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Changing primary care capacity in Canada: protocol for a cross-provincial mixed methods study

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ABSTRACT

Introduction Despite having more family physicians (FPs) and nurse practitioners (NPs) per capita than ever before in Canada, there is a clear gap between population primary care needs and system capacity. Primary care needs may be shaped by population ageing, increasing clinical and social complexity and growing service intensity. System capacity may be shaped by falling practice volumes, increasing administrative workload, changing clinician demographics and new health system roles (eg, hospitalist and focused practices). These changing factors could contribute to reduced patient access to primary care, worsened health inequities and stress and overwork among primary care clinicians. Workforce planning tools used in most countries do not adequately consider these factors. Our study will identify and explore factors shaping population service use and system capacity over time and develop planning tools to estimate future primary care needs and capacity.

Methods and analysis We will interview FPs and NPs about factors shaping workload, including patient characteristics, practice expectations and system context. This will inform analysis of administrative data to describe factors shaping primary care need (patient demographics, clinical and social complexity, service intensity) and capacity (provider supply, demographics, service volume, roles) over a 20-year period from 2004/2005 to 2023/2024. Qualitative and quantitative findings will inform analytical models that project and compare need and capacity under stakeholder-informed scenarios. The study includes the Canadian provinces of British Columbia, Manitoba, New Brunswick and Nova Scotia, provinces with varied policy and population contexts and complementary administrative health data.

Ethics and dissemination Research ethics board (REB) approval for the qualitative study has been provided by Research Ethics BC, with subsequent approvals from Horizon Health Network, Nova Scotia Health, University of Manitoba and University of Ottawa. REB approval for analysis of linked administrative data was obtained from the Nova Scotia Health REB, Research Ethics BC, University of Manitoba and University of New Brunswick. Our findings

STRENGTHS AND LIMITATIONS OF THIS STUDY

⇒ This study will generate new information about factors shaping changes in both population needs for primary care and the system's capacity to deliver these services.
⇒ This study will combine qualitative data with longitudinal, population-based, quantitative data from multiple provinces to address a clear knowledge gap.
⇒ This study will include multiple provinces with different geographical, population and policy contexts that will support effective analysis through complementary administrative health data.
⇒ This study will focus on services delivered by family physicians and nurse practitioners and does not directly inform deployment of team-based care, including specific activities and roles for all primary care clinicians.

will support primary care capacity planning to equitably meet the needs of a growing and ageing population.

INTRODUCTION

Primary care is central to the effectiveness and efficiency of health systems.[1][2] Although there are more family physicians (FPs) per capita than ever,[3] primary care is receiving renewed policy attention as many people in Canada do not have a regular place of care or access to timely services.[4][5] Several factors may explain the gap between population need and system capacity.

Factors impacting population need: The population is ageing,[6] and people are being treated for more health conditions with greater intensity (eg, more tests, prescriptions and medical services per person).[7][8] Some research has suggested that the impact

of ageing on health system demand may be modest, as people may age without experiencing a long period of illness before death[9] and as changes in care provision can shorten resource-intensive hospital stays.[10–13] However, a shift in services from hospital to community may mean that the impact of ageing on primary care differs from that on the acute care sector, though ageing and primary care capacity remain understudied.[13–15]

At the same time, clinical complexity within age groups is increasing.[7 8 16–18] Evidence is mixed about whether Canadians have more chronic conditions or are being treated for more chronic conditions than in the past, but both explanations for rising clinical complexity have implications for health services demand.[19] Complexity in primary care can also arise from socioeconomic needs, mental illness and substance use.[20] Service use for mental illness and substance use has accelerated since the onset of the COVID-19 pandemic.[21] With limited specialist mental health resources, much of this work may be falling to primary care.[22]

There have also been changes in the medical management of chronic conditions such that, while medical needs may be constant, the related service delivery has intensified. Treatments are now available for conditions that were not previously as actively managed in primary care (eg, hepatitis C, opioid use disorder)[23 24] and care options for conditions commonly managed in primary care have become more numerous and complex.[25–27] Changes may also reflect the medicalisation of ageing, as older people are treated more actively than in the past,[28] and/or seek care for conditions that have become less stigmatised like mental health and substance use disorders.[29] Together, this may mean that service intensity or the visits and other care processes (eg, laboratory testing, prescribing, imaging and referrals) for similar health needs have increased.[30–33]

Factors impacting system capacity: System capacity is also changing as FPs and nurse practitioners (NPs) work in roles outside of community-based primary care,[34 35] and as average visit counts and hours worked are declining.[36] More and more primary care clinicians have new roles within health systems such as delivering hospitalist care, providing treatment for substance use disorders and participating in other areas of focused practice outside longitudinal family practice.[35 37] At the same time, fewer FPs are providing primary care in multiple service settings (eg, home, long-term care and hospital), attending deliveries and delivering prenatal and postnatal care.[38] Whether declines in system capacity reflect an increase in patient complexity, service intensity, administrative burden or other factors (such as changes in patient expectations or professional norms, better quality of care or different choices about work) is not clear and requires further study. In addition, because visit volume varies over the course of FPs' careers, the demographic distribution of the workforce also shapes primary care capacity,[34 39–43] as do the ongoing impacts of the COVID-19 pandemic as well as expected future perturbations to the healthcare system.[33 44 45]

Limitations of current primary care workforce planning: While there is extensive literature on health workforce planning, its ongoing application within Canadian health systems remains minimal.[37 46] Approaches to primary care workforce planning vary, but have been largely supply-based at national[47–49] or regional[50] levels, with some exceptions.[51] The most widely used workforce planning approaches are not tailored to primary care and do not account for the changing drivers of population need and system capacity, including changing clinical complexity, service intensity and primary care clinician roles.[51–54] A commonly cited reason for continued reliance on conceptually invalid supply-based workforce planning models has been the lack of available data on key planning parameters.[55] In addition, existing measures of clinical complexity and case-mix systems are designed to predict total system costs and may not adequately reflect workload in primary care. Our operationalisation of complexity will aim to include clinical complexity, but also consider mental health and social complexity as important for planning specific to primary care. Taken together, new knowledge generated by this study will address previously identified evidence gaps and enable improvements to primary care workforce planning.

Objectives

This project will explore how factors shaping population service use and system capacity change over time and use this information to develop tools for workforce planning to estimate future need and system capacity. Ultimately, this work will enable more effective responses to expected structural changes to the healthcare system. Objectives and associated research questions (RQs) are:

1. Understand, from the perspective of primary care clinicians, the factors shaping workload over time:
   a. RQ 1.1 What factors do FPs and NPs perceive as being important in shaping their workload in primary care, and do they perceive that their workload has changed over time?
   b. RQ 1.2 How do perceptions of factors shaping workload vary by gender and other clinician characteristics?
2. Quantify factors shaping primary care need and system capacity over time (2004/2005 to 2023/2024):
   a. RQ 2.1 How have population ageing, complexity and service intensity contributed to changes in primary care service use?
   b. RQ 2.2 How might primary care service use change if inequities in access are addressed?
   c. RQ 2.3 How are elements of administrative workload (including testing, imaging, prescriptions, referrals) shaping capacity for direct patient care?
   d. RQ 2.4 To what extent are changing practice patterns, clinician demographics and roles of FPs and NPs outside community-based primary care shaping system capacity?

3. Develop models to estimate and compare future primary care need and capacity under a range of policy-relevant scenarios.

We use the language 'need' rather than 'demand' for care to refer to appropriate health care that people can benefit from, independent of perceived benefits and costs. We use 'capacity' to describe total potential supply of primary care services. We recognise that service use measured under Objective 2 is distinct from need and capacity and plan model scenarios that vary assumptions about the relationship between observed service use and predicted need and capacity.

METHODS AND ANALYSIS
Design
Within a sequential mixed-methods design,[56] qualitative interviews with primary care clinicians will explore factors shaping workload (Objective 1) and inform subsequent quantitative analysis of factors shaping primary care service use and system capacity over time (Objective 2). Results from Objectives 1 and 2 will be combined with national administrative data sources for models projecting need and capacity (Objective 3).

Setting
The study includes the Canadian provinces of British Columbia (BC), Manitoba (MB), New Brunswick (NB) and Nova Scotia (NS). These provinces were selected because they have comparable data on FP visits, as well as patient and clinician characteristics, while offering complementary strengths in capturing service use outside physician visits. The provinces vary with respect to geography, population characteristics, primary care organisation and payment models, supporting transferability of findings, while having complementary strengths in available administrative data.

Qualitative (Objective 1: understanding workload from the perspective of primary care clinicians)
Interview data
We will conduct semistructured interviews with FPs and NPs in BC, MB, NB and NS to understand factors shaping workload in community-based comprehensive primary care, including if and how gender and intersecting identities shape experiences of workload. We anticipate that factors shaping workload may reflect population (eg, patient demographics, clinical complexity, social location) or system context (eg, care coordination, paperwork, practice management), but other factors may be identified that can inform analysis under Objective 2 (if quantifiable in administrative data) or scenarios under Objective 3 (if descriptive or explanatory but not measurable).

Sample
Eligibility: We will conduct interviews with FPs and NPs who self-identify as providing community-based comprehensive primary care in BC, MB, NB, and NS. FPs who do at least some of their work in community-based primary care at the time of recruitment—either by providing longitudinal comprehensive care or working in a walk-in clinic—will be included. Participants must be able to communicate in English and/or French (Canada's two official languages) and provide informed consent.

Recruitment: We intend to maximise variation in the study sample of FPs/NPs within and across provinces.[57 58] We will use a screening questionnaire to ensure potential participants meet inclusion criteria and to support purposeful sampling. We will modify our purposeful sampling strategy as we collect data and learn more about the factors that shape workload.[57 59 60] Study participants will be recruited using multiple recruitment approaches facilitated by the study team and advisory members, including outreach through FP and NP associations and academic departments. We will include other approaches (eg, snowball sampling and social media advertisements) if needed to ensure we are recruiting participants from groups that may be harder to reach.

Sample size: Based on both published guidance and experience in previous multiprovincial qualitative studies,[58–60] we plan to interview approximately 8–10 FPs and 4–8 NPs in each study province (48–72 total participants). We expect this sample size will allow us to investigate patterns specific to provinces and subgroups (eg, gender, practice and payment model, urban or rural practice context). We will aim for data sufficiency within each province and the ability to explore differences by emergent subgroups of interest.[61–63]

Data collection
Interviews will be conducted remotely using Zoom or by telephone based on participant preference and are expected to last 45–60 min. Interviews will be audio-recorded and transcribed.

Analysis
We will use thematic analysis to analyse interview data.[64–67] Analyses will occur concurrently with data collection and will consist of line-by-line examination of interview transcripts to identify key patterns of meaning or themes,[64] and compare and contrast themes from our data with concepts in the literature.[67] Thematic analysis will be used for detailed description of workload.[68] Patterns within and between cases and themes will be used to develop a framework or a typology of factors shaping workload (RQ 1.1). We will also explore how these patterns and themes vary by province, gender, profession (FP/NP) and other subgroups as appropriate based on the data (RQ 1.2).[65 66] We will specifically explore differences in experiences by clinician gender, reflecting myriad ways gender is connected to clinical practice (including, eg, practice model, hours worked, administrative workload, patient expectations).

We will use NVivo to organise, code and analyse the unstructured data. Qualitative researchers from each

study province will participate in coding and in regular group analytical discussions to maintain the analysis as robust, reliable, valid and trustworthy.[69 70]

Quantitative (Objectives 2 and 3)
Linked administrative data
Linked data files will be housed separately in secure research environments within each study province. It is not possible to combine record-level data across provincial data sets. Instead, we will conduct distributed parallel analyses, allowing us to compare and contrast provincial experiences and outcomes. Unique de-identified clinician and patient numbers will allow for individual-level linkage across datasets within each province.

Within each province, we will examine a 22-year period of data (fiscal year 2002/2003 to 2023/2024) including 20 years of observation with a 2-year look-back window, to identify prevalent health conditions and to determine which clinicians have been seen previously. Data sources are described in the online supplemental file 1. The Health Data Research Network Data Access Support Hub will support data access in each study province.

Cohort
Analyses will include population-based cohorts composed of all people registered for provincial health insurance within each year, and all FPs and NPs licensed to practise.

Measures
Clinician demographics and training characteristics will be investigated (age group, years in practice, gender, location of training, urban/rural location of practice and FP/NP where available). Service delivery will be operationalised as service volume (eg, total patient visits per clinician (all service locations)), community-based primary care visits (eg, visits in office, home and long-term care), total patients seen (eg, across settings, only in the community, as the majority source of care, days active) and roles outside of comprehensive, community-based service delivery (eg, percentage of service delivery in hospital or emergency department) and community-based visits in focused areas of practice (eg, mental health/substance use, geriatrics, surgical assistance/anaesthesiology, maternity care/obstetrics, paediatrics, sexual health services).

Patient (population) characteristics observable in available data include age group, a binary measure of sex or gender and urban/rural location of residence. Provincial insurance registration forms contain the options of male and female, but whether responses reflect gender, sex assigned at birth or legal sex cannot be determined. We refer to this as 'administrative sex', reflecting sex categorised for administrative purposes, but not individual identity or biology.

There is no accepted measure of complexity in primary care, but our approach is to operationalise dimensions of complexity previously identified as relevant to workload, specifically clinical complexity, mental illness and socioeconomic or social complexity, working from data

that are consistently available across all provinces. The Canadian Chronic Disease Surveillance System (CCDSS) collects data on chronic conditions and multimorbidity in all provinces and territories. Importantly, indicators cover the whole study period, during which diagnosis coding in physician billing data is not available in all provinces. This permits examination of clinical complexity over time, including both a count of conditions treated and adjustment for individual conditions identified. CCDSS also contains a variable reflecting annual use of health services for mental illness and alcohol/drug-induced disorders, in alignment with mental illness as an additional dimension of complexity. Measures of social complexity that can be derived within administrative data are neighbourhood income quintile, low-income flag from provincial prescription coverage and immigration status, class and tenure in Canada. Measures of population service use include community-based primary care visits per person, which include unique provider/patient/date combinations (eg, in-person visits with regular provider, in-person walk-in visits, virtual visits with regular provider, episodic virtual visits); laboratory testing, imaging, prescribing, referrals and day surgeries per person; and emergency department visits, hospitalisations and days in hospital.

Analysis
Objective 2: factors shaping primary care need and system capacity over time
Population service use (RQ 2.1): This will determine if service use and intensity have changed beyond the degree to which can be explained by concurrent changes in population characteristics. Within each province, we will track primary care visit rates over time, stratified by age group, clinical complexity and administrative sex. We will repeat this process with other measures of service intensity where possible. To determine if the population has grown more clinically complex over and above illness associated with population ageing, we will study the average number of chronic conditions within age groups over time and use count models to quantify changes with each year entered as a dummy variable, adjusting for age. We will also consider the proportion of the population with annual use of health services for mental illness and alcohol/drug-induced disorders (CCDSS) and with indicators of social complexity.

We will then explore changes in service intensity over and above population ageing and clinical complexity using a regression-based decomposition approach. We will use generalised estimating equations with a negative binomial or Poisson distribution and log link to model the count outcome of annual primary care visits per person. While the majority of people in Canada have one or more primary care visits each year, if fit is poor because of a high proportion of people with zero visits, we will use zero-inflated models that separately model any primary care use and visit count. Models will include administrative sex, age group, year, urban/rural location and variables reflecting complexity (chronic conditions,

mental health/addictions and social complexity). We will use a two-way interaction between age group and year and determine if age-year interaction effects persist when adjusting for available measures of complexity, which we would interpret as changes in service intensity within age groups.

Social complexity and equitable service use (RQ 2.2): People with greater social complexity might require more primary care visits than those of similar age and clinical complexity, as reflected by chronic conditions and multimorbidity alone, but may also experience additional barriers accessing needed services.[71 72] We will explore (1) cross-sectional differences in health services across groups defined by social complexity and/or (2) trends in service use over time across these groups. Models will include administrative sex, age group, CCDSS multimorbidity and binary variables for individual chronic conditions, year and measures of social complexity. Models will be repeated with interaction terms between year and each measure of social complexity. If we observe lower service use in the context of greater social complexity (lower income, more precarious immigration status, fewer years in Canada) and/or if there is a more rapid decline in visit volume based on interaction terms with year, we will interpret this result as signalling an inequitable difference or change. These results will inform scenarios under Objective 3 that could assume no inequitable differences or changes going forward. While there is no 'ideal' level of service use or objective measure of need, this scenario would reflect estimated needs given equitable patterns of service use.

Administrative workload (RQ 2.3): Building on pilot analysis, for each patient we will count total laboratory tests, imaging, prescriptions dispensed, referrals and day surgeries. We will include all processes regardless of whether they were ordered by an FP/NP, as primary care clinicians will receive reports and there may be expectations of follow-up. We will compare two processes to attribute administrative workload to individual FPs/ NPs, one weighting services across all primary care clinicians within a given year and a second assigned based on formal or informal rostering (not all jurisdictions roster patients). We will track the ratio of service volume that may require administrative coordination over time to community-based primary care visits per FP/NP. We will also explore the degree to which changes in these volumes are explained by ageing and complexity. These results, combined with any relevant qualitative findings from Objective 1, will inform scenarios factoring in administrative workload under projection models (Objective 3).

System capacity (RQ2.4): The initial provider-level analyses will also be descriptive, exploring how the per capita supply and demographic distributions of FPs have changed and how service volume has changed within groups defined by sex and years in practice. To identify how roles outside of community-based primary care shape capacity over time, we will build on approaches used in a previous analysis,[73] identifying FPs with 20% or more

of patient contacts (roughly a day a week) in hospital or emergency departments or in a focused practice area (eg, mental health, substance use, surgical assistance). These FPs will be retained in the analysis as any community-based primary care visits these FPs provide contribute to capacity. However, we will also quantify the proportion of total primary care visits that are delivered by FPs with a focused practice, including the specific focused practice areas in which these services were delivered.

Models of primary care visit volume will include year, sex, years in practice and variables reflecting the proportion of visits in hospitalist, ED practice and other focused practice, payment under alternate payment plans, location of training and urban/rural practice location. We will include a multiway interaction term between sex, years in practice and year to examine any changes in service volume over and above the composition of the workforce with respect to sex and career stage.[34] As visits per physician are right skewed, we will compare model fit between log-transformed and non-transformed linear models. Using methods applied by team members, we will use model parameter estimates to estimate changes at the population level over the full study period.[74]

Objective 3: models to estimate and compare future primary care need and capacity

Analytical models will combine aggregate administrative data with national population and workforce data. To export administrative data for the development of projection models, we will construct matrices of age group by health profile group stratified by administrative sex and determine the distribution and summary statistics of the number of primary care visits per capita within each cell for each year and province. We will further stratify these matrices by measures of social complexity. This will permit a unified analysis using only aggregated administrative data. Since we seek the development of tools to support primary care workforce planning, data frames in Pandas (Python) will be created for easy processing, visualisation and analysis.

Population estimates will be anchored around Statistics Canada (2022) projections that estimate population growth based on past trends and different sets of assumptions regarding rates of fertility, mortality, immigration, emigration, non-permanent residents and internal migration patterns.

There are currently no national projections of FP and NP supply. We will use historical data to examine relevant trends and build analytical models of FP/NP supply to project them forward under varied assumptions related to relevant policy levers. Data will include historical counts of:
1. Geographical distribution, career-stage distribution and interprovincial migration of FPs and NPs compiled by the Canadian Institute for Health Information.[3 75]
2. Family medicine residency spots (and percentage filled) from the Canadian Residency Matching Service[76] and places in NP training programmes.

3. International medical graduates licensed to practise in Canada, including under practice readiness assessment programmes.[77]

Modelling approach: Workforce planning in Canadian jurisdictions has typically relied on relatively simple tools to project forward current per capita supply. An exception to this is the linear programming model proposed by Lavieri *et al* to support the planning of registered nurses' workforce in BC,[78] which informs our approach. Analytical models will be used to project primary care need and capacity, both measured in terms of visit volume, which can be translated into hours worked or provider supply using province-specific productivity estimates.[79] Models will be constructed reflecting a range of concrete scenarios. Example scenarios are below, but these will be refined and expanded based on findings of Objectives 1 and 2 and through consultation with stakeholder advisories.

We will consider the full range of major forecasting methods, including time series regression models, exponential smoothing, Autoregressive integrated moving average (ARIMA) models, dynamic regression models and grouped structures.[80] We will also evaluate the development of a system dynamics or simulation model to frame, understand and analyse the non-linear relationships existing among the different factors shaping the need and capacity in primary care (Objectives 1 and 2), including the case of capacity-dependent need.[81] While we will assume that all factors driving need and capacity are known, and there is associated uncertainty, this approach will allow policymakers to quantify and explore alignment between need and capacity under different scenarios.

The most basic models to estimate future capacity will project current age, administrative sex and urban/rural specific service volume based on the assumptions of constant entry to family medicine and a constant proportion of the workforce in roles outside of community-based primary care. Additional scenarios may vary assumptions about:

► Service volume per provider at different career stages (reflecting supports earlier or later in career).
► Distribution of the workforce in roles outside of community-based primary care.
► Changes in administrative workload over and above visit volume.
► Additional FP and NP training capacity.
► Percentage of physicians working within new payment models.
► Service volume delivered via episodic virtual care.
► Available/projected workforce in other specialty sectors (specialists, maternity, etc—if shrinking workforce in these other sectors, FPs and or NPs may be stretched further).

While workforce models sometimes incorporate recruitment of clinicians across jurisdictions within Canada, this only shifts capacity gaps. Aggressive recruitment of internationally educated physicians, as has been a past practice in Canada, has undermined the health workforces in low- and middle-income countries.[82–86] For this reason, we will consider international medical graduates entering practice within the model, but focus on changes in Canadian training capacity over recruitment between jurisdictions in scenarios examined.

Patient and public involvement

This project adheres to the definition of patient-oriented research articulated under Canada's Strategy for Patient Oriented Research as a continuum of research that focuses on patient-identified priorities, engages patients as partners and improves patient outcomes. This project will provide new information about the gap between growing per capita supply of primary care clinicians and patient experiences of limited access, identified as key issues within the national OurCare.ca primary care conversation.[87] Members of the Canadian Primary Care Research Network Patient Advisory consulted on RQs and approaches and will assist in interpretation of findings as they emerge and provide input on directions for future research. We have chosen an advisory model that will incorporate the perspectives of patients with a range of healthcare needs, living in different geographical settings and with a diverse mix of sociodemographic backgrounds, to reflect the diversity of patients who use primary care. This study is about health workforce planning, and patient outcomes will not be measured directly. However, the information the study will produce will inform policies that will ultimately support strengthened primary care and improved access for patients.

Methodological limitations

Our design accounts for some anticipated challenges and limitations that may be encountered. First, our workforce planning approach is flexible and recognises that there is no ideal level of service use or objective measure of primary care need. We will use historical patterns of service use to estimate future need, with various scenarios exploring the difference between observed use and predicted need.

Second, there are differences in the available data across jurisdictions. Data on population demographics, clinical complexity, primary care visits, social location, physician characteristics, service volume and roles are available for all provinces. While NP data are only available in BC and NB, the data are still relevant and valuable in capturing practice patterns that cannot be measured elsewhere. Despite data limitations, notably that data used to examine service volumes were not designed for this purpose but instead reflect billing systems, we are using the best data available to inform workforce planning, and our approach makes strategic use of complementary data across study provinces.

Third, while there is no direct measurement of team-based care, we acknowledge that primary care workload goes beyond individual patient visits. While data focus on FPs and NPs, more varied models of teamwork that include other professionals can be explored as part of

policy responses. Our approach to modelling total visits rather than precise constellations of team members will allow jurisdictions to explore more appropriate locally tailored approaches to team-based care delivery. Our focus on FP/NP work up to this point reflects both available data and the fact that even in interprofessional models, FPs/NPs largely remain gatekeepers to services delivered by other team members.

Lastly, our analysis will not (and cannot) distinguish between true changes in population health status and changes in the management of chronic conditions or in access to care that shape how conditions are recorded in administrative data. As both true changes in health status and changes in management are related to real primary care needs, such undifferentiation does not undermine our ability to achieve our overarching objective of supporting more nuanced planning for primary care capacity. It is also possible that codes for chronic conditions are being more consistently reported, as financial incentives tied to them have been introduced at various points in all jurisdictions. Comparing trends in clinical complexity across jurisdictions will help provide reassurance that changes are not unique to province-specific billing practices.

Timeline

This research study will span 4 years commencing in September 2024. We will conduct the primary analysis under Objectives 1 and 2 in years 1–2, develop projection models (Objective 3) in year 3 and refine them with input from advisors and complete end-of-grant knowledge translation in year 4.

ETHICS AND DISSEMINATION
Ethics

We obtained cross-jurisdictional approval for the qualitative arm of the study from the Research Ethics Boards of Simon Fraser University, University of Northern British Columbia and University of British Columbia via harmonised Research Ethics BC (#H24-01185) and for the quantitative arm of the study from the Nova Scotia Health Research ethics board (H1030703), with harmonised approval from partnering universities for both study arms.

Data curation and management

Once transcribed and checked for accuracy, audio files recording qualitative interviews will be securely archived. Transcripts will not contain identifying information. De-identified data (interview transcripts and node reports from qualitative coding) may be shared with project co-investigators and collaborators/knowledge users for analysis, their interpretation and expert insights. Audio files will be destroyed on completion of the study (ie, once the final ethics amendment is submitted indicating completion of the study). Other study data (eg, de-identified interview transcripts, NVivo coding projects and participant characteristics) will be kept electronically for 7 years, at which point it will be digitally destroyed.

Administrative data will be securely linked and de-identified by provincial data centres. All patient and physician identifiers will be replaced by a study-specific unique ID. No identifying information will be provided to the research team. All analysis and reporting of study results will proceed according to privacy, security and confidentiality standards of the data stewards and research ethics boards.

Dissemination

This work engages knowledge users as active participants in the research process,[88] and we plan tailored strategies for each of three broad groups: primary care policymakers and clinicians (who can use research findings and the results of models); people in workforce planning (who can design and apply models); and people who use primary care (who can use information about planning for primary care). This strategy is possible because our national team includes members of each of these groups, who have committed to knowledge translation and to participate in primary care policy, workforce planning and patient/public advisories.

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REFERENCES

1. Starfield B, Shi L, Macinko J. Contribution of primary care to health systems and health. *Milbank Q* 2005;83:457–502.
2. Shi L. The impact of primary care: a focused review. *Scientifica (Cairo)* 2012;2012:432892.
3. Canadian Institute for Health Information. Supply, distribution and migration of physicians in Canada. Canadian Institute for Health Information (CIHI); 2023. Available: https://secure.cihi.ca/estore/productSeries.htm?pc=PCC34
4. Canadian Institute for Health Information. How Canada compares: results from the commonwealth fund's 2021 international health policy survey of older adults in 11 countries. Canadian Institute for Health Information; 2022. Available: https://www.cihi.ca/sites/default/files/document/how-canada-compares-cmwf-survey-2021-chartbook-en.pdf
5. Statistics Canada. Primary health care providers, 2019. Health fact sheets, statistics Canada catalogue no 82-625-x. 2020. Available: https://www150.statcan.gc.ca/n1/pub/82-625-x/2020001/article/00004-eng.pdf
6. Sheets DJ, Gallagher EM. Aging in Canada: state of the art and science. *Gerontologist* 2013;53:1–8.
7. Whitty CJM, MacEwen C, Goddard A, *et al*. Rising to the challenge of multimorbidity. *BMJ* 2020;368:l6964.
8. Corazza GR, Formagnana P, Lenti MV. Bringing complexity into clinical practice: An internistic approach. *Eur J Intern Med* 2019;61:9–14.
9. Denton FT, Spencer BG. Chronic health conditions: changing prevalence in an aging population and some implications for the delivery of health care services. *Can J Aging* 2010;29:11–21.
10. Barer ML, Evans RG, Hertzman C. Avalanche or Glacier?: Health Care and the Demographic Rhetoric. *Can J Aging* 1995;14:193–224.
11. Canadian Institute for Health Information (CIHI). Health care in Canada, 2011: a focus on seniors and aging. Ottawa, ON CIHI; 2011.162. Available: https://secure.cihi.ca/free_products/HCIC_2011_seniors_report_en.pdf
12. Whittaker W, Birch S, MacKenzie A, *et al*. Cohort effects on the need for health care and implications for health care planning in Canada. *Health Policy* 2016;120:81–8.
13. Mason T, Sutton M, Whittaker W, *et al*. Exploring the limitations of age-based models for health care planning. *Soc Sci Med* 2015;132:11–9.
14. Colwill JM, Cultice JM, Kruse RL. Will Generalist Physician Supply Meet Demands Of An Increasing And Aging Population? *Health Aff (Millwood)* 2008;27:w232–41.
15. Petterson SM, Liaw WR, Phillips RL, *et al*. Projecting US primary care physician workforce needs: 2010-2025. *Ann Fam Med* 2012;10:503–9.
16. Koné Pefoyo AJ, Bronskill SE, Gruneir A, *et al*. The increasing burden and complexity of multimorbidity. *BMC Public Health* 2015;15.
17. Jarvi S, Richardson G, Flemming K, *et al*. Numbers, characteristics, and medical complexity of children with life-limiting conditions reaching age of transition to adult care in England: a repeated cross-sectional study [version 1; peer review: 2 approved]. *NIHR Open Res* 2022;2:27.
18. Canadian Institute for Health Information. Children and youth with medical complexity in Canada. Ottawa, p30. 2020. Available: https://secure.cihi.ca/free_products/children-youth-with-medical-complexity-report-en.pdf
19. Upshur REG. Understanding Clinical Complexity the Hard Way: A Primary Care Journey. *Healthc Q* 2016;19:24–8.
20. Loeb DF, Binswanger IA, Candrian C, *et al*. Primary care physician insights into a typology of the complex patient in primary care. *Ann Fam Med* 2015;13:451–5.
21. Public Health Agency of Canada. Canadian chronic disease surveillance system (CCDSS) — Canada.ca. 2024. Available: https://health-infobase.canada.ca/ccdss/data-tool/
22. Morkem R, Salman A, Kosowan L, *et al*. The burden of mental health on Canadian primary care following COVID-19. In: *Behavioral, psychosocial, and mental illness*. American Academy of Family Physicians, 2024: 5951.
23. Moroz N, Moroz I, D'Angelo MS. Mental health services in Canada: Barriers and cost-effective solutions to increase access. *Healthc Manage Forum* 2020;33:282–7.
24. Urbanoski K, Inglis D, Veldhuizen S. Service Use and Unmet Needs for Substance Use and Mental Disorders in Canada. *Can J Psychiatry* 2017;62:551–9.
25. Childs BP. The Complexity of Diabetes Care. *Diabetes Spectr* 2005;18:130–1.
26. McGrail K, Lavergne R, Lewis S. The chronic disease explosion: artificial bang or empirical whimper? *BMJ* 2016;352:i1312.
27. Corrigan PW, Druss BG, Perlick DA. The Impact of Mental Illness Stigma on Seeking and Participating in Mental Health Care. *Psychol Sci Public Interest* 2014;15:37–70.
28. McGrail K, Evans R, Barer M, *et al*. 2011 Diagnosing Senescence: Contributions to Physician Expenditure Increases in British Columbia, 1996/97 to 2005/06. *Hcpol*7:41–54.
29. Committee on the Science of Changing Behavioral Health Social Norms, Board on Behavioral, Cognitive, and Sensory Sciences, Division of Behavioral and Social Sciences and Education, National Academies of Sciences, Engineering, and Medicine. *Ending discrimination against people with mental and substance use disorders: the evidence for stigma change*. Washington (DC): National Academies Press (US), 2016. Available: http://www.ncbi.nlm.nih.gov/books/NBK384915/
30. Adams WL, McIlvain HE, Lacy NL, *et al*. Primary care for elderly people: why do doctors find it so hard? *Gerontologist* 2002;42:835–42.
31. Korownyk C, McCormack J, Kolber MR, *et al*. Competing demands and opportunities in primary care. *Can Fam Physician* 2017;63:664–8.
32. Millar E, Stanley J, Gurney J, *et al*. Effect of multimorbidity on health service utilisation and health care experiences. *J Prim Health Care* 2018;10:44–53.

33 CIHI. Canadian Institute for Health Information. COVID-19's impact on physician services. 2021. Available: https://www.cihi.ca/en/covid-19-resources/impact-of-covid-19-on-canadas-health-care-systems/physician-services

34 Rudoler D, Peterson S, Stock D, *et al*. Changes over time in patient visits and continuity of care among graduating cohorts of family physicians in 4 Canadian provinces. *CMAJ* 2022;194:E1639–46.

35 Kabir M, Randall E, Mitra G, *et al*. Resident and early-career family physicians' focused practice choices in Canada: a qualitative study. *Br J Gen Pract* 2022;72:e334–41.

36 Islam R, Kralj B, Sweetman A. Physician workforce planning in Canada: the importance of accounting for population aging and changing physician hours of work. *CMAJ* 2023;195:E335–40.

37 Watson DE, Reid R, Roos N, *et al*. Growing old together: the influence of population and workforce aging on supply and use of family physicians. *Can J Aging* 2005;24 Suppl 1:37–45.

38 Lavergne MR, Rudoler D, Peterson S, *et al*. Changes in comprehensiveness of services delivered by Canadian family physicians: Analysis of population-based linked data in 4 provinces. *Can Fam Physician* 2023;69:550–6.

39 Hedden L, Barer ML, Cardiff K, *et al*. The implications of the feminization of the primary care physician workforce on service supply: a systematic review. *Hum Resour Health* 2014;12:32.

40 Hedden L, Lavergne MR, McGrail KM, *et al*. Patterns of physician retirement and pre-retirement activity: a population-based cohort study. *CMAJ* 2017;189:E1517–23.

41 Watson DE, Slade S, Buske L, *et al*. Intergenerational Differences In Workloads Among Primary Care Physicians: A Ten-Year, Population-Based Study. *Health Aff (Millwood)* 2006;25:1620–8.

42 Crossley TF, Hurley J, Jeon SH. Physician labour supply in Canada: a cohort analysis. *Health Econ* 2009;18:437–56.

43 Sarma S, Thind A, Chu MK. Do new cohorts of family physicians work less compared to their older predecessors? The evidence from Canada. *Soc Sci Med* 2011;72:2049–58.

44 Dash D, Siu H, Kirkwood D, *et al*. Did the Long-Term Care Physician Workforce Change During the Pandemic? Describing MRP Trends in Ontario, Canada. *J Am Med Dir Assoc* 2023;24:1042–7.

45 Kiran T, Eissa A, Mangin D, *et al*. Brief on primary care part 1: the roles of primary care clinicians and practices in the first two years of the covid-19 pandemic in ontario. Ontario COVID-19 Science Advisory Table; 2022. Available: https://covid19-sciencetable.ca/sciencebrief/brief-on-primary-care-part-1-the-roles-of-primary-care-clinicians-and-practices-in-the-first-two-years-of-the-covid-19-pandemic-in-ontario

46 Health Workforce Canada. Health workforce modelling & forecasting in Canada: current state analysis report. Ottawa Health Workforce Canada; 2024.

47 Zhang X, Lin D, Pforsich H, *et al*. Physician workforce in the United States of America: forecasting nationwide shortages. *Hum Resour Health* 2020;18:8.

48 Van Greuningen M, Batenburg RS, Van der Velden LF. The accuracy of general practitioner workforce projections. *Hum Resour Health* 2013;11:31.

49 Matrix insight. EU level collaboration on forecasting health workforce needs, workforce planning and health workforce trends – a feasibility study. 2012.174. Available: https://health.ec.europa.eu/system/files/2016-11/health_workforce_study_2012_report_en_0.pdf

50 Bourgeault IL, Chamberland-Rowe C, Simkin S. Co-developing an integrated primary care workforce planning approach at a regional level: overarching framework and guiding principles. *Hum Resour Health* 2021;19:87.

51 Asamani JA, Christmals CD, Reitsma GM. The needs-based health workforce planning method: a systematic scoping review of analytical applications. *Health Policy Plan* 2021;36:1325–43.

52 MacKenzie A, Tomblin Murphy G, Audas R. A dynamic, multi-professional, needs-based simulation model to inform human resources for health planning. *Hum Resour Health* 2019;17:42.

53 Birch S, Kephart G, Murphy GT, *et al*. Health human resources planning and the production of health: development of an extended analytical framework for needs-based health human resources planning. *J Public Health Manag Pract* 2009;15:S56–61.

54 Glazier RH. Addressing unmet need for primary care in Canada. *Healthc Manage Forum* 2024;37:451–6.

55 Tomblin Murphy G, Birch S, MacKenzie A, *et al*. A synthesis of recent analyses of human resources for health requirements and labour market dynamics in high-income OECD countries. *Hum Resour Health* 2016;14.

56 Creswell JW. *Research design: qualitative, quantitative, and mixed methods approaches*. 4th edn. Thousand Oaks: SAGE Publications, 2013.

57 Patton M. *Qualitative research & evaluation methods*. 4th edn. Thousand Oaks: SAGE Publications, 2015.

58 Green J, Thorogood N. *Qualitative methods for health research*. 3rd edn. Los Angeles: SAGE Publications, 2013:360.

59 Sandelowski M. Sample size in qualitative research. *Res Nurs Health* 1995;18:179–83.

60 Morse JM. Analytic Strategies and Sample Size. *Qual Health Res* 2015;25:1317–8.

61 Varpio L, Ajjawi R, Monrouxe LV, *et al*. Shedding the cobra effect: problematising thematic emergence, triangulation, saturation and member checking. *Med Educ* 2017;51:40–50.

62 Malterud K, Siersma VD, Guassora AD. Sample Size in Qualitative Interview Studies: Guided by Information Power. *Qual Health Res* 2016;26:1753–60.

63 Vasileiou K, Barnett J, Thorpe S, *et al*. Characterising and justifying sample size sufficiency in interview-based studies: systematic analysis of qualitative health research over a 15-year period. *BMC Med Res Methodol* 2018;18:148.

64 Aronson J. A Pragmatic View of Thematic Analysis. *TQR* 1995;2:1–3.

65 Gale NK, Heath G, Cameron E, *et al*. Using the framework method for the analysis of qualitative data in multi-disciplinary health research. *BMC Med Res Methodol* 2013;13:117.

66 Ritchie J, Spencer L. Qualitative data analysis for applied policy research. In: *The qualitative researcher's companion*. SAGE Publications, Inc, 1994: 173–94. Available: https://dx.doi.org/10.4135/9781412986274

67 Strauss A, Corbin J. *Basics of qualitative research: techniques and procedures for developing grounded theory*. 2nd edn. SAGE Publications, Inc, 1998.

68 Sandelowski M. Whatever happened to qualitative description? *Res Nurs Health* 2000;23:334–40.

69 Lincoln YS, Guba EG. *Naturalistic inquiry*. SAGE Publications, Inc, 1985:416.Available: https://us.sagepub.com/en-us/nam/naturalistic-inquiry/book842

70 Mays N, Pope C. Rigour and qualitative research. *BMJ* 1995;311:109–12.

71 Field KS, Briggs DJ. Socio-economic and locational determinants of accessibility and utilization of primary health-care. *Health Soc Care Community* 2001;9:294–308.

72 Butler DC, Petterson S, Phillips RL, *et al*. Measures of social deprivation that predict health care access and need within a rational area of primary care service delivery. *Health Serv Res* 2013;48:539–59.

73 Lavergne MR, Goldsmith LJ, Grudniewicz A, *et al*. Practice patterns among early-career primary care (ECPC) physicians and workforce planning implications: protocol for a mixed methods study. *BMJ Open* 2019;9:e030477.

74 Hedden L, Barer ML, McGrail K, *et al*. In British Columbia, The Supply Of Primary Care Physicians Grew, But Their Rate Of Clinical Activity Declined. *Health Aff (Millwood)* 2017;36:1904–11.

75 CIHI. Nurse practitioners. Canadian Institute for Health Information; 2022. Available: https://www.cihi.ca/en/nurse-practitioners

76 The match - CaRMs. carms. 2023. Available: https://www.carms.ca/the-match/

77 Medical Council of Canada. Practice-ready assessment. Medical Council of Canada; 2023. Available: https://mcc.ca/assessments/practice-ready-assessment/

78 Lavieri MS, Regan S, Puterman ML, *et al*. Using operations research to plan the british columbia registered nurses' workforce. *Healthc Policy* 2008;4:e117–35.

79 Simkin S, Chamberland-Rowe C, Bourgeault IL. An integrated primary care workforce planning toolkit at the regional level (part 2): quantitative tools compiled for decision-makers in Toronto, Canada. *Hum Resour Health* 2021;19:86.

80 Hyndman RJ, Athanasopoulos G. *Forecasting: principles and practice*. 3rd edn. Melbourne, Australia, 2021. Available: https://otexts.com/fpp3/

81 Wolstenholme E, McKelvie D. *The dynamics of care: understanding people flows in health and social care*. 1st edn. Germany: Springer International Publishing, 2019.

82 Zubaran C. The international migration of health care professionals. *Australas Psychiatry* 2012;20:512–7.

83 McIntosh T, Torgerson R, Klassen N. The ethical recruitment of internationally educated health professionals: lessons from abroad and options for Canada, report no.: 11. Ottawa, ON Canadian Policy Research Networks; 2007.44. Available: https://www.aspeninstitute.org/wp-content/uploads/files/content/images/options%20for%20canada.pdf

84 Saluja S, Rudolfson N, Massenburg BB, *et al*. The impact of physician migration on mortality in low and middle-income countries: an economic modelling study. *BMJ Glob Health* 2020;5:e001535.

85 Labonté R, Packer C, Klassen N. Managing health professional migration from sub-Saharan Africa to Canada: a stakeholder inquiry into policy options. *Hum Resour Health* 2006;4:22.

86 Walton-Roberts M. The ethics of recruiting foreign-trained healthcare workers. *Healthc Manage Forum* 2022;35:248–51.

87 OurCare Project team. OurCare survey report. MAP Centre for Urban Health; 2023. Available: https://static1.squarespace.com/static/6262cccb57de734a6952e846/t/6480d3f78aaf372e1b7cc604/1686164473545/OurCare+-+Survey+Report+EN.pdf

88 Bowen S, Graham I. Integrated knowledge translation. In: *Knowledge translation in health care*. Chichester, UK: John Wiley & Sons, Ltd, 2013: 14–23.