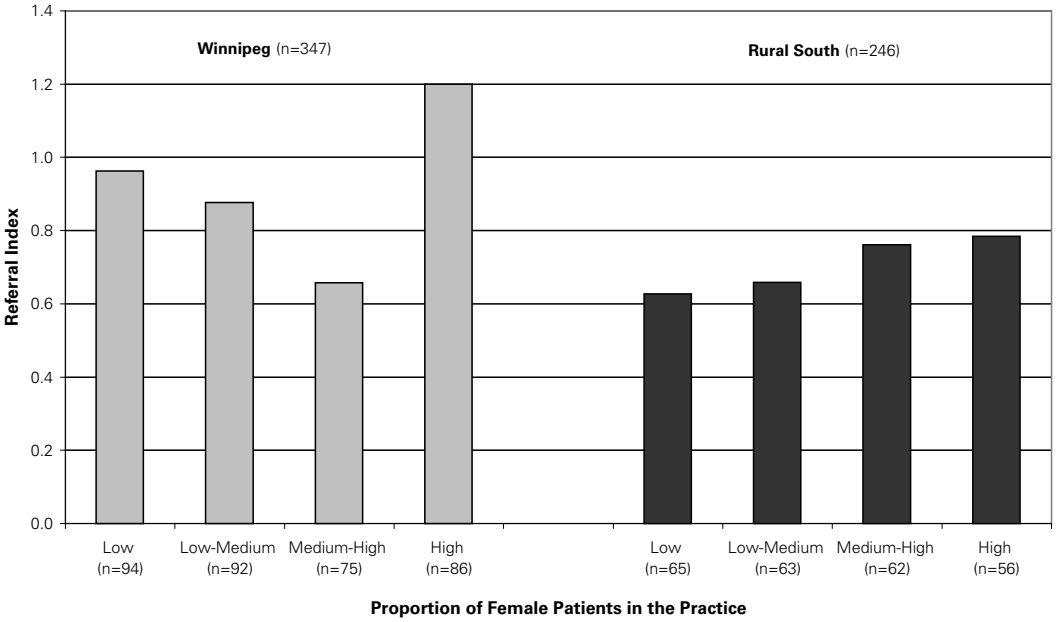
Appendix Figure A.8: Referral Index by Proportion of Above Average SEFI Patients in the Practice: Core Patients



Source: Manitoba Centre for Health Policy, 2006

Figure A.8 shows how, in Winnipeg, the RI_{core} varied as a function of the percentage of high SEFI patients in the physician's practice. (Recall that high SEFI means higher socioeconomic risk.) The RI_{core} dropped from 1.04 (higher than expected) to 0.80 (lower than expected), as the percentage of patients of above average SEFI increased. This is contrary to what one would expect, but the relationship has been observed on a population basis in previous MCHP reports (Frohlich et al., 2001). It raises questions about the way in which referrals are distributed across socioeconomic groups. By contrast, the SES of rural patients in a practice did not seem to affect physicians' scores on the RI_{core}, and the trend, if anything, was in the opposite direction.

Appendix Figure A.9: Referral Index by Proportion of Female Patients in the Practice: Core Patients

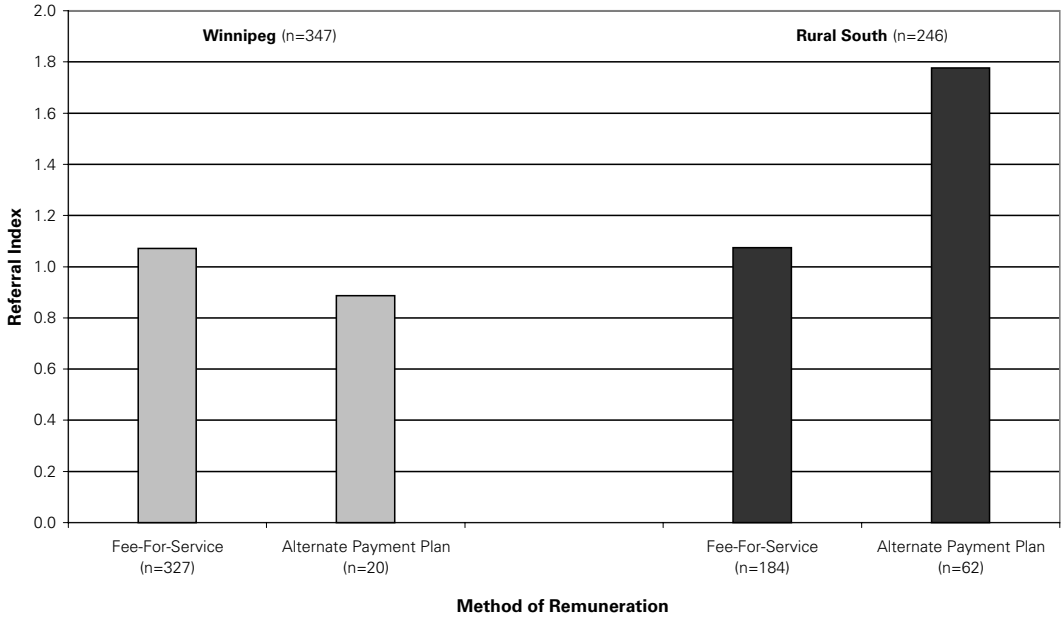


Source: Manitoba Centre for Health Policy, 2006

The RI_{core} also varied with the percentage of female patients in a physician's practice (Figure A.9). In Winnipeg, practices with a very large percentage of female patients provided more referrals than would be expected, (RI_{core} = 1.20) while practices with a more even mix of male and female patients had lower than expected referral rates (RI_{core} = 0.88 and 0.66). In Rural South, the RI_{core} increased (from .62 to .78) as the percentage of female patients in a practice rose.

Referral Index – Occasional Patients (RI_{occ})

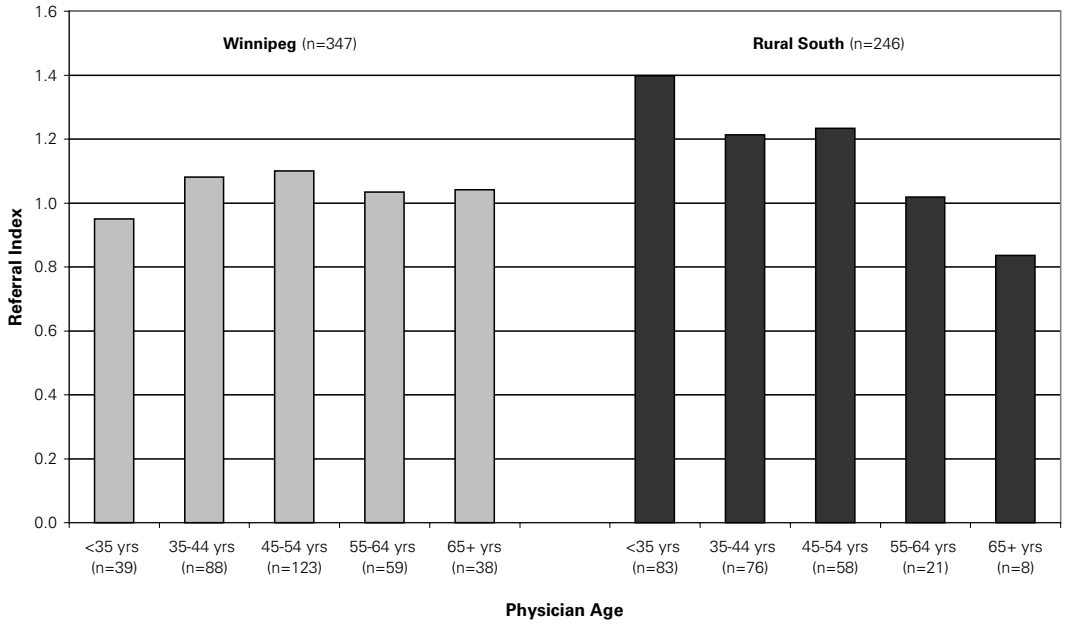
Appendix Figure A.10: Referral Index by Method of Remuneration (Fee-for-Service vs. Alternate Payment Plan): Occasional Patients



Source: Manitoba Centre for Health Policy, 2006

As shown in Figure A.10, in Rural South, occasional patients of APP physicians were referred much more than occasional patients of their FFS colleagues, with RI_{occ} scores of 1.78 and 1.07, respectively—a major difference. In Winnipeg, no significant relationship was found.

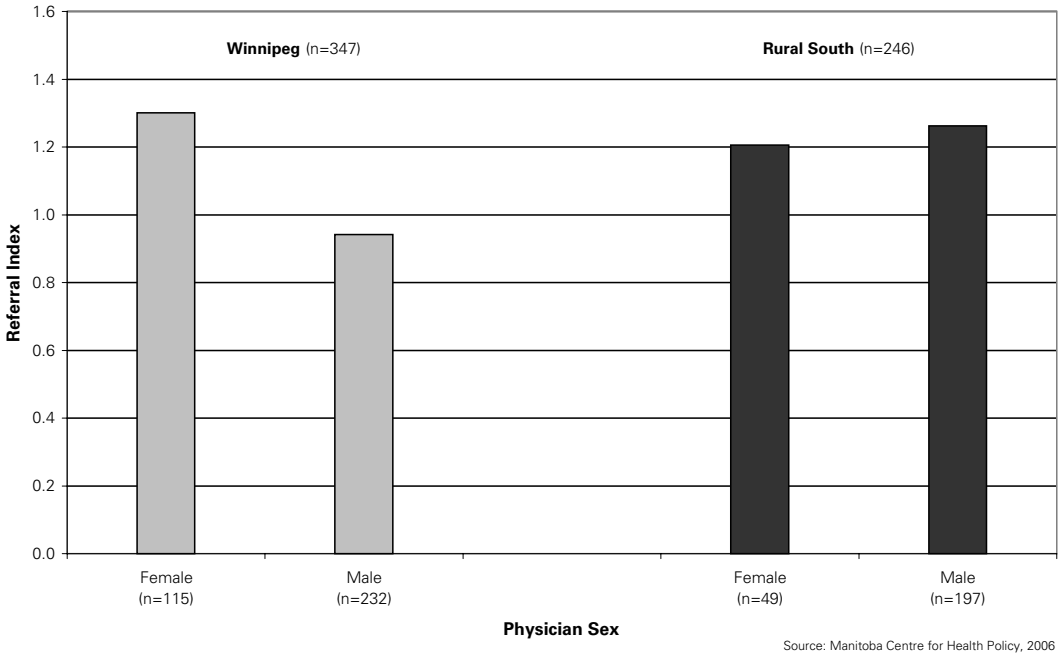
Appendix Figure A.11: Referral Index by Physician Age: Occasional Patients



Source: Manitoba Centre for Health Policy, 2006

Physician age appears to be almost uniformly inversely related to RI_{occ} scores in Rural South, ranging from 1.40 for the youngest physicians to 0.84 for physicians aged 65 and older although the relationship was not significant in the regression.[9] There was no discernable trend in Winnipeg (see Figure A.11).

Appendix Figure A.12: Referral Index by Physician Sex: Occasional Patients

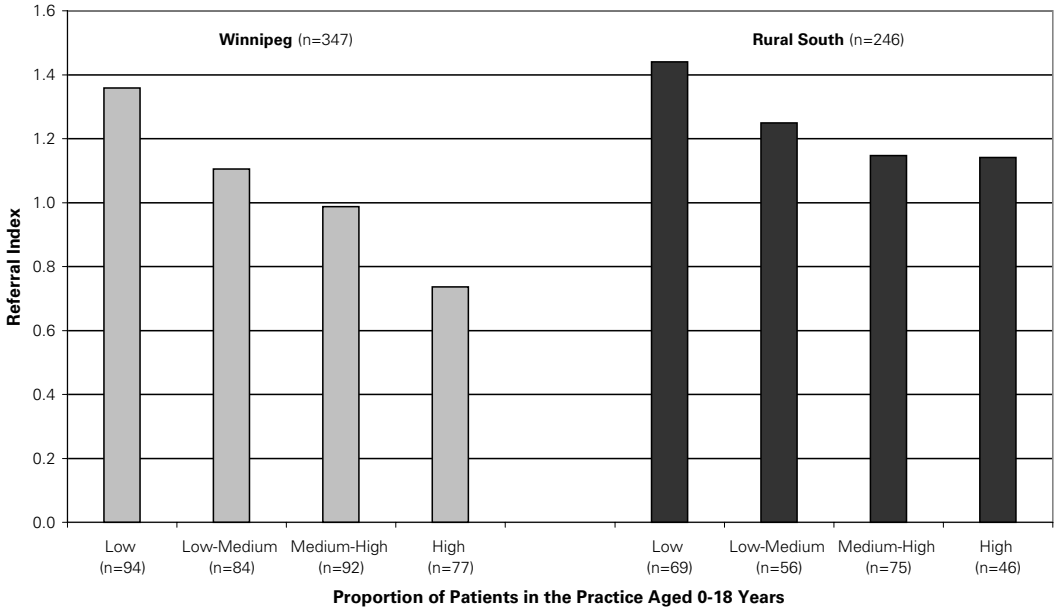


Source: Manitoba Centre for Health Policy, 2006

Physician sex also showed different patterns in the two regions. In the regression analyses, the sex of the physician was only significant in Rural South. In Rural South, male physicians had marginally higher scores (see Figure A.12).

[9] The fact that age entered signficantly in interaction terms may explain this lack of significance.

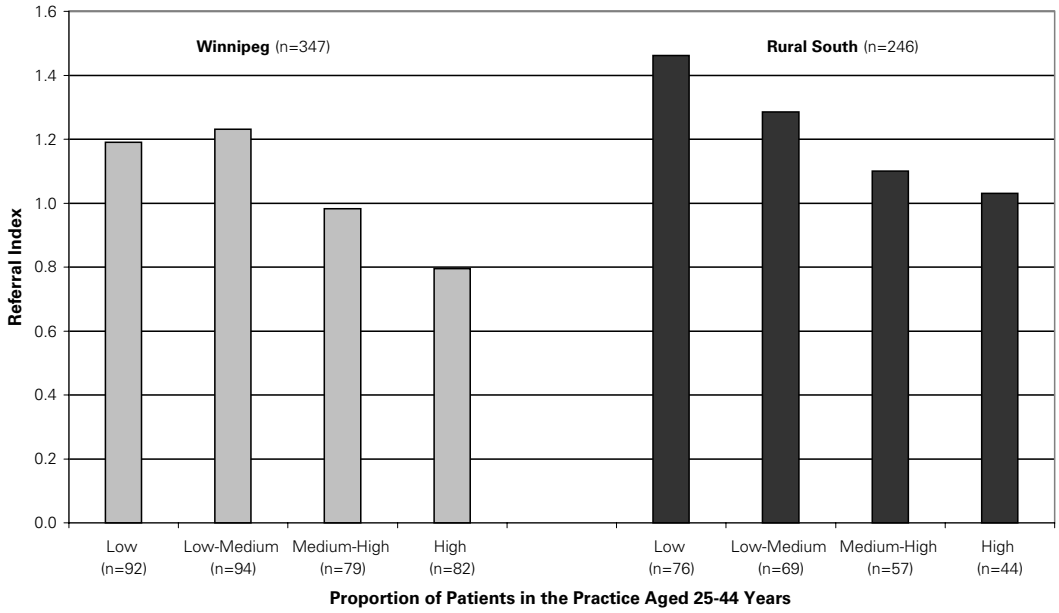
Appendix Figure A.13: Referral Index by Proportion of Patients in the Practice Aged 0-18 Years: Occasional Patients



Source: Manitoba Centre for Health Policy, 2006

The mix of patients, by age group in a physician's practice, seems to have had an effect on the RI_{occ}. In both regions, physicians with higher proportions of young patients (0–18 years) scored lower on the RI_{occ} than did physicians with lower proportions (see Figure A.13), although the differences were, again, significant in the regression only in Winnipeg. RI_{occ} scores ranged from 1.36 to 0.74 in Winnipeg, and from 1.44 to 1.14. in Rural South.

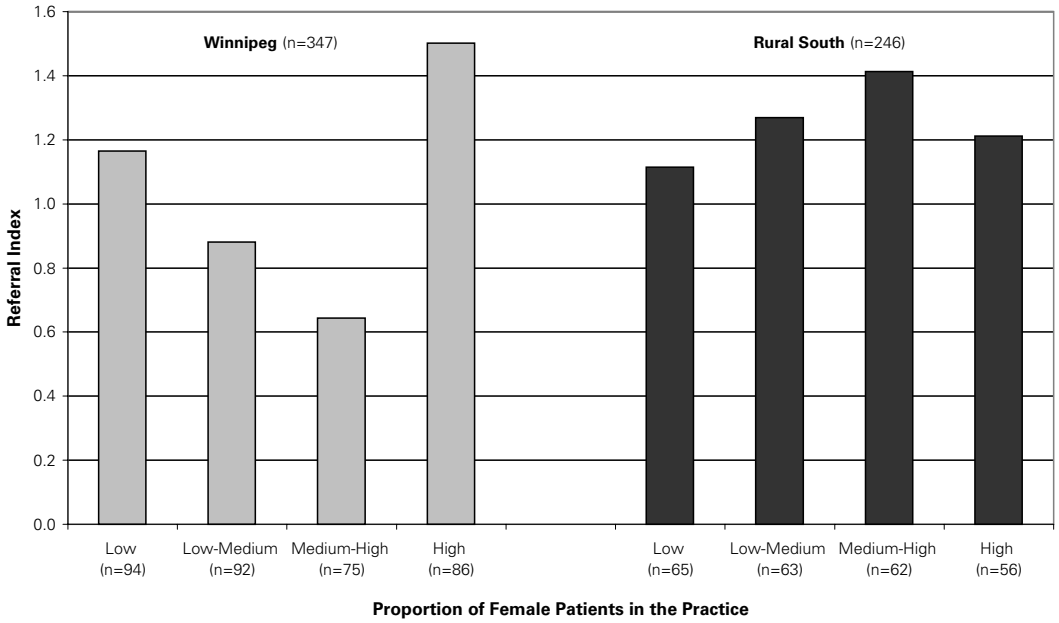
Appendix Figure A.14: Referral Index by Proportion of Patients in the Practice Aged 25-44 Years: Occasional Patients



Source: Manitoba Centre for Health Policy, 2006

There was a similar trend in Winnipeg for physicians regarding the proportion of patients between the ages of 25 and 44 years of age. Higher proportions of these patients were associated with lower RI_{occ} scores. In Rural South, that factor was not significant in the regression (see Figure A.14). Looking at a complementary age group of patients, having higher proportions of patients over 65 years of age was positively related to RI_{occ} scores in Rural South, (graph not shown), although this variable was not significant in the Winnipeg model. Rural South physicians showed a uniform gradient from 1.03 to 1.55 as the proportion of older patients in their practices rose.

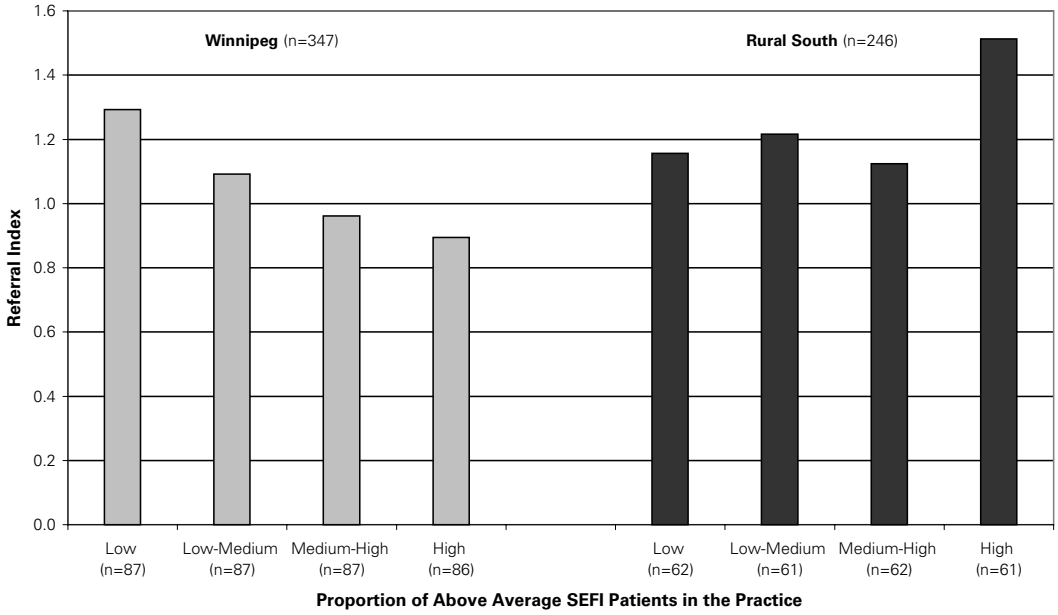
Appendix Figure A.15: Referral Index by Proportion of Female Patients in the Practice: Occasional Patients



Source: Manitoba Centre for Health Policy, 2006

Figure A.15 shows the relationship of the proportion of female patients to RI_{occ} scores. In both areas, a higher proportion of female patients was associated with higher RI_{occ} scores.

Appendix Figure A.16: Referral Index by Proportion of Above Average SEFI Patients in the Practice: Occasional Patients



Source: Manitoba Centre for Health Policy, 2006

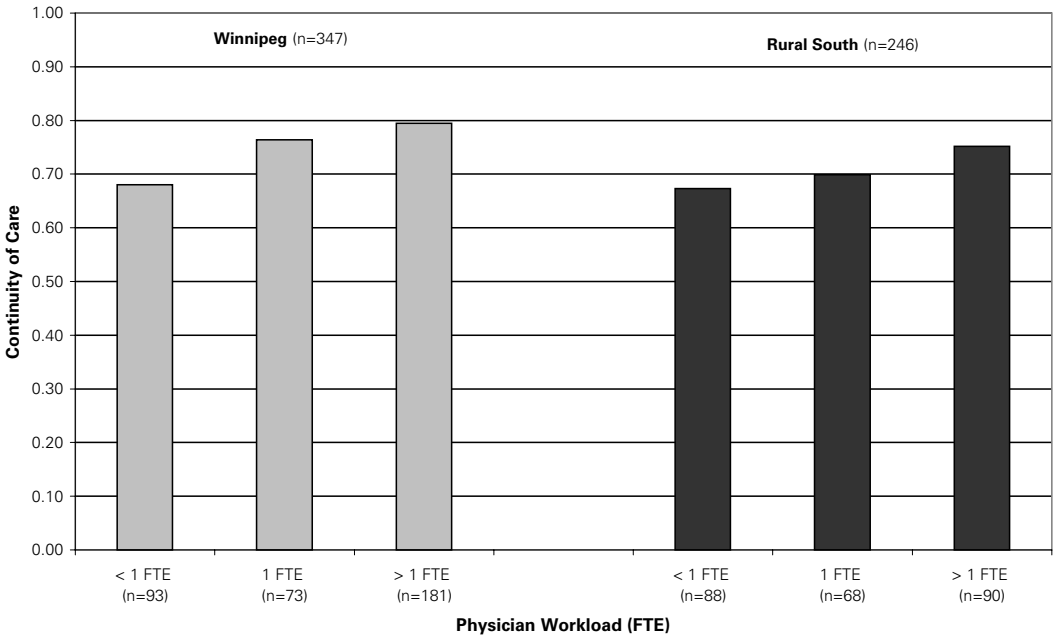
In Winnipeg, the percentage of above average SEFI patients was inversely related to RI_{occ} scores going from 1.29 to 0.89 (see Figure A.16). In Rural South, it appeared to trend in the opposite direction, although it was not a significant factor in the Rural South model.

Consultation Index (CI)

No bi-variates done.

Continuity of Care Index (COCI)

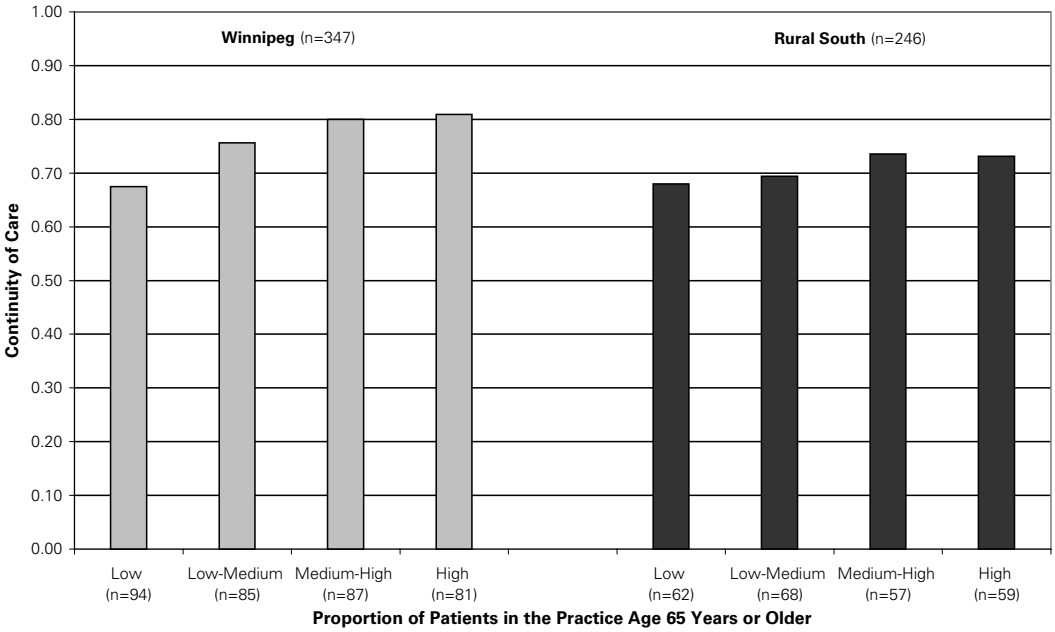
Appendix Figure A.17: Continuity of Care Index by Physician Workload (FTE)



Source: Manitoba Centre for Health Policy, 2006

Figure A.17 shows the relationship between physician workload and COCI. The trend was quite pronounced, with COCI rising fairly uniformly with increasing workload. The range in Winnipeg was from 0.68 to 0.79, while in Rural South it went from 0.67 to 0.75.

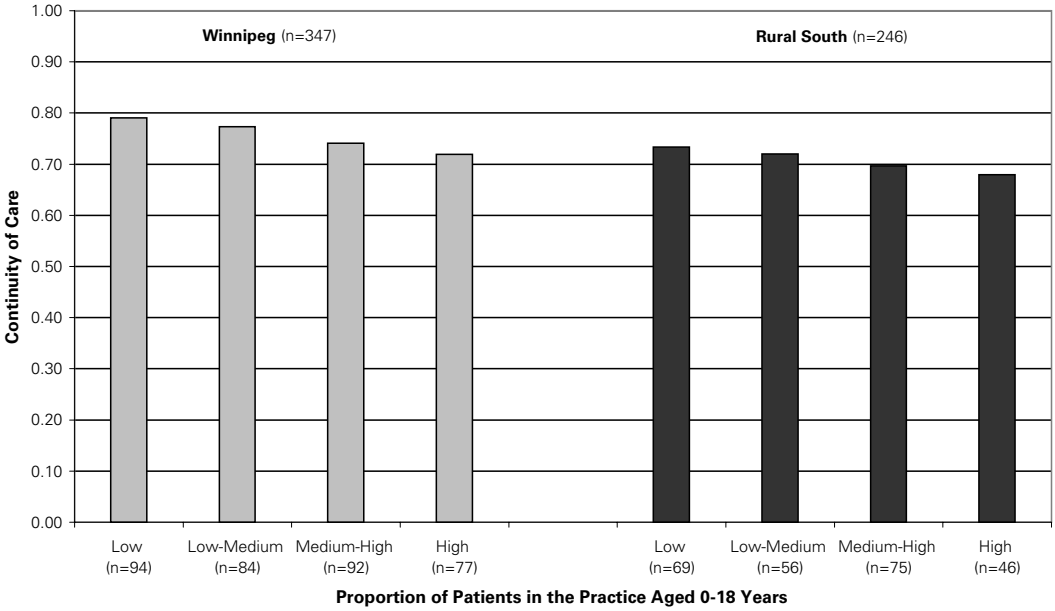
Appendix Figure A.18: Continuity of Care Index by Patients in the Practice Aged 65 Years or Older



Source: Manitoba Centre for Health Policy, 2006

In Winnipeg, COCI scores increased from 0.67 for physicians with a low proportion of patients above 65 years of age to 0.81 for physicians with a high proportion (see Figure A.18). The trend in Rural South was similar but less pronounced.

Appendix Figure A.19: Continuity of Care Index by Proportion of Patients in the Practice Aged 0-18 Years

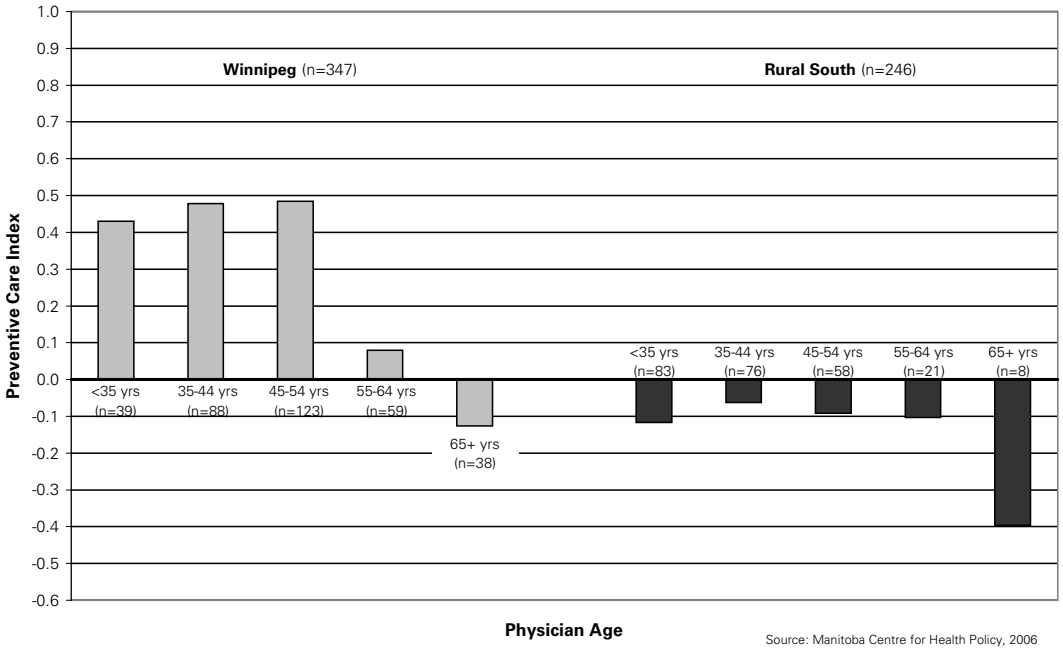


Source: Manitoba Centre for Health Policy, 2006

There was a negative relationship between COCI and percentages of young patients (0–18 years) in a practice. COCI fell from 0.73 to 0.68 in Rural South and from 0.79 to 0.72 in Winnipeg (see Figure A.19).

Preventive Care Index (PCI)

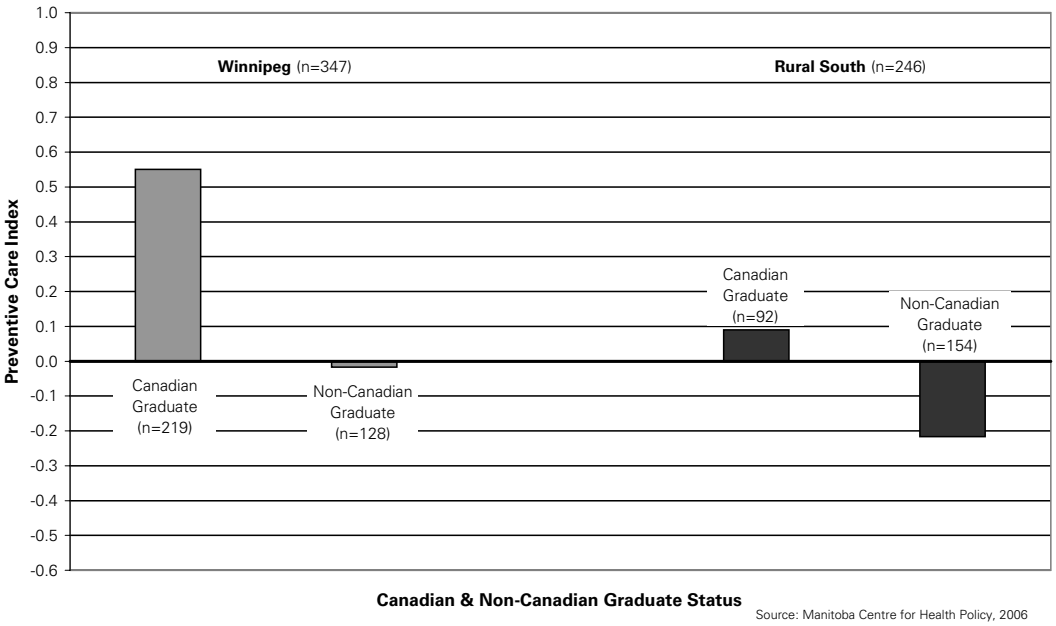
Appendix Figure A.20: Preventive Care Index by Physician Age



Source: Manitoba Centre for Health Policy, 2006

PCI scores followed very different patterns across physician age between the two regions. Age was only significant in Winnipeg, but there appears to be a tendency for scores to fall in both regions as physicians pass their mid-fifties (see Figure A.20).

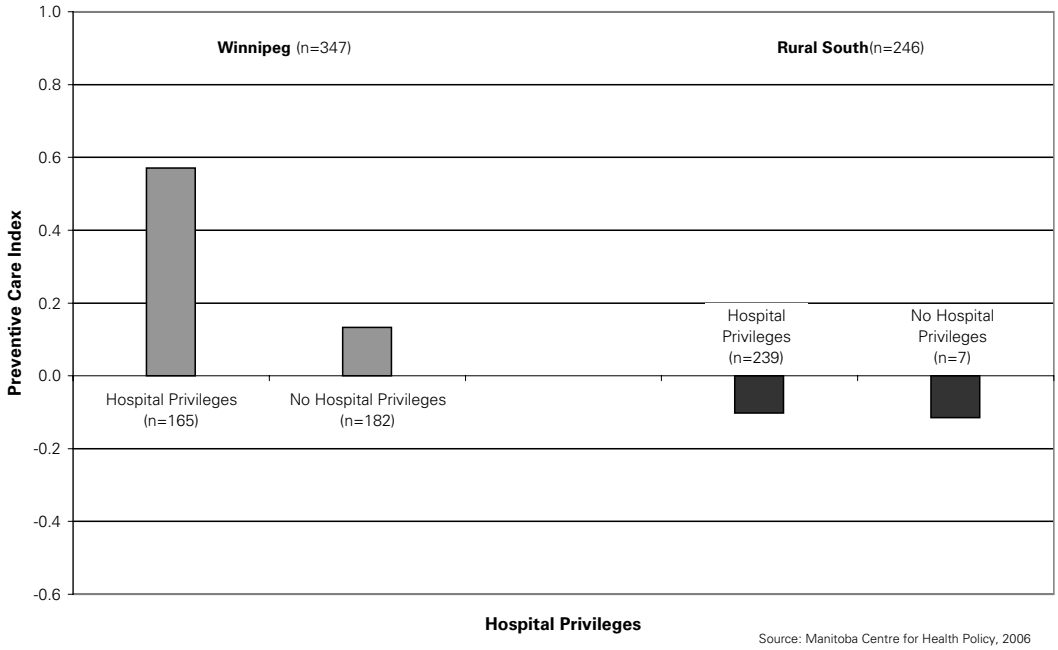
Appendix Figure A.21: Preventive Care Index by Canadian and Non-Canadian Graduate Status



Source: Manitoba Centre for Health Policy, 2006

Figure A.21 also shows regional differences for Canadian graduate status, with non-Canadian graduates showing lower preventive care. The differences in performance between Canadian and foreign graduates were quite large, ranging from 0.55 to -0.02 in Winnipeg and from 0.09 to -0.22 in Rural South, respectively.

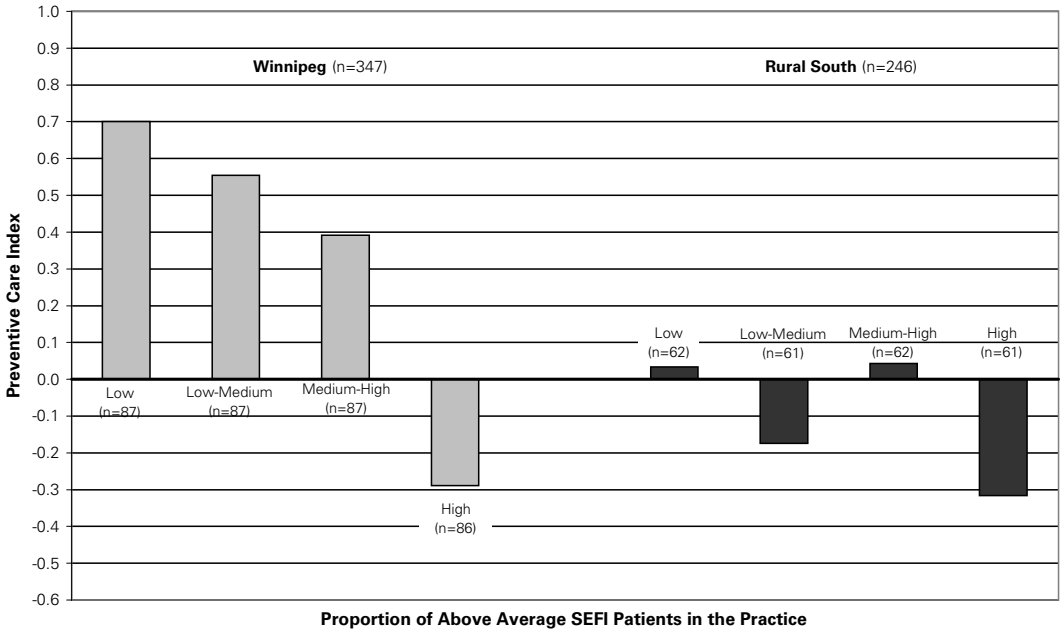
Appendix Figure A.22: Preventive Care Index by Hospital Privileges



Source: Manitoba Centre for Health Policy, 2006

In Winnipeg, physicians with hospital privileges tended to provide higher levels of preventive care (see Figure A.22). The number of rural physicians without hospital privileges in Rural South was very small and modelling could not be performed to establish a significant relationship.

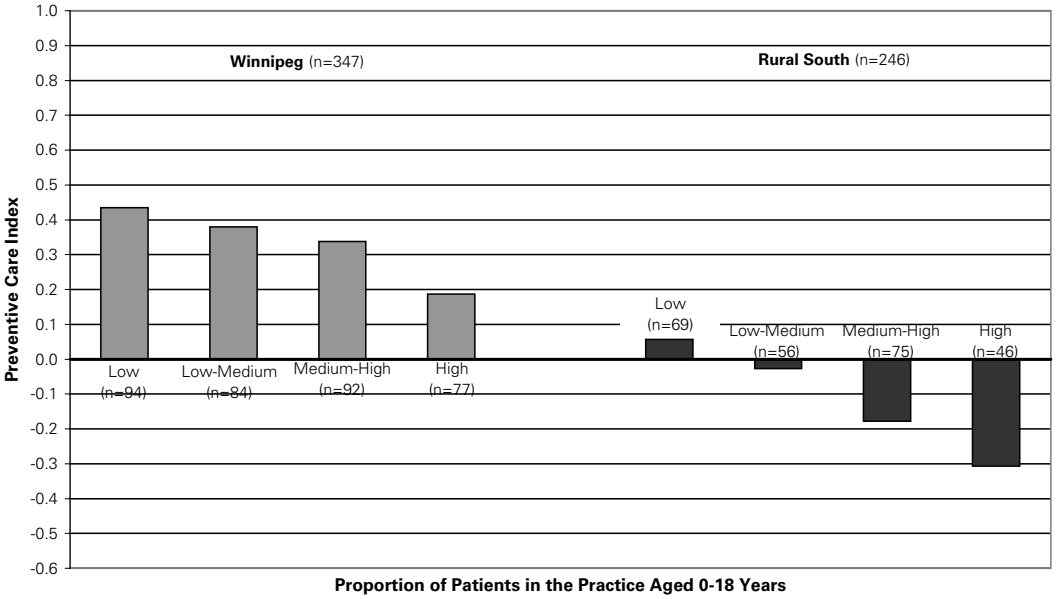
Appendix Figure A.23: Preventive Care Index by Proportion of Above Average SEFI Patients in the Practice



Source: Manitoba Centre for Health Policy, 2006

The relationship between practices with higher proportions of high SEFI patients and the PCI is shown in Figure A.23. Scores on the Index ranged from 0.70 for physicians with low proportions of high SEFI patients to -0.29 for physicians with high proportions. A less pronounced, relationship was observed in Rural South, with physicians with high levels of above average SEFI patients showing the lowest PCI scores.

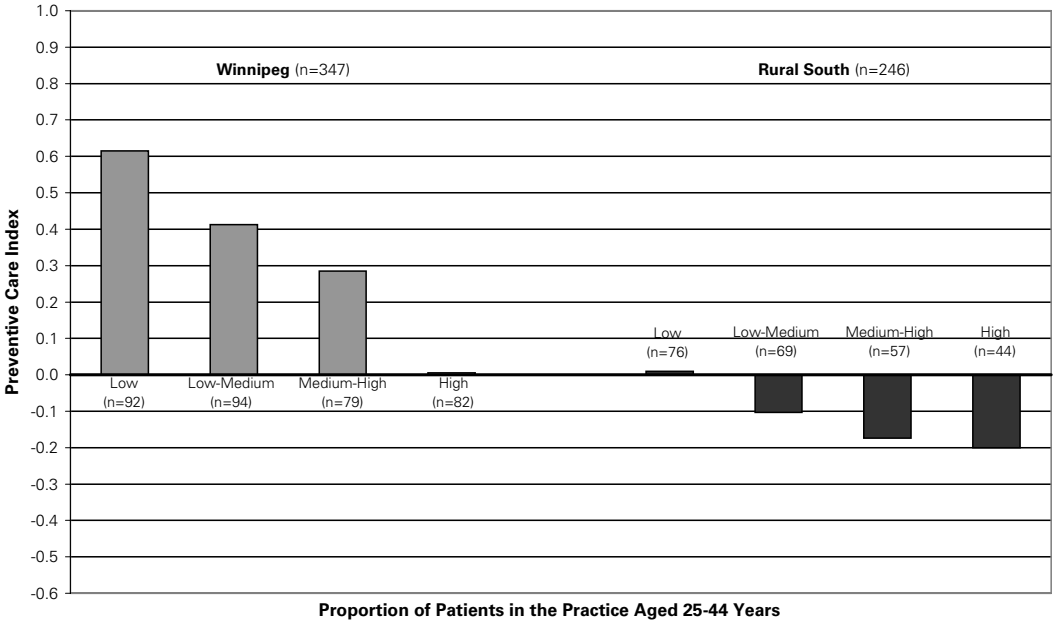
Appendix Figure A.24: Preventive Care Index by Proportion of Patients in the Practice Aged 0-18 Years



Source: Manitoba Centre for Health Policy, 2006

Patient age was also related to physicians' scores on the PCI. In Winnipeg, physicians' scores declined from a mean of 0.44 for physicians with a low proportion of patients between the ages of 0 and 18 years to 0.19 for those with a high proportion of younger patients (Figure A.24). In Rural South, no significant relationship was found with the age of patients.

Appendix Figure A.25: Preventive Care Index by Proportion of Patients in the Practice Aged 25-44 Years

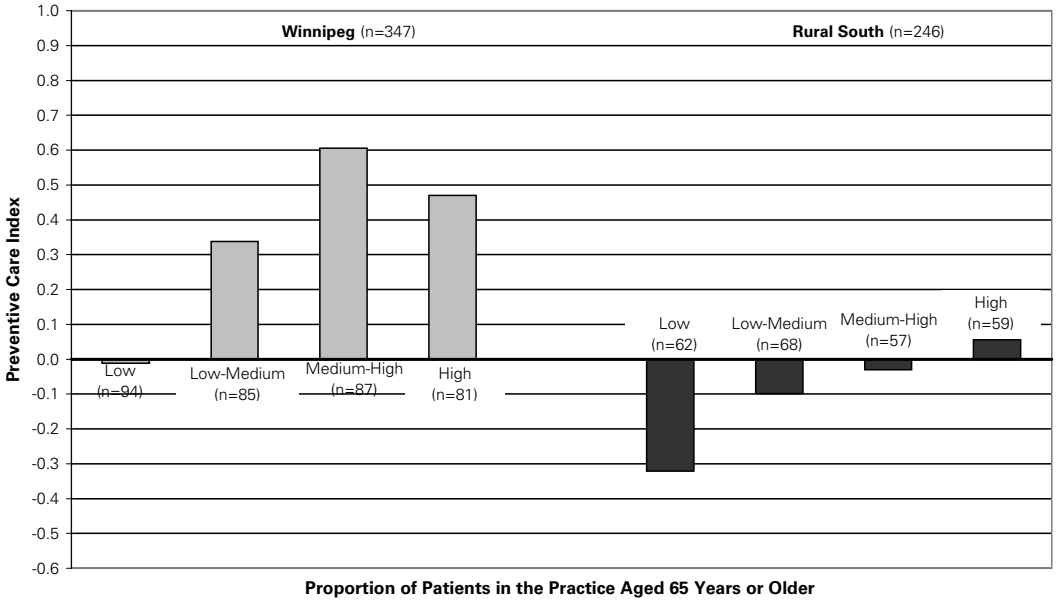


Source: Manitoba Centre for Health Policy, 2006

In Winnipeg, there was a similar relationship between the PCI and the proportion of patients between the ages of 25 and 44 (see Figure A.25). The overall trend would appear to indicate that physicians provided lower levels of preventive care as the proportion of patients in this age group in their practice increased. In contrast, as Figure A.26 shows, PCI scores increased for higher proportions of patients over 65 years in Rural South.[10]

[10] In the Rural South regression, the proportion of patients over 65 years of age failed to reach significance, but was significant in an interaction term. The bi-variate analyses are provided here to display their potential individual effects.

Appendix Figure A.26: Preventive Care Index by Proportion of Patients in the Practice Aged 65 Years or Older



Source: Manitoba Centre for Health Policy, 2006

APPENDIX B: CONSTRUCTING THE VISIT INDEX

The first step in constructing the VI was to establish the expected visit level for primary care patients in each of the two regions of the Province, taking into account factors that might influence their expected visit rates. We first modelled the actual number of ambulatory visits of each core patient in our study (n=646,508), against the age, sex, morbidity and SES of the patient. We used generalized linear models (SAS GENMOD procedure) with the negative binomial distribution option. Separate regression models were used for patients of Winnipeg and Rural South physicians. The actual number of visits for each patient was calculated as the number of visits the patient made to all family physicians (not limited to physicians in the study cohort) and primary care paediatricians[11] in the Province during the year. Since age and sex are known to affect visit rates, patients were classified by sex and age was stratified into 21 groups (0-1, 2-4, 5-9, 10-14, 15-19, 20-24, 25-29, 30-34, 35-39, 40-44, 45-49, 50-54, 55-59, 60-64, 65-69, 70-74, 75-79, 80-84, 85-89, 90-94 and 95+).

Similarly, SES was measured using SEFI (Martens et al., 2003), which is a continuous variable with greater values corresponding to higher risk areas and higher levels of need for health care services. SEFI was calculated for each of 71 Manitoba areas: 25 neighbourhoods in Winnipeg and 46 rural RHA districts. The MI was entered as a continuous variable constructed for each patient based on their assignment into ACGs and on average regional costs (assessed separately in Winnipeg and Rural South) associated with these ACGs. To determine a patient's ACG(s), all their contacts with the health care system, including hospitalizations and medical claims, are used (for details see Reid et al., 1999). We added a squared term for the MI into the models since we presumed a non-linear relationship between morbidity of the patients and their need for primary care.[12]

The two regressions were used to calculate the expected visit level for each patient in the study. We then calculated each patient's ratio of actual visits over expected visits or AV/EV. A ratio greater than 1 indicates that patient received more than the average expected number of visits (given age, sex, morbidity and SES), while a ratio less than 1 indicates that fewer than the average number of visits were provided to that patient. Using these ratios,we

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[11] In Winnipeg, a substantial part of primary care to children is provided not by family doctors, but by paediatricians. A primary care pediatric visit was defined as a visit to a pediatrician without being referred.

[12] As we hypothesized, the addition of this term significantly improved the models' fit.

constructed a VI score for the practice of each physician in the cohort. We focussed on calculating a VI for the core patients in each physician's practice: the patients they were more responsible for than was any other physician. The VI score was calculated as a sum of individual core patients' ratios divided by the total number of core patients in the practice, or:

$$\frac{\sum_{i=1}^{N} AV_i / EV_i}{N}$$

It was the average of all core patients' AVs/EVs. A VI score greater than 1 indicated that a physician's core patients were receiving, on average, more visits than would be expected correcting for the age, sex, SEFI, and MI of that patient mix. A score less than 1 would indicate a lower than expected average visit rate consumed by core patients.

As noted above, the VI takes into account *all* visits received by core patients. Since patients are free to see other physicians, visits to other than their most responsible physician need to be taken into account in some meaningful way. This Index provides a measure of the level of visits received by a physician's core patients.

APPENDIX C: CONSTRUCTING THE REFERRAL INDEX[1]

It is to be expected that the need for referrals will be a function of patients' characteristics. As with the VI described previously, we wished to construct a Referral Index (RI) for physicians, correcting for the characteristics of the patients in the physician's practice. To construct the RI, we first established the probability of each core patient being referred using a binary outcome, *Referred – Yes=1/No=0*. It was assigned a value of 1 if the patient had at least one ambulatory visit with a referring physician identified on the claim of the physician providing the service. To calculate the probability of being referred, the variable '*Referred – Yes/No*' was modeled against patient sex, age, morbidity, and SES, using probabilistic models (SAS LOGISTIC procedure, with model options: CLODDS=pl CLPARM=pl LACKFIT EXPB). Separate regression models were used for core patients of Winnipeg and Rural South physicians. The referring physician also had to be a generalist practicing in the province, but not necessarily part of our physician cohort. We excluded tariffs for pre-natal care.

As with the VI, patient sex was entered and patient age was stratified into 21 groups (0-1, 2-4, 5-9, 10-14, 15-19, 20-24, 25-29, 30-34, 35-39, 40-44, 45-49, 50-54, 55-59, 60-64, 65-69, 70-74, 75-79, 80-84, 85-89, 90-94 and 95+).

SES was measured by SEFI (Martens et al., 2003), a continuous variable with higher scores corresponding to greater socioeconomic risk, poorer regional health status, and higher levels of need for health care services. SEFI was calculated for each of 71 Manitoba areas: 25 neighbourhoods in Winnipeg and 46 rural RHA districts.

The MI was also a continuous variable constructed for each patient based on their assignment into ACGs and on average regional costs (assessed separately in Winnipeg and Rural South) associated with these ACGs. To determine each patient's ACG(s), all their contacts with the health care system, including hospitalizations and medical claims, are used (for details, see Reid et al., 1999). We added a squared term for the MI into the models, due to the non-linear relationship between morbidity of the patients and their need for primary care, which significantly improved the models' fit.

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13 Construction of the Consultation Index in Rural South followed the same methods for the RI, described here.

Logistic regressions were used to calculate the probability of being referred by a primary care physician for core patients in the study. Thus, each patient was assigned an expected probability of being referred from the regression. Applying these probabilities for each patient in a practice and aggregating from the patient to the individual physician practice level, however, required adjustment for patients with visits to more than one physician. Since access to physicians is not formally restricted and patients may seek consultations with any family physician, many patients see more than one physician in a year. Assuming that the probability of being referred by a given physician was proportional to the number of visits a patient received from that physician, and taking into account the patient's mobility, we counted patients in a physicians' practices on a proportional basis. Specifically, for each physician a patient visited we used the following ratio to allocate proportional patients:

$$\frac{\text{\# visits received from the physician}}{\text{Total \# visits received from any physician}}$$

This ratio was a continuous measure, varying from 1 to about 0.09 for core patients and from 0.5 to less than 0.007 for non-core patients. For each proportional patient, the physician was assigned that proportion of the patient's expected probability of being referred. The adjusted probabilities were summed across patients in the practice to yield the expected referral level for the physician's practice according to regional norms. The actual referral level for each physician was calculated as the number of referred patients (i.e. patients who received at least one referral from this physician) in the study year. The RI was defined separately for core and occasional patients as the ratio:

$$\frac{\text{Actual referral level}}{\text{Expected referral level}}$$

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