



DRIVERS OF PRIMARY HEALTH CARE UNATTACHMENT

Why is the number of Nova Scotians unable to find a regular family doctor rising? Changes in factors affecting Nova Scotia's supply of and requirements for family doctors, 2006 - 2016


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PROJECT INFORMATION

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ACRONYMS

BRIC-NS	Building Research for Integrated Primary Healthcare Nova Scotia
CCDSS	Canadian Chronic Disease Surveillance System
CCHS	Canadian Community Health Survey
CIHI	Canadian Institute for Health Information
CIHR	Canadian Institutes for Health Research
COPD	Chronic Obstructive Pulmonary Disease
DAD	Discharge Abstract Database
DHW	Nova Scotia Department of Health and Wellness
GP	General Practitioner
HDNS	Health Data Nova Scotia
HHR	Health Human Resources
MSI	Nova Scotia Medical Services Insurance Program
MSSU	Maritime SPOR SUPPORT Unit
NPS	National Physician Survey
PHCC	Primary Health Care Connections
PHC	Primary Health Care
PIHCI	Primary and Integrated Health Care Innovations
SPOR	Strategy for Patient-Oriented Research
SUPPORT	Support for People- and Patient-Oriented Research and Trials



PLAIN LANGUAGE SUMMARY

The COVID-19 pandemic has added to the challenges facing Nova Scotia's health care system. Among these is the challenge of 'unattached' patients – that is, Nova Scotians without a regular health care provider who are actively seeking one. The number of unattached patients in Nova Scotia began growing rapidly in 2016, and since that time has remained in the tens of thousands, ranging between about 40,000 and 60,000 between January 2018 and March 2021.

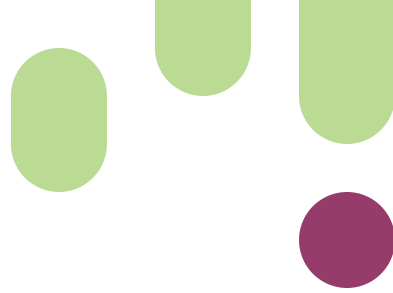
The reasons for the sudden growth in the number of unattached patients in Nova Scotia that began in 2016 are unknown. The reasons so many Nova Scotians continue to be unable to find a family doctor are likely changing over time, and may be different now than they were when this study began in 2016. The goal of this study was to find potential explanations for the initial increase in unattached patients in the province. This was done by measuring changes between 2006 and 2016 in factors that affect the supply of and need for family doctors in Nova Scotia, and whether any of these factors changed enough over the last year of the study to explain why tens of thousands of Nova Scotians suddenly reported being unable to find a family doctor in 2016. This same approach can be used on an ongoing basis to help understand what is driving changes over time in the number of Nova Scotians unable to find a family doctor.

For this study, changes were measured using data from administrative databases, the Census, and the National Physician Survey. The strengths and limitations of these sources are reviewed in the main body of this report – briefly, none of them perfectly measures the things we used them to measure. That means it's possible that there were some changes in the factors that affect the supply of and need for family doctors in Nova Scotia during this period that do not show up in our results.

The study found no evidence that any of these factors changed enough to explain, on its own, the sudden increase in the number of unattached patients in Nova Scotia that began in 2016. For example, at the end of the study period in mid-2016 there were actually more physicians licensed as general practitioners or family physicians in Nova Scotia than ever before. Further, while the provincial population grew by several thousand people in 2016, the growth in the number of unattached patients was several times larger – that is, the number of unattached patients grew much more than the number of people in the province overall.

The findings also identified several gradual, long-term trends affecting the supply of and need for family physicians in Nova Scotia. In addition to the average age of the population increasing, the study found that, according to physician billing and hospital records, Nova Scotians aged 80 and older in 2016 had more chronic diseases and injuries than Nova Scotians aged 80 and older did in 2006. For all other age groups, the reverse was true—for example, Nova Scotians in their 60s and 70s in 2016 had fewer chronic diseases and injuries than Nova Scotians in their 60s and 70s did in 2006. The study also found that family physicians in Nova Scotia billed for fewer services per physician and fewer services per patient, and on fewer days per year, between 2006 and 2016. Data from the National Physician Survey suggest that the average Nova Scotia family doctor works well over 40 hours per week plus 'on-call' time.

Overall, the study findings support the idea that the 2016 increase in unattached patients resulted from multiple gradual, long-term trends that finally reached a "tipping point", as opposed to any one factor changing suddenly. These findings, and ongoing monitoring of these trends, can be used to inform future planning for the province's family physician workforce.



EXECUTIVE SUMMARY

Rationale

Access to primary health care is essential to both individual and population health, particularly in the context of a global pandemic. Primary health care includes medical services for prevention, wellness and common illnesses. While nurses, pharmacists, and other professionals have taken on larger roles in recent years, primary health care in Nova Scotia is mainly accessed through family physicians. There is evidence that the number of unattached patients – Nova Scotians without a regular family physician, but who are actively seeking one – began growing at an unprecedented rate in 2016. The reasons for this growth are unknown. The reasons so many Nova Scotians continue to be unable to find a family doctor are likely changing over time, and may be different now than they were when this study began in 2016. This study focused on understanding the causes of the increase in unattached patients in Nova Scotia in 2016; the same approach can also be used on an ongoing basis to help understand what is driving changes over time in the number of Nova Scotians unable to find a family doctor.

Aim

Generate hypotheses (i.e., potential explanations) about the causes of the 2016 increase in unattached patients in Nova Scotia.

Objectives

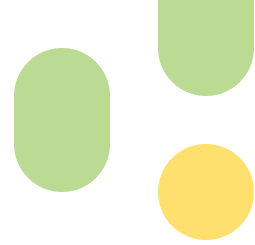
The objectives of this study were to estimate changes in population size and age structure, population health, levels of family physician service delivery, the number of family physicians, and family physician participation, activity, and rate of service provision in Nova Scotia between 2006 and 2016 in order to identify possible causes of the increase in the number of unattached patients beginning in 2016.

Study design

This was a population-based, hypothesis-generating study with repeated cross-sectional descriptive analysis. Administrative data housed at Health Data Nova Scotia, in addition to data from the Census and the National Physician Survey, were used to conduct the analyses.

Analytical framework

An analytical framework was used to estimate changes in the immediate determinants of the supply of and requirements for family physicians in Nova Scotia over time. The framework chosen was developed by Birch et al.¹ and disaggregates the supply of and requirements for health human resources (HHR) into several key determinants.



UNDER THIS FRAMEWORK:

The supply of HHR is the result of:

- **Stock**—The number of individuals licensed to practice as members of the profession in question (in this case, family physicians)
- **Participation Level**—The proportion of those individuals who provide any direct patient care
- **Activity Level**—The proportion of full-time working hours those individuals spend on direct patient care as opposed to other activities such as administration or research


Requirements for HHR are the product of:

- **Demography**—The size and demographic structure of the population to be served
- **Epidemiology**—The distribution of health and illness, and risks to health, within that population
- **Levels of service**—The number and type of services to be provided per individual according to their level of health or illness, or risks to health
- **Productivity**—The rate at which members of the profession in question can provide each type of service at an acceptable standard of quality

Data sources

Data on factors affecting family physician requirements were obtained as indicated below.

REQUIREMENTS		SUPPLY	
DEMOGRAPHY	<ul style="list-style-type: none"> • Census • Medical Services Insurance registry (MSI) 	STOCK	<ul style="list-style-type: none"> • Provider registry
HEALTH STATUS	<ul style="list-style-type: none"> • Physician billings + hospital discharge abstract database (DAD) 	PARTICIPATION	<ul style="list-style-type: none"> • Provider registry • Physician billings
LEVEL OF SERVICE	<ul style="list-style-type: none"> • Physician billings 	ACTIVITY	<ul style="list-style-type: none"> • Physician billings • National Physician Survey
RATE OF SERVICE PROVISION	<ul style="list-style-type: none"> • Physician billings • National Physician Survey (NPS) 		



Summary: Data from the Census and MSI registry indicate that Nova Scotia's population grew and aged throughout the study period; Census data indicate that the population grew more between 2015 and 2016 than in any other year of the study period. Estimated changes in population health, levels of service provision, and family physician stock, participation, activity, and service delivery rates between the last two years of the study were no larger than those observed in the preceding decade.

Specific findings:

Population size and age structure

- Census and MSI registry data provide different accounts of the growth in Nova Scotia's population during the study period. Census data indicate that most of the growth in the provincial population between 2006 and 2016 occurred in the year between 2015 and 2016. In contrast, MSI registry data indicate the growth in the provincial population between 2015 and 2016 was no larger than it had been in other recent years. In both cases, the growth in unattached patients was several times larger than the growth in the provincial population over the same period.
- The size of the population aged 65 and older is growing faster than the rest of the population. The median age of the population increased by an average of 0.3 years per year over the study period, including an increase of 0.2 years in 2015-16.

Population health status

- During the study period, treatment prevalence of chronic diseases and injuries increased for those aged 80 and older, and decreased for all other age groups. For example, according to physician billing and hospital discharge records, Nova Scotians in their 60s and 70s in 2016 had fewer chronic diseases and injuries than Nova Scotians in their 60s and 70s did in 2006.

Levels of family physician service provision

- Aside from the introduction of new incentive fee codes years prior, the volume and mix of services Nova Scotia family physicians billed for did not change more between the last two years of the study than between previous years.

Rates of family physician service provision

- For most services, the volume family physicians reported providing each year decreased throughout the study period. The largest decrease was for regular office visits.

Stock of family physicians

- The stock increased between 2014–15 and 2015–16. During the last year of the study period, there were more people licensed to practice in family medicine or general practice in Nova Scotia than ever before.

Levels of family physician participation

- The proportion of family physicians who reported providing at least some family medicine services varied between 88% and 90%. In 2015–16 the proportion was 89%, as it was in several other years during the study period.

Levels of family physician activity

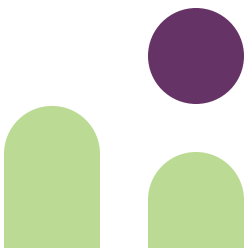
- Overall, the average number of days per year on which Nova Scotia family physicians billed for providing any service shifted lower during the study period. The change in this distribution of days billed between the last two years of the study was no larger than between previous years in the study period.


Limitations

Even though the datasets used for the study were the best sources available, the findings need to be considered in light of their various limitations, which are discussed in more depth in the main body of this report. In particular, physician billing data do not capture the full range or scope of the work physicians do, nor do they fully capture the health status of people cared for by those physicians. As such, it is possible that factors affecting the supply of and requirements for family physicians in Nova Scotia changed during the study period in ways not captured by these data and therefore not evident in the results presented here.

Conclusions

Changes observed over the study period suggest that gradual, long-term trends—as opposed to sudden, dramatic changes—are affecting the supply of, and requirements for, family physicians in Nova Scotia. The growth in the provincial population estimated by the Census (roughly 7,000 people) is several times lower than the estimated growth in the number of unattached patients in the province (roughly 40,000 at the end of 2016). This means, population growth is not enough to explain, on its own, the sudden growth in unattached patients in Nova Scotia that year.





The view that the sudden growth in unattached patients in Nova Scotia is attributable to a decline in the health of the provincial population is not supported by the findings of this study. Firstly, our analyses suggest that the health of the population is changing too gradually to explain, on its own, why thousands of Nova Scotians suddenly reported being unable to find a family physician in the spring of 2016. Secondly, while our analyses suggest a gradual decline in the health of Nova Scotians aged 80 and above over the study period, they also suggest gradual improvements in the health of the rest of the province's residents, who make up 95% of its population.

Similarly, the view that the sudden growth in unattached patients in Nova Scotia is explained by the fact that family physicians are doing much more for their patients than before is not supported by these analyses, which show that these physicians are, on average, reporting providing fewer services to their patients overall. They are also reporting providing fewer services per patient, on average, given their patients' age and health status, year by year. This may reflect limitations in the billing data from which these findings were derived—that is, physicians may be increasingly providing services for which they cannot and/or do not bill. Other things being equal, this would mean more family physicians are required in Nova Scotia.

The findings related to family physician activity from billing data and the NPS must be interpreted together. While the former suggest Nova Scotia family physicians may be working less, on average, than in previous years, the latter suggest they continue to work well beyond what would be considered full-time hours for other professions, even without accounting for time spent on-call. A health care system dependent on most of its physicians averaging 60 hours of work per week for decades to come may not be sustainable.

The analyses of billing data support the view that family physicians in Nova Scotia are working less, on average, than in previous years. The decrease in physician-reported activity measured here has not been large or rapid enough to explain, on its own, the sudden increase in unattached patients seen in 2016. This trend is instead gradual and occurring over many years. Regardless of the reason for it, this trend, in combination with the known aging of the population, would result in gradual increases in the numbers of family physicians required to care for Nova Scotia's population.

In summary, estimated changes in population aging, population health, levels of family physician service provision, and family physician stock, participation, activity, and service delivery rates between the last two years of the study were no larger than those observed in preceding years.

The COVID-19 pandemic has provided a more dramatic and ongoing demonstration of what these findings have shown - namely that the factors that determine Nova Scotia's supply of and need for family physicians are constantly changing. It is therefore critical that plans for ensuring an adequate provincial health workforce monitor these factors on an ongoing basis to track changes in them and account for these in provincial health workforce planning.

BACKGROUND

Nova Scotia Health defines Primary Health Care as a multidimensional system that is responsible for organizing and providing care for individuals across the continuum of care over the entire lifespan. Primary Health Care “acknowledges the determinants of health and the importance of healthy individuals and communities. It focuses on factors such as where people live, the state of the environment, education and income levels, genetics, and relationships with friends and family.”² Patients and families represent core partners in the Primary Care team and can receive care from family physicians, nurses, physiotherapists, pharmacists, dentists and other health care professionals. “Primary health care is the foundation of the health system, where the majority of people experience most of their health care, in the community, and is the ongoing point of contact a person has with the overall health system.”²

There is strong evidence that, in Canadian health care systems, patients with a regular primary care provider are more likely to receive routine and preventive care and less likely to have a visit to an Emergency Department that could be avoidable.³⁻¹¹ Compared to patients without a regular provider, patients who are “attached” to a primary care provider receive more preventive care,^{12, 13} have better care coordination,^{14, 15} chronic disease management,¹⁶ and health outcomes.^{17, 18} More broadly, access to PHC is understood to be fundamental to the health of individuals as well as populations.^{13, 19-22} Although the value of access to PHC is clear, through a national survey in 2016, approximately 15% of the Canadian population reported not having a regular PHC provider.²³

The Nova Scotia Health’s Primary Health Care Connections (PHCC) service was established to match Nova Scotians seeking a regular PHC provider with PHC practices in Nova Scotia Health’s Central Zone accepting new patients.²⁴ In 2016, PHCC received more calls than it had in the preceding three years combined. Other parts of the province similarly experienced an increased volume of calls over that time. In November 2016, a provincial registry was established for individuals without a regular PHC provider who are actively seeking one—often referred to as unattached patients. While approximately 178,609 Nova Scotians have since found a PHC provider through this registry, as of December 1, 2020, there were 51,735 unattached patients on the registry, representing 5.3% of the provincial population.^{25, 26} More broadly, data from Statistics Canada’s Canadian Community Health Survey (CCHS) indicate that the proportion of Nova Scotians over the age of 12 years who reported not having a regular health care provider (a larger group that includes those not actively seeking one) was 14.4% in 2018, similar to the national proportion of 14.7%.^{27, 28} Improving the accessibility of PHC in general and reducing the number of Nova Scotians unable to find a regular PHC provider specifically remain top priorities for the Nova Scotia Department of Health and Wellness (DHW).^{20, 30}



The Canadian Institute for Health Information (CIHI) estimates that the ratio of family medicine physicians to population in Nova Scotia increased from 120 per 100,000 people in 2006 to 128 per 100,000 people in 2016.³¹ Despite this increase in both the number and ratio of family medicine physicians, an overall decrease in the total volume of services these physicians report providing in Nova Scotia was observed over that time period.^{32, 33} The reasons for these apparently opposing trends are not clear. Existing evidence from Nova Scotia and other provinces suggests they may be partially due to a concurrent increase in the age of Nova Scotia's population²⁸ and/or reductions in physician activity levels over that time period.³⁴⁻³⁷

Although the growth and aging of Nova Scotia's population (increasing need for PHC) and the decrease in the volume of services produced by Nova Scotia's family physicians (decreasing supply of PHC) over much of the study period may explain some of the observed increase in the number of unattached patients, these phenomena are too gradual to explain the sudden and substantial growth seen in 2016. While a variety of opinions³⁸⁻⁴¹ as to the underlying cause(s) of the growth in the number of Nova Scotians unable to find a family doctor have been posited, the degree to which these explain recent growth in the number of unattached patients in Nova Scotia has not been scientifically assessed.

Objectives

The overarching aim of this study was to generate hypotheses about the causes of the 2016 increase in unattached patients in Nova Scotia. Within that aim, the specific objectives were to estimate changes between 2006 and 2016 in the immediate determinants of the supply of and requirements for family physicians in Nova Scotia according to the Birch et al.¹ framework—namely:

- 1) The size and age structure of Nova Scotia's population;
- 2) The distribution of health status among Nova Scotia's population;
- 3) Levels of family physician services provided to Nova Scotians;
- 4) The provincial stock of family physicians;
- 5) The level of participation among Nova Scotia family physicians;
- 6) The level of activity among Nova Scotia family physicians; and
- 7) Rates of service provision among Nova Scotia family physicians.

METHODS

Study design

This was a population-based, hypothesis-generating study based on repeated cross-sectional descriptive analysis of secondary data. The analytical basis for the study was the framework for health human resources (HHR) planning developed by Birch and colleagues.¹ This framework has previously been applied to estimate and compare supply and requirements of several different types of HHR in various jurisdictions, including Nova Scotia.⁴²⁻⁴⁶

Under this framework, two distinct quantities are estimated and then compared for specific periods of time:

- 1) the number of HHR available to deliver services to the population (supply); and
- 2) the number of HHR required to deliver services to a population (requirements).

The framework further disaggregates supply and requirements into their immediate determinants.¹ Specifically, for any given period of time, the determinants are as follows:

Supply

- 1) **Stock**—The number of providers qualified to provide services and practice in the jurisdiction
- 2) **Participation level**—The proportion of qualified providers who provide direct patient care
- 3) **Activity level**—The average proportion of full-time equivalent (FTE) hours spent providing direct patient care among participating providers

Requirements

- 4) **Demography**—The size and demographic (age–sex) makeup of the population to be served
- 5) **Epidemiology**—The distribution of health status within that population, i.e., the need for care within that population
- 6) **Level of service**—The number and type of services to be provided to people of different levels of health status
- 7) **Productivity**—The rate at which different types of services are to be delivered by individual providers

Study populations

The study populations were: 1) all Nova Scotia residents between 2006 and 2016 (objectives 1–3), and 2) all family physicians in NS between July 1, 2006 and June 30, 2016 or June 30, 2017 for Objective 4 (stock).

Family physicians were chosen as the primary care providers of focus for this study because, while the roles of nurses, pharmacists, and other care providers are now expanding to include more PHC provision,^{47–52} family physician-led practices remain the main access point for PHC for most Nova Scotians.

While the sudden and sustained growth in Nova Scotia’s unattached patient population appeared to begin in 2016, the longer study period was chosen to provide a frame of reference for any changes in study variables observed in the most recent year.

Data collection

Data were extracted from the following databases from July 1, 2004 to June 30, 2016, with the exception of the National Physician Survey (NPS), for which data from the 2007, 2010, and 2014 waves were accessed (the survey was discontinued after 2014) and the Provincial physician registry for which data from July 1, 2006 to June 30, 2017 was accessed. All data — except for the Census and MSI registry, from which population estimates are publicly available online — were made available and accessed through Health Data Nova Scotia (HDNS) at Dalhousie University.

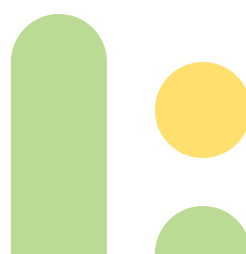


Table 1: Study data sources

REQUIREMENTS		SUPPLY	
DEMOGRAPHY	<ul style="list-style-type: none"> • Census • MSI registry 	STOCK	<ul style="list-style-type: none"> • Provider registry
HEALTH STATUS	<ul style="list-style-type: none"> • Physician billings + hospital discharge abstract database (DAD) 	PARTICIPATION	<ul style="list-style-type: none"> • Provider registry • Physician billings
LEVEL OF SERVICE	<ul style="list-style-type: none"> • Physician billings 	ACTIVITY	<ul style="list-style-type: none"> • Physician billings • NPS
RATE OF SERVICE PROVISION	<ul style="list-style-type: none"> • Physician billings • NPS 		

Data analysis

Because of limitations in existing sources of data available on level of service, the framework was not used to estimate historical requirements for family physicians in Nova Scotia within the present study. In this modified application, the measure of interest was instead the degree of change in each element of the framework over the study period. More specifically:

Demography

- Annual estimates of Nova Scotia's population size by sex and age group (0-12, 12-19, 20-29, 30-39... 70-79, 80+ years) was derived from publicly available Statistics Canada data as well as reports from the provincial MSI registry database for each year of the study period.

Epidemiology

- Comorbidity number: The number of conditions for which each eligible Nova Scotia resident meets established case definitions for arthritis, asthma, cancer, chronic obstructive pulmonary disease (COPD), dementia, diabetes, heart failure, hypertension, injuries, ischemic heart disease, mental health conditions, osteoporosis, and/or stroke each year was calculated using the same definitions and

methods as an earlier MSSU study⁵³ along with others published in the peer-reviewed literature.^{54,55} The case definitions for these conditions are provided in Appendix I and were drawn from all diagnosis fields in the physician billings and discharge abstract databases; some also draw on physician specialty and procedure code fields. These were applied using 1- or 2-year windows, as specified for each definition, beginning in 2006 and looking backward in time (so that 2006 estimates are based on data from 2004 to 2006, 2007 estimates from 2005-7, and so on). DAD data were also included where required by the case definitions for each condition.

Level of service

- Provided PHC services (physician billings): Nova Scotia residents' mean number and type of services (as reported in the provincial MSI billings database) received from a family physician (as identified in the provincial provider registry) per year by age and comorbidity number were estimated for residents with 0, 1, 2, 3, and 4 or more of the above comorbidities. Types of services were classified from billing data according to Table 2.

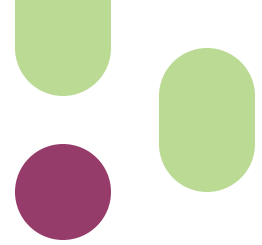


Table 2: Service categorization

SERVICE TYPE	CCP* CATEGORY (CCPCAT)	CCP* CODE & SHORT DESCRIPTION (CCPCODE + CCPQUAL)	LOCATION
Consultation	CONS	03.07 or 03.08	Any
Complex Care Visit	VIST	03.03B	OFFC
Other Office Visit	VIST	03.03, 03.04	OFFC
Hospital Visit	VIST	03.03, 03.04	HOSP
Nursing Home Visit	VIST	03.03, 03.04	NRHM
Home Visit	VIST	03.03, 03.04	HOME
Psychiatric Services	PSYC	08.41, 08.44, 08.45, 08.49A, 08.49B, 08.49C	Any
Incentive Programs	DEFT	CDM1, ENH1, UPB1, CGA1	Any
Diagnostic & Therapeutic	VADT	03.26A (Pap smear) 50.99H (Venipuncture of a person seven years or older)	Any
	ADON	13.59L (Provincial immunizations)	Any
Other	All others	All others	All others

*CCP = Canadian Classification of Diagnostic, Therapeutic, and Surgical Procedures

Stock

- Using the provincial provider registry, annual counts of the number of unique physicians with GENP (General Practitioner) as one of their specialties were calculated.

Participation

- According to the Canadian College of Family Physicians, family physicians are qualified as general practitioners (GPs) and have additional, specialized training in family medicine.⁵⁶ Nova Scotia's physician registry does not distinguish family medicine as a specialty separate from general practice. In the absence of a standard definition of a family physician in terms of administrative data in Nova Scotia, annual levels of participation among family physicians were estimated as follows:
 - Annual counts of the number of unique physicians with a) GENP as one of their specialties and b) at least one billing record that year with an attached billing specialty of GENP, divided by the annual family physician supply.

Activity

- In Canada, there is currently no widely accepted measure of physician activity that is comparable over time.³¹ Nova Scotia family physician activity was measured as the proportion of days per year that a family physician billed for a service.

Rate of service provision

- Annual rates of service provision were calculated by dividing total PHC service volume by total annual GP activity product:
 - Annual PHC service volume: Annual total volumes of service provision—separately for each type of service listed in Table 2—by all family physicians in the province were estimated by summing, across all family physicians, the numbers of services they report each year.
 - Annual GP activity product: Products of physician stock, participation levels, and activity levels (calculated as described above) for each year of the study period.

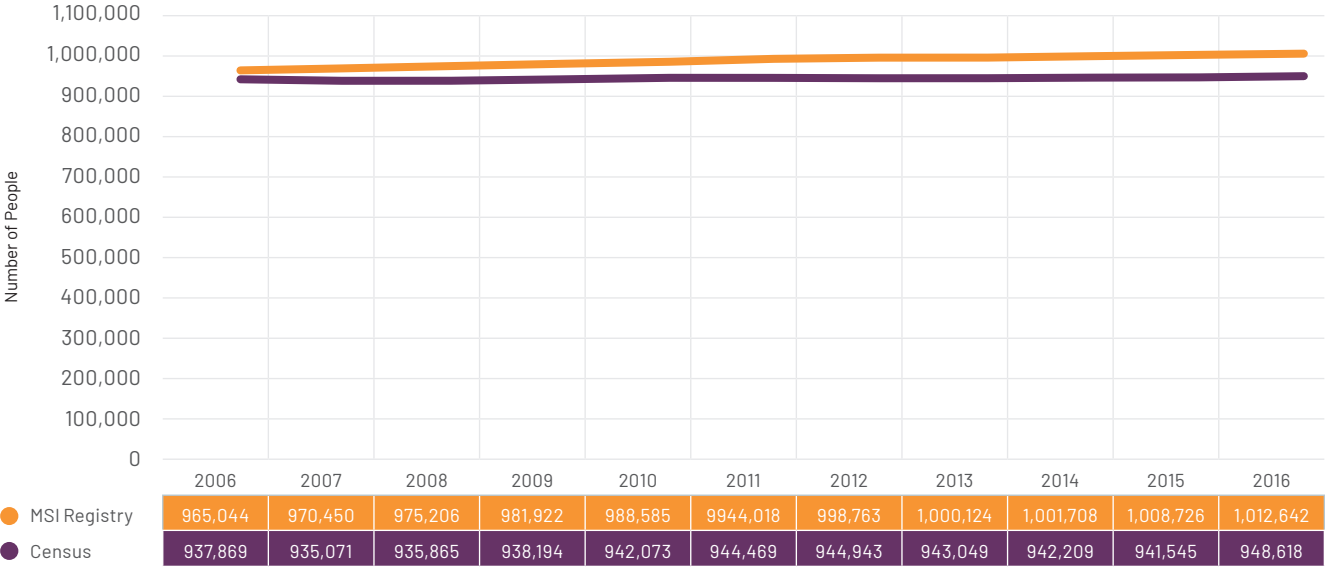
RESULTS

The following presents a summary of results for each of the study objectives—i.e., according to the determinants in the HHR model described above.

POPULATION SIZE AND AGE STRUCTURE

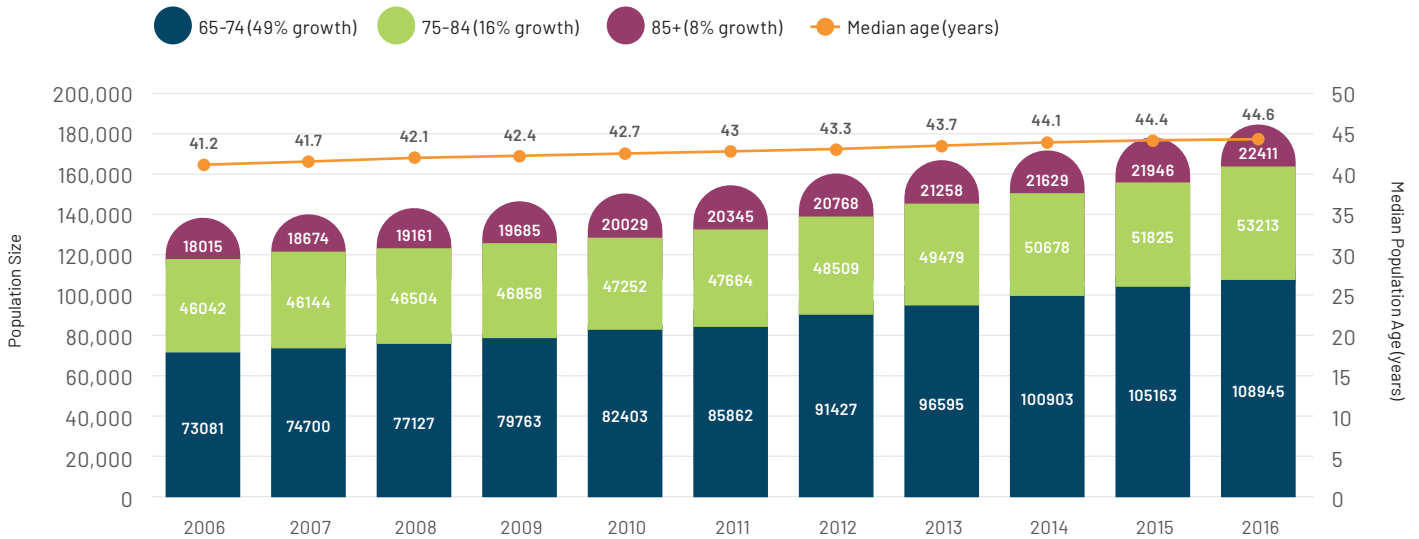
The Nova Scotia population size was estimated using two different data sources: annual reports published by Health Canada on the provincial MSI Registry, and census data (Figure 1). These two sources provide increasingly divergent estimates of the size of Nova Scotia’s population, differing by fewer than 30,000 people in 2006 compared to more than 60,000 in 2016. According to both sources, growth in the provincial population between 2015 and 2016 was larger than it had been in several years. According to the MSI registry, 2015-16 saw the largest increase in the provincial population in 4 years. According to the Census, 2015-16 saw the largest increase in the provincial population in 31 years.

Figure 1: Estimated Nova Scotia population by data source



The Nova Scotia population aged 65 and older is growing proportionally faster than the rest of the population (Figure 2). Between 2015 and 2016, both the number of seniors and the median age of the provincial population increased. In both cases the amount of the increase was less than the year-to-year increases seen in the recent past. The increase in the province’s median age from 2015-16 was the smallest in the past decade.

Figure 2: Nova Scotia senior population vs. overall median age, 2006-2016



Source: Statistics Canada CANSIM Table 051-0001

POPULATION HEALTH STATUS

During the study period, according to physician billing and hospital data, treatment prevalence of chronic diseases and injuries remained relatively stable (Figure 3a). While the number of Nova Scotians identified as having multiple chronic conditions or injury increased over the last two years of the study, it had decreased during the preceding three years. Further, the number of Nova Scotians identified as having multiple chronic conditions or injuries in the last year of the study was lower than it had been in both 2009-10 and 2010-11 (Figure 3b).

Figure 3a: Estimated Nova Scotia population by number of chronic conditions + injuries, 2006-7 through 2015-16

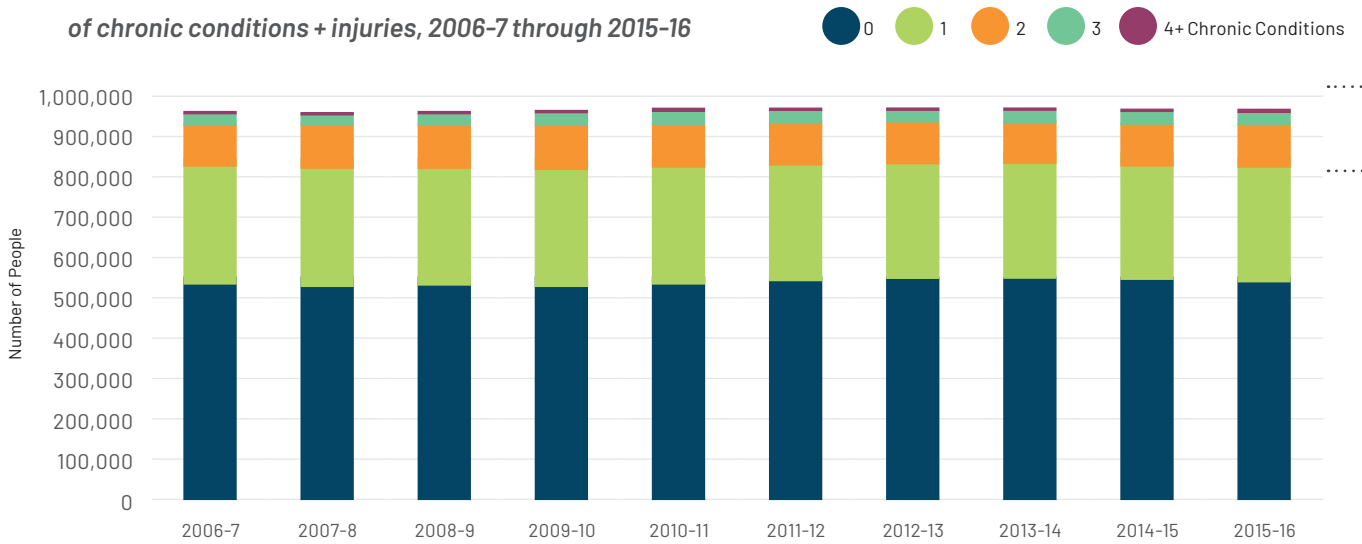
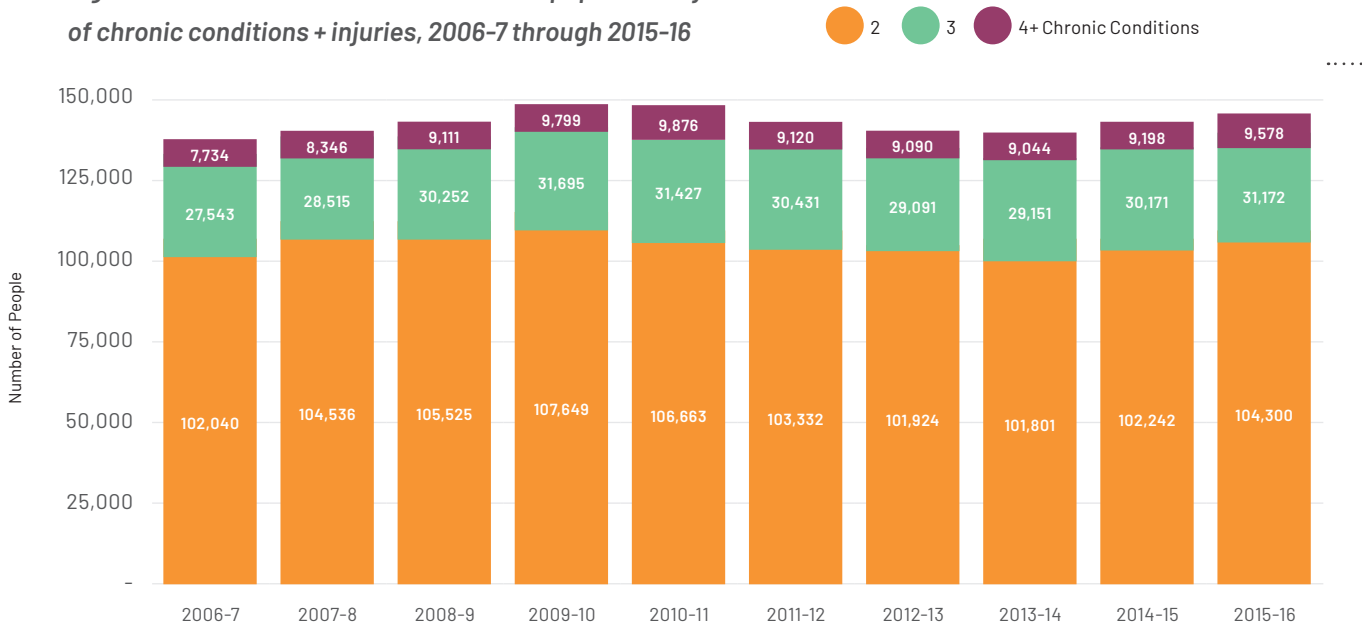


Figure 3b: Detail of estimated Nova Scotia population by number of chronic conditions + injuries, 2006-7 through 2015-16



Note: 'Years' cover July 1 – June 30 (e.g., 2006 covers July 1, 2006 through June 30, 2007).
Sources: MSI Insured Patient Registry, MSI Physician Billings Database, CIHI Discharge Abstract Database

During the study period, treatment prevalence of chronic diseases and injuries increased for those aged 80 and older, and decreased for all other age groups. For example, in 2006-7 an estimated 37% of Nova Scotia residents aged 80 and older had one chronic condition while 12% had three; in contrast, by 2015-16, an estimated 35% had one chronic condition while 14% had three (Figure 4a).

The opposite trend was observed for every other age group. For example, in 2015-16 Nova Scotians in their 70s were less likely to have any chronic condition, and were likely to have fewer of them, compared to Nova Scotians who were in their 70s in 2006-7 (Figure 4a). For no age group was the estimated change in the distribution of co-morbidities between 2015 and 2016 larger than changes observed in previous years. Detailed tables of these findings are presented in Appendix III.

Figure 4a: Distribution of number of chronic conditions + injuries among Nova Scotians 80+, from 2006-7 to 2015-16

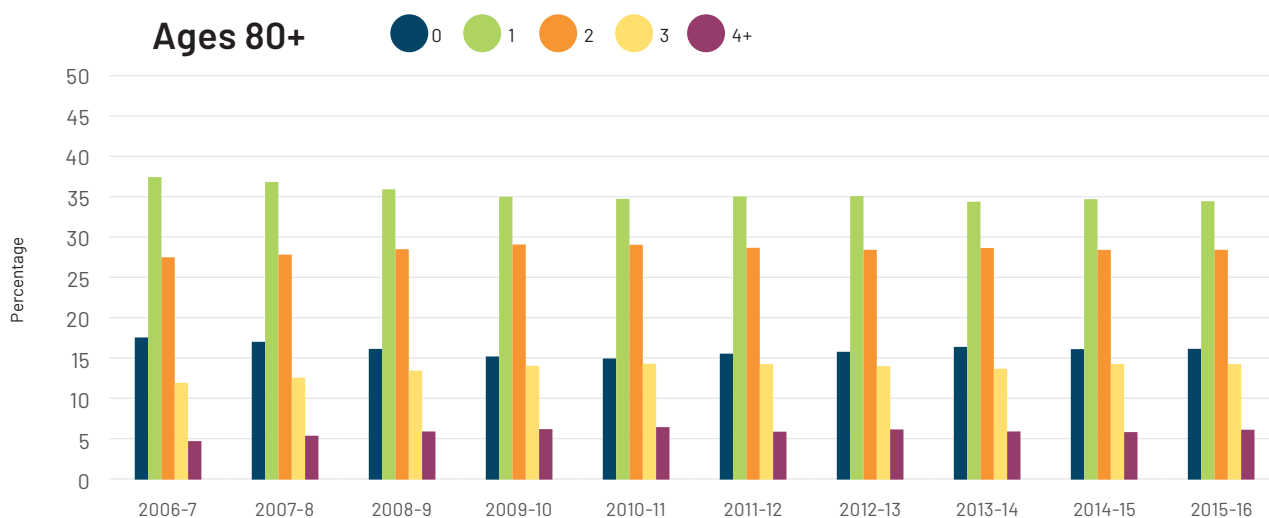
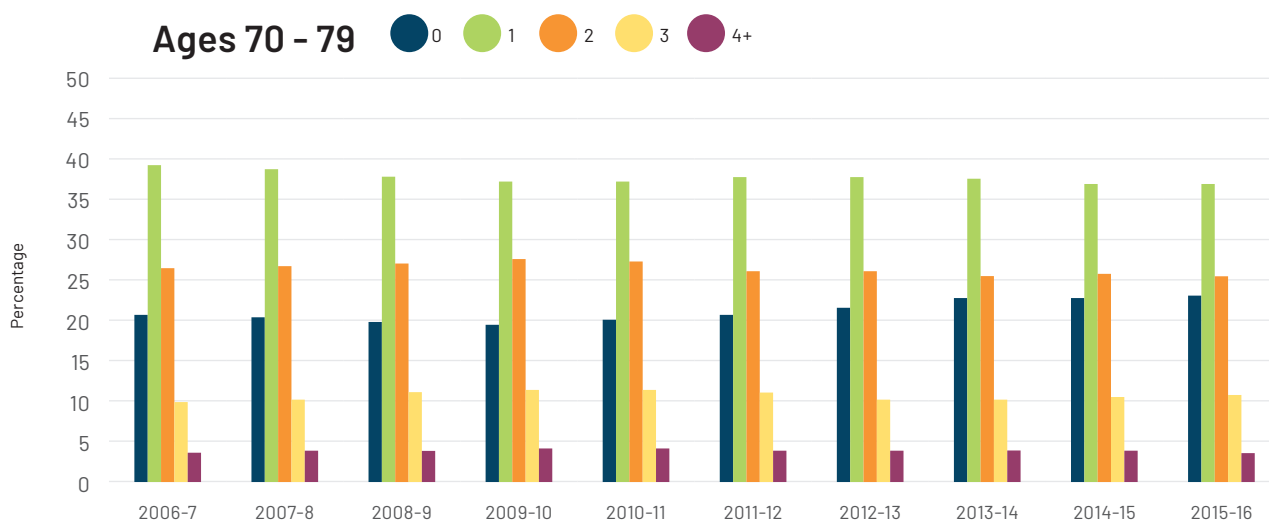


Figure 4b: Distribution of number of chronic conditions + injuries among Nova Scotians 70-79, from 2006-7 to 2015-16



LEVELS OF FAMILY PHYSICIAN SERVICE PROVISION

Between 2015 and 2016, the average numbers and types of services billed by Nova Scotia family physicians per patient, for patients of a given age and health status, did not change any more than they had in previous years. Figures 5a-d show, for Nova Scotians aged 80 and above, the mean number of 'regular' (i.e., non-complex) office visits, hospital visits, 'complex' office visits, and services billed under various provincial family medicine incentive programs each year of the study period.

Figures 5a-d: Changes in billed levels of family physician service provision to Nova Scotians aged 80+ by number of chronic conditions and injuries, 2006-7 to 2015-16

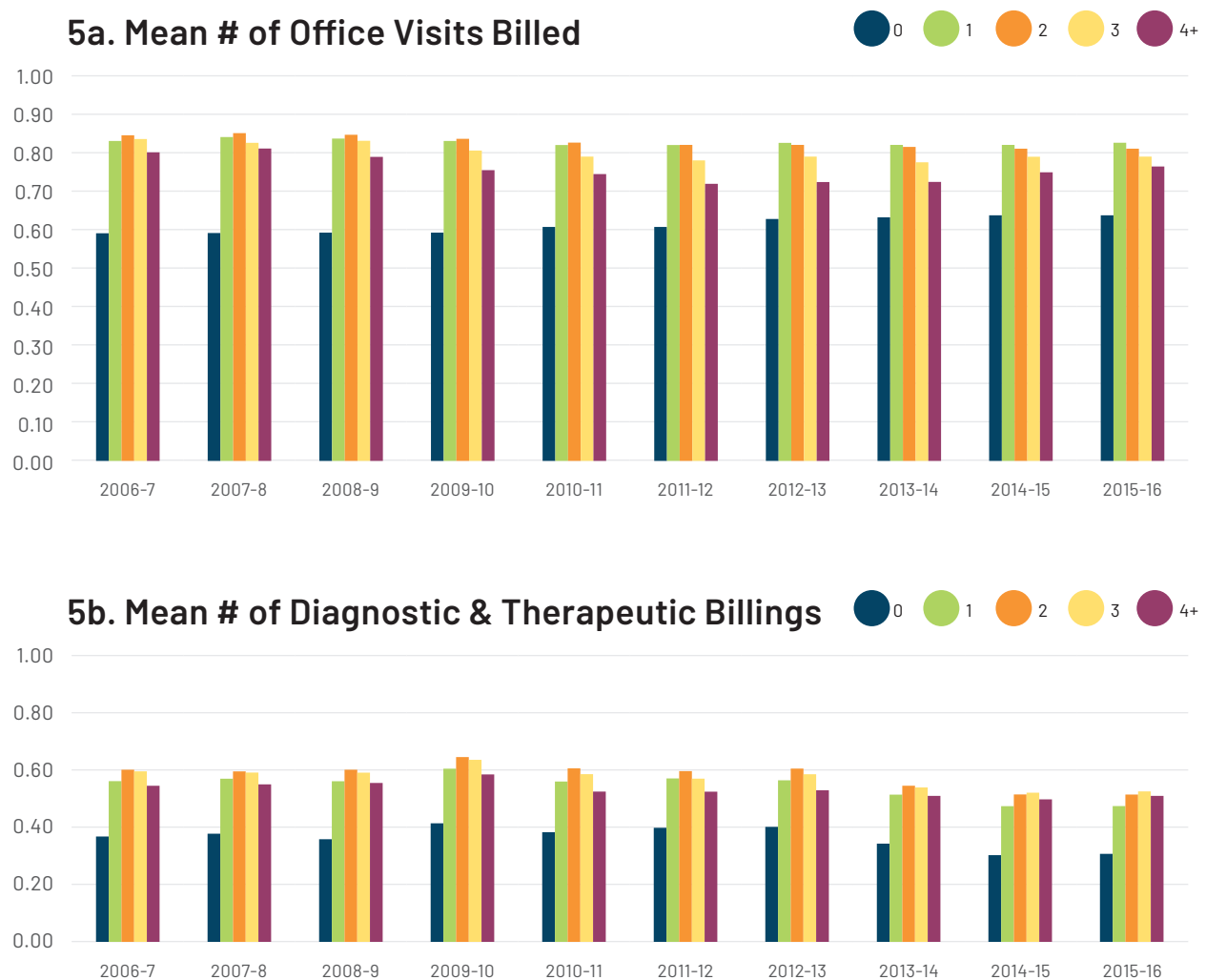
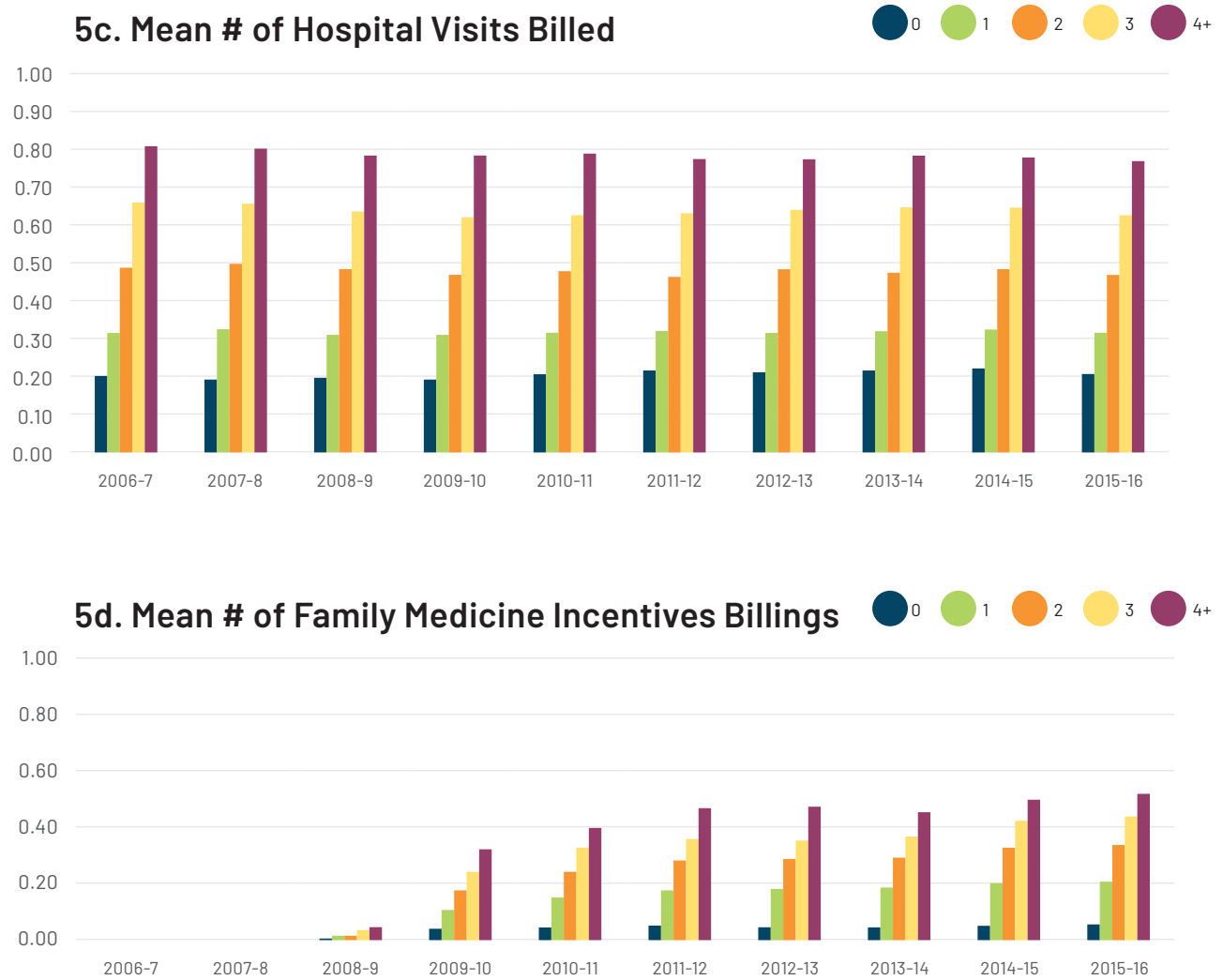
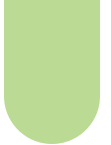


Figure 5 cont.



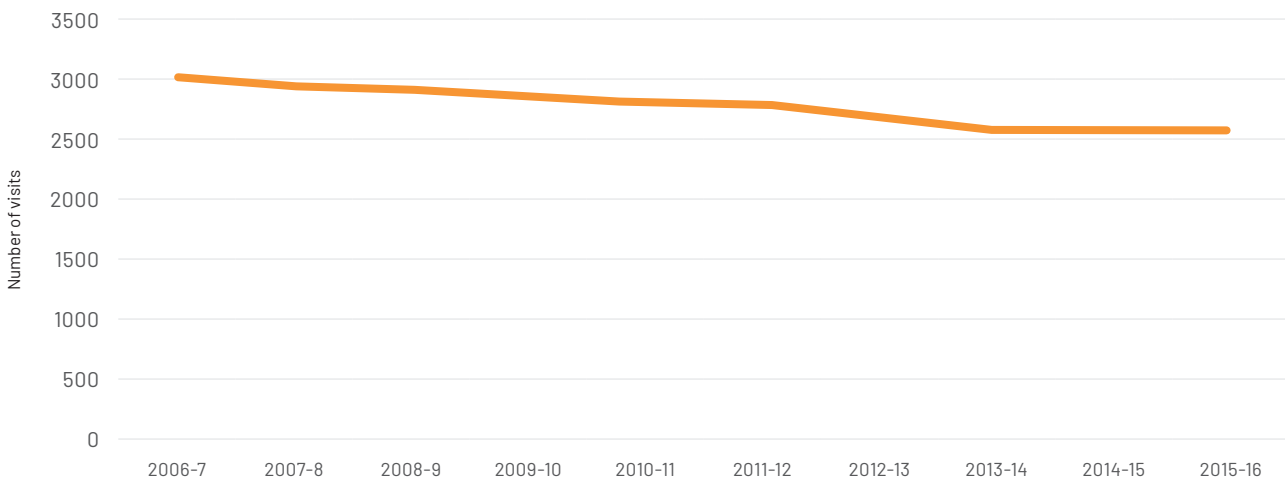
For earlier parts of the study period, substantial increases in volumes of complex care visits and other incentive program billings—coinciding with their introduction—are evident. In addition, the results show how average numbers of most types of services billed increase with the number of chronic conditions patients have—complex care visits, hospital visits, house calls, nursing home visits, incentive program visits, psychiatric services, and other services. In contrast, for regular office visits (i.e., visits other than those billed as complex care, which are for patients with a combination of different chronic health conditions) and diagnostic and therapeutic services no such gradient is observed. Detailed tables of these findings are presented in Appendix IV. For no age group or type of service did the average annual number of services billed per patient change more between the last two years of the study than it had over preceding years in the study period.



RATES OF FAMILY PHYSICIAN SERVICE PROVISION

Similar to the number and type of services billed per patient shown above, according to billing data, the number and type of services billed per physician changed no more between the last two years of the study period than they had in earlier years. Throughout the study period, Nova Scotia family physicians billed for more regular office visits than for all other services combined, and the number of these services billed per physician per year declined each year between 2006-7 and 2013-14, then remained stable through 2015-16 (Figure 6).

Figure 6: Total office visits billed per NS family physician per year

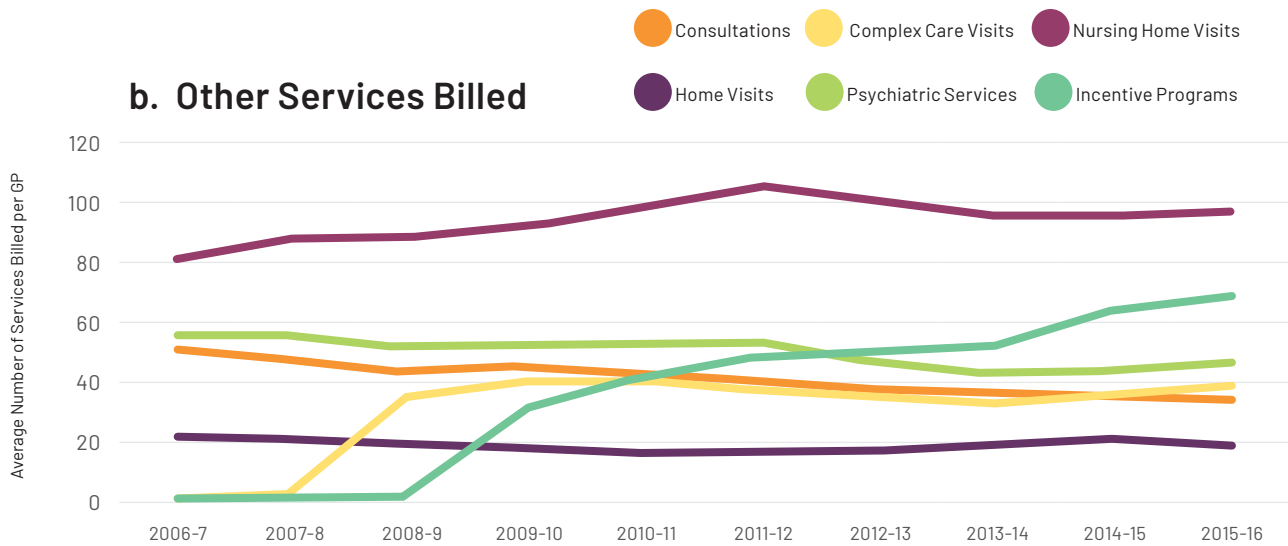
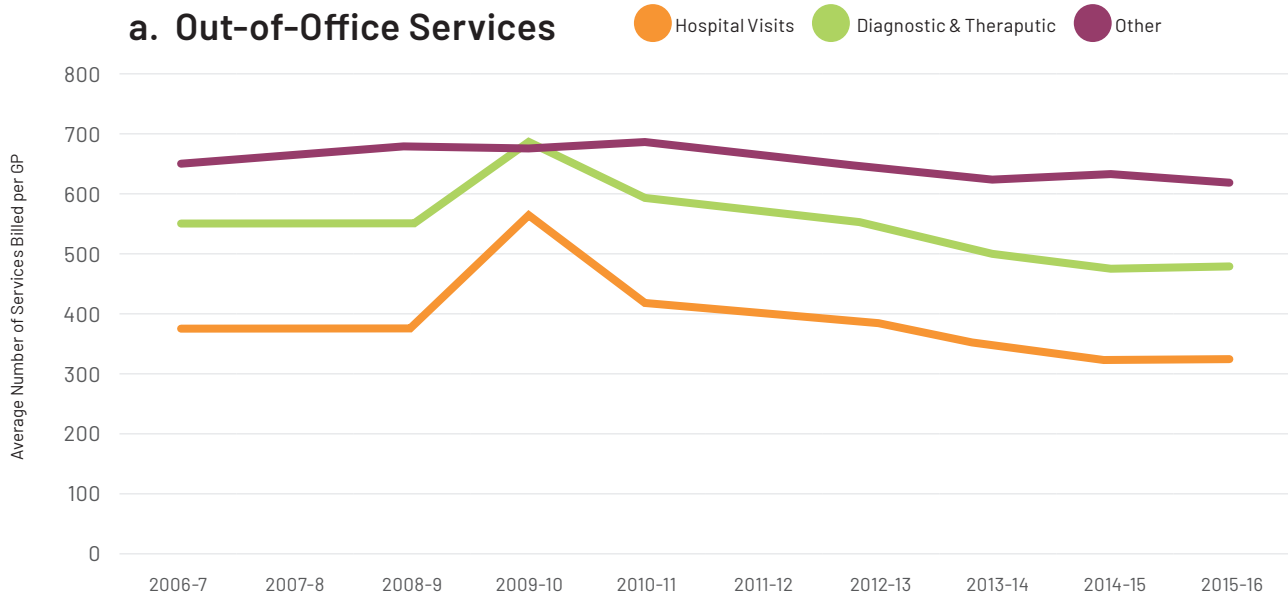


Note: 'Years' cover July 1 - June 30 (e.g., 2006 covers July 1, 2006 through June 30, 2007).

Sources: MSI Insured Patient Registry, MSI Physician Billings Database

Average numbers of hospital visits billed per family physician per year increased from about 650 to 700 between 2006-7 and 2010-11 and then declined to about 620 per year, where they remained relatively stable from 2013-14 through 2015-16 (Figure 7a). Numbers of nursing home visits billed per family physician increased between 2006-7 and 2011-12, declined between 2011-12 and 2013-14, and then remained stable through 2015-16 (Figure 7b). The number of complex care visits billed per family physician per year has remained relatively stable at about 40 since that fee code's introduction in 2008-9. Numbers of consultations and psychiatric services billed per family physician generally declined each year over the study period from about 55 and 58 each in 2006-7 to about 45 and 38 each in 2015-16. The numbers of home visits billed per physician per year remained relatively stable at about 20. The temporary increases in numbers of diagnostic, therapeutic and other services billed per physician in 2009-10 coincide with the H1N1 influenza pandemic.

Figure 7: Other services billed per NS family physicians per year

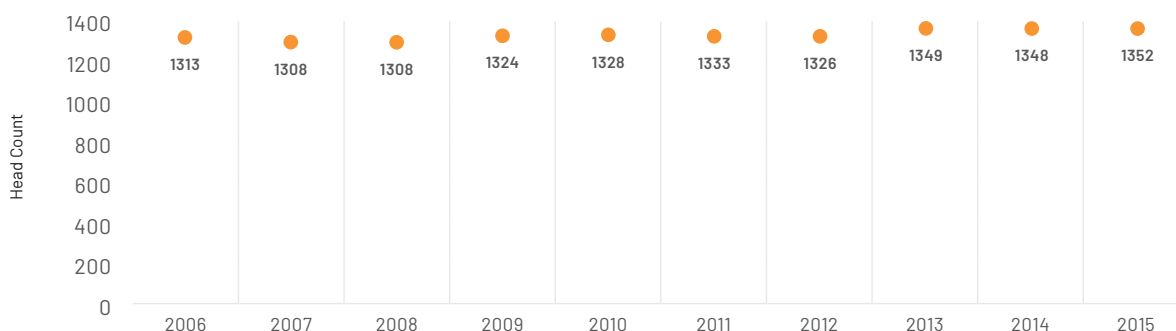


Note: 'Years' cover July 1 - June 30 (e.g., 2006 covers July 1, 2006 through June 30, 2007), average number of services estimated from total volume of services billed / MSI estimate of supply of physicians providing service in a given year. Sources: MSI Insured Patient Registry, MSI Physician Billings Database

STOCK OF FAMILY PHYSICIANS

The number of individuals licensed to practice as general practitioners in Nova Scotia was estimated from the provincial registry, and demonstrates a slight increase ($\approx 3.0\%$) in the number of practitioners licensed over the course of the study period (Figure 8). In addition, the stock of family physicians in Nova Scotia increased over the last year of the study period from 1,348 to 1,352.

Figure 8: Estimated stock of family physicians licensed to practice in NS, 2006-7 to 2015-16

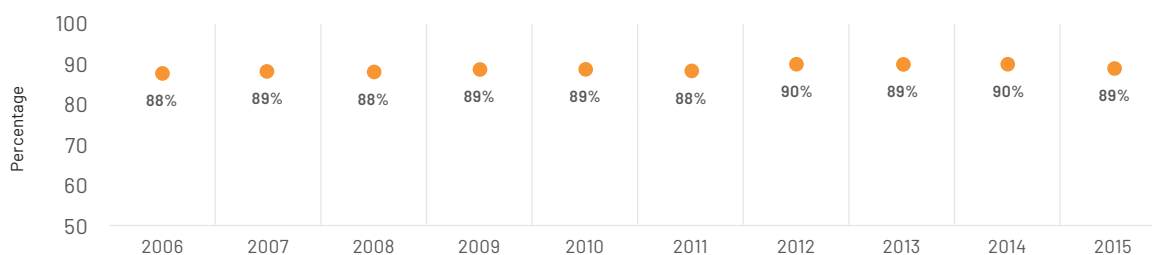


Note: 'Years' cover July 1 - June 30 (e.g., 2006 covers July 1, 2006 through June 30, 2007). Source: Provincial physician registry

LEVELS OF FAMILY PHYSICIAN PARTICIPATION

The proportion of Nova Scotia family physicians who billed for at least one family medicine service for each year of the study period is shown in Figure 9. This value remained relatively stable, between 88% and 90%, throughout the study period. The change observed between the final two years of the study period was no larger than those observed in previous years.

Figure 9: Proportion licensed NS GPs billing for any service as a GP, 2006-7 to 2015-16

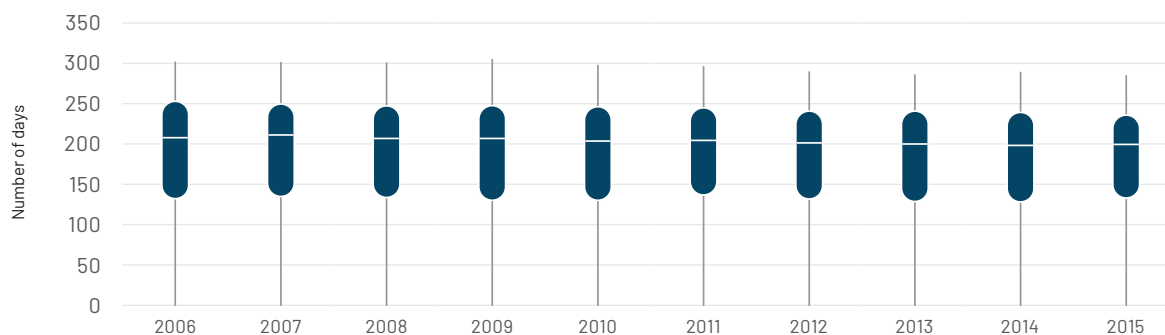


Note: 'Years' cover July 1 - June 30 (e.g., 2006 covers July 1, 2006 through June 30, 2007). Sources: Provincial physician registry; MSI billings database

LEVELS OF FAMILY PHYSICIAN ACTIVITY

Figure 10 shows box-and-whisker plots of the number of days on which Nova Scotia family physicians billed for any service in each year of the study period. The median number of days that these physicians billed for any service decreased slightly over the study period. In 2006-7, 50% of the province's family doctors billed for a service on more than 216 days, 25% billed for a service on fewer than 142 days, and 25% billed for a service on more than 261 days. At the end of the study period, in 2015, 50% billed for service on more than 208 days, 25% fewer than 142 days, and 25% more than 245 days. The size of the change between the last two years is no more than those seen between prior years.

Figure 10: Number of days on which NS family physicians billed for any service, 2006-7 to 2015-16

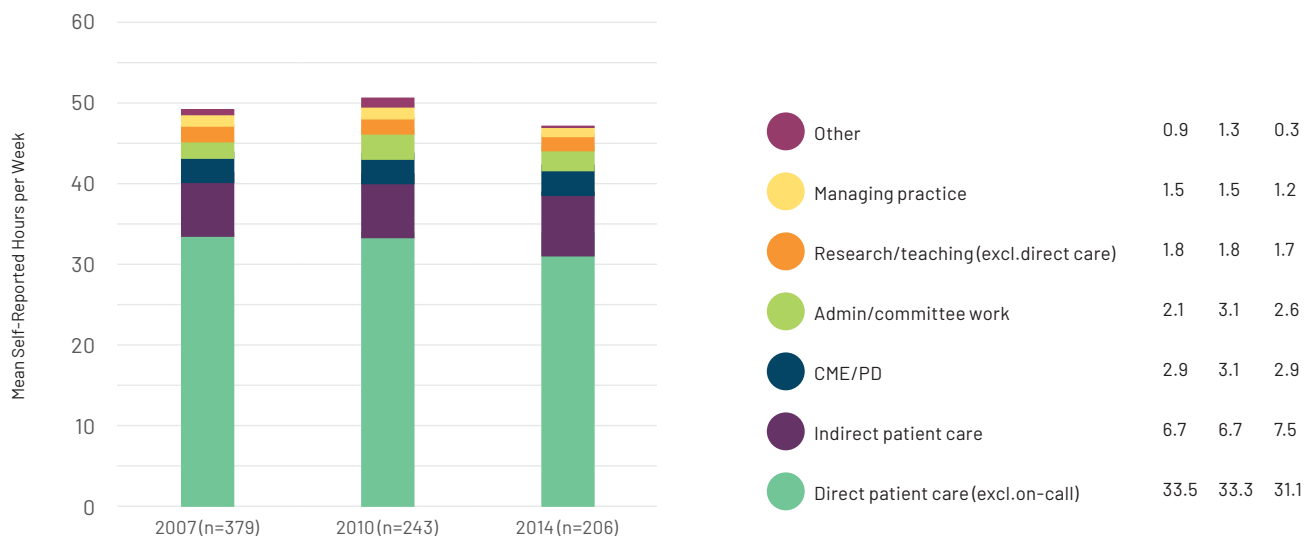


Notes: 'Years' cover July 1 – June 30 (e.g., 2006 covers July 1, 2006 through June 30, 2007)

'Whiskers' indicate 1st and 99th percentiles. Source: MSI Physician Billings Database

Figure 11 shows the average self-reported worked hours per week, excluding on-call time, by Nova Scotia family physicians who responded to the NPS in 2007, 2010, and 2014. These data show that the average number of hours a family physician reports working ranged from 47.3 per week in 2014 to 50.8 in 2010, excluding on-call time.

Figure 11: NS family physicians' mean self-reported worked hours per week by task - excluding on-call time



LIMITATIONS

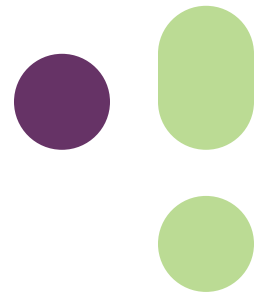
Achievement of the study objectives was hindered by systemic limitations in the available data, on the factors that influence the supply of and requirements for family physicians, in Nova Scotia.

None of the data sources available for the present study are ideal for measuring changes in the health status of Nova Scotia's population over time. Administrative data do not fully capture the impacts or severity of health issues and are likely under-representative of unattached patients (among other populations who may have difficulty accessing health care), while survey data are captured infrequently and for a relatively small sample of the population. This means that the health of Nova Scotia's population could not be measured comprehensively throughout the study period.

A further limitation of using physician billing data to measure population health status is that physicians sometimes only record one diagnostic code on a billing even in cases where they addressed multiple health conditions during a visit. This means that the prevalence of health problems may be underestimated. The case definitions for the health conditions used in the present study have been developed to offset this limitation as much as possible, and both increases and decreases in prevalence for different age groups were detected in these analyses. Billing data do not—and were not designed to—fully capture the full scope or complexity of the services provided by physicians. This means that neither levels of service received by patients nor the rates of service provision by family physicians can be measured comprehensively with existing data.

Existing sources of information on physician activity are either limited by low response rates and self-reporting issues (i.e., the NPS) or capture activity only indirectly (i.e., physician billing data). This means that family physician activity cannot be comprehensively measured with existing data. The measure of activity proposed here will underestimate the change during the study period if family physicians have been working fewer hours per day instead of, or in addition to, working fewer days per week or per year. Similarly, we overestimate the change in activity during the study period if family physicians have been compensating for working fewer days by working more hours during those days.

The above limitations in the available data must shape any interpretation of the study findings.

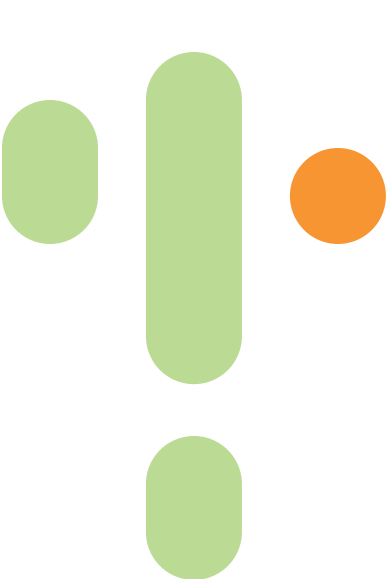


DISCUSSION

According to census estimates, the sudden increase in unattached patients in Nova Scotia coincided with the largest growth in the provincial population in over 20 years.²⁸ Other things being equal, substantial growth would mean more family physicians would be required to care for Nova Scotian’s population. However, since the growth in the provincial population estimated by the Census (roughly 7,000 people) is several times lower than the estimated growth in the number of unattached patients in the province (roughly 40,000 at the end of 2016),⁵⁷ population growth is not enough to explain, on its own, the sudden growth in unattached patients in Nova Scotia that year. The fact that census data and the provincial MSI registry are providing increasingly divergent estimates of the size of the provincial population warrants further investigation.

The view that the sudden growth in unattached patients in Nova Scotia is attributable to declines in the health of the provincial population is not supported by the findings of this study. Firstly, our analyses suggest that the health of the population is changing too gradually to explain why thousands of Nova Scotians suddenly reported being unable to find a family physician in the spring of 2016. Secondly, while our analyses suggest a gradual decline in the health of Nova Scotians aged 80 and above over the study period, they also suggest gradual improvements in the health of the rest of the province’s residents, who make up 95% of its population. This finding is consistent with other studies showing improvements in population health within age groups over time, which may mitigate effects of population aging on health workforce requirements.⁵⁸⁻⁶¹

Similarly, the view that the sudden growth in unattached patients in Nova Scotia is explained by the fact that family physicians are doing much more for their patients than before is not supported by these analyses, which show that these physicians report providing fewer services to their patients, on average, given their patients’ age and health status, year by year. This may reflect limitations in the billing data from which these findings were derived—that is, physicians may be increasingly providing services for which they cannot and/or do not bill. Other things being equal, this would mean more family physicians are required in Nova Scotia.



The analyses of billing data support the view that family physicians in Nova Scotia are working less, on average, than in previous years. The decrease in activity measured here has not been large or rapid enough to explain, on its own, the sudden increase in unattached patients seen in 2016. This trend is instead gradual and occurring over many years, consistent with other studies of physician activity across Canada.^{34-37, 62} While some of this trend in reduced billing by physicians is likely the result of shifting from fee-for-service to alternate payment models, it is noteworthy that similar trends have been observed in provinces where uptake of alternate payment models has been much lower.^{37, 62} Regardless of the reason for it, this trend, in combination with the known aging of the population, would result in gradual increases in the numbers of family physicians required to care for Nova Scotia's population.

The findings related to family physician activity from billing data and the NPS must be interpreted together. While the former suggest Nova Scotia family physicians may be working less, on average, than in previous years, the latter suggest they continue to work well beyond what would be considered full-time hours for other professions, even without accounting for time spent on-call. To the degree that provincial physician workforce planning relies on the assumption that family physicians' activity levels remain constant over time,⁶³ these plans will require adjustment to account for potential future changes in their hours of work.



CONCLUSIONS AND NEXT STEPS

The objective of this study was to generate hypotheses, and to form the basis for discussions with a broad range of stakeholder groups across Nova Scotia. Some of this work has begun, and the views expressed by members of these groups have been incorporated as much as possible into the interpretation of results from this study.

The changes over time observed in this study are suggestive of gradual, long-term trends—as opposed to sudden, dramatic changes—affecting the supply of and requirements for family physicians in Nova Scotia. With the exception of the size of the provincial population as measured by census data, there was no single determinant of the supply of, or requirements for, family physicians in Nova Scotia that rose or fell more between 2015 and 2016 (when there was a sudden increase in the number of unattached patients in Nova Scotia) than it had over the preceding decade. In addition, the findings have important implications for the planning of the provincial family physician workforce, and highlight several questions to be addressed with subsequent research, for example:

- Is the population really getting healthier overall?
- Are service levels really flat or decreasing?
- Are physicians really working less?
- And what are the determinants of these determinants—for example, if physicians are working less, why is that happening?
 - Is this happening due to an increased focus on well-being and work-life balance among family physicians?
 - Is this happening due to a more modernized health care system where other health care professionals (i.e., Pharmacists, Nurse Practitioners) are performing more direct patient care?

The above findings are specific to the study period ending in 2016 and the potential causes of the sudden increase in unattached patients that began that year. Because these causes can be expected to change over time - for example, data from the Canadian Institute for Health Information indicate that the number of family physicians in Nova Scotia fell after the study period ended in 2016 and then increased for the next three years - continued monitoring of the determinants of Nova Scotia's supply of and requirements for family physicians is required to identify any changes in the trends documented in this report and ensure provincial workforce planning is adjusted accordingly.⁶⁴ To this end, the MSSU and the study team has worked with the Nova Scotia DHW, Nova Scotia Health, and Doctors Nova Scotia to use these findings to inform future planning for the province's family physician workforce.



APPENDIX I: Case definitions

CONDITION	SOURCE	ALGORITHM	ICD CODES	DIAGNOSTIC FIELDS
Diabetes	CCDSS	One or more hospitalizations or two or more physician claims within two years	ICD-9: 250 ICD-10: E10; E11; E12; E13; E14	All
Hypertension	CCDSS	One or more hospitalizations or two or more physician claims within two years	ICD-9: 401; 402; 403; 404; 405 ICD-10: I10; I11; I12; I13; I15	All
Asthma	CCDSS	One or more hospitalizations or two or more physician claims within two years	ICD-9: 493 ICD-10: J45; J46	Hospital: all Physician: first
COPD	CCDSS	One or more hospitalizations or one or more physician claims	ICD-9: 491; 492; 496 ICD-10: J41; J42; J43; J44	Hospital: all Physician: first
Ischemic heart disease	CCDSS	One or more hospitalizations or procedure code or two or more physician claims within one year	ICD-9: 410; 411; 412; 413; 414 ICD-10: I20; I21; I22; I23; I24; I25 Procedures (CCI) 1IJ50; 1IJ54; 1IJ57GQ; 1IJ76	All
Heart failure	CCDSS	One or more hospitalizations or two or more physician claims within one year	ICD-9: 428 ICD-10: I50	All
Osteoporosis	CCDSS	One or more hospitalizations or one or more physician claims within one year	ICD-9: 733 ICD-10: M80; M81	Hospital: all Physician: first

Appendix I: Case definitions

CONDITION	SOURCE	ALGORITHM	ICD CODES	DIAGNOSTIC FIELDS
Osteoarthritis	Rahman et al. ¹	One or more hospitalizations or one or more physician claims	ICD-9:715 ICD-10: M15-M19	All
Rheumatoid arthritis	Widdifield et al. ²	One or more hospitalizations or three or more physician claims, provided one of the physician claims is by a specialist	ICD-9:714 ICD-10: M05-M06 Specialties: Rheumatology, orthopedic surgery, internal medicine	All
Mental illness (omnibus)	CCDSS	One or more hospitalizations or physician claims within one year	ICD-9: 290-319 ICD-10: F00-F99	Hospital: first Physician: first
Cancer	-	One or more hospitalizations or two or more physician claims within one year	ICD-9: 140-195; 196-198; 199; 200-208; 209 ICD-10: C00-C97	All
Dementia	MSSU Report ³	2 diagnoses between 60 and 730 days or a specialist diagnosis, or an in-hospital diagnosis	ICD-9: 290; 291.1-291.2; 294.0-294.1; 331.0-331.3, 331.5-331.7, 331.82, 331.83, 331.89, 331.9,797 ICD-10: F01.x, F05.1, F10.6, F10.7, F04, F00, F02, G30.x, G31.0, G31.1, G31.8, G31.9, G32.8, G91.0, G91.2-G91.3, G91.8, G91.9, G94, R54 Specialties: gerontology, neurology, psychiatry	All

Appendix I: Case definitions

CONDITION	SOURCE	ALGORITHM	ICD CODES	DIAGNOSTIC FIELDS
Stroke	Mayo et al. ⁴	One or more hospitalizations or one or more physician claims within one year	ICD-9: 430,431,432, 433,434,436,437 ICD-10: I61,I62,I65,I63,I66,I64, I67,I68,G46	All
Injury	CCDSS	<ul style="list-style-type: none"> - one hospital record with a relevant external cause of injury code and - injury code is associated with an injury code with a diagnostic type of M, 1, 2, W, X, or Y and - the hospitalization has a level of care of Acute and - hospitalization is not within 28 days of the admission date of a previous hospitalization with the same injury code 	ICD-9: 800-909.2, 909.4, 909.9, 910-994.9, 995.5, 995.80-995.85 ICD-10: S00-S99, T07-T34, T36-T50 with a 6th character of 1, 2, 3, or 4 (Exceptions: T36.9, T37.9, T39.9, T41.4, T42.7, T43.9, T45.9, T47.9, and T49.9 with a 5th character of 1, 2, 3, or 4), T51-T76, T79, [V00-V99, W00-X58, X71-X83, X92-X99 Y00-Y09, Y21-Y33, Y35-Y38 as long as 7th character is A, D, or missing] ⁵	All

CCDSS Canadian Chronic Disease Surveillance System

¹ Rahman MM, Kopec JA, Goldsmith CH, Anis AH, Cibere J. Validation of administrative osteoarthritis diagnosis using a clinical and radiological population-based cohort. *Int J Rheumatol*. 2016;6475318.

² Widdifield J, Bernatsky S, Paterson JM, Tu K, Ng R, Thorne JC, Pope JE, Bombardier C. Accuracy of Canadian health administrative databases in identifying patients with rheumatoid arthritis: a validation study using the medical records of rheumatologists. *Arthritis Care Res (Hoboken)*. 2013 Oct;65(10):1582-91.

³ Maritime SPOR SUPPORT Unit. *The incidence, prevalence, and cost of dementia in Nova Scotia, 1999-2012* [Internet]. Halifax: Nova Scotia Department of Health; 2014.

⁴ Mayo NE, Chockalingam A, Reeder BA, Phillips S. Surveillance for stroke in Canada. *Health Rep*. 1994;6(1):62-72.

⁵ Hedegaard HB, Johnson RL, Ballesteros MF. Proposed ICD-10-CM Surveillance Case Definitions for Injury Hospitalizations and Emergency Department Visits. *Natl Health Stat Report*. 2017 Jan;(100):1-8.

APPENDIX II: Mathematical description of Birch et al. framework

Under the analytical framework on which the study is based,¹ the variables for demography, health status, and level of service are multiplied to produce a number and type of services required to care for a population of a given size, demographic structure and distribution of need according to a specific service model. The numbers of each type of service required are then divided by productivity to estimate the numbers of FTE HHR required to deliver those volumes of services. This number is then compared to the estimated number of FTE HHR available to delivery services in a given year, which is the product of the stock, participation, and activity variables.

Mathematically, these relationships can be expressed as follows:

$$(1) N_{n,t} = \sum_q \frac{\sum_{h,i,j} (P_{i,j,t} \times H_{h,i,j,t} \times Q_{h,i,j,n,q,t})}{R_{n,q,t}}$$

and

$$(2) N'_{n,t} = S_{n,t} \times D_{d,t} \times A_{n,t}$$

Where¹:

- $N_{n,t}$ is the number of FTE HHR of type n required to deliver a given service model $Q_{h,i,j,n,q,t}$ to a given population over a period of time t ;
- $N'_{n,t}$ is the number of FTE HHR of type n available to deliver services to a given population during time t ;

¹ Note that this mathematical depiction of the framework differs from that used in the 2007 paper by Birch and colleagues.

- $P_{i,j,t}$ is the size of that population of age group i and sex j in the jurisdiction in question in time period t (i.e., demography);
- $H_{h,i,j,t}$ is the proportion of the jurisdictional population with health status h of age group i and sex j in time period t (i.e., health status);
- $Q_{h,i,j,n,q,t}$ is the mean number of services of type q planned or otherwise required, under a specified service model, to address the needs of individuals of health status h in age group i and sex j and to be delivered by HHR of type n over time period t (i.e., level of service);
- $R_{n,q,t}$ is the mean number of services of type q that an FTE HHR of type n can be expected to perform within time period t (i.e., productivity);
- $S_{n,t}$ is the number of HHR of type n qualified to practice in the jurisdiction during time period t (stock);
- $D_{n,t}$ is the proportion of qualified HHR of type n who provide any direct patient care during time period t (participation); and
- $A_{n,t}$ is the mean proportion of an FTE represented by participating HHR of type n during time period t (activity).



Under this framework, the essence of HHR planning is to align the number and type of HHR available, $N'_{n,t}$, with those required, $N_{n,t}$, by influencing – directly or indirectly – the values of their determinants.

Because no data exist on the planned level of service provision by family physicians in Nova Scotia over the study period, and instead only provided levels of service are being measured, the number of family physicians required in NS over the study period cannot be estimated. Under many traditional approaches to HHR planning, the historical number and type of services provided has been – implicitly or explicitly – assumed to be equal to the number and type of services required. Because productivity is measured as the total volume of services provided divided by the number of FTEs, this assumption implies that the number of required HHR is equal to the number available, i.e., that $N_{n,t} = N'_{n,t}$. For this reason (among others), approaches using this assumption are not useful for HHR planning.



APPENDIX III: Distribution of number of chronic conditions + injuries among Nova Scotians by age group, 2006-7 to 2015-16

		% WITHIN EACH AGE GROUP WHO HAVE THE NUMBER OF CHRONIC CONDITIONS INDICATED									
AGE GROUP	# OF CHRONIC CONDITIONS	2006-7	2007-8	2008-9	2009-10	2010-11	2011-12	2012-13	2013-14	2014-15	2015-16
0-12	0	76.7	76.8	77.7	78.0	79.2	80.6	81.8	82.2	82.6	82.5
	1	20.6	20.6	19.9	19.7	18.8	17.7	16.7	16.4	16.2	16.2
	2	2.5	2.5	2.3	2.2	1.9	1.6	1.4	1.4	1.2	1.2
	3	≤0.1	≤0.1	≤0.1	≤0.1	≤0.1	≤0.1	≤0.1	≤0.1	≤0.1	≤0.1
	4+	≤0.1	≤0.1	≤0.1	≤0.1	≤0.1	≤0.1	≤0.1	≤0.1	≤0.1	≤0.1
12-19	0	69.8	69.6	70.3	70.3	70.5	70.8	71.3	71.7	71.6	70.4
	1	25.7	25.7	25.3	25.2	25.2	25.2	24.8	24.5	24.4	25.5
	2	4.2	4.4	4.1	4.2	4.0	3.9	3.7	3.6	3.8	3.9
	3	0.3	0.3	0.3	0.3	0.3	0.2	≤0.1	0.2	0.2	≤0.1
	4+	≤0.1	≤0.1	≤0.1	≤0.1	≤0.1	≤0.1	≤0.1	≤0.1	≤0.1	≤0.1
20-29	0	69.7	69.6	70.0	70.1	70.4	71.1	71.9	71.9	71.9	70.7
	1	25.0	25.1	24.9	24.7	24.8	24.4	23.9	24.0	23.9	25.0
	2	4.8	4.8	4.7	4.7	4.4	4.2	3.9	3.9	4.0	4.1
	3	0.5	0.4	0.4	0.4	0.4	0.3	0.3	0.2	0.2	0.2
	4+	≤0.1	≤0.1	≤0.1	≤0.1	≤0.1	≤0.1	≤0.1	≤0.1	≤0.1	≤0.1
30-39	0	64.8	64.2	64.4	64.2	64.6	65.3	66.3	66.7	66.7	66.4
	1	28.0	28.3	28.0	28.3	28.1	27.9	27.3	27.2	27.3	27.5
	2	6.3	6.6	6.5	6.4	6.3	6.0	5.6	5.5	5.4	5.4
	3	0.9	0.8	1.0	0.9	0.9	0.7	0.7	0.6	0.6	0.6
	4+	≤0.1	≤0.1	≤0.1	≤0.1	≤0.1	≤0.1	≤0.1	≤0.1	≤0.1	≤0.1
40-49	0	57.3	57.0	57.0	57.1	57.2	58.2	59.3	59.7	59.6	59.3
	1	31.3	31.3	31.3	31.0	31.2	31.0	30.3	30.3	30.4	30.4
	2	9.3	9.4	9.4	9.5	9.3	8.7	8.6	8.3	8.3	8.4
	3	1.8	1.9	1.9	2.0	1.9	1.7	1.5	1.5	1.5	1.6
	4+	0.3	0.3	0.4	0.4	0.3	0.3	0.3	0.3	0.3	0.3

Appendix III: Distribution of number of chronic conditions + injuries among Nova Scotians by age group, 2006-7 to 2015-16

		% WITHIN EACH AGE GROUP WHO HAVE THE NUMBER OF CHRONIC CONDITIONS INDICATED									
AGE GROUP	# OF CHRONIC CONDITIONS	2006-7	2007-8	2008-9	2009-10	2010-11	2011-12	2012-13	2013-14	2014-15	2015-16
50-59	0	44.3	44.2	44.5	44.6	45.5	46.8	47.7	48.3	48.7	48.5
	1	36.0	36.0	35.6	35.4	35.2	34.9	34.8	34.4	34.1	34.0
	2	14.7	14.9	14.9	14.8	14.5	13.8	13.3	13.2	13.0	13.3
	3	4.0	4.0	4.0	4.2	3.9	3.7	3.4	3.4	3.4	3.5
	4+	0.9	0.9	0.9	1.0	0.9	0.8	0.8	0.7	0.8	0.8
60-69	0	30.7	30.6	30.8	30.7	31.8	33.2	34.3	34.7	35.0	35.1
	1	39.2	39.0	38.6	38.1	38.0	37.9	37.8	37.5	37.4	36.8
	2	21.3	21.4	21.2	21.5	21.0	20.3	19.7	19.8	19.5	19.8
	3	6.9	7.0	7.2	7.4	7.1	6.7	6.4	6.2	6.3	6.4
	4+	1.9	2.0	2.1	2.3	2.2	2.0	1.8	1.8	1.8	1.9
70-79	0	20.6	20.3	19.9	19.6	20.0	20.9	21.6	22.7	22.8	23.2
	1	39.4	38.8	37.8	37.2	37.1	37.8	37.9	37.6	36.9	36.8
	2	26.3	26.8	27.1	27.5	27.2	26.2	26.2	25.6	25.7	25.4
	3	10.1	10.3	11.2	11.5	11.4	11.2	10.4	10.3	10.7	10.7
	4+	3.7	3.8	4.1	4.3	4.3	3.9	3.9	3.8	3.8	3.8
80+	0	17.7	17.0	16.1	15.4	15.1	15.7	15.9	16.6	16.2	16.3
	1	37.4	37.0	36.0	35.1	34.7	35.1	35.2	34.6	34.8	34.6
	2	27.7	28.0	28.4	29.0	29.2	28.7	28.5	28.7	28.6	28.5
	3	12.1	12.7	13.5	14.1	14.3	14.4	14.0	13.9	14.3	14.4
	4+	5.0	5.3	6.0	6.5	6.6	6.2	6.3	6.2	6.0	6.2

APPENDIX IV: Changes in billed levels of family physician service provision to Nova Scotians, 2006-7 to 2015-16

AGE GROUP	# OF CHRONIC CONDITIONS	2006-7	2007-8	2008-9	2009-10	2010-11	2011-12	2012-13	2013-14	2014-15	2015-16
Ages 0-12	0	0.61	0.59	0.61	0.61	0.61	0.61	0.60	0.58	0.60	0.59
	1	0.88	0.87	0.88	0.88	0.88	0.89	0.89	0.89	0.89	0.89
	2	0.96	0.97	0.96	0.97	0.97	0.97	0.97	0.98	0.98	0.98
	3	0.99	0.98	1.00	1.00	1.00	0.99	1.00	0.97	0.98	1.00
	4	1.00	0.00	4.00	1.00	1.00	2.00	0.67	0.75	0.00	0.00
Average		0.89	0.68	1.49	0.89	0.89	1.09	0.83	0.83	0.69	0.69
Ages 13-19	0	0.57	0.57	0.57	0.57	0.55	0.55	0.55	0.53	0.54	0.53
	1	0.87	0.86	0.87	0.87	0.87	0.88	0.89	0.88	0.90	0.90
	2	0.95	0.96	0.97	0.96	0.95	0.96	0.96	0.97	0.97	0.97
	3	0.99	0.98	0.99	0.96	0.99	0.94	0.96	0.98	0.97	0.99
	4	1.00	1.00	1.00	1.00	1.00	1.00	0.67	0.50	1.00	1.00
Average		0.88	0.87	0.88	0.87	0.87	0.87	0.81	0.77	0.88	0.88
Ages 20-29	0	0.53	0.53	0.53	0.53	0.52	0.52	0.51	0.50	0.50	0.50
	1	0.92	0.92	0.92	0.92	0.91	0.92	0.92	0.92	0.93	0.92
	2	0.97	0.98	0.98	0.97	0.97	0.98	0.98	0.98	0.97	0.97
	3	0.99	0.99	0.99	0.99	0.99	0.99	0.98	0.98	0.97	0.98
	4.00	1.00	1.00	1.00	0.97	1.00	1.00	1.00	1.00	1.00	1.00
Average		0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.87	0.88
Ages 30-39	0	0.58	0.57	0.57	0.57	0.57	0.57	0.57	0.56	0.56	0.55
	1	0.94	0.94	0.94	0.94	0.94	0.94	0.95	0.94	0.94	0.95
	2	0.99	0.98	0.99	0.98	0.98	0.98	0.99	0.99	0.99	0.98
	3	0.99	0.99	0.99	0.99	0.98	0.99	0.99	0.98	0.98	0.98
	4	0.98	0.98	1.00	0.99	0.97	0.99	0.96	0.98	0.99	0.99
Average		0.89	0.89	0.90	0.90	0.89	0.89	0.89	0.89	0.89	0.89

Appendix IV: Changes in billed levels of family physician service provision to Nova Scotians 2006-7 to 2015-16

AGE GROUP	# OF CHRONIC CONDITIONS	2006-7	2007-8	2008-9	2009-10	2010-11	2011-12	2012-13	2013-14	2014-15	2015-16
Ages 40-49	0	0.61	0.60	0.60	0.60	0.60	0.60	0.59	0.58	0.59	0.58
	1	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
	2	0.99	0.99	0.98	0.99	0.98	0.98	0.98	0.98	0.99	0.98
	3	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99
	4	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.97	0.98	0.96
Average		0.91	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.89	0.90
Ages 50-59	0	0.65	0.64	0.64	0.64	0.64	0.63	0.63	0.63	0.63	0.63
	1	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96
	2	0.99	0.99	0.99	0.98	0.98	0.98	0.98	0.98	0.98	0.98
	3	0.99	0.99	0.99	0.99	0.98	0.98	0.98	0.98	0.98	0.98
	4	0.99	0.99	0.99	0.98	0.97	0.97	0.97	0.97	0.97	0.98
Average		0.92	0.91	0.91	0.91	0.91	0.91	0.91	0.90	0.91	0.90
Ages 60-69	0	0.68	0.69	0.68	0.68	0.68	0.69	0.69	0.68	0.68	0.68
	1	0.97	0.97	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96
	2	0.98	0.98	0.98	0.98	0.98	0.98	0.97	0.97	0.97	0.97
	3	0.98	0.98	0.98	0.98	0.97	0.97	0.97	0.97	0.97	0.96
	4	0.97	0.98	0.97	0.97	0.95	0.96	0.96	0.96	0.96	0.96
Average		0.92	0.92	0.92	0.91	0.91	0.91	0.91	0.91	0.91	0.91
Ages 70-79	0	0.70	0.71	0.70	0.71	0.71	0.71	0.72	0.72	0.72	0.72
	1	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
	2	0.96	0.96	0.96	0.95	0.95	0.95	0.95	0.95	0.95	0.95
	3	0.95	0.95	0.94	0.95	0.94	0.94	0.94	0.94	0.94	0.93
	4	0.92	0.93	0.93	0.92	0.90	0.90	0.91	0.90	0.91	0.91
Average		0.90	0.90	0.90	0.90	0.89	0.89	0.89	0.89	0.89	0.89
Ages 80+	0	0.59	0.59	0.59	0.59	0.60	0.61	0.63	0.63	0.64	0.63
	1	0.83	0.83	0.83	0.83	0.82	0.82	0.82	0.82	0.82	0.82
	2	0.84	0.85	0.84	0.83	0.82	0.82	0.81	0.81	0.80	0.81
	3	0.83	0.82	0.83	0.80	0.78	0.78	0.79	0.77	0.79	0.79
	4+	0.80	0.80	0.79	0.75	0.74	0.72	0.72	0.72	0.75	0.76
Average		0.78	0.78	0.77	0.76	0.75	0.75	0.75	0.75	0.76	0.76

REFERENCES

1. Birch S, Kephart G, Tomblin Murphy G, O'Brien-Pallas L, Alder R, MacKenzie A. Human resources planning and the production of health: a needs-based analytical framework. *Canadian Public Policy*. 2007;33(Supplement 1):S1-S16.
2. Primary Health Care, NSHA. Strengthening the Primary Health Care System in Nova Scotia. Evidence Synthesis and Guiding Document for Primary Care Delivery: Collaborative family practice teams and health homes. Nova Scotia: Primary Health Care, Nova Scotia Health Authority; 2017.
3. Ionescu-Ittu R, McCusker J, Ciampi A, Vadeboncoeur A-M, Roberge D, Larouche D, et al. Continuity of primary care and emergency department utilization among elderly people. *Canadian Medical Association Journal*. 2007;177(11):1362-8.
4. Hay C, Pacey M, Bains N, Ardal S. Understanding the unattached population in Ontario: evidence from the Primary Care Access Survey (PCAS). *Healthcare Policy*. 2010;6(2):33.
5. McCusker J, Roberge D, Lévesque J-F, Ciampi A, Vadeboncoeur A, Larouche D, et al. Emergency department visits and primary care among adults with chronic conditions. *Medical Care*. 2010;972-80.
6. Moineddin R, Meaney C, Agha M, Zagorski B, Glazier RH. Modeling factors influencing the demand for emergency department services in Ontario: a comparison of methods. *BMC Emergency Medicine*. 2011;11(1):13.
7. Doupe MB, Palatnick W, Day S, Chateau D, Soodeen R-A, Burchill C, et al. Frequent users of emergency departments: developing standard definitions and defining prominent risk factors. *Annals of Emergency Medicine*. 2012;60(1):24-32.
8. McAlister FA, Youngson E, Bakal JA, Kaul P, Ezekowitz J, van Walraven C. Impact of physician continuity on death or urgent readmission after discharge among patients with heart failure. *Canadian Medical Association Journal*. 2013;185(14):E681-E9.
9. Tiagi R, Chechulin Y. The effect of rostering with a patient enrolment model on emergency department utilization. *Health Policy*. 2014;9(4):105.
10. Weaver RG, Manns BJ, Tonelli M, Sanmartin C, Campbell DJ, Ronksley PE, et al. Access to primary care and other health care use among western Canadians with chronic conditions: a population-based survey. *Canadian Medical Association Journal*. 2014;2(1):E27.
11. Hudon C, Sanche S, Haggerty JL. Personal characteristics and experience of primary care predicting frequent use of emergency department: a prospective cohort study. *PLoS One*. 2016;11(6):e0157489.
12. Grunfeld E, Levine MN, Julian JA, Coyle D, Szechtman B, Mirsky D, et al. Randomized trial of long-term follow-up for early-stage breast cancer: a comparison of family physician versus specialist care. *J Clin Oncol*. 2006;24(6):848-55.
13. Starfield B, Shi L, Macinko J. Contribution of primary care to health systems and health. *The Milbank Quarterly*. 2005;83(3):457-502.
14. Bayliss EA, Edwards AE, Steiner JF, Main DS. Processes of care desired by elderly patients with multimorbidities. *Family practice*. 2008;25(4):287-93.
15. Fung CS, Wong CK, Fong DY, Lee A, Lam CL. Having a family doctor was associated with lower utilization of hospital-based health services. *BMC health services research*. 2015;15(1):42.

16. Østbye T, Yarnall KS, Krause KM, Pollak KI, Gradison M, Michener JL. Is there time for management of patients with chronic diseases in primary care? *The Annals of Family Medicine*. 2005;3(3):209-14.
17. Griffin SJ, Kinmonth A-L, Veltman MW, Gillard S, Grant J, Stewart M. Effect on health-related outcomes of interventions to alter the interaction between patients and practitioners: a systematic review of trials. *The Annals of Family Medicine*. 2004;2(6):595-608.
18. Oates J, Weston WW, Jordan J. The impact of patient-centered care on outcomes. *Fam Pract*. 2000;49(9):796-804.
19. World Health Organization. Declaration of Alma-Ata Geneva: WHO.; 1978 [Available from: http://www.who.int/publications/almaata_declaration_en.pdf?ua=1].
20. Macinko J, Starfield B, Shi L. The contribution of primary care systems to health outcomes within Organization for Economic Cooperation and Development (OECD) countries, 1970–1998. *Health Services Research*. 2003;38(3):831-65.
21. Muldoon LK, Hogg WE, Levitt M. Primary care (PC) and primary health care (PHC): what is the difference? *Canadian Journal of Public Health/Revue Canadienne de Santé Publique*. 2006:409-11.
22. Canadian Institute for Health Research. Community-Based Primary Health Care Overview. Ottawa 2015 [Available from: <http://www.cihr-irsc.gc.ca/e/44079.html>].
23. Commissaire à la santé et au bien être. Perception et expériences de la population : le Québec comparé – résultats de l'enquête internationale sur les politiques de santé du Commonwealth Fund; 2014.
24. Weld Viscount P. Personal Communication. 2017.
25. Nova Scotia Health Authority. Reports, Statistics and Accountability 2020 [Available from: <http://www.nshealth.ca/need-family-practice-data>].
26. Nova Scotia Health Authority. Need a Family Practice Wait List. Halifax: NSHA; 2017.
27. Statistics Canada. Table 13-10-0096-01 Health characteristics, annual estimates 2020.
28. Statistics Canada. Table 051-0001: Estimates of population, by age group and sex for July 1, Canada, provinces and territories Ottawa: Statistics Canada; 2016 [Available from: <http://www5.statcan.gc.ca/cansim/a26?lang=eng&retrLang=eng&id=0510001&pattern=&stByVal=1&p1=1&p2=37&tabMode=dataTable&csid=>].
29. Laroche J. Nova Scotia doctor numbers haven't changed much in last 10 years. *CBC News*. 2019.
30. Department of Health and Wellness. Health and Wellness Business Plan. Province of Nova Scotia; 2019.
31. Canadian Institute for Health Information. National Physician Database Data Release 2014–15 – Methodological Notes Ottawa. 2016 [Available from: https://secure.cihi.ca/estore/productFamily.htm?locale=en&pf=PF_C3268&lang=en].
32. Nova Scotia Department of Health and Wellness. Effect of Incentive Payments on GP FFS Office Visit Volumes. Halifax, Nova Scotia: DHW; 2014.
33. Canadian Institute for Health Information. National Physician Database Historical Utilization: Data Tables Ottawa. 2015 [Available from: <https://secure.cihi.ca/estore/productSeries.htm?pc=PCC476>].

34. Crossley TF, Hurley J, Jeon SH. Physician labour supply in Canada: a cohort analysis. *Health Economics*. 2009;18(4):437-56.
35. Sarma S, Thind A, Chu M-K. Do new cohorts of family physicians work less compared to their older predecessors? The evidence from Canada. *Social Science Medicine*. 2011;72(12):2049-58.
36. Contandriopoulos D, Perroux M. Fee increases and target income hypothesis: Data from Quebec on physicians' compensation and service volumes. *Healthcare Policy*. 2013;9(2):30.
37. Lavergne MR, Peterson S, McKendry R, Sivananthan S, McGrail K. Full-service family practice in British Columbia: policy interventions and trends in practice, 1991-2010. *Healthcare Policy*. 2014;9(4):32.
38. Auld A. Nova Scotia needs to recruit 100 doctors a year for next decade, group says. *CBC News*. 2017.
39. Bradley S. Doctors Nova Scotia blames doctor shortage on fee-for-service system. *CBC News*. 2018.
40. Fraser E. Want more physicians? Tax less and recruit more doctors, medical society says. *CBC News*. 2019.
41. Gorman M. 'Why would you come?' Nova Scotia family doctors the worst paid in the country. *CBC News*. 2018.
42. Tomblin Murphy G, Alder, R, & MacKenzie, A, editor *An Innovative Needs-based Approach to Family Physician Planning - Canada*. International Medical Workforce Collaborative Conference; 2008; Edinburgh, Scotland: Royal College of Physicians and Surgeons of Canada.
43. Tomblin Murphy G, MacKenzie A, Alder R, Birch S, Kephart G, O'Brien-Pallas L. An applied simulation model for estimating the supply of and requirements for registered nurses based on population health needs. *Policy, Politics, and Nursing Practice*. 2009;10(4):240-51.
44. Tomblin Murphy G, Birch S, MacKenzie A, Alder R, Lethbridge L, Little L. Eliminating the shortage of registered nurses in Canada: an exercise in applied needs-based planning. *Health Policy*. 2012;105(2-3):192-202.
45. Tomblin Murphy G, MacKenzie A, Guy-Walker J, Walker C. Needs-based human resources for health planning in Jamaica: using simulation modelling to inform policy options for pharmacists in the public sector. *Human Resources for Health*. 2014;12(1):67.
46. Tomblin Murphy G, Birch S, MacKenzie A, Rigby J. Simulating future supply of and requirements for human resources for health in high-income OECD countries. *Human Resources for Health*. 2016;14(1):77.
47. Health Council of Canada. *Decisions, decisions: family doctors as gatekeepers to prescription drugs and diagnostic imaging in Canada*: Health Council of Canada; 2010 [Available from: http://www.healthcouncilcanada.ca/tree/2.33-DecisionsHSU_Sept2010.pdf].
48. DiCenso A, Bourgeault I, Abelson J, Martin-Misener R, Kaasalainen S, Carter N, et al. Utilization of nurse practitioners to increase patient access to primary healthcare in Canada—thinking outside the box. *Nursing Leadership*. 2010;23:239-59.
49. Nova Scotia Health Authority. 2014-15: Year at a Glance Halifax: NSHA; 2015 [Available from: <http://www.cdha.nshealth.ca/primary-health-care>].

50. Canadian Pharmacists Association. A Review of Pharmacy Services in Canada and the Health and Economic Evidence Ottawa. 2016 [Available from: <https://www.pharmacists.ca/cpha-ca/assets/File/cpha-on-the-issues/Pharmacy%20Services%20Report%201.pdf>].
51. Martin-Misener R, Bryant-Lukosius D. Guest Editors' Reflections on Progress in the Development of Advanced Practice Nursing in Canada. *Nursing Leadership*. 2016;29(3):6-13.
52. Currie B. 'A really positive thing': Wider prescription range for pharmacists applauded. *CBC News*. 2019.
53. Kephart G AY, Atherton F, Burge F, Campbell LA, Campbell M, Dowling L, Dyer J, Lawson B, Lethbridge, L LA, Terashima M. Small Area Rate Variation in the Prevalence and Characteristics of High-Cost Users of Health Care Services in Nova Scotia. Halifax, Nova Scotia: Maritime SPOR SUPPORT Unit; 2015.
54. Rahman MM, Kopec JA, Goldsmith CH, Anis AH, Cibere J. Validation of administrative osteoarthritis diagnosis using a clinical and radiological population-based cohort. *International Journal of Rheumatology*. 2016;2016.
55. Widdifield J, Bernatsky S, Paterson JM, Tu K, Ng R, Thorne JC, et al. Accuracy of Canadian health administrative databases in identifying patients with rheumatoid arthritis: a validation study using the medical records of rheumatologists. *Arthritis Care & Research*. 2013;65(10):1582-91.
56. Canadian College of Family Physicians. Is family medicine the same as general practice? Ottawa. 2017 [Available from: <http://www.cfpc.ca/FAQ/>].
57. The Chronicle Herald. Number of Nova Scotians registered to find family doctor rises again. 2018. Available from: <https://www.thechronicleherald.ca/news/local/number-of-nova-scotians-registered-to-find-family-doctor-rises-again-257177/>.
58. Tomblin Murphy G, Kephart G, Lethbridge L, O'Brien-Pallas L, Birch S. Planning for what? Challenging the assumptions of health human resources planning. *Health Policy*. 2009;92(2-3):225-33.
59. Birch S, Mason T, Sutton M, Whittaker W. Not enough doctors or not enough needs? Refocusing health workforce planning from providers and services to populations and needs. *Journal of Health Services Research & Policy*. 2013;18(2):107-13.
60. Mason T, Sutton M, Whittaker W, Birch S. Exploring the limitations of age-based models for health care planning. *Social Science & Medicine*. 2015;132:11-9.
61. Whittaker W, Birch S, MacKenzie A, Tomblin Murphy G. Cohort effects on the need for health care and implications for health care planning in Canada. *Health Policy*. 2016;120(1):81-8.
62. Hedden L, Barer ML, McGrail K, Law M, Bourgeault IL. In British Columbia, the supply of primary care physicians grew, but their rate of clinical activity declined. *Health Affairs*. 2017;36(11):1904-11.
63. Government of Nova Scotia. Shaping our Physician Workforce: Province of Nova Scotia; 2013 [updated Dec 10, 2017. Available from: <https://novascotia.ca/dhw/ShapingPhysicianWorkforce/updates.asp>].
64. Canadian Institute for Health Information. Supply, Distribution and Migration of Physicians in Canada: Data Tables Ottawa2019 [Available from: <https://www.cihi.ca/sites/default/files/document/supply-distribution-migration-physicians-in-canada-data-tables-en.zip>].