THE IMPORTANCE OF DIVISION OF WORK AND CLINICAL FOCUS IN HEALTH HUMAN RESOURCES PLANNING: A DYNAMIC, MULTI-PROFESSIONAL, NEEDS-BASED SIMULATION MODEL

by © Adrian MacKenzie

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ABSTRACT

Background: Comprehensive health human resources (HHR) planning is essential for addressing population health needs and meeting other common health care system objectives. For reasons that remain unclear, conceptually invalid approaches to HHR planning remain commonplace in Canada and other countries. The overarching aim of this study is to assess the feasibility of using a dynamic, multi-professional, needs-based simulation model to inform HHR planning in Nova Scotia.

Objectives: 1) Estimate the supply of and requirements for physicians, nurses, social workers, and psychologists to address anxiety and depression among school-aged children in Nova Scotia through 2032; and 2) Identify technical and political factors affecting the choice of HHR planning models in Nova Scotia.

Methods: A dynamic, multi-professional, needs-based simulation model was used to achieve the first objective. A series of key informant interviews with HHR planners from different Nova Scotia stakeholder groups was conducted to address the second objective.

Results: Simulation modeling suggests Nova Scotia currently lacks the number and mix of HHR required to address anxiety and depression among its school-aged children, and that this problem will worsen without intervention. Examples of policy interventions with the potential to address simulated HHR gaps are provided. The most important factor identified as affecting the choice of HHR planning model in Nova Scotia was the buy-in of key stakeholder groups. Other factors identified as particularly important in determining this choice were the model's balance between comprehensiveness and

complexity, the political and technical capacity of individuals and organizations responsible for HHR planning, and concerns regarding the availability of appropriate planning data to populate the model.

Conclusion: Use of this model to inform HHR planning in Nova Scotia is feasible with appropriate engagement of key stakeholders. The structure and presentation of the model are viewed by HHR planners in the province as being suited to facilitating such engagement. Coordinated investments are needed to ensure adequate planning capacity among the individuals and organizations responsible for HHR planning in Nova Scotia, and the availability of adequate data to inform HHR and health system planning.

Key Words: HHR, health human resources, HRH, human resources for health, health workforce, planning, health services, mental health, nurses, physicians, psychologists, social workers

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LIST OF ABBREVIATIONS

AACAP: American Association of Child and Adolescent Psychiatrists

ACHDHR: Advisory Committee on Health Delivery and Human Resources

ADAC: Anxiety Disorders Association of Canada

APNS: Association of Psychologists of Nova Scotia

ASDUS: Atlantic Student Drug Use Survey

CACAP: Canadian Association of Child and Adolescent Psychiatrists

CAPA: Choice and Partnership Approach

CAPER: Canadian Post-MD Education Registry

CBT: Cognitive Behavioural Therapy

CCHS: Canadian Community Health Survey

CES: Centre for Epidemiologic Studies

CfWI: Centre for Workforce Intelligence

CIDI: Composite International Diagnostic Interview

CIHI: Canadian Institute for Health Information

CMA: Canadian Medical Association

CNA: Canadian Nurses Association

CPA: Canadian Psychiatry Association

DHW: Department of Health and Wellness

DSM: Diagnostic and Statistical Manual

ED: Emergency Department

FP: Family Physician

FTE: Full-Time Equivalent

GMENAC: Graduate Medical Education National Advisory Committee

GP: General Practitioner

HBS: Health Behaviours Survey

HDNS: Health Data Nova Scotia

HHR: Health Human Resources

HRH: Human Resources for Health

HWA: Health Workforce Australia

ICD: International Classification of Diseases

IWK: Izaak Walton Killam

mhGAP: Mental Health Gap Action Programme

NICE: National Institute for health and Care Excellence

NIVEL: Netherlands Institute for Health Services Research

NP: Nurse Practitioner

NSCSW: Nova Scotia College of Social Work

NSHA: Nova Scotia Health Authority

NSHRF: Nova Scotia Health Research Foundation

OECD: Organisation for Economic Co-operation and Development

PAHO: Pan American Health Organization

RCP: Royal College of Psychiatrists

RN: Registered Nurse

SCID: Structured Clinical Interview for Diagnostic and Statistics Manual

UK: United Kingdom

USA: United States of America

WHO: World Health Organization

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CHAPTER 1: INTRODUCTION

The problem: Inadequate health service and health human resource planning

Planning for health care services and health human resources (HHR) in Canada, as in other countries, has historically had substantial methodological weaknesses. These have contributed to misalignment between the health care available to Canadians and the health care Canadians need, which in turn has resulted in unnecessarily poor outcomes at the individual and societal levels. To help address this problem, the overarching aim of this thesis is to assess the feasibility of using a dynamic, needs-based, multi-professional HHR planning simulation model to help address the mental health care needs of school-aged children with anxiety and depression in Nova Scotia. Within that aim, its two specific objectives are to:

1. Estimate the supply of and requirements for physicians, nurses, social workers, and psychologists to address anxiety and depression among school-aged children in Nova Scotia through 2032; and
2. Identify technical and political factors affecting the choice of HHR planning models in Nova Scotia.

HHR planning involves both technical and political processes (Mejía & Fülöp, 1978; Tomblin Murphy, et al., 2012; Birch, Mason, Sutton, & Whittaker, 2013; Birch, Tomblin Murphy, MacKenzie, & Cumming, 2015; Tomblin Murphy, Birch, MacKenzie, Rigby, & Purkis, 2017) As such, it is intended that the degree to which the first of these objectives can be achieved will illustrate the degree to which implementing the model is

feasible from a technical perspective given the data available in the province, while the second objective would illustrate the feasibility of implementing this approach from a political (and, to a lesser extent, technical) perspective.

The focus of the first objective on anxiety and depression among school-aged children was chosen for several reasons, which are outlined in more detail later in this chapter. First, mental disorders have been identified as the leading cause of years lost to disability worldwide. Second, most mental disorders first manifest, and are most amenable to treatment, during childhood and adolescence. Third, anxiety and depression are the most common mental disorders among children and adolescents in Nova Scotia.

HHR Planning in Canada

HHR and health service planning in Canada has tended not to explicitly incorporate measures of population health, and has tended to be conducted for single health professions in isolation from one another (Cameron Health Strategies Group, 2009; MacKenzie, Birch, & Tomblin Murphy, 2012; Tomblin Murphy, Birch, MacKenzie, Bradish, & Elliott Rose, 2016). This is despite the facts that health care in Canada is to be provided based on need (Health Canada, 2012), and that comprehensive health care frequently requires the services of multiple health professions working interdependently (Reeves, Lewin, Espin, & Zwarenstein, 2010, p. 26; Curson, Dell, Wilson, Bosworth, & Baldauf, 2010; Jones, Bhanbhro, Grant, & Hood, 2013; Morgan, Pullon, & McKinlay, 2015; Klaasen, Bowman, & Komenda, 2016; Nova Scotia Health Authority, 2017). In these limitations, Canada is typical of other countries (Ono,

Lafortune, & Schoenstein, 2013; Tomblin Murphy, Birch, MacKenzie, Bradish, & Elliott Rose, 2016).

Poor health service and HHR planning lead to unmet health care needs

A natural consequence of this failure to directly consider population health needs in HHR and health care planning is the frequent and widespread misalignment between those needs and the services and the HHR available to address them (Lomas, Stoddart, & Barer, 1985; Birch & Chambers, 1993; Newbold, Eyles, Birch, & Spencer, 1998; Dussault & Dubois, 2003; Birch, et al., 2007; Tomblin Murphy, et al., 2012) (Birch, Tomblin Murphy, MacKenzie, & Cumming, 2015; Birch, Tomblin Murphy, MacKenzie, Whittaker, & Mason, 2017). Decades of evidence from Canada (Roos & Roos, 1982; Roos L. , 1983; Béland, Lemay, & Boucher, 1998; Hall & Tu, 2003; Ko, et al., 2007; Alter, Stukel, & Newman, 2008; You, et al., 2008; Tran, Wijeysundera, Qui, Tu, & Bhatia, 2014) (Rudmik, et al., 2015; Lavergne, et al., 2016; Deslauriers, et al., 2017; Hall, Irish, Groome, Griffiths, & Hurlburt, 2017; Cheung, et al., 2018; Jin, Hanna, Cook, Miao, & Brundage, 2018; Symonds, Chen, Rose, & Cooke, 2018) as well as other countries (Glover, 1938; Roos, Wennberg, & McPherson, 1988; Goodman, Fisher, Gittelsohn, & Fleming, 1994; Weiner, Starfield, Powe, Stuart, & Steinwachs, 1996; Cutler & Sheiner, 1999; Wennberg, Fisher, & Skinner, 2002; Goodman, et al., 2002; Fisher, Gottlieb, Lucas, & Pinder, 2003) (Hetemaa, Keskimaki, Manderbacka, Leyland, & Kosiken, 2003; Ko, et al., 2008; Busato, Matter, & Künzi, 2009; Kopetsch & Schmitz, 2014; White, Gutacker, Jacobs, & Mason, 2014; Rudmik, Holy, & Smith, 2015; Shah, et al., 2017;

Kasumova, et al., 2017) have demonstrated numerous instances where the deployment of health care services and HHR have been found to be uncorrelated with measures of population health.

Reports of health care needs going unmet are common among both those seeking care and those providing it across Canada (Sanmartin & Ross, 2006; Marshall, 2011; Gillan, et al., 2012; Lévesque, et al., 2012; Harrington, Wilson, Rosenberg, & Bell, 2013; Casey, 2015; Oosterveer & Young, 2015; Ornstein, et al., 2015; Ahmed, et al., 2016; Urbanoski, Cheng, Rehm, & Kurdyak, 2018). Although unmet health care needs are the result of multiple factors at the individual (e.g., lack of knowledge regarding available services), system (e.g., failure to plan for the provision of needed services), and societal (e.g., stigma regarding certain health conditions) levels, the basic availability of services and the HHR to provide them is consistently identified as a major determinant of unmet needs (Sanmartin & Ross, 2006; Harrington, Wilson, Rosenberg, & Bell, 2013; Campbell, et al., 2014; Manhendran, Speechley, & Widjaja, 2017; Oda, et al., 2017; Domagała & Kilch, 2018).

Unmet health care needs negatively impact individuals, the health care system, and society

Individuals with unmet health care needs face increased risks of worsening mental and physical health (Karananayake & Pahwa, 2009; Lévesque, et al., 2012; Pappa, Kontodimonpolous, Papadopoulos, Tountas, & Niakas, 2013; Ornstein, et al., 2015). In their interactions with the health care system, people with unmet health care needs are

more likely to use more health care services than would otherwise be expected given their health status (Allin, Grignon, & Le Grand, 2010), and to access them through emergency departments as opposed to community-based providers (McCusker, et al., 2010). Unmet health care needs also frequently exacerbate – and are exacerbated by – broader socioeconomic problems such as unemployment (Huang, Birkenmaier, & Kim, 2014; Calzón Fernández, Fernández Ajuria, & Martín, 2015), problematic drug use (Palepu, et al., 2013; Fleury, Grenier, Bamvita, Pereault, & Caron, 2016), homelessness (Argintaru, et al., 2013; Noel, et al., 2015), and involvement with the justice system (Durbin, Sirotich, & Durbin, 2014; Barnert, Perry, & Morris, 2016). In short, failing to consider population health care needs in health care planning results in unmet health care needs; this in turn leads to negative outcomes for individuals, the health care system, and populations.

The importance of mental health

Mental disorders[2] have been identified as the leading cause of years lost to disability worldwide (Whiteford, et al., 2013), and it has been estimated that nearly 30% of the global population experiences some type of mental disorder over the course of their lifetimes (Steel, et al., 2014). People with poor mental health face increased risk for a variety of social, economic, and other health problems, including incarceration (Fazel & Danesh, 2002; Baillargeon, Binswanger, Penn, Williams, & Murray, 2009),

[2] The mental health literature uses several different terms – whose intended meanings do not appear consistent across documents – to describe the varying states of mental health and well-being or the absence thereof. In the interests of reporting evidence in a manner that is faithful to the various source materials, the terms used in this thesis are the same as those used in the various cited documents.

unemployment and welfare dependency (Jefferis, et al., 2011; Butterworth, Leach, Pirkis, & Kelaher, 2012), and increased mortality overall (Lawrence, Kisely, & Pais, 2010) as well as mortality due to specific illnesses such as cancer (Kisely, Sadek, MacKenzie, Lawrence, & Campbell, 2008) and cardiovascular disease (Kisely, et al., 2013). Estimates of the costs of mental health conditions – to individuals who have them, to their families, and to broader society – find these costs to be similar to those of physical health problems (Smit, et al., 2006; Alonso, et al., 2011).

Most mental health disorders first emerge during youth (Kim-Cohen, et al., 2003; Kessler, et al., 2007; Skovgaard, 2010; de Girolamo, Dagani, Purcell, Cocchi, & McGorry, 2012). Children and adolescents who experience mental health problems are more likely to continue to have mental health challenges as adults (Fergusson, Horwood, & Ridder, 2005; Copeland, Shanahan, Costello, & Angold, 2007; Kosterman, et al., 2009). Young people who endure mental health problems also face elevated risks of significant social problems as adults (Colman, et al., 2009), such as substance abuse and addiction (Fergusson, Horwood, & Ridder, 2007), and the inability to live independently (Burgess & Gutstein, 2007), maintain employment (Public Health Agency of Canada, 2012; Reneflot & Evensen, 2014), or maintain financial independence (Canadian Population Health Initiative, 2008).

Anxiety and depression are among the most common mental health conditions among children and youth (Cummings, Caporino, & Kendall, 2014), and the two conditions often co-occur (Essau, 2008; Garber & Weerasing, 2010; Meng & D'Arcy, 2012; Patten, et al., 2015). Estimates of the incidence and prevalence of these conditions

vary depending on the measurements used. The most recent published estimates for Nova Scotia, for example, are as follows:

- Data from the 2016 Canadian Community Health Survey (CCHS) (Statistics Canada, 2017) suggest that the prevalence of mood disorders (including but not limited to depression) among Nova Scotians aged 12 to 17 years was 8.1% (95% confidence interval: 4.0% to 12.3%).
- Data from the Atlantic Student Drug Use Survey (ASDUS) suggest that in 2012 24.4% of Nova Scotia grade 7, 9, 10, and 12 students showed a somewhat elevated risk of depression and 8.7% showed very elevated risk (Asbridge & Langille, 2013).
- Data from the 2010-2011 Health Behaviour Survey (HBS) suggested 23.5% of Nova Scotia high school students were at an elevated risk for depression (Asbridge, Azagba, Langille, & Rasic, 2014).
- Analysis of data from the 2010 CCHS puts the prevalence of anxiety disorders among Nova Scotia respondents aged 12-19 at 4.9%, while data from the 2007 CCHS put the incidence of major depressive episodes within the past year among Nova Scotia respondents aged 12-24 at 4.7% (Asbridge, Pauley, Langille, Kisely, & Whipp, 2011).

These conditions can cause significant functional impairment (Kendall, et al., 2010), and contribute to socio-economic problems such as substance abuse (Lopez, Turner, & Saavedra, 2005), poor academic performance (Fletcher, 2008) and work impairment (Miller, Constance, & Brennan, 2007). They also increase the risk of other

health problems, including becoming obese adults (Hasler, et al., 2005) and attempting suicide (Cheung & Dewa, 2006; Cheung & Dewa, 2007).

Unmet mental health care needs

Despite the existence of a wide range of prevention and treatment options found to be effective (Knapp, McDaid, & Parsonage, 2011; Sandler, et al., 2014; Ye, et al., 2014; Pennant, et al., 2015; Zhou, et al., 2015; Bellón, et al., 2015; Stockings, et al., 2016), shortages of resources and poor coordination mean that unmet needs for mental health care remain problematic among children and adolescents in Canada (Kirby & Keon, 2006; Kutcher & McLuckie, 2010; Asbridge, Pauley, Langille, Kisely, & Whipp, 2011; Asbridge & Langille, 2013) and abroad (Rocha, Graeff-Martins, Kieling, & Rohde, 2015). Survey data from 2012 indicated that 21.2% of Nova Scotia junior and senior high school students sought help for symptoms of depression yet only 7.7% received it (Asbridge & Langille, 2013). Data from another survey in 2007 indicated that 12% and 9% of Nova Scotia secondary school students had sought help for depression and anxiety, respectively, but not received it (Asbridge, Pauley, Langille, Kisely, & Whipp, 2011); no studies of unmet needs for mental health care among Nova Scotia children or youth have been published since that time.

In addition to the risks outlined above, children and adolescents whose mental health care needs go unmet face increased risk of suicide (Renaud, et al., 2014) and poorer mental and physical health as adults (Hargreaves, Elliott, Viner, Richmond, & Schuster, 2015; Ritzema, Lach, Nicholas, & Sladeczek, 2018). Having a child with unmet

mental health needs also adversely affects their parents' health (Brown, Green, Desai, Weitzman, & Rosenthal, 2014).

Planning for mental health care in Nova Scotia

As part of its efforts to better address the mental health needs of its population, Nova Scotia's first mental health strategy (Province of Nova Scotia, 2013) called for several improvements to how government-run services across multiple sectors are organized with a view toward promoting mental health and well-being across the province. According to the most recent progress report on the strategy (Province of Nova Scotia, 2016), changes to child and adolescent mental health services in the province since its launch have included:

- Establishment and expansion of a telephone-based coaching program for families with children with anxiety or behavioural problems;
- Placement of mental health clinicians in schools across the province;
- Training of primary care providers in management of mild to moderate mental health problems and issues;
- Training for paramedics in understanding mental illness;
- Restructuring the intake process for community mental health services;
- Establishment of a clinician-led group therapy program for families;
- Pharmacist-led enhanced medication management and monitoring;
- Expansion of a clinician-staffed mental health crisis line to be available province-wide;

- Introduction of community-based, non-clinician peer support specialists to complement existing, clinician-led services;
- Online training for clinicians in the treatment of concurrent mental health and addictions issues;
- Training for clinicians in providing appropriate mental health services to specific populations such as First Nations and African Nova Scotians;
- Placement of mental health clinicians within First Nations communities; and
- Funding for 37 other, community-based organizations focused on improving quality of life for Nova Scotians with mental health and/or addictions issues.

A 2017 investigation by the provincial Auditor General (Office of the Auditor General of Nova Scotia, 2017) identified several shortcomings in the implementation of the strategy in the 5 years since its launch. Among these were that service availability – including but not limited to mental health crisis services – varied widely across the province, and that a province-wide plan for mental health services did not exist.

HHR planning in Nova Scotia

Many of the service changes implemented as part of Nova Scotia's mental health strategy have significant implications for the province's mental health workforce, not the least of which is that, other things equal, more of them are now required to provide the additional services described. The planning model the province is currently using for physicians (Social Sector Metrics Inc., Health Intelligence Inc., 2012), however, lacks the capacity to account for, among other relevant factors, the new model of care being

95developed for youth mental health in the province (Province of Nova Scotia, 2017). Nova Scotia's nursing strategy was partially informed by its use of a dynamic, needs-based simulation model to plan for registered nurses (Tomblin Murphy & MacKenzie, 2014), and identifies mental health as an area of focus insofar as replacing retiring nurses (Province of Nova Scotia, 2015). However, the nursing strategy makes no reference to any additional nurses being required in keeping with the provincial mental health strategy. Moreover, neither of the strategies for physicians nor nurses makes any reference to each other nor to any of the province's plans for other professions, while the province's overarching HHR action plan has not been updated since 2005 (Nova Scotia Department of Health, 2005). In addition, the physician planning model uses a supply-based approach to estimating HHR requirements, the RN planning model does not allow for consideration of the level of clinical focus on a particular type of service (e.g., mental health), and neither the physician nor the RN models explicitly incorporates the concept of division of work in estimating HHR requirements.

In short, the existing HHR planning tools being used in Nova Scotia are not adequate to plan to meet the mental health care needs of the province's children. There is therefore great potential for an improved HHR planning model to facilitate more comprehensive mental health service planning and service delivery in Nova Scotia.

Summary of rationale for the thesis

The knowledge produced in achieving the objectives of this thesis is intended to directly facilitate improved HHR planning for mental health in Nova Scotia. The methods

used, although customized to suit Nova Scotia's unique context, are designed to be transferrable to other populations, health issues, and jurisdictions, and to facilitate improved HHR planning in other jurisdictions.

To summarize, the HHR planning approaches used by governments and health authorities in Canada have largely failed to consider the health care needs of the Canadian population and the growing interdependence (not to mention the potential for substitution) between different types of HHR. This failure has contributed to many of those needs being unmet, which in turn exacerbates health and socioeconomic problems. One reason for this failure is a lack of access to the types of planning tools that facilitate the alignment of HHR with population health care needs as well as multi-professional planning; however, the feasibility of applying such tools has not been empirically studied.

To address this problem, this thesis describes the structure and application of a dynamic, multi-professional, needs-based simulation model to inform HHR mental health planning related to anxiety and depression among children and youth in Nova Scotia. It also identifies technical and political factors that may support or hinder its incorporation into HHR planning processes in the province.

The next chapter in this thesis reviews past research relevant to its objectives. Chapter three presents the methods – including the underlying theoretical and analytical frameworks – used in the thesis. Results are presented in the fourth chapter. The fifth and final chapter discusses the strengths and weaknesses of the study and the significance of its results for Nova Scotia and in the context of relevant research by others.

CHAPTER 2: LITERATURE REVIEW

Overview

This chapter reviews the literature relevant to the thesis objective. This includes the different modeling approaches to HHR planning as well as evidence on the political and technical factors that affect the adoption of a given approach to HHR planning. The different modeling approaches to HHR planning are reviewed first. Next, the overlap and distinction between HHR planning and strategic human resource management are illustrated. Because hundreds of HHR planning models have been published to date, the features of these are described generally before focusing in more depth on models that have been specifically applied to planning for mental health care. Different measures of anxiety and depression in children and adolescents are then reviewed, followed by models of service delivery to address anxiety and/or depression in children and adolescents. Relevant literature on factors determining the adoption of a particular HHR planning approach is then also summarized. The chapter concludes with a description of the knowledge gaps in each of these areas as they pertain to the objectives of this study.

Models for needs-based HHR planning

What is Health Human Resources Planning?

Health Human Resources (HHR) planning is, 'the process of estimating the number of persons and the kind of knowledge, skills, and attitudes they need to achieve predetermined health targets and ultimately health status objectives" (Mejía & Fülöp, 1978). Put more simply, it involves matching the supply of HHR with the requirements

for the services they produce (Birch, O'Brien-Pallas, Alksnis, Tomblin Murphy, & Thomson, 2003; Birch, et al., 2007). Because of the importance and complexity of this task, HHR issues have been consistently identified as a priority area for health system planning and research in Canada (Romanow, 2002; Kirby M. J., 2003; Advisory Committee on Health Delivery and Human Resources, 2004; Advisory Committee on Health Delivery and Human Resources, 2007) and internationally (World Health Organization, 1971; Pan American Health Organization, 2005; Campbell, et al., 2014; Kuhlmann, et al., 2018). Despite this attention, HHR planning remains a significant challenge worldwide. For example, many countries still lack the capacity to maintain accurate counts of their health care providers (Matrix Insight, 2012), while other countries' efforts focus on monitoring HHR supply without considering whether it is adequate to meet HHR requirements (Dussault, Buchan, Sermeus, & Padaiga, 2010; Ono, Lafortune, & Schoenstein, 2013).

Approaches to HHR planning have been reviewed and catalogued repeatedly and thoroughly elsewhere (Baker, 1966; Hall T. , 1978; Breegle & King, 1982; Markham & Birch, 1997; O'Brien-Pallas, et al., 2001; Dreesch, et al., 2005; Roberfroid, Leonard, & Stordeur, 2009; Lopes, Almeida, & Almada-Lobo, 2015; Tomblin Murphy, Birch, MacKenzie, Bradish, & Elliott Rose, 2016), and differ chiefly in the methods they use for estimating HHR requirements as opposed to their methods for estimating supply. These approaches fall into three main categories: supply-based, utilization- or demand-based, and needs-based approaches. Differences between these types of approaches are summarized in Table 1.

Table 1: Types of Approaches for Estimating HHR Requirements

Type of approach	Guiding question	Main strengths	Main weaknesses
Supply-based	What HHR are required to maintain a given ratio of HHR to population?	• Relatively simple • Easy to explain • Requires the least data to implement	• Based on demonstrably false assumptions • Yields misalignment between HHR and the need for their services
Utilization-based	What HHR are required to provide a certain volume of services?	• Appropriate when specified service volumes happen to match needs	• Lack capacity to plan for future changes to population health needs
Demand-based	What HHR is the jurisdiction willing and able to pay for?	• Facilitates direct consideration of financial constraints • Appropriate in systems where ability to pay is to be the primary criteria for providing services	• Inappropriate for systems where services are to be provided based on need as opposed to ability to pay
Needs-based	What HHR are required to address the health care needs of the jurisdiction?	• Appropriate for systems where services are to be provided based on need as opposed to willingness to pay • Facilitates explicit consideration of population health needs, levels of service provision, HHR productivity	• Requires large amounts of data to implement • Relatively complicated

Under supply-based approaches, requirements for HHR are estimated primarily by multiplying current or target provider-population ratios to the estimated size of the future population, sometimes adjusting for basic demographic factors like age and sex. In utilization-based approaches, current or target utilization rates are multiplied by estimates of future population size (sometimes stratified by demographic factors like age and sex), which are then converted to HHR requirements using productivity estimates. Under needs-based approaches, best (or currently accepted) practices in terms of the number and type of services to be provided to individuals according to their level of health are applied to expected future distributions of levels of health across population age-sex groups, which are in turn applied to estimates of future population size by age and sex. Provider requirements are then estimated from best practice (or current productivity norms) of rates of service provision per provider.

HHR planning approaches can also be classified as dynamic or static, or as single- or multi-professional. Static models (e.g., (Bruckner, et al., 2011; Segal, Leach, May, & Turnbull, 2013)) produce estimates of HHR supply and/or requirements at a single point in time, while dynamic models (e.g., (Starkiene, Smigelskas, Padaiga, & Reamy, 2005; United Kingdom Centre for Workforce Intelligence, 2013)) produce estimates for various future points in time, accounting for potential changes to planning parameters over time (Allpass, 1964). Hence a dynamic approach was chosen for this thesis to allow for future planning and the potential for changes to planning parameters over time.

Single-profession models estimate HHR supply and/or requirements for one type of HHR at a time (e.g., (Laurence & Karnon, 2016; United States Health Resources and

Services Administration, 2017)); they can also be applied to multiple professions independently (e.g., (Crettenden, et al., 2014; Liu, Goryakin, Maeda, Bruckner, & Scheffler, 2017)). In contrast, multi-professional models integrate planning for more than one type of HHR into a single model such that estimates of supply and/or requirements for each type of HHR are dependent on the others (e.g., (Gallagher, Lim, & Harper, 2013; United Kingdom Centre for Workforce Intelligence, 2014).

HHR Planning vs. Strategic Human Resource Management

The processes of human resource planning – including but not limited to HHR planning – are inextricably linked with the processes of human resource management. Indeed, strategic human resource management is not possible without robust human resource planning (Schwind, Das, & Wagar, 2005, pp. 24-26; Lepak & Gowan, 2010, pp. 120-121).

These processes are similar in that, to be effective, both HR planning and strategic HR management should be founded in the objectives of an organization as well as broader societal goals (Schwind, Das, & Wagar, 2005, p. 25). They are different in that, where human resource planning "…systematically forecasts an organization's future demand for and supply of employees, and then matches supply with demand" (Schwind, Das, & Wagar, 2005, p. 110), strategic human resource management aims to maximize the effectiveness of an organization's employees (Schwind, Das, & Wagar, 2005, p. 25). In other words, the former involves specifying how many of what kind of personnel are required to perform which services, whereas the latter involves determining how best to

acquire and influence those personnel to provide those services as efficiently and effectively as possible.

Strategic HR management includes several processes that, while separate from HR planning, play a part in determining how many of what kind of HR an organization requires, and the degree to which the services provided by those HR meet organizational and societal objectives. These include:

- Job analysis and design (Schwind, Das, & Wagar, 2005, pp. 87-95; Lepak & Gowan, 2010, pp. 8-9)
- Maintaining compliance with employment legislation (Schwind, Das, & Wagar, 2005, p. 196)
    - Occupational health & safety (Schwind, Das, & Wagar, 2005, p. 579; Lepak & Gowan, 2010, p. 12)
- Recruitment (Schwind, Das, & Wagar, 2005, p. 237; Lepak & Gowan, 2010, p. 10)
- Hiring (Schwind, Das, & Wagar, 2005, p. 291; Lepak & Gowan, 2010, p. 10)
- Orientation, training, and development (Schwind, Das, & Wagar, 2005, pp. 343-344; Lepak & Gowan, 2010, p. 11)
- Performance appraisal and management (Schwind, Das, & Wagar, 2005, p. 376; Lepak & Gowan, 2010, p. 11)
- Compensation (Schwind, Das, & Wagar, 2005, p. 424; Lepak & Gowan, 2010, p. 12)
- Employee relations (Schwind, Das, & Wagar, 2005, p. 501)

- Union relations and collective agreements (Schwind, Das, & Wagar, 2005, p. 624)

HR planning and strategic HR management should complement and, ideally, mutually influence one another so that HR are deployed to maximum efficiency in meeting organizational and societal goals (Schwind, Das, & Wagar, 2005, p. 112).

Why a needs-based approach?

Of these different types, a needs-based approach is most appropriate for HHR planning in Canada – and was therefore chosen as the approach for this thesis – for several reasons. First, it is consistent with the overarching purpose of the Canadian health care system – that is, ensuring "medically necessary health care services provided on the basis of need, rather than the ability to pay." (Health Canada, 2012). The objective of addressing population health needs is shared by many countries' health care systems (Tomblin Murphy, Birch, MacKenzie, & Rigby, 2016). Supply-based approaches do not consider population health needs and thus do not reflect the purpose of health care in Canada.

Second, because needs-based approaches require explicit consideration of the degree to which supplies of HHR are aligned with the needs of the populations they serve, they directly facilitate consideration of potential inefficiencies in how these resources are being used. Because of their implicit assumptions that current HHR densities and levels of service provision are optimal, supply- and utilization-based approaches do not allow for the consideration of potential changes to these. Hence the

use of these approaches perpetuates and exacerbates any existing inefficiencies and inequities in how health care is being provided (World Health Organization, 1971; Lomas, Stoddart, & Barer, 1985; Birch, 1985; Birch, 1988; Birch & Chambers, 1993; Lavis & Birch, 1997) (Birch, et al., 2007; Evans R. , 2009; Lewis, 2013; Birch, Mason, Sutton, & Whittaker, 2013; Lopes, Almeida, & Almada-Lobo, 2015; Birch, Tomblin Murphy, MacKenzie, Whittaker, & Mason, 2017).

Proponents of utilization-based approaches have argued that these are more efficient than needs-based approaches because of instances where those who need care do not actually seek it (e.g., (Basu & Pak, 2015)). Accepting that such instances occur, using them to justify utilization-based approaches to health care planning ignores the purpose of health care systems such as Canada's (as outlined above). Further, utilization-based approaches are incompatible with health promotion efforts – such as those currently underway in Nova Scotia (Province of Nova Scotia, 2013) – to encourage increased use of health service among specific populations, including but not limited to those with mental health issues. This argument also ignores the inherent inefficiencies of utilization-based approaches, which are no less problematic. One example of such inefficiencies is supplier-induced demand, wherein health care providers increase service provision to increase revenues as opposed to in response to actual health needs (Van Doorslaer & Geurts, 1987; Birch, 1988; Schaafsma, 1994; Richardson & Peacock, 2006; van Dijk, et al., 2013; Shigeoka & Fushimi, 2014; Bogg, Diwan, Vora, & DeCosta, 2016; Meyer, 2016). Supplier-induced demand thus results in unjustified increases in health care expenditures. Avoiding such results is of concern in Canada, where recent public health

care expenditures have grown faster than the revenue streams that fund the public health care system (Canadian Institute for Health Information, 2012; Commission on the Reform of Ontario's Public Services, 2012; Canadian Institute for Health Information, 2017).

Third, the use of a needs-based approach is consistent with calls from multiple key health care stakeholder groups in Canada to better align health care system and HHR planning with population health needs. In a joint 1999 document, the Canadian Institute for Health Information, Health Canada, and Statistics Canada (CIHI, Health Canada, & Statistics Canada, 1999) laid out a roadmap for the country's health data to contribute to, "building a comprehensive national health information system and infrastructure to provide Canadians with the information they need to maintain and improve Canada's health system and the population's health." In another joint document, the Canadian Nurses Association and the Canadian Medical Association (CNA & CMA, 2005) identified a needs-based approach as the first core principle of health system planning, stating that, "Planners need to adopt a needs-based approach that anticipates the current and emerging health needs of the population that are determined by demographic, epidemiological, cultural and geographic factors." The first stated goal of Nova Scotia's HHR strategy (Nova Scotia Department of Health, 2005) is, "To improve Nova Scotia's capacity to plan for the optimal number, mix, and distribution of healthcare professionals based on system design, service delivery models and population health needs." Nunavut's Department of Health and Social Services described needs-based planning as being "absolutely consistent with its HHR strategy (Nunavut Health and Social Services, 2005).

Manitoba's HHR strategy (Manitoba Health, 2006) states that, "an effective HHR plan must take an approach based on population health needs." Ontario is already using a needs-based approach to plan for its physicians (HealthForce Ontario, 2008; Singh, et al., 2010). The Health Action Lobby, a coalition of more than 30 Canadian health and consumer associations and organizations, identified population needs-based planning as the first strategic direction that should be undertaken as part of a pan-Canadian Health Human Resources plan (Health Action Lobby, 2006). Health Canada's Federal/Provincial/Territorial Advisory Committee on Health Delivery and Human Resources noted that:

> "Jurisdictions across the country want to give all Canadians timely access to high quality, effective, patient-centered, safe health services. To do this, they need a collaborative approach that supports their individual efforts to plan and design health systems based on population health needs, and identify the HHR required to work within their service delivery models." (Advisory Committee on Health Delivery and Human Resources, 2007)

Saskatchewan's HHR strategy (Saskatchewan Ministry of Health, 2011) identifies "changing health needs in the population" as one of the factors that must be taken into account in HHR planning. British Columbia's Ministry of Health, which previously identified a needs-based approach as the basis for the HHR component of its pandemic planning (British Columbia Ministry of Health, 2012), stated in its overall HHR strategy that it is aiming to re-align the province's health professional education and training programs with the health needs of its population (British Columbia Ministry of Health,

2015). One of the strategic directions identified in Newfoundland and Labrador's health workforce plan (Government of Newfoundland and Labrador, 2015) refers to, "an efficient health and community services system designed to meet the health needs of the population," while one of the actions specified under that direction is to "identify and move towards optimal health team composition to meet the health needs of the population served."

Despite this growing consensus on the importance of using needs-based approaches to HHR planning among key Canadian stakeholder groups, only a few examples of the application of such approaches by Canadian health care system administrators exist (Cameron Health Strategies Group, 2009; MacKenzie, Birch, & Tomblin Murphy, 2012; Ono, Lafortune, & Schoenstein, 2013; Tomblin Murphy, Birch, MacKenzie, Bradish, & Elliott Rose, 2016). These include the models used by the Ontario Ministry of Health and Long-Term Care to inform planning for physicians (Singh, et al., 2010), and the models developed by Tomblin Murphy and colleagues for the Canadian Nurses Association (Tomblin Murphy, et al., 2006; Tomblin Murphy, et al., 2012), and for Nova Scotia's Department of Health and Wellness and Nunavut's Department of Health to inform planning for multiple professions (Tomblin Murphy, et al., 2009; Tomblin Murphy, et al., 2013).

Overview of existing needs-based HHR planning models

Needs-based approaches to health system and HHR planning are not new. Over 40 years ago the WHO, for example, outlined a history of them dating back to at least the

1930s in the United States (World Health Organization, 1971). They were also commonly used in former Soviet republics (Popov, 1971). Hall provided a more detailed description in a subsequent book published by the WHO (Hall T. , 1978), and specific examples of needs-based approaches to health care resource allocation were also described in the 1980s in the United States (GMENAC, 1980; Breegle & King, 1982) and the United Kingdom (Birch, 1985; Birch & Maynard, 1985) and in the 1990s in Canada (Eyles, Birch, Chambers, Hurley, & Hutchinson, 1991; Birch & Chambers, 1993; Birch, Eyles, & Newbold, 1996; Newbold, Eyles, Birch, & Spencer, 1998). Since that time, needs-based approaches to HHR planning have been described in additional developed and developing countries and applied to a wide range of professions and health conditions (MacKenzie, Elliott Rose, Tomblin Murphy, & Price, 2013; Tomblin Murphy, Birch, MacKenzie, Rigby, & Langley, 2017).

Multi-professional HHR planning models

Two recent reviews across OECD countries found that HHR planning is almost invariably done on a profession-specific basis, without integration into broader health system planning or across professions (Ono, Lafortune, & Schoenstein, 2013; Tomblin Murphy, Birch, MacKenzie, Bradish, & Elliott Rose, 2016). This is despite the fact that the increasingly complex nature of health care provision – particularly in the case of mental health – means that more and more individuals seeking care require the competencies of more than one type of health profession, and so some level of collaboration across these professions is increasingly required (Reeves, Lewin, Espin, &

Zwarenstein, 2010, p. 26; Curson, Dell, Wilson, Bosworth, & Baldauf, 2010; Jones, Bhanbhro, Grant, & Hood, 2013; Morgan, Pullon, & McKinlay, 2015; Klaasen, Bowman, & Komenda, 2016; Nova Scotia Health Authority, 2017). It is for this reason that a multi-professional approach was chosen for this thesis.

In Canada, there are only two HHR planning models in use by governments or health authorities that include any consideration of the impacts of different types of HHR on requirements. Alberta Health Services uses a model that allows for some substitution between licensed practical nurses and registered nurses (Bloom, Duckett, & Robertson, 2012), and Ontario's physician planning model estimates requirements for emergency room physicians based in part on the supply and referral patterns of primary care physicians (Singh, et al., 2010). In both cases, the models are restricted to the professional groups of nurses and physicians, respectively. The reasons for this dearth of examples of needs-based HHR planning by Canadian governments and health authorities contrasting with widespread calls for their use are not clear.

Multi-professional, needs-based HHR planning models have been developed for several contexts. Among the earliest of these was the health Need – service Target – Task – Productivity (NTTP) approach used by Kurowski and colleagues to plan for health workforces in Tanzania and Chad (Kurowski C. , Wyss, Abdulla, Yemadji, & Mills, 2003; Kurowski C. , Wyss, Abdulla, & Mills, 2007). In Australia, Andrews and the Tolkien II team developed a multi-professional needs-based approach to planning for mental health service (Andrews, 2007; Andrews & Titov, 2007). Subsequently Segal and colleagues, also in Australia, described multi-professional, needs-based planning for

several different health conditions, including mental health conditions in Australia (Segal, Dalziel, & Bolton, 2008; Segal & Leach, 2011; Segal, Leach, May, & Turnbull, 2013; Furber, et al., 2015). New Zealand's Ministry of Health has undertaken workforce service forecasts for several different types of its services (Gorman, 2015), including but not limited to youth health services (New Zealand Ministry of Health, 2011) and mental health and addictions services (New Zealand Ministry of Health, 2011), using this type of approach. Tomblin Murphy and colleagues have described the application of multi-professional, needs-based models to planning for older adults (Tomblin Murphy, et al., 2013) and for pandemic influenza (Tomblin Murphy, et al., 2013; Tomblin Murphy, Birch, MacKenzie, Rigby, & Langley, 2017) in Canada, and to planning for HIV/AIDS and malaria in Zambia (Goma, et al., 2014).

In recent years, more sophisticated utilization-and demand-based approaches have emerged that include measures of need as a determinant of HHR requirements and explicitly link HHR requirements to specific health care services. For example, Gallagher and colleagues have described dynamic, multi-professional approaches to planning for oral health at different jurisdictional levels within the United Kingdom (Gallagher, Kleinman, & Harper, 2010; Gallagher, Lim, & Harper, 2013). Aside from the model being used in the present study, the model described by Gallagher and colleagues appears to be the only dynamic, multi-professional HHR planning model that explicitly links specific service requirements to HHR requirements and incorporates measures of population health needs in doing so (MacKenzie, Elliott Rose, Tomblin Murphy, & Price, 2013; Ono, Lafortune, & Schoenstein, 2013; Tomblin Murphy, Birch, MacKenzie,

Bradish, & Elliott Rose, 2016). It differs from the model used in the present study in three main ways. First, it estimates health service utilization instead of health service needs, although it could produce results consistent with a needs-based approach by assuming 100% attendance. Second, its application to date appears to have been restricted to types of HHR that practice exclusively within a single specialty area – oral health. Third, it does not distinguish between different determinants of HHR supply such as training and migration, instead assuming constant rates of in- and out-flow from the existing HHR stock based on regression analyses of historical data.

More recently, Dall and colleagues have described a dynamic model to estimate demand for physician services in the United States that explicitly incorporates not only measures of population health but also measures of risks to health (Dall, West, Chakrabarti, & Iacobucci, 2015; Dall, Chakrabarti, Iacobucci, Hansari, & West, 2017) - very few HHR planning models include both these types of parameters (Tomblin Murphy, Birch, MacKenzie, Bradish, & Elliott Rose, 2016). It also integrates planning for different types of physicians into a single model. It differs from the model used in the present study by being demand- as opposed to needs-based, incorporating risks to health in addition to health status in estimating HHR requirements, and being restricted to planning for physicians.

Needs-based HHR planning in mental health

Several studies have explicitly incorporated measures of population health care needs to planning for mental health, some of which have done so in a manner that

simultaneously considers the roles of more than one type of HHR. The United States Graduate Medical Education National Advisory Committee (GMENAC) used data on trends in the incidence and prevalence of mental illness in estimating future requirements for psychiatrists in the country (GMENAC, 1980). More specifically, the Committee estimated psychiatrist requirements based on the number of people to be provided with psychiatry services, the amount of those services to be provided per patient, and the rate at which psychiatrists are expected to perform those services. The Committee defined the first of those parameters as the number of people expected to seek psychiatric care (given that they had some mental illness) as opposed to the number of people actually needing psychiatric treatment, and as such its approach is more demand- than needs-based. Further, the number and type of psychiatric services to be provided to address mental illness appear to have been identified based on professional opinions; the degree to which these were supported by evidence of these services' appropriateness and effectiveness is not clear.

More recent American work described an approach to estimating requirements for psychiatrists in a hypothetical population in the United States which they describe as being very similar to that used by the GMENAC in that it estimates psychiatrist requirements based on the number of people to be provided with psychiatry services, the amount of those services to be provided per patient, and the rate at which psychiatrists are expected to perform those services (Faulkner & Goldman, 1997; Faulkner, 2003). Unlike the GMENAC approach, however, this more recent method is entirely needs-based, explicitly considers treatments supported by research evidence, and does not consider

potential changes in planning parameters over time. Because it is entirely theoretical and has not been applied to any actual population, its value to informing HHR planning for mental health remains untested. Further, like the GMENAC approach, it applies only to psychiatrists.

Lund and colleagues described an approach to estimating the services and human resources needed to care for people with severe psychiatric conditions in a hypothetical population of 100,000 people in South Africa (Lund, Flisher, Lee, Porteus, & Robertson, 2000). This was done based on estimates of the incidence and prevalence of these conditions in South Africa, target numbers of facility visits per patient, and historical data on numbers of patients seen per provider. Although the analysis included nurses, physicians, and different types of allied health care providers, the division of services amongst these professions appears to have been implicitly fixed based on existing practices and did not consider the potential implications of alternative service models on HHR requirements. Further, the model did not have any dynamic capacity.

Also in the United States, Thomas, Konrad and colleagues used a needs-based approach to estimate shortages of mental health professionals across the country at the county level (Konrad, Ellis, Thomas, Holzer, & Morrissey, 2009; Thomas, Ellis, Konrad, Holzer, & Morrissey, 2009; Thomas, Ellis, Konrad, & Morrissey, 2012). They estimated the prevalence of need for mental health care based on population surveys, and specified the service requirements associated with that need based on existing levels of service provision. They also considered multiple health professions in their analyses, distinguishing between two groups: prescribers (including psychiatrists, family

physicians, and general practitioners) and non-prescribers (mental health nurses, social workers, psychologists, and any other mental health professions for which prescribing medication is outside their scope of practice). The authors' model is static as opposed to dynamic – it estimates shortages at a single point in time and does not consider flows in and out of the supply of mental health professionals, nor does it consider the potential for changes to any parameters over time.

Scheffler, Bruckner and colleagues have published a need-based approach to estimating supply and requirements for the mental health workforce which they have applied to developing countries. This model does not explicitly differentiate between the services provided by different professions – instead, staff mix ratios are fixed based on published literature and expert consultation (Bruckner, et al., 2011; Scheffler, et al., 2011). This means their approach cannot directly consider the HHR implications of differences in scopes of practice across professions, future changes in these scopes, or service-specific changes in care delivery models. Like the models used by Faulkner and by Thomas, Konrad et al., this model is also static, and as such does not allow planners to dynamically test the potential impacts of HHR planning strategies over time.

Burke and colleagues estimated the number of behavioural health professionals required to address the behavioural health needs of underserved and newly insured Americans aged 12 and over in 2010 (Burke, et al., 2013). The authors used population-based survey data to estimate health status. They assumed historical utilization patterns reflected appropriate levels of service provision and used current rates of visits per FTE as productivity estimates. Like Thomas, Konrad, and colleagues, the authors grouped all

behavioural health care providers into two categories, in this case according to whether they were licensed professions (e.g., psychologists, social workers) or not (e.g., counselors, support workers). Like the models used by Faulkner, by Thomas, Konrad, et al., and by Scheffler, Bruckner and colleagues, this model lacks dynamic planning capacity.

Most recently, Furber and colleagues described an integrated needs-based approach to estimating workforce and service requirements pertaining to mental illness in Australia (Furber, et al., 2015). Although directly based on population health needs and applied across multiple professional groups, this approach lacks dynamic planning capacity, and to date there is no evidence of its actual application. The focus of their application is on prevention of mental illness as opposed to a broader range of service needs that also includes treatment. The consideration of treatment services, in addition to prevention, is imperative in the case of mental health for several reasons. First, people suffering from them – including children – often wait years before seeking or receiving any services, at which point prevention is often precluded (Kirby & Keon, 2006; Wang, et al., 2007; Kutcher & McLuckie, 2010; de Girolamo, Dagani, Purcell, Cocchi, & McGorry, 2012). Second, adequate prevention services are often unavailable (Wang, Demler, & Kessler, 2002; Mental Health Commission of Canada, 2012). Third, even those who a) seek and b) receive some care often fail, for any number of reasons, to adhere to their treatment (Nosé, Barbui, & Tansella, 2003; Soery, Papakostas, & Trivedi, 2006; Lipman, Kenny, & Marziali, 2011; Lalla & Arshoff, 2013).

Measures of anxiety and depression in children and adolescents

Measuring health care needs

The main challenges associated with needs-based approaches to HHR and health systems planning have to do with defining the need for health care among the population to be served and obtaining data that adequately capture that need (Hall T. , 1978; Birch & Chambers, 1993; O'Brien-Pallas, et al., 2001; Dreesch, et al., 2005). Defining the need for health care is a challenge for several reasons (Culyer & Wagstaff, 1993; Culyer A. , 1995; Culyer A. , 1998), perhaps the most immediate of which is that perceptions of such needs vary from person to person (Acheson, 1978) – including, frequently, between health care providers and their clients (Donabedian, 1973, pp. 62-64; Gifford, Franaszek, & Gibson, 1980; Hurt, DeHart, Allison, & Whitely, 1996; Little, et al., 2004; Bowling, et al., 2012), including mental health needs (Cleary, Freeman, Hunt, & Walter, 2006; Nolte, et al., 2016). In the case of pediatric mental health care, differences between patients' and their parents' perceptions of need present an additional challenge to arriving at agreement on what services should be provided (Roberts, Alegria, Roberts, & Chen, 2005; Williams, Lindsay, & Joe, 2011).

Different approaches to defining need also exist among academics who make it a focus of their research. For example, Donabedian's groupings of need are defined in terms of the degree of impact on an individual's life, regardless of whether any means of addressing that impact is known to exist (Donabedian, 1973, p. 73). In contrast, Culyer and Wagstaff specify that a) some effective means of addressing a particular health problem or condition exist for the latter to be considered a health care need, and b) that,

where multiple treatment options exist, only the most cost-effective of these can be 'needed' (Culyer & Wagstaff, 1993; Culyer A. , 1995; Culyer A. , 1998). Similarly, Birch and colleagues describe health care needs in terms of the expected impact of that care on health status, and distinguish between needs for health care and needs for health improvement (Birch & Chambers, 1993; Birch, Eyles, Hurley, Hutchinson, & Chambers, 1993; Eyles & Birch, 1995). Both of these conceptualizations of need are useful for different planning purposes. The former is most relevant from an individual or patient perspective, and is important, for example, for identifying debilitating health conditions for which effective treatments are yet to be identified or developed and guiding health research programs accordingly. The latter is more important for determining how best to utilize existing health care resources, including – but not limited to – as part of HHR planning.

In addition to distinguishing between different conceptualizations of need, it is also necessary to distinguish health care need from the demand for and from the utilization of health care. Although many HHR planning approaches continue to confuse these terms, others have understood and repeatedly explained how these are distinct concepts, none of which can be considered to be a proxy for the other (Tomblin Murphy, Birch, MacKenzie, Bradish, & Elliott Rose, 2016). In contrast to health care need as defined above, demand in this context refers to the health care a person or population is willing and able to purchase, which may or may not be driven by need. Demand exceeds need in cases where a person or population may have no health problems, or none for which an effective treatment is available, but is nonetheless willing and able to pay for

some health care service; an example would be a patient who demands an antibiotic prescription to treat a viral infection. Need exceeds demand when a person or population has health problems for which effective treatments exist but is not willing and/or able, for any of a myriad of reasons, to obtain those treatments. As outlined above, this is a common occurrence for people with mental health problems in Canada (Kutcher & McLuckie, 2010). Utilization is the intersection of supply and demand, and overlaps need only insofar as both the services available (supply) and sought (demand) are determined by need as opposed to other factors (Hall T. , 1978; Birch, 1985; Markham & Birch, 1997; Birch, et al., 2007).

General measures of needs for mental health care

There are several methods for measuring mental health generally – and anxiety and depression specifically – among children and adolescents at the population level. These include measures based on individuals' own reports and those based on clinicians' assessments. There are advantages and disadvantages to using each of these types of measures for HHR planning purposes.

The simplest self-reported measures of general mental health include single questions that ask respondents, for example, to rate their mental health on five-point Likert scales, or how many days during the past month they felt that their mental health was good. More complex examples include the General Health Questionnaire (Goldberg & Blackwell, 1970; Banks, 1983), the mental health components of the Short Form-12 and Short Form-36 (SF-12 or SF-36) questionnaires (Jenkinson & Layte, 1997;

Jenkinson, 1998), the emotion component of the Health Utilities Index (Eiser & Morse, 2001), and the World Health Organization's Well-Being Index (Topp, Østergaard, Søndergaard, & Bech, 2015). While such general measures have value for understanding a population's general mental health and for monitoring it over time, because they do not measure specific health conditions, they do not lend themselves to planning for specific health care services beyond some initial assessment. Fortunately, decades of research have produced a large and growing number of valid and reliable measures of various aspects of health status that can be readily administered using self-assessments (McDowell & Newell, 2006, pp. 11-12), including measures of anxiety and depression.

Self-reported measures of anxiety and depression

Multiple widely-used self-report-based instruments for measuring depression in individuals have been developed, for example the Hamilton Rating Scale for Depression (Hamilton, 1960), the Beck Depression Inventory (Beck, Ward, Mendelson, Mock, & Erbaugh, 1961), the Zung Self-Rating Depression Scale (Zung, Richards, & Short, 1965), the Center for Epidemiologic Studies Depression (CES-D) Scale (Sawyer Radloff, 1977), the Montgomery Äsberg Depression Rating Scale (Montgomery & Äsberg, 1979), the Major Depression Inventory (Bech, Rasmussen, Olsen, Noerholm, & Abildgaard, 2001), the Kutcher Adolescent Depression Scale (Brooks, Krulewicz, & Kutcher, 2003), and the Symptom Checklist-Core Depression Scale (Magnusson Hanson, et al., 2014). Examples of available tools for measuring anxiety based on self-reported information include the Taylor Manifest Anxiety Scale (Taylor, 1953), the Hamilton Anxiety Rating Scale

(Hamilton, 1959), the Zung Self-Rating Anxiety Scale (Zung W. , 1971), the Beck Anxiety Inventory (Beck, Epstein, & Brown, 1988), the State-Trait Anxiety Inventory for Children (Carey, Faulstich, & Carey, 1994), Spence's Children's Anxiety Scale (Spence, 1998), and the Screen for Child Anxiety Related Emotional Disorders (Wren, Bridge, & Birmaher, 2004). Tools also exist for measuring both anxiety and depression together based on self-reported data, including the Hospital Anxiety and Depression Scale (Zigmond & Snaith, 1983); Depression Anxiety Stress Scales-21 (Henry & Crawford, 2005); and the Patient-Reported Outcome Measurement Information System (PROMIS) anxiety & depression short forms (Pilkonis, et al., 2011).

A key advantage of self-reported measures such as these is that they can be administered across large representative samples of the population through surveys. This method of data collection can incorporate the perspectives of individuals who, for any of a variety of reasons (e.g., accessibility issues), may not be included in measures drawn from administrative databases or clinicians' charts. They also provide insight into quality of life issues which are often less apparent through clinician assessments or diagnostic codes, and do not require physically invasive procedures or expensive laboratory analyses. However, although each of these instruments has been found to have value in identifying and monitoring changes in illness over time at the individual level, the evidence of their appropriateness for children and adolescents is mixed, and their large and growing number of them has been described as complicating rather than simplifying the identification and treatment of these conditions (Brooks & Kutcher, 2001; Brooks & Kutcher, 2003; Han, 2009; Choi, Mayerk, Williams, & Gatchel, 2014). The scoring

algorithms for several of these parameters are proprietary, presenting an additional hurdle to their adoption by health system planners.

Clinician-administered measures of anxiety and depression

Clinician-administered instruments for measuring anxiety and depression are relevant for planning purposes because, in addition to measuring the severity of these conditions, they tend to be explicitly linked to specific clinical interventions and treatment paths according globally-recognized diagnostic categories, including the Diagnostics and Statistical Manual (DSM) of Mental Disorders and the International Classification of Diseases (ICD). Perhaps the most common of these are based on either the Structured Clinical Interview for the DSM (SCID) and the WHO's Comprehensive International Diagnostic Interview (CIDI). While the former of these two, as its name suggests, is linked specifically to the DSM, the latter was developed to also be consistent with the ICD.

For the purposes of HHR and health system planning, a disadvantage of clinician-administered measurement tools is that their applications are inherently limited to those individuals who are willing and able to access the services of relevant clinicians. As such, estimates of the incidence and prevalence of any particular health condition – including anxiety and depression – based on clinician-administered measures will likely underestimate their true values. This limitation can be overcome by applying clinician-administered measures at the population level, for example through a large population health survey. For example, the 2002 and 2012 iterations of the Canadian Community

Health Survey used the CIDI as part of its measures of mental health (Pearson, Janz, & Ali, 2015).

Models of service delivery to address pediatric anxiety and/or depression

Treatment models

Treatment models for anxiety and depression in children and adolescents have been the subjects of large amounts of scientific research. Mental health stakeholder organizations such as the Canadian Psychiatric Association (CPA), the American Academy of Child & Adolescent Psychiatry (AACAP), and the Royal College of Psychiatrists (RCP) in the United Kingdom periodically review this evidence to produce treatment guidelines. The CPA's guidelines for depression have not been updated since 2001, and its guidelines for anxiety have not been updated since 2006; both documents are described by the CPA as historical reference documents only. Similarly, the AACAP's practice parameters for both conditions have not been updated since 2007 and are flagged as not being current.

In 2016, the Journal of the Canadian Academy of Child and Adolescent Psychiatry (CACAP) published an updated position paper on the use of specific types of medications in treating anxiety disorders and major depressive disorder among children and adolescents (Garland, Kutcher, Virani, & Elbe, 2016); the paper was "not intended to be a comprehensive review of the treatment options for anxiety and depression in children and adolescents." Also in 2016, the Canadian Pediatric Society reaffirmed its position statement (Korczak, 2013) on the use of selective serotonin reuptake inhibitors

in the treatment anxiety disorders or depression in children and adolescents. Like the CACAP position paper, this document did not provide guidance on the treatment of these conditions more broadly.

The RCP collaborates with the British Psychological Society through the National Collaborating Centre for Mental Health to produce mental health-related clinical guidelines for the National Institute for Health and Clinical Excellence (NICE). The NICE guidelines pertaining to depression in children and young people (National Collaborating Centre for Mental Health, 2015) were most recently updated in 2015. The guidelines first call for an initial assessment to determine the acuity of each patient's depression. For patients with mild depression, the guidelines suggest a 2- to 3-month course of individual or group cognitive behavioural therapy (CBT), or guided self-help. For patients with moderate to severe depression, the guidelines suggest a specific psychological therapy (individual CBT, interpersonal therapy, family therapy, or psychodynamic psychotherapy). If this is not found to be effective after four to six sessions over a three-month period, the guidelines recommend trying a different type of therapy for another four to six sessions. If this second therapy is found not to be effective, the guidelines suggest prescribing medication in addition to the psychotherapy treatments, and to try this combination for six more sessions before considering further alternate therapies or medications. For patients with a high risk of attempting suicide, high risk of serious self-harm or high risk of self-neglect, the guidelines suggest more intensive treatment, which may be most readily available through admission to an inpatient facility. In such instances patients should be provided with individual or group

therapy, family support, education, recreation, and medication until they are no longer deemed to be high-risk, at which point the less intensive therapies described above would be used. The NICE guidelines for depression do not specify the length of the therapy sessions it describes. As of March 2019 there are no NICE guidelines pertaining to anxiety in children or adolescents.

The Anxiety Disorders Association of Canada (ADAC) last published clinical practice guidelines for the management of anxiety disorders, with special considerations for children and adolescents, in 2014 (Katzman, et al., 2014). These guidelines suggest weekly psychotherapy sessions for 12-20 weeks, then a further assessment 4 weeks later, followed by additional sessions every 2-3 months for up to 2 years. Medication may be prescribed in conjunction with psychotherapy. Like NICE, ADAC does not specify a length for psychotherapy sessions. Further, the ADAC guidelines also specifically consider comorbid anxiety and depression, noting that patients with both conditions are likely to have more acute symptoms, and that antidepressants have been found to be effective in treating patients with comorbid anxiety and depression. However, this evidence is not specific to children and adolescents; the guidelines note that while some medications have been found to be effective in treating these conditions among children and adolescents, their use is recommended only when psychotherapies are found to be ineffective, only under close supervision, and only in conjunction with continued psychotherapy (Katzman, et al., 2014).

At the global level, the World Health Organization (WHO)'s mental health gap action programme includes a management protocol and psychosocial interventions for

several child and adolescent mental and behavioural disorders, including emotional disorders such as anxiety and depression as a group (World Health Organization, 2016). The protocol and interventions are broader in the range of potential services and interventions they include than either the NICE or ADAC protocols, however they are not specific to either anxiety or depression.

The protocol first provides guidance on the distinguishing emotional disorders from other mental health issues such as conduct disorders. It then suggests an assessment of the home and/or school environment(s) by way of specific types of questions for the child or adolescent, with the option that these be posed without parents present. For children and adolescents with emotional disorders, in addition to behavioural and/or psychological interventions such as those outlined in the NICE and ADAC protocols, the mhGAP protocol recommends guidance and education for patients and carers regarding child or adolescent well-being and the assessment and management of stressors; support for carers such as parental skills training; and strengthening social supports by liaising with teachers and other school staff and connecting the family with relevant community resources. The protocol advises against the use of any pharmacological interventions for children younger than 12 years. For older children, the protocol indicates that the only medication that should be considered is Fluoxetine, only in consultation with a specialist, and only if the other steps suggested in the protocol are not successful. This protocol is not specific as to the frequency or duration of visits (World Health Organization, 2016).

Prevention models

Hundreds of models for the prevention of anxiety and depression among children and adolescents have been developed and published in the clinical and academic literature. These were the subject of a recent meta-analysis and systematic review of reviews which classified these interventions according to their scope, methods, setting, duration, and the personnel involved (Stockings, et al., 2016). 'Universal' interventions are those applied across a given population (e.g., an entire school), interventions targeted only at children and adolescents at increased risk of anxiety and/or depression (e.g., those known to have been exposed to trauma), and indicated interventions for children and adolescents exhibiting potential symptoms of either conditions. Most of the prevention models included in their review utilized psychological interventions such as CBT. Other approaches were based on educational interventions such as videos or pamphlets, or physical interventions such as group exercise or team sports. Several models used some combination of psychological, educational, and/or physical interventions. The vast majority of the models reviewed were administered in school settings, with a few in other community-based settings such as clinics or individuals' homes. Some were also delivered online. The mean duration of these interventions was just under 20 days. Most of included models were delivered by clinicians (usually psychologists), with a small minority being provided by school counselors or other specially trained school employees (Stockings, et al., 2016).

A wide range of these models have been shown to be effective individually, and the review and meta-analysis by Stockings et al. suggest that, for the prevention of

anxiety and depression, universal models based on psychological interventions are supported by the most evidence. However, they also indicate that that targeted and indicated models based on either a) combined psychological and educational or b) physical interventions have been found to be effective, although these have not been subjected to as much study as universal models. The analysis also suggested that universal models were more effective if delivered by teachers or other trained school staff than by clinicians or researchers. Neither the exposure time of the interventions nor their setting (e.g., in school vs. at home or online) were found to be significant predictors of the models' effectiveness (Stockings, et al., 2016).

Factors Affecting Choice of HHR Planning Models

The existing empirical research on this topic pertains to factors affecting the use of evidence in health services planning and policy broadly as opposed to what determines the use of HHR planning models specifically. The former issue – including but not limited to the so-called 'evidence-policy gap' – is the focus of a large and growing body of research, particularly in the fields of implementation science and knowledge translation research. Factors frequently identified as contributing to this gap include: a lack of alignment between the research priorities of governments, academics, and funders; inaccessibility of scientific evidence; competing demands for policy-makers' time and attention; personal, jurisdictional, and temporal variation in policy-making processes; differing timeframes of the research and policy processes; differing levels of comfort with scientific uncertainty; a lack of engagement of policy-makers,

administrators and clinicians in the research process; and differing views between researchers and policy-makers on what types of evidence are most important and compelling for informing policy (Lavis, et al., 2002; World Health Organization, 2008; Straus, Tetroe, & Graham, 2009; Lomas & Brown, 2009; Orton, Lloyd-Williams, Taylor-Robinson, O'Flaherty, & Capewell, 2011; Oliver, Lorenc, & Innvær, 2014; Andermann, Pang, Newton, Davis, & Panisset, 2016; Cairney & Oliver, 2017).

Opinions and specific experiences as to political factors influencing the use of particular HHR planning approaches have been presented in several works. In separate chapters of the WHO's seminal text on HHR planning, different contributing authors identify several of these factors. Tejada-de-Rivero notes that the strong vested interests of firmly established stakeholder groups – such as those representing health care professionals – can result in the needs of the health care system itself taking priority over the needs of the people it is meant to serve (Tejada-de-Rivero, 1978). Mejía and Fülöp go into further detail in identifying political factors as influencing the approach to – and impact of – HHR planning within jurisdictions (Mejía & Fülöp, 1978). These include:

- Leadership readiness for and commitment to change;
- The degree to which legislation enables HHR planning and implementation;
- The administrative and diplomatic capacities of HHR planners to develop sufficiently robust plans and encourage various stakeholder groups "to subordinate to the greatest degree possible their own individual preferences and their own parochial interests";
- The dominant position of physicians in the health care system;

- The intrinsic complexity of the health sector;
- Strong professional traditions that emphasizes individual and institutional autonomy over an integrated team approach to providing care;
- Distrust of planning and of planned change;
- Performance in implementing any prior HHR plans; and
- Inter-agency and intersectoral consultation (Mejía & Fülöp, 1978).

Later in the same text, Hall adds that the choice of model(s) to be used in HHR planning will depend on the degree to which different models are consistent with the planners' view of how the health care system operates, and on the type of role the planner expects to play in that operation (Hall T. , 1978). More specifically, in his view need- and service target-based approaches, "are appropriate when health authorities can and intend to take an active role in shaping future sectoral developments, while [demand- or utilization-based] methods are more suited for anticipating future developments without necessarily seeking to modify them significantly." Finally, Hall and Kleczkowski add the following factors as influencing the choice of HHR planning methods:

- The political structure (e.g., federal vs. unitary government; number, nature, and relative popularity of political parties) of the jurisdiction in which planning is to be conducted;
- The degree to which planning and political processes are integrated as opposed to operating separately, and the clarity of the respective scope and functions of these processes;

- The respective capacities and competencies of health care planners, policy-makers, and administrators;
- The degree to which government takes responsibility for the health of its citizens;
- The societal balance between individualism (e.g., as found many western countries) and collectivism (e.g., as found in China);
- The degree to which all citizens expect and are entitled to the same level of service from the health care system (as opposed to barriers existing due to, for example, ability to pay or travel required); and
- The openness and effectiveness of communication structures within the broader political system and, as such, the degree to which community needs can be voiced, innovation supported, and stakeholder concerns articulated (Hall & Kleczkowski, 1978).

Several of the factors identified in this text are also identified by various authors writing more recently. Multiple authors have consistently identified the existing, deeply entrenched practices, interests, and expectations of the various health professions – manifested through educational institutions, unions, professional associations, and regulatory bodies – as being the main determinants of how HHR (and health services) planning is conducted in Canada and the United Kingdom. They each draw particular attention to the dominant position of physicians across these various hierarchies (Lomas, Stoddart, & Barer, 1985; Adams, 1992; Evans R. , 1998; Lewis, 1998; Evans R. , 2009; Lewis, 2013; Birch, Mason, Sutton, & Whittaker, 2013). Birch, Tomblin Murphy, and colleagues have also repeatedly noted how approaches to HHR planning in Canada and

other countries appear to have been driven to a large degree by the availability of data as opposed to the objectives of the health care systems in question (Lavis & Birch, 1997; Birch, O'Brien-Pallas, Alksnis, Tomblin Murphy, & Thomson, 2003) (Birch, et al., 2007; Tomblin Murphy, et al., 2012; Birch, Tomblin Murphy, MacKenzie, & Cumming, 2015; Tomblin Murphy, Birch, MacKenzie, Bradish, & Elliott Rose, 2016).

The remaining evidence on the factors affecting the choice of HHR planning models takes the form of case reports, most of which have been written by HHR planners themselves. These present reports on planning models in Canada, the United Kingdom, Australia, the Netherlands, New Zealand, and Germany.

Bloom and colleagues identified several factors that determined the approach used by Alberta Health Services in planning its nursing workforce (Bloom, Duckett, & Robertson, 2012). These included values of the organization responsible for planning, the responsibility of the organization for planning care delivery (contrasted against that of the Ministry of Health, which had no such responsibility), and the strength (or lack thereof) of relationships between the organization and key partners such as the government ministry responsible for post-secondary education and training and with the institutions responsible for that training.

The United Kingdom's Centre for Workforce Intelligence (CfWI) explained its rationale for choosing its HHR modeling approach in one of its earliest reports (United Kingdom Centre for Workforce Intelligence, 2012). These included the degree to which it supported articulation of specific policy scenarios, lent itself to the CfWI's stakeholder engagement methods such as Delphi processes, provided a clear logical separation of key

planning parameters, and supports the modeling of changes to these parameters over time.

McCarty, Crettenden and colleagues devote two papers to describing the establishment of Health Workforce Australia (HWA), "the national agency to progress health workforce reform to address the challenges of providing a skilled, innovative and flexible health workforce in Australia" (McCarty & Fenech, 2012; Crettenden, et al., 2014). The papers provide little information on why the specific methods used by HWA were adopted; the three factors mentioned are the restriction of HWA's mandate to planning for midwives, nurses, and physicians; the degree to which assumptions could be clearly articulated; and the availability of data.

Van Greuningen and colleagues have published two papers on the Netherlands' approach to HHR planning for physicians. In these, the only information provided on the reasons for adopting that particular approach are that it provides a basis for specifying the number and generalist/specialist mix of enrollments in medical schools (Van Greuningen, Batenburg, & Van der Velden, 2012), and that the accuracy of future supply and demand projections is a central factor in how the 'success' of this model is viewed by local planners (Van Greuningen, Batenburg, & Van der Velden, 2013).

Health Workforce New Zealand developed its Workforce Service Forecast program to allow it to account for several anticipated changes in how health care is expected to be delivered in the country in the future (Gorman, 2015). These included 1) new and changing roles for various types of HHR; 2) a shift in service emphasis toward community-based delivery and models of prevention, rehabilitation, and self-care; and 3)

increasing use of technological resources such as telemedicine (New Zealand Ministry of Health, 2014). More broadly, this approach was chosen to facilitate the engagement of key stakeholders in articulating the future of the country's health workforce, and to allow for workforce requirements to be determined by population health needs and the associated service requirements (Naccarella, Greenstock, & Wraight, 2013).

More recently, Kuhlmann and colleagues described the labour market monitoring process used by the German state of Rhineland-Palatinate to inform its HHR planning for nurses, therapists, and allied health professions (Kuhlman, Lauxen, & Larsen, 2016). The paper provides no information on why this approach was chosen aside from noting that it is based on three pillars: data collection, communication with key stakeholders, and decision-making.

Nova Scotia's Context

In Nova Scotia, both the Nova Scotia Health Authority (NSHA) and the IWK Health Centre have identified the Choice and Partnership Approach (CAPA) as the service delivery model for child and adolescent health services (Courey, Hodder, & MacNeil, 2017). CAPA was developed in the United Kingdom and has been implemented across child and adult mental health and addictions program areas in parts of Europe, Australia, New Zealand and Canada (United Kingdom Child and Adolescent Mental Health Services, 2017). The CAPA model begins with a 'choice' appointment, during which the client and their family work with clinicians in articulating the problem(s) to be addressed along with associated measurable and achievable treatment

goals. They also develop a care plan for reaching those goals. Clients and families are matched to clinicians with competencies relevant to their goals of treatment, and an open clinic booking system is used to allow clients and their families to leave Choice appointments with a booked second visit referred to as a 'Core Partnership' appointment. At these and subsequent appointments, a range of intensities and complexities of interventions are offered through Core (the majority of services) and Specific work (treatments that are of a longer or shorter duration or require a particularly unique skill set). Clients and families also work with clinicians to determine the steps to be taken to allow for transition to other levels of care, including self-management (United Kingdom Child and Adolescent Mental Health Services, 2017).

Unlike the clinical practice guidelines discussed above, CAPA does not mandate a specific number or type of services to be offered to address specific mental health issues – instead these are determined on a case-by-case basis by clients, their families, and clinicians working in partnership. Further, a 2016 implementation of CAPA by different child and adolescent mental health providers with both the IWK and NSHA has varied widely, and the province overall is estimated to be in low partial compliance with the CAPA model (Nova Scotia CAPA Evaluation Working Group, 2016). More broadly, the provincial Auditor General reported that, at least as of November 2017, Nova Scotia lacks a provincial plan for the delivery of mental health services – including but not limited to those for children and adolescents (Auditor General of Nova Scotia, 2017). Considerable effort is being undertaken to move toward consistent practices and models of care generally and those pertaining to mental health specifically – therefore ongoing

changes to existing practices are likely in the future (Province of Nova Scotia, 2016; Nova Scotia Department of Health and Wellness, 2017).

In the meantime, there is no system-level documentation detailing how pediatric mental health services are currently provided in Nova Scotia. A recent report by the province's Mental Health and Addictions Health Services Planning Advisory Committee noted widespread variation in the volumes, types, and mechanisms of mental health service provision across the province (Courey, Hodder, & MacNeil, 2017).

The only data collected system-wide on these services include physician billings and hospital discharge records, which do not capture all the services that actually transpire in these settings; for example, billing records do not specify what type(s) of psychotherapy are provided by physicians. Further, most of the province's mental health services are delivered outside acute care settings by non-physicians. As such, there is no comprehensive source of information on the frequency with which most mental health services are delivered to Nova Scotia's children, or on the respective roles of different types of HHR in delivering these services.

Summary of relevant knowledge gaps

The number and variety of modeling tools to inform HHR planning are large and growing. However, most widely-used tools do not allow planners to directly consider potential changes in population health needs, nor do they allow for planning across multiple professions simultaneously (including but not limited to potential substitution of service provision across professions) (Ono, Lafortune, & Schoenstein, 2013; Tomblin

Murphy, Birch, MacKenzie, Bradish, & Elliott Rose, 2016). The political and technical factors perceived to affect the approaches taken by various jurisdictions to HHR planning are discussed with some frequency in the scientific literature (e.g., (Crettenden, et al., 2014)), but these have not been investigated empirically.

Advancements in methods of measuring various aspects of health status – including mental health status – at the population level have made it easier for planners to assess a population's need for services, although these are still often reliant on clinician assessments (McDowell & Newell, 2006). Despite service guidelines often being outdated, an expanding base of evidence on the most appropriate prevention and treatment methods for different types of health problems (e.g. (Stockings, et al., 2016)) provides planners and clinicians with a range of options for addressing the health care needs of people with those conditions.

The way mental health services for children and adolescents in Nova Scotia are currently delivered is highly variable – depending, for example, on historical norms, the preferences of individual clinicians and/or patients and families, and the local availability of resources – and undergoing a transformational change (Courey, Hodder, & MacNeil, 2017). The province's HHR plan (Nova Scotia Department of Health, 2005) does not reflect that change, and the planning model the province uses for its physician workforce (Social Sector Metrics Inc., Health Intelligence Inc., 2012) lacks the capacity to account for that change. More broadly, the province is seeking to move toward an HHR planning process that is more directly integrated with its health services planning processes and is multi-professional in scope.

These advancements, in combination, underscore the need for HHR planning tools that a) explicitly account for the health needs of the population to be served, b) consider the interdependence of different types of HHR, and c) allow for the direct consideration of potential future changes to key planning parameters on both the supply and requirements sides. None of the HHR planning models applied by governments or health authorities in Nova Scotia meets each of these criteria. In addition, there is a distinct gap in empirical knowledge as to the factors that may support or hinder the potential use of such tools by HHR planners. The objectives of this thesis – to use a dynamic, multi-professional, needs-based simulation model to estimate the supply of and requirements for HHR to address anxiety and depression among school-aged children in Nova Scotia, and to identify the political and technical factors affecting the choice of model by HHR planners in the province – have been formulated to address these gaps.

CHAPTER 3: METHODS

Overview

This chapter describes the methods used in achieving the aim of this thesis, namely assessing the feasibility of using a dynamic, multi-professional, needs-based simulation model to inform HHR planning for anxiety and depression among school-aged children in Nova Scotia. First, the study design is described, followed by the conceptual framework underpinning it. Next, the quantitative methods used to achieve the first objective of this thesis – estimating HHR supply and requirements – are described. The qualitative methods used to achieve the second objective – identifying the technical and political factors affecting the potential uptake of the model – are described next. Finally, the limitations of the study are itemized.

Study Design

HHR planning involves both technical and political processes (Mejía & Fülöp, 1978; Tomblin Murphy, et al., 2012; Birch, Mason, Sutton, & Whittaker, 2013; Birch, Tomblin Murphy, MacKenzie, & Cumming, 2015; Tomblin Murphy, Birch, MacKenzie, Rigby, & Purkis, 2017) and cannot be understood using a single type of data. Assessing the feasibility of applying an approach to HHR planning in Nova Scotia therefore requires the analysis of both qualitative and quantitative data. A concurrent mixed-methods study design was therefore employed to allow for a more compete and synergistic utilization of different types of data than would be possible under a solely qualitative or solely quantitative design (Wisdom & Creswell, 2013; Almalki, 2016).

The first study objective is amenable to specialized quantitative methods designed to answer specific, closed questions; a dynamic, needs-based, multi-professional simulation model was used to achieve it. It is intended that, with regard to the study's overarching aim of assessing the feasibility of using such a model to inform HHR planning in Nova Scotia, the degree to which this objective can be achieved will illustrate the degree to which implementing the model is feasible from a technical perspective given the data available in the province. In contrast, the second objective is more open-ended and thus requires qualitative methods to achieve it. Specifically, a series of interviews with Nova Scotia HHR planners was conducted, as outlined below. With regard to the study's overarching aim, it is thus intended that this objective will illustrate the political (and, to a lesser extent, the technical) feasibility of implementing the model from the perspectives of the individuals who are ultimately responsible for choosing to incorporate it into Nova Scotia's HHR planning processes or not.

The two sets of methods were applied concurrently, and findings integrated according to the two objectives of this thesis (Zhang & Creswell, 2013).

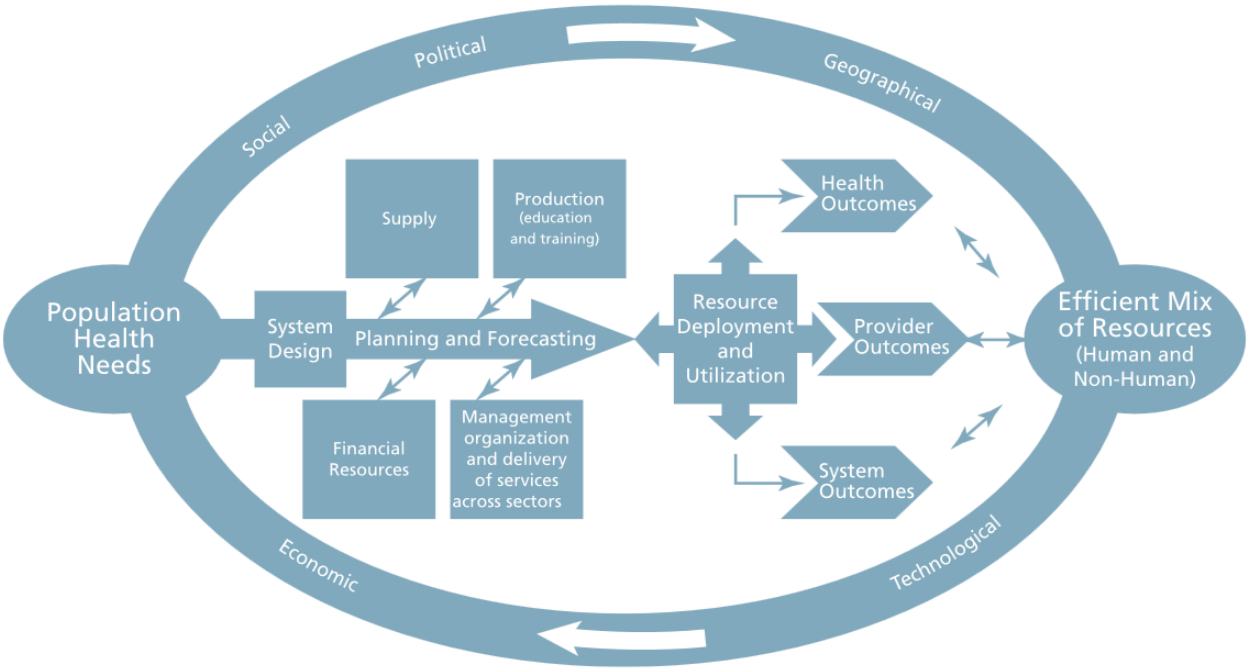
Conceptual Framework

The conceptual basis for this thesis is the framework for needs-based HHR and health system planning described by O'Brien-Pallas, Tomblin Murphy, and Birch (O'Brien-Pallas, Tomblin Murphy, & Birch, 2001). This framework (Figure 1) depicts the dynamic nature of the relationships among the many components of the health care system.

The outer band represents the importance of considering the range of relevant social, political, geographical, technological and economic factors that influence population health and the health care system – these factors must also be considered when performing HHR planning. Across all sectors of care (system design), HHR planning must work with the current practice pool of providers, noting that this supply is maintained by the production of new providers, and the flow of services from that supply is influenced by the financial resources made available, the ways in which service delivery is managed and organized (e.g., through particular models of care), and the deployment (e.g., the makeup of interprofessional teams) and utilization (e.g., the services delivered by different members of interprofessional teams) of these resources.

Figure 1: Conceptual Framework for Needs-Based HHR Planning

(O'Brien-Pallas, Tomblin Murphy, & Birch, 2001)



These human resources, when supported by non-human resources (e.g., facilities and equipment), yield patient, provider and system outcomes that are optimized when there is an efficient mix of human and non-human resources in the jurisdiction.

The present study focuses on a subset of the elements of this conceptual framework. These include: Political context, Population Health Needs; System Design; Planning and Forecasting; Supply; Production; Management, Organization, and Delivery of services; Resource Deployment and Utilization; Provider Outcomes, and System Outcomes. Specifically, the Political and Technological contextual factors, and the Planning and Forecasting component are the focus of the study's qualitative methods, which are designed to identify the technical and political factors that influence the choice of planning and forecasting model(s) in Nova Scotia. The quantitative methods focus on more components, including Population Health Needs; Supply; Production; Management, Organization, and Delivery of Services; Resource Deployment and Utilization; and Provider Outcomes, all of which correspond to elements of the analytical framework (presented in detail later in this chapter) used to address the study's primary objective. This objective also addresses, more broadly, the Planning and Forecasting component of the conceptual framework.

The conceptual framework provides a visual representation of the key factors to be considered in conducting needs-based HHR planning, as well as the direction of relationships between those factors. To 'operationalize' these concepts so as to allow quantitative estimation of HHR supply and requirements, an analytical framework that

defines these parameters more explicitly and specifies the relationships between them mathematically is required.

Quantitative Methods

Analytical Framework

The analytical framework on which this study's quantitative methods are based expands on the work of Birch and colleagues (Birch, et al., 2007). Under both frameworks, two distinct quantities are estimated and then compared over specified periods of time:

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

The Birch et al. framework further disaggregates supply and requirements into their immediate determinants. Specifically, for any given period of time, supply is the product of i) the number of HHR of a given type available to provide services (provider stock), ii) the proportion of available providers delivering any direct patient care (provider participation), and iii) the proportion of full-time equivalent (FTE) hours spent providing direct patient care among participating providers (provider activity). Requirements are the product of i) the size and age-sex structure of the population to be served (demography), ii) the distribution of health status – i.e. the need for care – within that population (need), iii) the number and type of services to be provided for a given level of health status (level of service); and iv) the rate at which an FTE care provider can be

expected to perform those services (productivity). Mathematically, these relationships can be expressed as follows:

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

And

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

Where[3]:

- $N_{n,t}$ is the number of FTE HHR of type *n* required to deliver a given service model $Q_{h,i,j,q,t}$ 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*;
- $P_{i,j,t}$ 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

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

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 a 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 devoted to direct patient care by participating HHR of type *n* during time period *t* (activity).

This way of disaggregating the determinants of HHR requirements is effective for single professions or types of HHR at a time – as evidenced by its application to a variety of HHR planning contexts (Birch, et al., 2004; Tomblin Murphy, et al., 2006; Tomblin Murphy, Alder, Pelletier, & MacKenzie, 2007; Tomblin Murphy, Alder, & MacKenzie, 2008; Tomblin Murphy, et al., 2009; Tomblin Murphy, Birch, Alder, Lethbridge, & MacKenzie, 2009) (Guy-Walker, et al., 2011; Tomblin Murphy, et al., 2012; Tomblin Murphy, MacKenzie, Walker, & Guy-Walker, 2014; Tomblin Murphy & MacKenzie, 2014; Tomblin Murphy, Birch, MacKenzie, & Rigby, 2016). It is not optimal for planning across professions for two reasons. First, this equation specifies the planned service model only insofar as it pertains to the individual type of HHR in question (e.g., what services are required of social workers) – it does not capture the full scope of the

model (i.e. the full range of service to be provided to the population to address their health needs). Second, it does not specify the extent to which specific services are to be provided by specific types of HHR. These limitations become increasingly important as more comprehensive models of care are developed that require the services of multiple types of HHR (Reeves, Lewin, Espin, & Zwarenstein, 2010, p. 26; Curson, Dell, Wilson, Bosworth, & Baldauf, 2010; Jones, Bhanbhro, Grant, & Hood, 2013; Morgan, Pullon, & McKinlay, 2015; Klaasen, Bowman, & Komenda, 2016; Nova Scotia Health Authority, 2017).

A more recent, modified version of this framework addresses the former of these limitations by specifying the number and type of services to be delivered, across professions, to address specified health conditions among a population (Tomblin Murphy, et al., 2006; Tomblin Murphy, et al., 2013; Tomblin Murphy, et al., 2013; Goma, et al., 2014; Tomblin Murphy, Birch, MacKenzie, Rigby, & Langley, 2017). This modified framework also partially addresses the latter of these limitations because it involves specifying which types of HHR are able to provide each type of service given the existing legal and regulatory context and their respective competencies.

However, this modified framework does not specify how those services are to be allocated between specific types of HHR. Put another way, applications of the more recent version of the Birch et al. framework specify which services *can* be provided by which types of HHR, but it do not specify which services *should* be provided by which types of HHR. Implicit assumptions involved in applying this version of the Birch et al. framework, then, are that:

i. All types of HHR who *can* provide a service *will* provide that service (for example, all physicians will spend time taking patients' temperatures); and

ii. The provision of a given service will be allocated across the professions able to perform it according to their respective proportions of the workforce (for example, if 20% of the HHR able to check a patient's temperature are physicians, then 20% of temperature checks will be performed by physicians).

In addition, this modified version of the Birch et al. framework is static as opposed to dynamic in nature – i.e. it is designed to plan for the present or very near future and does not allow for the consideration of the impacts of changes to planning parameters over time.

An additional limitation of both the original and modified versions of the Birch/Tomblin Murphy et al. framework is that neither explicitly accounts for the proportion of providers' direct care time spent on the specific populations and/or health issues in question. This limitation does not factor into applications of the framework to, for example, all registered nurses caring for the entire population (Tomblin Murphy, et al., 2012) of a jurisdiction. This limitation is relevant, however, when planning for populations that make up only a portion of those to be cared for by the included types of HHR (Tomblin Murphy, et al., 2013) and/or when planning for specific health conditions that are a subset of those to be addressed by the included types of HHR (Tomblin Murphy, et al., 2013). For example, in applying the modified Birch/Tomblin Murphy et al. framework to pandemic planning, the authors noted that it was necessary for planners to account for the need to carry on other essential, non-pandemic services in addition to

the pandemic response, and that this could be done to some degree by adjusting either the participation or activity parameters (Tomblin Murphy, Birch, MacKenzie, Rigby, & Langley, 2017). However, this accommodation requires the conflation of the proportion of health care providers' direct care time spent on pandemic response with either their participation in direct patient care at all or the amount of time they spend on direct patient care, both of which are distinct determinants of HHR supply and are influenced by different policy levers.

The implications of this limitation are more apparent as it applies to their study of family physicians in Nova Scotia (Tomblin Murphy, Alder, & MacKenzie, 2008). In that application, the authors measured family physicians' level of activity by analyzing their billing volumes; implicit in this approach was the assumption that all family physicians' activity (as reported through their billings) had been – and would continue to be – for the purposes of providing family medicine as opposed to other types of medicine. In fact, family physicians in Nova Scotia (and elsewhere) often divide the time they devote to direct patient care between a family practice and other specialized clinical interests such as emergency or sports medicine (Nova Scotia Department of Health and Wellness, 2014). Failing to explicitly account for this distinction overestimates the supply of family medicine services. More broadly, it does not allow planners to use the model to consider the potential impacts of policies aimed at increasing proportion of direct care time family physicians spend on family medicine as opposed to other types of direct care, which are likely to be different from policies aimed at influencing either family physicians' participation or activity levels.

Under the analytical framework used in the present study, HHR requirements are estimated using the following equation:

$$(3)\ N_{n,t} = \sum_{q} \frac{\sum_{h,i,j}\left(P_{i,j,t} \times H_{h,i,j,t} \times Q_{h,i,j,q,t} \times W_{h,i,j,n,q,t}\right)}{R_{n,q,t}}$$

Where:

- $N_{n,t}$ is the number of FTE HHR of type *n* required to deliver a given service model $Q_{h,i,j,q,t}$ to a given population over a period of time *t*;
- $P_{i,j,t}$ 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);
- $Q_{h,i,j,q,t}$ 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* over time period *t* (i.e. level of service);
- $W_{n,q,t}$ is the proportion of services of type *q* to be performed by HHR of type *n* for individuals of health status *h*, age group *i*, and sex *j* over time period *t* (i.e. division of work); and
- $R_{n,q,t}$ is the mean number of services of type *q* that a FTE HHR of type *n* can be expected to perform within time period *t* (i.e. productivity).

Different from the analytical framework originally described by Birch et al., specifying the division of work *W* according to the age, sex, and health status of

individuals to be provided with each service allows for – but does not require – tailoring the planned service model for specific subpopulations and types of HHR. For example, in the present study this parameter specifies how the number of psychotherapy sessions required by school-aged children with anxiety or depression in Nova Scotia should be allocated across the multiple professions whose training and scopes of practice qualifies them to provide such services according to patients' levels of need. This parameter has been included to better facilitate the analysis of the HHR implications of such potential policies as a directive that the treatment of children with severe depression comorbid with anxiety be reserved to psychiatrists. Because all the different types of services included in the level of services parameter (*Q*) must be allocated across professions through the division of work parameter (*W*), this parameter also makes explicit the interdependencies of requirements for individual types of HHR, because changing what is expected of one type of HHR automatically affects what is expected of the remaining types.

Under the analytical framework used in the present study, HHR supply is estimated as follows:

$$(4)\ N'_{n,t} = S_{n,t} \times D_{n,t} \times A_{n,t} \times F_{n,t}$$

Where:

- $S_{n,t}$ 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);

- $A_{n,t}$ is the mean proportion of an FTE devoted to direct patient care by participating HHR of type *n* during time period *t* (activity); and
- $F_{n,t}$ is the mean proportion of an FTE devoted to the population(s) or health issue(s) being considered by HHR of type *n* during time period *t* (clinical focus).

The clinical focus term, which is not part of the framework described by Birch and colleagues, allows for explicit consideration of, for example, the proportion of a family physician's practice that is devoted to anxiety and depression among school-aged children as opposed to the other conditions and populations for which that physician provides services. Although in a recent study Tomblin Murphy and colleagues noted that clinical focus in this sense could also be accounted for by adjusting the participation and/or activity parameters (Tomblin Murphy, Birch, MacKenzie, Rigby, & Langley, 2017), clinical focus is a separate determinant of effective HHR supply that is likely to be sensitive to different policy interventions than either participation or activity. Moreover, both participation and activity are important enough determinants of effective HHR supply to warrant explicit consideration without confounding them with clinical focus, because the policy interventions that may be used to influence clinical focus (e.g., service contracts between health authorities and individual physicians) are likely to be different from those that may be used to influence either participation (e.g., national specialty requirements) or activity (e.g., provincial physician billing regimens). Besides including the clinical focus parameter in this way, another means of HHR planning for a specific clinical service area would be to add another parameter 'narrowing' the stock to those who provide the specified service(s). This would allow for the distinction between policy

interventions aimed at getting more HHR to provide the specified services (on the stock side) and those aimed at getting those who already provide some of the specified services to spend a larger proportion of their time on them. In terms of the number of FTEs ultimately available to care for children with anxiety or depression, this approach would yield the same results with a more complicated model.

In the present study, the determinants of HHR supply are further disaggregated as follows:

$$(5)\ S_{n,t} = \sum_{i} \left(S_{i,n,t-1} \times (1 - E_{i,n,t})\right) + \sum_{i} I_{i,n,t}$$

Where:

- $E_{i,n,t}$ is the proportion of members of HHR of age group *i* and type *n* licensed to practice in year *t-1* but did not retain their licenses for year *t*;
- $I_{i,n,t}$ is the number of members of HHR of age group *i* and type *n* entering practice in the jurisdiction in question in year *t*.

$$(6)\ I_{i,n,t} = G_{i,n,t} \times \left(1 - O_{n,t}\right) + M_{i,n,t}$$

Where:

- $G_{i,n,t}$ is the number of HHR of age group *i* and type *n* who graduate from an entry-to-practice training program in the jurisdiction in question in year *t;*
- $O_{n,t}$ is the proportion of new graduates of HHR of type *n* who do not begin practicing at least some direct patient care in the jurisdiction in question in year *t*; and

- $M_{i,n,t}$ is the number of HHR of age group *i* and type *n* who obtain a new license to practice in the jurisdiction in question in year *t*.

$$(7)\ G_{i,n,t} = C_{n,t-y} \times (1 - F_{n,t}) \times D_{i,t}$$

Where:

- $C_{n,t-y}$ is the total number of students enrolled in all entry-to-practice training programs for HHR of type *n* in the jurisdiction in question in year *t* that are *y* years in duration;
- $F_{n,t}$ is proportion of students in all entry-to-practice training programs in the jurisdiction in question who first enrolled in the program in year *y-t* and do not successfully complete it by year *t* (also referred to as 'program attrition'); and
- $D_{i,t}$ is the proportion of graduates of all entry-to-practice training programs in the jurisdiction in question of age group *i*.

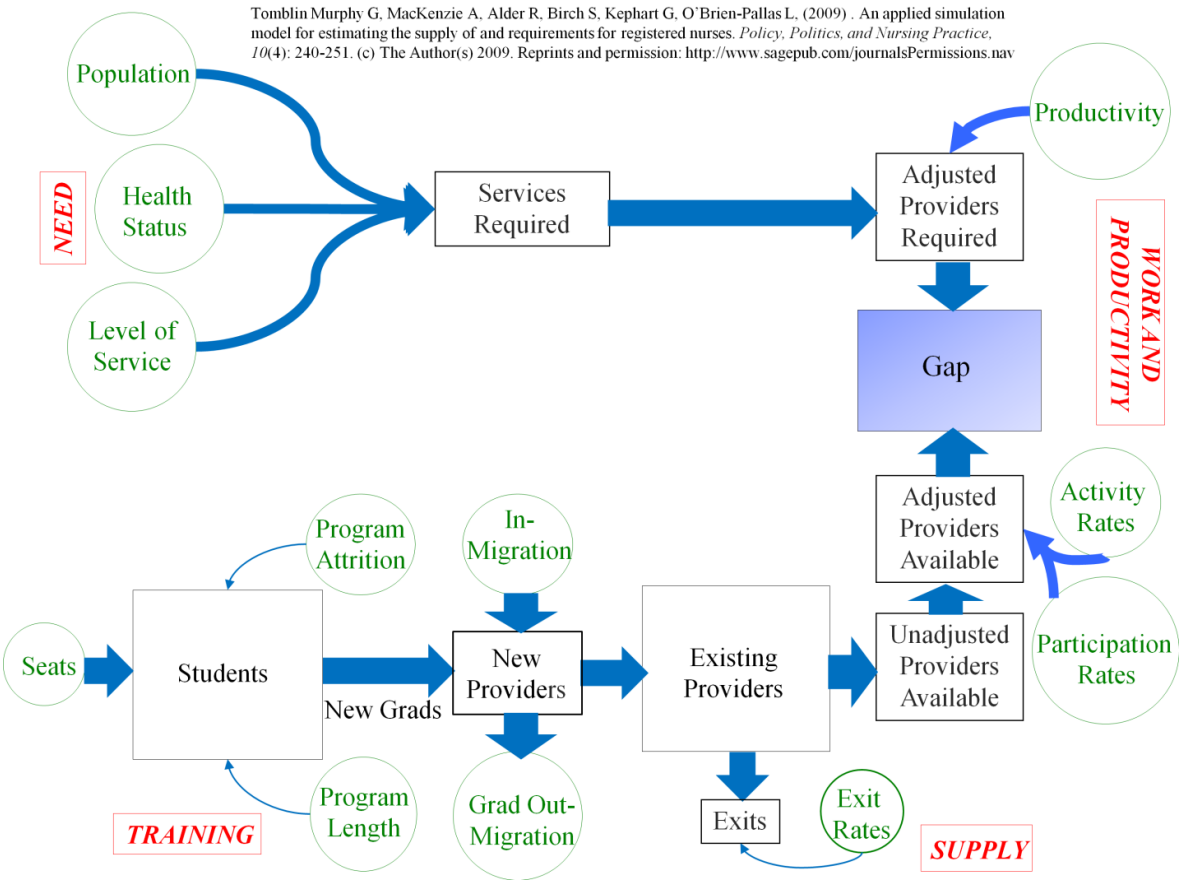
Equations (3) – (5) illustrate how HHR supply is estimated using a stock-and-flow model (Hall T. , 1978; Birch, et al., 2007; Curson, Dell, Wilson, Bosworth, & Baldauf, 2010; Sobolev, Sanchez, & Kuramoto, 2012, p. 55). In this case, the 'stock' is the number of licensed care providers, the 'flows' into that stock include new, locally-trained graduates as well as those migrating in from other jurisdictions, and the flows out include those no longer holding a license to practice in the jurisdiction in question.

Simulation Model

The simulation modeling approach used in this study builds on both the needs-based simulation modeling approach (Birch, et al., 2004; Tomblin Murphy, et al., 2006;

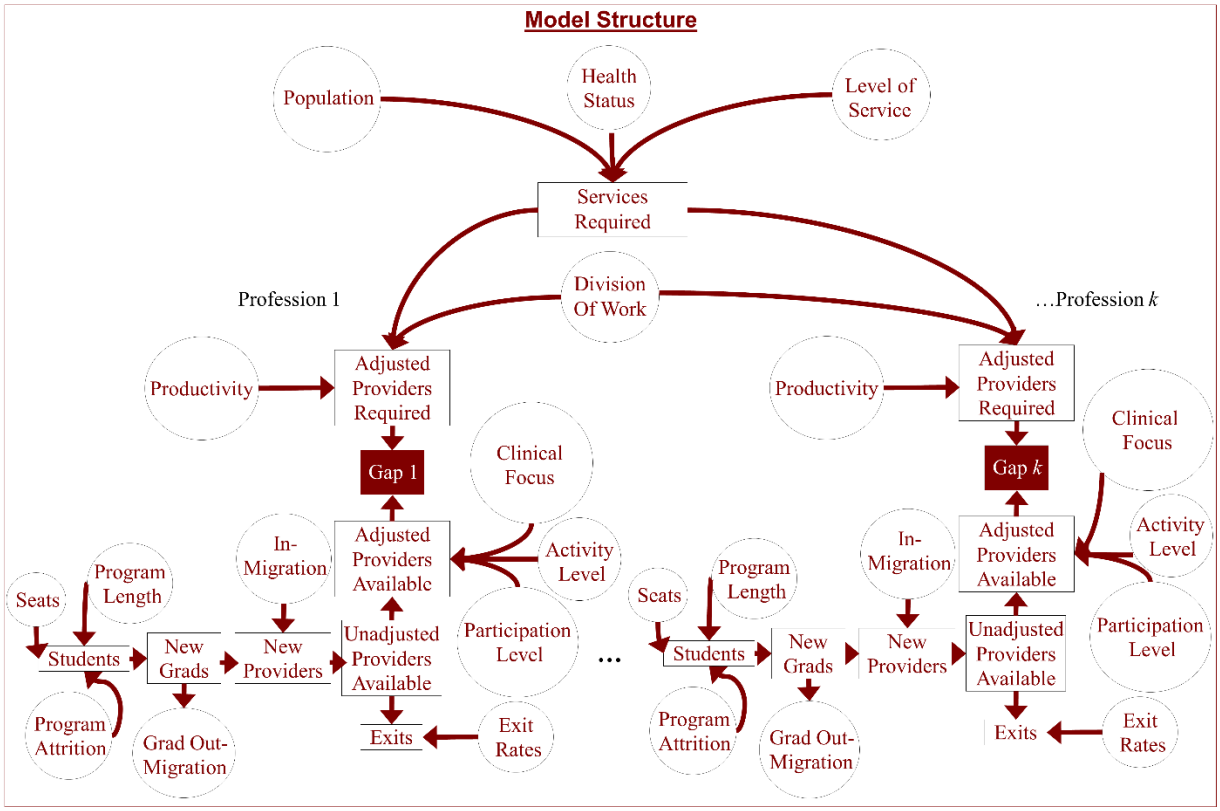
Tomblin Murphy, Alder, Pelletier, & MacKenzie, 2007; Tomblin Murphy, Alder, & MacKenzie, 2008; Tomblin Murphy, et al., 2009; Guy-Walker, et al., 2011; Tomblin Murphy, et al., 2012; Tomblin Murphy, MacKenzie, Walker, & Guy-Walker, 2014) (Tomblin Murphy, Birch, MacKenzie, & Rigby, 2016) and the integrated needs-based health service and workforce planning approach (Tomblin Murphy, et al., 2006; Tomblin Murphy, et al., 2013; Tomblin Murphy, et al., 2013; Goma, et al., 2014; Tomblin Murphy, Birch, MacKenzie, Rigby, & Langley, 2017) developed by Tomblin Murphy, Birch and colleagues. The general structure of the original simulation model used by Tomblin Murphy and colleagues is illustrated in Figure 2.

Figure 2: Tomblin Murphy et al. Model Structure



The model used in the present study (Figure 3) is based on the expanded analytical framework described above. Like the model used by Tomblin Murphy and colleagues, the purpose of this approach is not to predict the future. Instead, the model intended to integrate knowledge of different types of HHR and other aspects of the health care system into a single planning and communication tool so as to promote understanding of how various factors affect the supply of and/or requirements for HHR and identify policy levers for influencing these.

Figure 3: Present Study Model Structure



In this way, the approach is designed to enable health policy makers to 'rehearse' potential policy changes by altering the value of the determinants in the model and then

examining the estimated impacts of such changes on the supply of and/or requirements for given types of health care provider. Simulating over a period of 10-15 years is important because the impacts of some policy interventions take that long to become evident. For example, an increase in undergraduate medical school seats aimed at increasing the supply of psychiatrists would not produce any 'extra' psychiatrists for 9 years (4 years for the 'extra' MDs to complete their training, 5 years for residency training), and those 'extra' psychiatrists would initially be few relative to those already in practice.

Ultimately, this simulation modeling approach is designed to help health policy makers identify the most effective and efficient ways to manage HHR under different future scenarios. In the context of planning for pediatric mental health services in Nova Scotia, the model allows for the direct estimation of the HHR implications of the various policy changes included in its mental health strategy (Province of Nova Scotia, 2013) to facilitate discussions of how best to implement them.

The model components, most of which are also described in detail elsewhere (Tomblin Murphy, et al., 2009; Tomblin Murphy, et al., 2012; Tomblin Murphy, MacKenzie, Walker, & Guy-Walker, 2014; Tomblin Murphy, Birch, MacKenzie, & Rigby, 2016), are defined as follows:

For each of *k* professions included in the model, the model estimates the flow of *new graduates* from the various pre-licensure educational programs for these professions based on the size of its enrollment (*seats*), the *program length* (in years), the proportion of entrants who graduate on time (*program attrition*), and the proportion of graduates

who enter clinical practice within the region in which they graduated as opposed to migrating or entering administrative or other positions that do not include direct care provision (*grad out-migration*).

The model then uses a stock-and-flow approach common in HHR planning models (Hall T. , 1978; Dal Poz, et al., 2010; Ono, Lafortune, & Schoenstein, 2013; Tomblin Murphy, Birch, MacKenzie, Bradish, & Elliott Rose, 2016) to estimate the future size of the stock of each included profession based on the current number of members of that profession currently licensed to practice (*unadjusted providers available*), the number of *new providers* entering that stock (either as *new graduates* or *in-migrants* from other jurisdictions), and the number of *exits* from that supply over time.

The unadjusted number of each type of providers available is then adjusted according to the proportion of licensed members who engage in at least some direct patient care (*participation*), the mean proportion of an FTE they devote to direct patient care (*activity*), and the proportion of that FTE they devote to the population and/or health conditions in question (*clinical focus*) – in the present study, these are anxiety and depression among school-aged children in Nova Scotia.

In keeping with the analytical framework described above, the model estimates the number and type of services required based on the size and age-sex distribution (as noted in earlier chapters, the age groups used in this study are 5-12 and 13-19) of the population to be served (*population*), the distribution of health status within that population (*health status*), and the number and type of services to be provided according to different levels of health status (*level of service*) in the same way as described by

Tomblin Murphy and colleagues elsewhere (Tomblin Murphy, Birch, MacKenzie, & Rigby, 2016). These are then translated into FTE requirements for different types of HHR by multiplying by the proportion of each type of service to be provided by each type of HHR (*division of work*) and dividing by the rate at which each type of HHR can be expected to perform each type of service (*productivity*).

So if, for example, multiplying the population, health status, and level of service parameters yields an estimate of 100,000 psychotherapy sessions being required to address anxiety and depression among school-aged children in Nova Scotia in 2018, the division of work parameter allows users to specify how those sessions are to be divided up amongst the different types of HHR qualified to provide that particular service – for instance with 40% being provided by social workers, 30% by psychologists, and 30% by psychiatrists. To convert these profession-specific service requirements to service-specific FTE requirements, the numbers of psychotherapy sessions to be performed by each profession (in this example, 40,000 for social workers and 30,000 each for psychologists and psychiatrists) are divided by the rate at which each of those professions can be expected to perform psychotherapy sessions over time (i.e. productivity). This process is then repeated for each type of service to be provided and the resulting FTE requirements summed for each type of HHR included in the model.

This model represents a partial reflection of the various elements and relationships depicted in the study's conceptual framework. Population health needs are captured through the *health status* parameter. A key aspect of system design is reflected in the *level of service* parameter. The *unadjusted providers available* parameters for the *k*

professions reflect the supply of HHR. The management, organization, and delivery of services is reflected in the *division of work*, *participation*, *activity*, and *clinical focus* parameters. The *productivity* parameter is reflective of resource deployment and utilization. The various training parameters capture the production of HHR. Finally, *exits* and the *gap* for each of the *k* types of HHR included in the model are examples of provider and system outcomes, respectively.

The key structural differences between the model used in the present study and the approach developed by Tomblin Murphy and colleagues, then, are:

a) The development and incorporation of the *clinical focus* parameter;
b) The development and incorporation of the *division of work* parameter; and
c) The incorporation of multiple parallel training and supply modules to account for dynamic changes to the supplies of *k* different types of HHR as opposed to a single type.

Data Sources

To apply this approach to planning for anxiety and depression among school-aged children in Nova Scotia, the model has been populated with data gathered from several sources, which are described below. First, the different types of data sources used are described in general terms. Next, specific data sources used for estimating service requirements are identified by model component. Second, data sources for estimating supply are identified by profession. Finally, all sources are summarized in Table 2.

Administrative databases

Several databases systematically capture data generated as part of administering the health care system in Nova Scotia. Those used in the present study include the provincial physician billings database and provincial HHR registries. The former of these includes records of claims submitted by the province's physicians for services they have provided to patients through the provincial medical services insurance program. This database was accessed through Health Data Nova Scotia. The latter of these includes registration data submitted annually by members of regulated health professions to their respective regulatory bodies as part of licensing requirements.

Canadian Post-MD Education Registry (CAPER)

CAPER is a national repository for data on postgraduate medical education in Canada. The registry maintains individual-level data for all postgraduate medical residents and fellows gathered on an annual basis from all Canadian Faculties of Medicine. Data included in the present study were obtained from CAPER's Annual Census of Post-M.D. Trainees (CAPER, 2018), including:

- The numbers and types of physicians being trained in various medical specialties at Dalhousie University;
- The numbers of international medical graduates (IMGs) and visa trainees studying in Canada;
- The number of residents and fellows exiting post-M.D. training programs;
- Ongoing practice location of postgraduate trainees following training.

Clinician panel

To address gaps in the above data sources, a multidisciplinary panel of clinicians experienced in the treatment of anxiety and depression among school-aged children in Nova Scotia was convened. This type of approach has been used for the same purpose in previous applications of needs-based, multi-professional HHR planning frameworks (Tomblin Murphy, et al., 2013; Goma, et al., 2014; Tomblin Murphy, Birch, MacKenzie, Rigby, & Langley, 2017).

Participants in the panel were invited through the mental health service lead and vice president of clinical practice of IWK health centre and included members of each of the professions included in the present study. Through a discussion facilitated by the principal investigator of this study, participants were asked to provide estimates of current values of several model parameters – including levels of service, division of work, productivity, and division of work – based on their knowledge and experience. For each parameter, consensus was reached among participants on either a point estimate or range of values. Where a range of values was specified, the midpoint of these values was incorporated into the model.

Demography

Data on Nova Scotia's current population of school-aged children by age and sex, along with future projections under different growth scenarios, were obtained from Statistics Canada's website (Statistics Canada, 2016).

Health Status

Data on the prevalence of anxiety and depression among school-aged children in Nova Scotia were obtained from analyses of 2007 and 2010 Canadian Community Health Survey data by Asbridge and colleagues (Asbridge, Pauley, Langille, Kisely, & Whipp, 2011); these are the most recently published population-based estimates of the prevalence of either condition among school-aged children in Nova Scotia. Estimates of the distribution of acuity of depression among school-aged children in Nova Scotia were taken from analyses of provincial survey data published by Asbridge and colleagues (Asbridge, Azagba, Langille, & Rasic, 2014).

For the purposes of this study, the 2007 and 2010 population-based estimates were taken to be accurate and applied to all school-aged children in the province. The distribution of acuity of depression between mild and moderate was assumed to be proportional to the prevalence different degrees – somewhat elevated, very elevated – of risk of depression estimated from 2012 survey data of secondary school students in Nova Scotia (Asbridge & Langille, 2013). The prevalence of severe depression was assumed to be equal to the incidence of hospitalization for depression among children estimated in an Ontario study (Amartey, et al., 2017).Estimates of the degree of comorbidty between these two conditions were taken from a Canadian study not specific to Nova Scotia (Meng & D'Arcy, 2012).

Level of Service

Because of the lack of administrative data on this parameter (as noted in the literature

review chapter), estimates to populate the model's level of service component were obtained from multiple sources, as follows. The CAPA model of choice and partnership appointments (United Kingdom Child and Adolescent Mental Health Services, 2017), which has been chosen as the basis for mental health service provision by both the Nova Scotia Health Authority and the IWK health centre (Courey, Hodder, & MacNeil, 2017), was used as the general structure. The various services provided during these appointments were identified during the clinician panels, as follows:

- Children presenting to a physician or psychologist in a primary care setting with potential anxiety and/or depression symptoms are diagnosed using established criteria. Depending on the clinician's level of familiarity with pediatric anxiety or depression, a second clinician with more expertise (e.g., a pediatric psychiatrist) may be asked to confirm or change the diagnosis. In complex cases multiple diagnostic tests may need to be applied.
- Children who are referred (e.g., by a school counselor) to outpatient mental health teams work with clinicians – typically psychologists, social workers, and/or RNs – and their parents or home caregivers to articulate the specific problem(s) for which they are seeking help during a choice appointment. In this process the focus is less on making a formal diagnosis than on defining the problem in a way that is mutually understood by all parties.
- Children who present to an urgent or emergency care setting are first assessed by a triage RN for risk of self-harm and medical needs. Those deemed to be at high risk of self-harm are provided with acute therapeutic interventions by

psychologists, social workers, pediatricians, or psychiatrists and with education regarding self-care and community-based supports by either these same clinicians or by RNs. Children with most severe depression may be admitted to an inpatient mental health bed where they receive nursing care (primarily from RNs), education (along with their parents or home caregivers) regarding self-care (from RNs and/or psychiatrists, psychotherapy (typically from psychiatrists), and potentially pharmacotherapy (from psychiatrists). Those deemed not to be at risk of self-harm are referred to local mental health teams.

- A plan of care with mutually agreed upon and measurable treatment goals is developed, either with the child's regular primary health care provider or with a mental health team made up primarily of psychologists, social workers, and/or RNs.
- The patient and their parents or home caregivers are provided with education regarding self-care strategies that can be utilized between visits to clinicians.
- The care plan is customized to each child and may include any of a range of services, only some of which – such as psychotherapy and, in some cases, pharmacotherapy – fall within the purview of provincial mental health services.

Productivity

Physician productivity was estimated using billing data as described below in the data analysis section. In the absence of systematically collected data on the productivity of other types of HHR in Nova Scotia, estimates of the frequency with which different

types of HHR could reasonably be expected to provide each of the types of service included in the model were provided by the multidisciplinary clinician panel.

Division of Work

Division of work between different types of physicians was estimated using billing data as described below in the data analysis section. Division of work more broadly – between types of nurses, physicians, psychologists, and social workers – was estimated based on data from the multidisciplinary clinician panel.

Clinical Focus

For physicians, clinical focus was estimated based on billing data. For psychologists, clinical focus was estimated based on the proportion of members of the Association of Psychologists of Nova Scotia (APNS) who reported treating children and/or adolescents for anxiety and/or depression as part of their practice. For professions other than physicians, assumed values for clinical focus were used, with any broader specialization data from regulatory colleges (e.g., % specializing in pediatrics or mental health) serving as upper bounds for these values when available. Specifically, it was assumed that members of these professions spend the following proportions of their direct care time on addressing anxiety and depression among school-aged children:

- NPs and RNs: 0.1% each (fewer than 3% of RNs and 2% of NPs work in pediatrics, and most of these work in inpatient hospital settings focused on issues other than mental health).

- Social Workers: 10% (roughly 23% of social workers report working with children, and roughly half report providing mental health and addictions services).

Nurses

Data on the existing stocks of nurse practitioners (NPs) and registered nurses (RNs) in Nova Scotia by age, along with recent historical measures of participation, activity, and specialization were obtained from the Nova Scotia Department of Health and Wellness (DHW). Recent historical data on flows in and out of those stocks were obtained from the Canadian Institute for Health Information (CIHI)'s Health Workforce Database (Canadian Institute for Health Information, 2017; Canadian Institute for Health Information, 2017). Data on nurse education and training programs were obtained from the four institutions in the province that provide entry-to-practice training for nurses: Dalhousie University's School of Nursing (for NPs and RNs), the Cape Breton University Department of Nursing (for RNs), and the St. Francis Xavier University Department of Nursing (for RNs). Data on the total volume of inpatient services produced by RNs were obtained from CIHI (Canadian Institute for Health Information, 2016). Some information on the division of work between types of nurses and other types of HHR was obtained from provincial and health authority role descriptions (IWK Health Centre, 2013; IWK Health Centre , 2013; Nova Scotia Department of Health, 2013).

Physicians

Aggregate data on numbers of seats, program length, and graduate retention for

the types of physicians included in the model have been taken from the Canadian Post-MD Education Registry (CAPER)'s annual census (CAPER, 2018). Aggregate data on the stock of physicians by age and specialty, and flows in and out of that stock, were obtained from the provincial physician registry. Levels of physician service provision, clinical focus, and activity were estimated from physician billing data.

Psychologists

Aggregate data on the current supply of psychologists in the province and levels of participation, activity, and clinical focus were provided by the Association of Psychologists of Nova Scotia (APNS). Data on clinical psychology education were provided by Dalhousie University's Department of Psychology and Acadia University's Department of Psychology, which provide the only clinical psychology programs in the province. Some information on the division of work between psychologists and other types of HHR was obtained from provincial role descriptions (IWK Health Centre, 2013).

Social Workers

Data on the supply of social workers in Nova Scotia were obtained from the Nova Scotia College of Social Work (NSCSW) and from a database maintained at the University of New Brunswick as part of an Atlantic Canada-wide study on mental health services (ACCESS Mental Health, 2017). Data on social work education were provided by Dalhousie University's School of Social Work, which delivers the only such program in the province. Some information on the division of work between social workers and

other types of HHR was obtained from provincial role descriptions (IWK Health Centre, 2012; IWK Health Centre, 2013).

These data sources are summarized in Table 2, which also provides information on the availability and completeness of the sources available. Cells with text but no shading indicate that the data available are adequate for planning purposes. Cells with grey shading indicate that the data available have substantial limitations – e.g., not being Nova Scotia-specific – which are explained in the limitations section. Blank cells indicate that there is no known source for this information and that assumed values have been used – these are also described in the limitations section.

Table 2: Data Availability by Model Parameter and Profession

Model Parameter	FPs/GPs	NPs	Pediatricians	Psychiatrists	Psychologists	RNs	Social Workers
Population	Statistics Canada						
Health Status	Asbridge et al., 2011; Meng & D'Arcy, 2012; Asbridge et al., 2014						
Level of Service	UK Child and Adolescent Mental Health Services, 2017; Billings database; Clinician panel						
Existing Stock	DHW	DHW	CIHI/DHW	CIHI/DHW	DHW	CIHI/DHW	NSCSW
Exit rates	DHW	DHW	DHW	DHW		CIHI	CIHI
Activity	Billings database	DHW	Billings database	Billings database	APNS	DHW	
Participation	DHW	DHW	CIHI/DHW	CIHI/DHW	APNS	CIHI/DHW	
Grad out-migration	CAPER/ DHW	DHW	CIHI/DHW	CIHI/DHW		CIHI/DHW	
In-migration	CIHI/CAPER	DHW	CIHI/DHW	CIHI/DHW		CIHI/DHW	CIHI
Program attrition	CAPER	Dal	CAPER	CAPER	Dal	CBU/Dal/ StFX	Dal
Program length	CAPER	Dal	Dal	Dal	Dal	CBU/Dal/ StFX	Dal
Seats	CAPER	CIHI/ Dal	CAPER	CAPER	Dal	CBU/Dal/ StFX	Dal
Division of Work	Billings database	Clinician panel	Billings database	Billings database	Provincial role descriptions	Provincial role descriptions	Provincial role descriptions
	Clinician panel		Clinician panel	Clinician panel	Clinician panel	Clinician panel	Clinician panel

Model Parameter	FPs/GPs	NPs	Pediatricians	Psychiatrists	Psychologists	RNs	Social Workers
Productivity	Billings database Clinician panel	Clinician panel	Billings database Clinician panel	Billings database Clinician panel	Clinician panel	CIHI Clinician Panel	 Clinician panel
Clinical Focus	Billings database		Billings database	Billings database	APNS	DHW	NSCSW/ ACCESS database

Data Analysis

The data analysis undertaken for the study is described below in three stages:

1. Populating the model;
2. Running the model to produce 'baseline' results; and
3. Sensitivity testing and policy simulation.

Stage1: Populating the model

Due to data limitations discussed in the final section of this chapter, the only data analyses conducted to populate the model pertained to levels of physician services, division of work across different types of physicians, and measures of physicians' activity, clinical focus, and productivity. These analyses were conducted using the provincial physician billings database.

- Level of physician service: The mean number and type of physician services received by Nova Scotia school-aged children from different types of physicians per year by age group and sex were estimated for each of anxiety, depression, and comorbid anxiety and depression (as identified by diagnostic codes attached to each billing records) from the provincial physician billing database for 2015 (the most current year for which data were available). More specifically, all physician billings for 2015 pertaining to children eligible for the provincial medical insurance program aged 5-19, had an attached diagnostic code for anxiety or depression (coded under the International Classification of Diseases 9th Edition as 300.0 or 300.2 for anxiety and 296.20-.25, 296.30-.35, 300.4, or 311 for

depression[4]), and an attached physician billing specialty of general practice, pediatrics, or psychiatry were analyzed. Individual patients were classified as being aged 5-12 or 13-19 (these are the age groups according to which mental health services are organized at the IWK) and being diagnosed with anxiety, depression, or both. At the individual patient level, the number of each of the following types of services received over 2015 were summed:

  - Assessments;
  - Family or group therapy;
  - Individual behavioural therapy, psychotherapy, hypnotherapy, or counseling; and
  - Other consultations or visits.

  At the individual patient level, the mean number of each type of service received was calculated, stratifying by patient age group (5-12, 13-19) and diagnosis type (anxiety only, depression only, both).

- Division of physician work: Using the same database, division of work for each of these specialties was estimated as the proportion of all billings made by physicians classified with that specialty. Physicians were classified as either a general practitioner, pediatrician, or psychiatrist according to which of those three specialties appears most often as the billing specialty attached to their individual billing records in 2015.

[4] These codes were used based on work by Fiest and colleagues for depression (Feist, et al., 2014) and Marrie and colleagues for anxiety (Marrie, et al., 2014; Marrie, et al., 2016).

- Physician activity: For each individual physician, activity was measured as the proportion of days in 2015 (out of 249 total working days) that they billed for any service. The mean value of this proportion was calculated separately for general practitioners, pediatricians, and psychiatrists.
- Physician clinical focus: This was estimated as the proportion of billings associated with anxiety and depression among school-aged children, as follows: For each individual physician, the total number of billings reported in 2015 were counted. Then, the number of those billings associated with a patient aged 5-19 (as of the last day of the billing year) and with an attached diagnosis code of anxiety or depression was counted and divided by the total number of billings. This proportion was calculated separately for each type of physician - family physicians/general practitioners, pediatricians, and psychiatrists.
- Physician productivity: This was calculated at the physician and service level by dividing a) the total number of each type of service reported by each physician by b) each physician's activity level.

Stage 2: Running the model

As specified in equation (3) and described in more detail above, population, health status, and level of service were multiplied to produce estimated numbers of specific types of services required to address anxiety and depression among school-aged children in Nova Scotia. These were then multiplied by division of work and productivity to estimate the number of each type of HHR required to deliver those services.

The numbers of each type of HHR available to provide services in Nova Scotia were then estimated according to equation (4). This was done by multiplying the current stock of each profession by their respective levels of participation, activity, and clinical focus. Changes to this supply over years were estimated by adding in new graduates and in-migrants and subtracting exits as specified in equations (5) and (6). Annual numbers of new graduates were estimated by multiplying enrollment sizes and program attrition rates as per equation (7).

Stage 3: Sensitivity testing and simulating policy scenarios

For key model parameters, in addition to the 'baseline' or 'status quo' value used to populate the model initially, two alternative scenarios are presented to demonstrate the model's sensitivity to different values of that parameter. Wherever possible, these different values have been chosen to reflect realistic policy scenarios, such as those found in Nova Scotia in the recent past, contemporaneously in other jurisdictions, or known to be under consideration as a potential policy intervention in the province. The specific scenarios simulated are described below according to the parameter to which they pertain.

Population: In addition to Statistics Canada's medium growth projection scenario, its low and high growth projection scenarios (Statistics Canada, 2016) have been incorporated to simulate the potential impact of different future demographic scenarios on the requirements for HHR to address anxiety and depression among school-aged children in Nova Scotia.

Health Status: In addition to the 'status quo' scenario in which the age-sex-specific prevalence of anxiety and depression among school-aged children in Nova Scotia remains constant, alternative scenarios in which a) the prevalence of anxiety and depression instead follow recent (increasing) trends in mood disorders in the province observed through the Canadian Community Health Survey (Statistics Canada, 2016), and b) the prevalence of anxiety and depression instead decrease to match the national prevalence.

Level of Service: In addition to the 'status quo' scenario in which levels of service provision by age, sex, and health status remain constant in the future, two alternative scenarios are included. In the first, beginning in 2019, 50% of the psychotherapy sessions for children with mild or moderate depression and/or anxiety are delivered in a group setting and 50% through individual sessions. Clinical practice guidelines for the treatment of these conditions in children and adolescents (Katzman, et al., 2014; National Collaborating Centre for Mental Health, 2015) are not specific as to the circumstances under which individual or group therapy may be preferable. In the second scenario, beginning in 2019, the levels of acute services – specifically, inpatient days and Emergency Department visits – provided to school-aged children with moderate or severe depression and/or anxiety are reduced by 50% and community-based group therapy sessions provided in their place. Such a scenario may be considered in response to the current shortage of community-based services (Williams, 2017).

Division of Work: In addition to the 'status quo' scenario in which the division of work between types of HHR remains constant in the future, two additional scenarios are

presented. First, beginning in 2021, the division of work for several services are shifted from relatively 'scarce' professions – physicians, psychologists, and social workers – to nurses, who are available in greater numbers. Specifically:

- Instead of 60% of diagnostic assessments being performed by psychiatrists and 20% each by psychologists and social workers, 10% are performed by family physicians, 5% by NPs, 10% by pediatricians, 40% by psychiatrists, 25% by psychologists, and 10% by social workers.
- RNs take on 40% of clinical assessments, reducing the proportions to be performed by FPs (from 15% to 10%), pediatricians (from 20% to 10%), psychiatrists (from 15% to 5%), psychologists (from 10% to 5%) and social workers (from 35% to 25%).
- Nurses take on 45% of care plan development (40% for RNs, 5% for NPs), reducing the proportions to be provided by FPs (from 10% to 5%), pediatricians (from 15% to 5%) and social workers (from 45% to 15%).
- Psychiatrists and pediatricians take on larger proportions (increasing from 1% and 9%, respectively, to 15% each) of individual psychotherapy sessions, reducing the proportions to be provided by FPs (from 30% to 15%) and psychologists (from 25% to 20%)[5].

Second, beginning in 2019, the psychotherapy services performed by family physicians in the baseline scenario are instead performed by psychiatrists. Such a policy

[5] Data on this parameter is not systematically collected in the province except for physicians. These values are intended as an example of a how the model can be used to simulate the implications of changes in how services are allocated across different types of HHR.

change may conceivably be made to ensure these services are delivered by physicians with specialized training in mental health care.

Productivity: Along with the 'status quo' scenario in which HHR productivity remains constant in the future, additional scenarios in which, beginning in 2019, productivity instead a) increases by 1% per year and b) decreases by 1% per year[6] are included.

Clinical Focus: In addition to the 'status quo' scenario in which the proportion of health care providers' direct care time spent on pediatric anxiety and depression remains constant in the future, two alternative scenarios are presented. In the first, beginning in 2023, the clinical focus of all professions except social workers are increased. More specifically, levels of clinical focus are increased from 0.4% to 2% for FPs, from 0.1% to 2% for NPs, from 1.8% to 10% for pediatricians, from 4.1% to 10% for psychiatrists, from 9.3% to 15% for psychologists, and from 0.1% to 1% for RNs. This change is simulated because of the relatively small estimated current levels of clinical focus among these professions. In the second, the clinical focus of social workers is reduced from 10% to 5% beginning in 2019. Such a policy change may be implemented, for example, to accommodate growing need for social workers' services outside the health care sector (Stratford, 2017).

[6] The productivity of different types of HHR has been found to be influenced – both positively and negatively – by a wide range of factors (Evans, Schneider, & Barer, 2010). Examples include care delivery models (McDonnell, Carpenter, Jacobsen, & Kadish, 2015) and processes (Sullivan, Soefje, Reinhart, McGeary, & Cabie, 2014), incentive structures (Brocklehurst, et al., 2013), and workplace culture (Dewa, Loong, Bonato, Thanh, & Jacobs, 2014).

Qualitative Methods

The study's qualitative methods were informed by a post-positivist perspective, common among quantitatively trained health researchers, focusing on the perceptions and perspectives of multiple participants (Creswell, 2006). To identify the technical and political factors affecting the choice of HHR planning models in Nova Scotia, a series of semi-structured interviews were conducted with HHR planners in the province. HHR planners were chosen over other stakeholder groups such as HHR researchers or health care because of their first-hand knowledge of HHR planning and decision-making processes (Creswell, 2009, pp. 157-158); in particular, because HHR planning is a relatively specialized field, and because there is little publicly available information on existing methods of HHR planning in the province, Nova Scotia health care providers and consumers would not have the necessary background knowledge to comment on factors that would support or hinder the uptake of a new approach into those processes.

Interviews were chosen as the method of data collection over others for several reasons:

- Given the politically sensitive and confidential nature of much of their work, direct observation of HHR planners was not feasible.
- Survey mechanisms would not allow for the desired richness of discussion.
- Focus groups were not considered feasible because of the risk that participants would not feel comfortable giving fulsome, candid responses with colleagues present (Creswell, 2009, pp. 157-158).

Due to the relatively small number of individuals responsible for HHR planning in the province (between 5-7 people were estimated to have this as part of their professional roles across the provincial health authorities and Department of Health and Wellness), a purposive sample was developed with two aims: First, to ensure perspectives from health authorities, government, and health professions education were incorporated; and second, to provide diversity of experience with HHR planning (Creswell, 2009, pp. 112-113).

To achieve these aims, five potential participants were initially identified. In addition to providing a diversity of perspectives in terms of HHR planning experience (ranging from 3 to 25 years) and the organizations represented (including both provincial health authorities, the Department of Health and Wellness, and health professions education). These individuals were also selected based on their familiarity with the principal investigator; given competing demands for their time, it was expected that individuals with whom the PI had an established relationship would be more likely to agree to participate. Further, the existing rapport between the participants and the interviewer was expected to allow the latter to feel comfortable speaking freely (Thomas, Nelson, & Silverman, 2011). All five of the selected individuals agreed to participate.

The interviews were one hour in duration and were conducted in person as opposed to via phone to help ensure a rapport between the interviewer and interviewees. To maximize convenience for the interviewees, interviews were conducted in participants' private offices or nearby meeting rooms of their choice. These private settings were chosen to make participants as comfortable as possible for a fulsome, candid discussion

(Creswell, 2009, p. 185). Related to this point, the interviews were not recorded so as to ensure they felt free to respond honestly to the questions posed.

To better facilitate data capture in the absence of interview recordings (and therefore transcripts), a template for note-taking was developed prior to the interviews. This consisted of tabulated lists of the technical and political factors that had been identified in prior case reports and opinion articles (outlined in the literature review chapter) as influencing the choice of HHR planning models in various jurisdictions (Creswell, 2009, pp. 201-203).

After obtaining informed consent to participate, the study's aim and objectives were presented, along with its methods. The model parameters and the relationships between them were then explained using the graphic illustration in Figure 3 as a visual aid. Interviewees were provided with time during and after this explanation to ask questions regarding the model. Once the interviewees' questions were answered to their satisfaction, the interviewer began asking questions. Interviews were structured around three questions:

1. Thinking about this model, are there features of it that you think would a) facilitate its use by your organization to inform HHR planning? b) make it difficult for your organization to use to inform HHR planning?
2. Thinking instead about the existing tools and procedures that currently make up your organization's HHR planning process, are there aspects of these that you think a) could be strengthened by incorporating this model? b) would make it difficult for your organization to incorporate this model?

3. Do you have any other comments about this model from the perspective of someone involved in HHR planning at the provincial level?

Follow-up questions used to probe more deeply into some interviewees' initial responses included variations of the following:

- Why do you think this is the case?
- Can you elaborate on that point based on your own experience?
- How do you think this problem could be addressed?

During each interview, notations were made according to these lists when respondents identified one of these factors, and items were added when respondents identified a factor not already on the list. This allowed for an analysis of which items were mentioned most frequently across interviews as the interviews were being conducted (Creswell & Poth, 2017, pp. 183-185). Memos were added to the margins of the lists to capture remarkable comments by interviewees; some of these included the specific phrasing used by the interviewees. The degree of similarity in responses across participants was such that saturation was deemed to be achieved after these five interviews (Guetterman, 2015). More specifically, after three interviews no new technical or political factors were added to the list.

Research Ethics

Approval to conduct the study was obtained from the Newfoundland and Labrador Health Research Ethics Board and Dalhousie University's Research Ethics Board.

CHAPTER 4: RESULTS

Chapter Overview

This chapter presents the results of the study's analyses. Results of the simulation modeling are presented first, followed by those of the interviews with HHR planners. This is followed by a section in which the quantitative and qualitative findings are integrated according to the two objectives of this thesis, which are to estimate the supply of and requirements for physicians, nurses, social workers, and psychologists to address anxiety and depression among school-aged children in Nova Scotia through 2032, and to identify technical and political factors affecting the choice of HHR planning models in Nova Scotia. The chapter concludes with a summary of all the study findings.

Modeling Results

In this section, the simulated Nova Scotia HHR gaps for addressing anxiety and depression among school-aged children under various scenarios are presented. Each scenario is accompanied by a pair of graphs showing, for each profession included in the model, how the difference (or 'gap') between the number of full-time equivalents (FTE) required and available varies by year throughout the study period. A negative value indicates that the number required exceeds the number supplied (i.e. a shortage), whereas a positive value indicates that the number available exceeds the number required (i.e. a surplus). The first figure for each scenario shows the absolute gaps for each profession. The second figure shows the relative gaps – with the absolute values divided by the head count of licensed providers in the provincial supply.

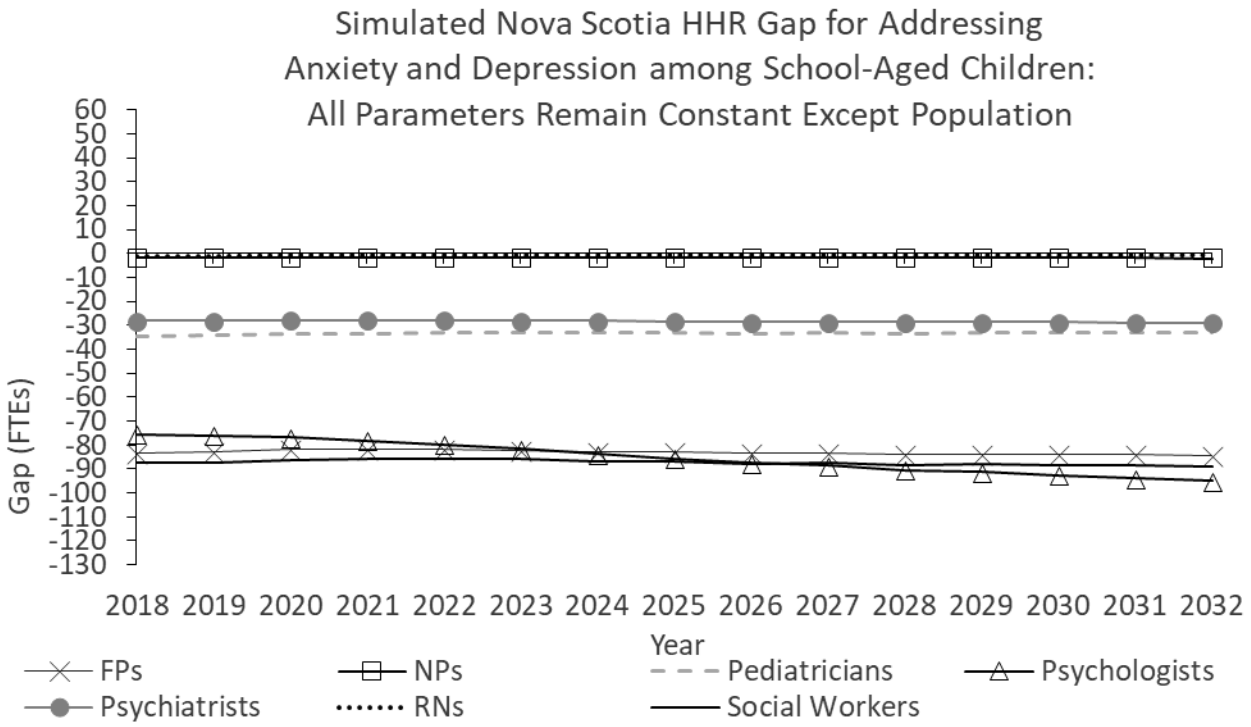
This section begins with an illustration of a 'baseline' or 'status quo continues' scenario in which all model parameters are held constant for the duration of the simulated time period with the exception of population. In each scenario presented here, the size and age-sex structure of Nova Scotia's population of school-aged children is taken from Statistics Canada's medium-growth projections based on Census data (Statistics Canada, 2017).

Several policy scenarios are then presented to illustrate the potential impact of different future values of key planning parameters, including health status, levels of service, productivity, division of work, and clinical focus. These scenarios also demonstrate the relative sensitivity of the results to changes in the value of each parameter; comparable analyses for the remaining model parameters are included as Appendix I. Finally, a scenario in which multiple parameters changed during the simulation period is presented as an example of how the cumulative impacts of multiple coinciding policy changes can be simulated using the model.

'Status Quo Continues' Scenario

Figures 4.1a and 4.1b show the simulated Nova Scotia HHR gap for addressing anxiety and depression among school-aged children under a scenario in which all model parameters are held constant for the duration of the study period except population.

Figure 4.1a



As Figure 4.1a shows, as of 2018 there is a shortage of each type of HHR included in the model, including 83 FTE family physicians (FPs), 2 nurse practitioners (NPs), 35 pediatricians, 28 psychiatrists, 76 psychologists, 1 registered nurse (RN), and 87 social workers. In this scenario, the shortages of all professions but psychologists remain relatively stable throughout the study period, growing by 0-2 FTEs. The shortage of psychologists increases by 19 FTEs over the study period.

Figure 4.1b

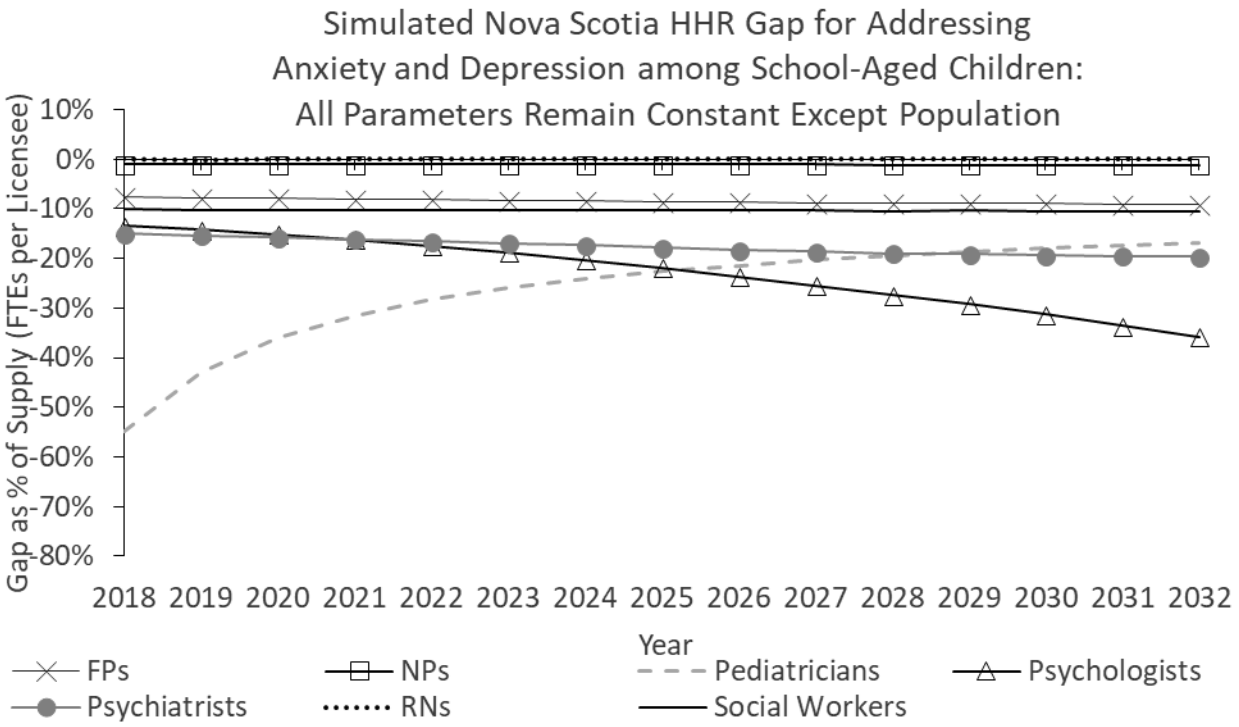


Figure 4.1b shows the sizes of these simulated gaps relative to the simulated stock of each profession and how these change over the study period. The magnitudes of the initial shortages of the various professions vary, as do their respective trajectories over the study period. The initial shortages of NPs and RNs are both less than 2% of their respective stocks, and these remain relatively stable throughout the study period. The initial shortages of FPs and social workers represents 8% and 10% of their initial stocks, and these increase to 9% and 11%, respectively, over the study period. The initial shortages of psychiatrists and psychologists represent 13% and 15% of their respective stocks. The relative shortage of psychiatrists increases to 20% over the study period, while the relative shortage of psychologists increases to 36% over the same period. These

relative shortages increase because the supplies of these professions decrease over the study period in this scenario.

In contrast to those of the other included professions, the relative shortage of pediatricians begins at 55% of its initial stock and decreases to 17% of the stock. The reason this 'relative' gap decreases while the absolute gap does not is because the provincial stock of pediatricians increases in this scenario, however pediatricians' clinical focus (at least, as measured by billing data) on anxiety and depression is only 2%, meaning these 'extra' pediatricians devote little of their time to these specific health issues.

Health Needs Scenarios

Figures 4.2a and 4.2b show the simulated Nova Scotia HHR gap for addressing anxiety and depression among school-aged children under a scenario in which all model parameters are held constant for the duration of the study period except population and health status. In this scenario, the prevalence rates of anxiety and depression among school-aged children in Nova Scotia change in the future according to recently observed increasing trends in mood disorders among Nova Scotia youth (Statistics Canada, 2016). The increasing prevalence in this scenario results in larger shortages for each profession compared to the baseline scenario.

Figure 4.2a

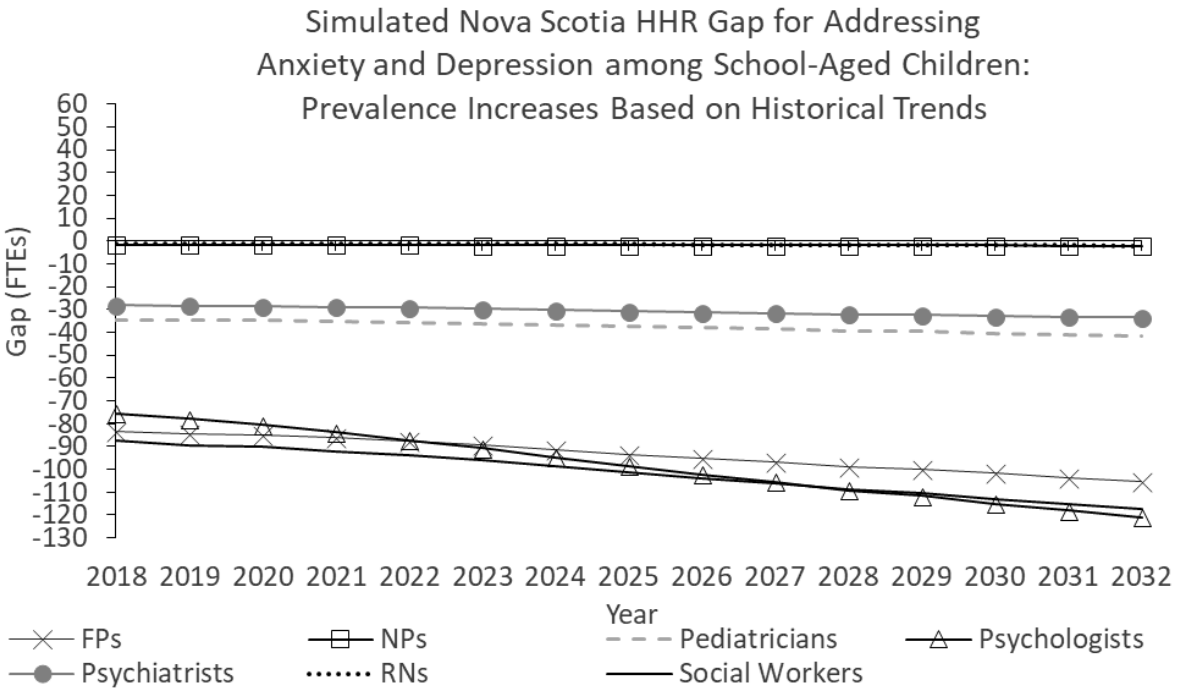
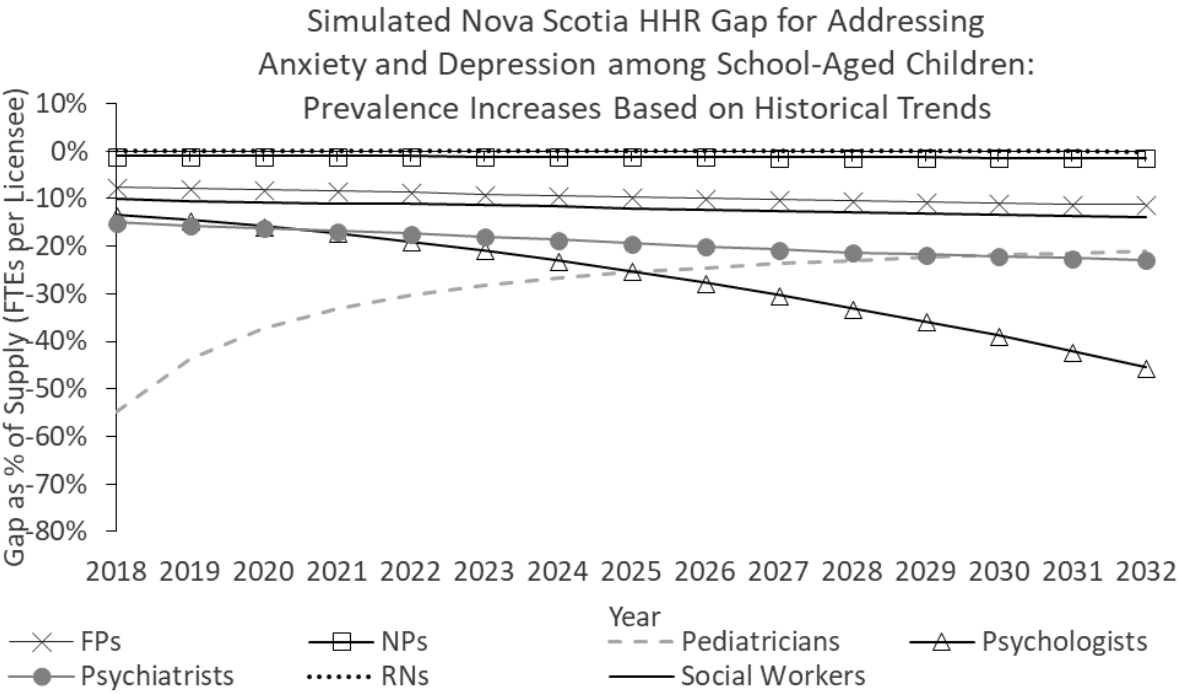


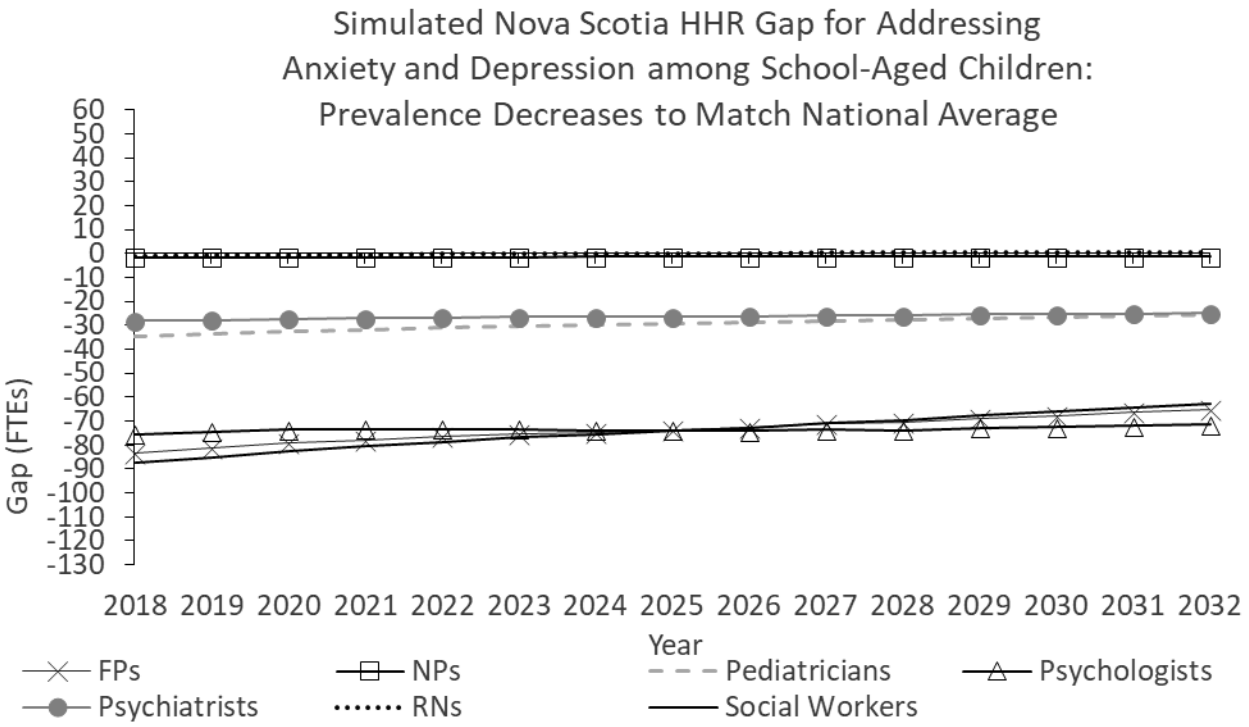
Figure 4.2b



The shortages increase in this scenario because, other things equal, more FTEs of each profession are required to care for a less healthy population.

Figures 4.3a and 4.3b shows the simulated Nova Scotia HHR gap for addressing anxiety and depression among school-aged children under a scenario in which all model parameters are held constant for the duration of the study period except population and health status.

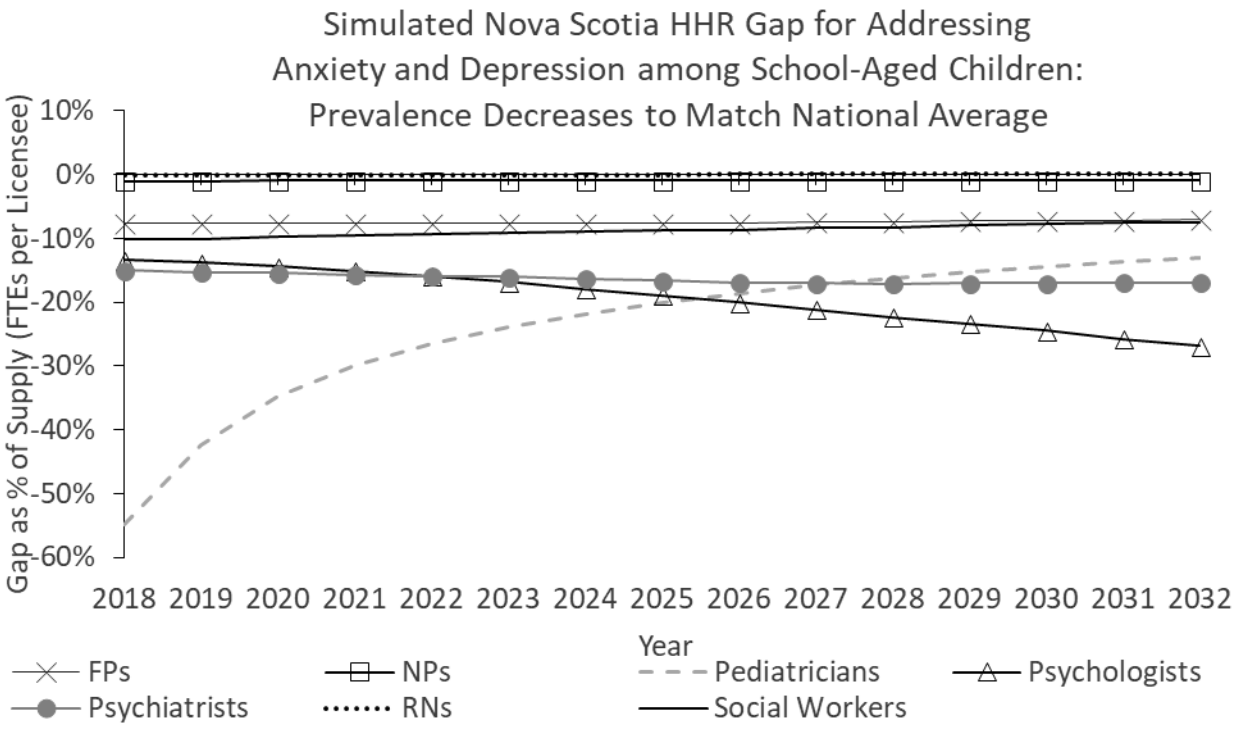
Figure 4.3a



In this scenario, the prevalence rates of anxiety and depression among school-aged children in Nova Scotia decrease to match national levels (Statistics Canada, 2016) by the end of the simulation period. Put another way, in this scenario, by the end of the

simulation period, anxiety and depression are no more common among Nova Scotia school-aged children than they are among school-aged children in Canada, on average.

Figure 4.3b



As a result of this improvement in health status, initial shortages of each profession decrease over the 15-year study period to varying degrees. The shortage of NPs decreases from 2 to 1 FTEs, and the initial shortage of 1 FTE RN becomes a surplus of 1 FTE. The initial shortages of psychiatrists and psychologists decrease by 3 and 4 FTEs, respectively, while those of FPs, pediatricians, and social workers respectively decrease by 18, 9, and 24 FTEs.

Level of Service Scenarios

Figures 4.4a and 4.4b show the simulated Nova Scotia HHR gap for addressing anxiety and depression among school-aged children under a scenario in which all model parameters are held constant for the duration of the study period except population and level of service. In this scenario, beginning in 2019, 50% of the psychotherapy sessions for children with mild or moderate depression and/or anxiety are delivered in a group setting and 50% through individual sessions. The most recently published (as of this writing) clinical practice guidelines for the treatment of these conditions in children and adolescents (Katzman, et al., 2014; National Collaborating Centre for Mental Health, 2015) are not specific as to the circumstances under which individual or group therapy may be preferable. This contrasts with the 'baseline' scenario in which 100% of these sessions are delivered in individual sessions.

The effect of this change is to reduce shortages of each profession beginning in 2019, with the size of the reduction varying according to how much of the psychotherapy to be delivered to this population is allocated to each profession. This change therefore has little impact on NPs, psychiatrists, and RNs (simulated shortages of which increase by 0-2 FTEs, much as in the baseline scenario).

Figure 4.4a

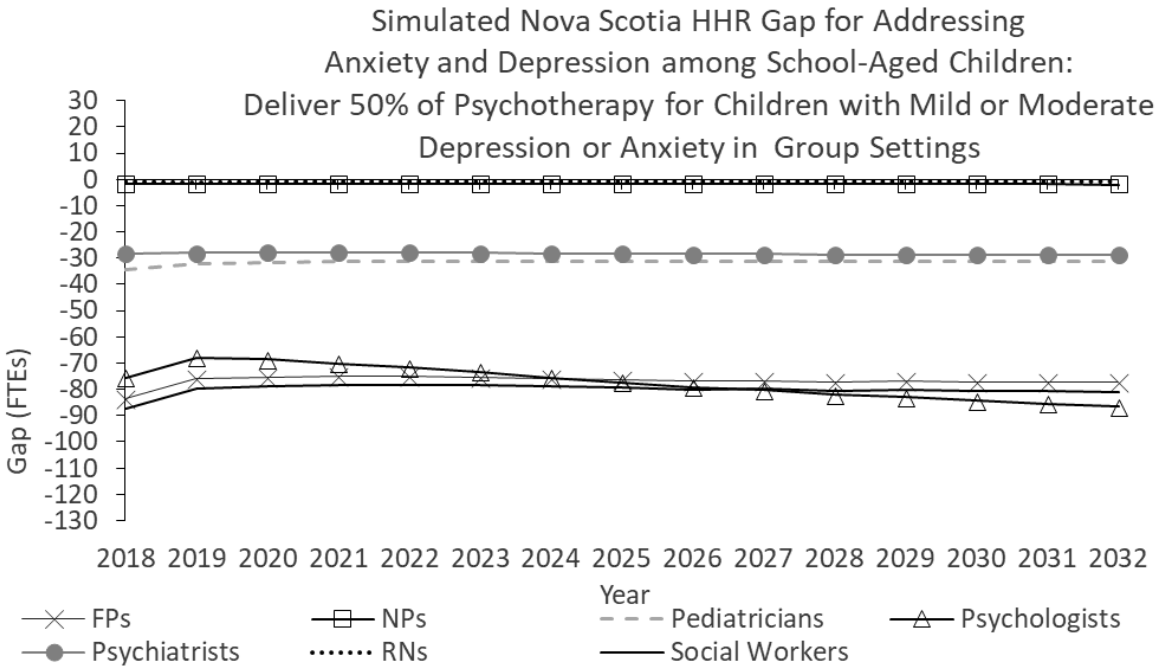
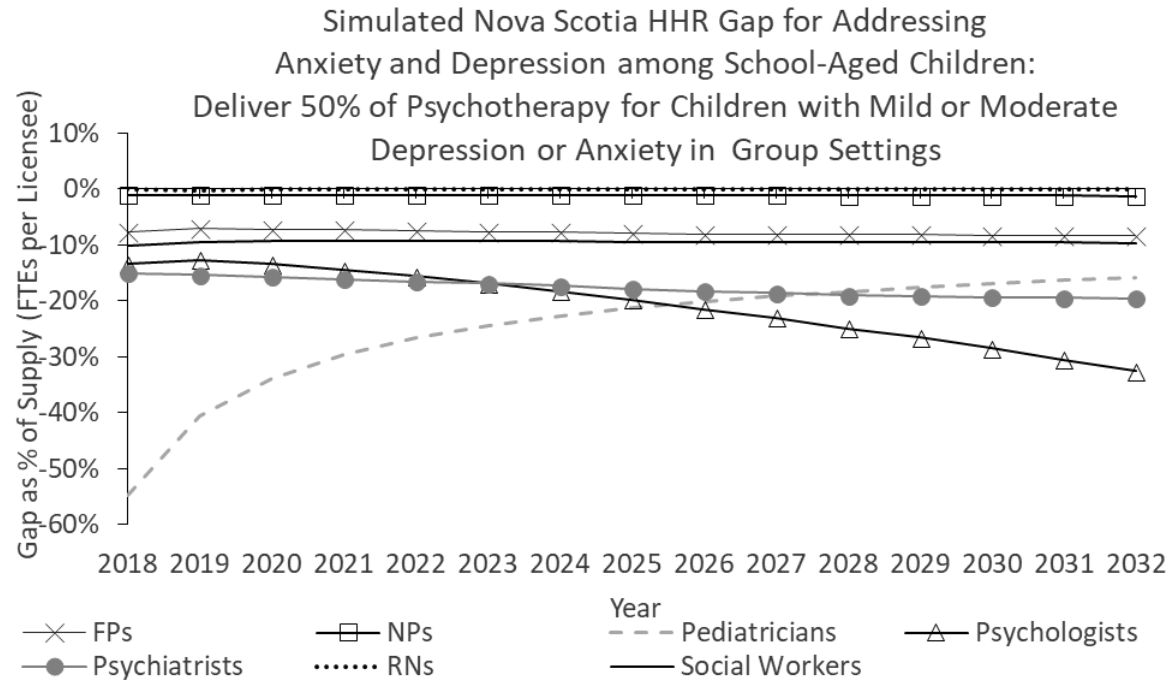


Figure 4.4b



In contrast, the simulated shortages of family physicians, pediatricians, psychologists, and social workers increase by 7, 3, 8, and 7 FTEs, respectively in 2019 compared to 2018.

Figures 4.5a and 4.5b show the simulated Nova Scotia HHR gap for addressing anxiety and depression among school-aged children under a scenario in which all model parameters are held constant for the duration of the study period except population and level of service. In this scenario, beginning in 2019, the levels of acute services – specifically, inpatient days and Emergency Department visits – provided to school-aged children with moderate or severe depression and/or anxiety are reduced by 50% and community-based group therapy sessions provided in their place.

Figure 4.5a

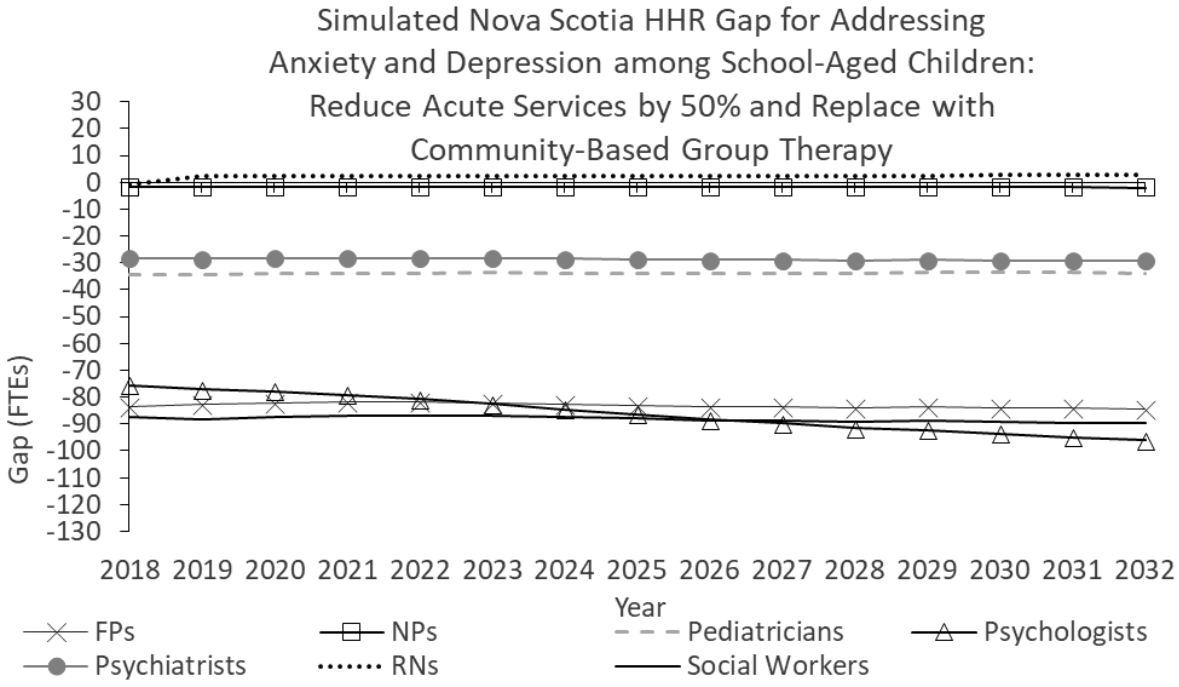
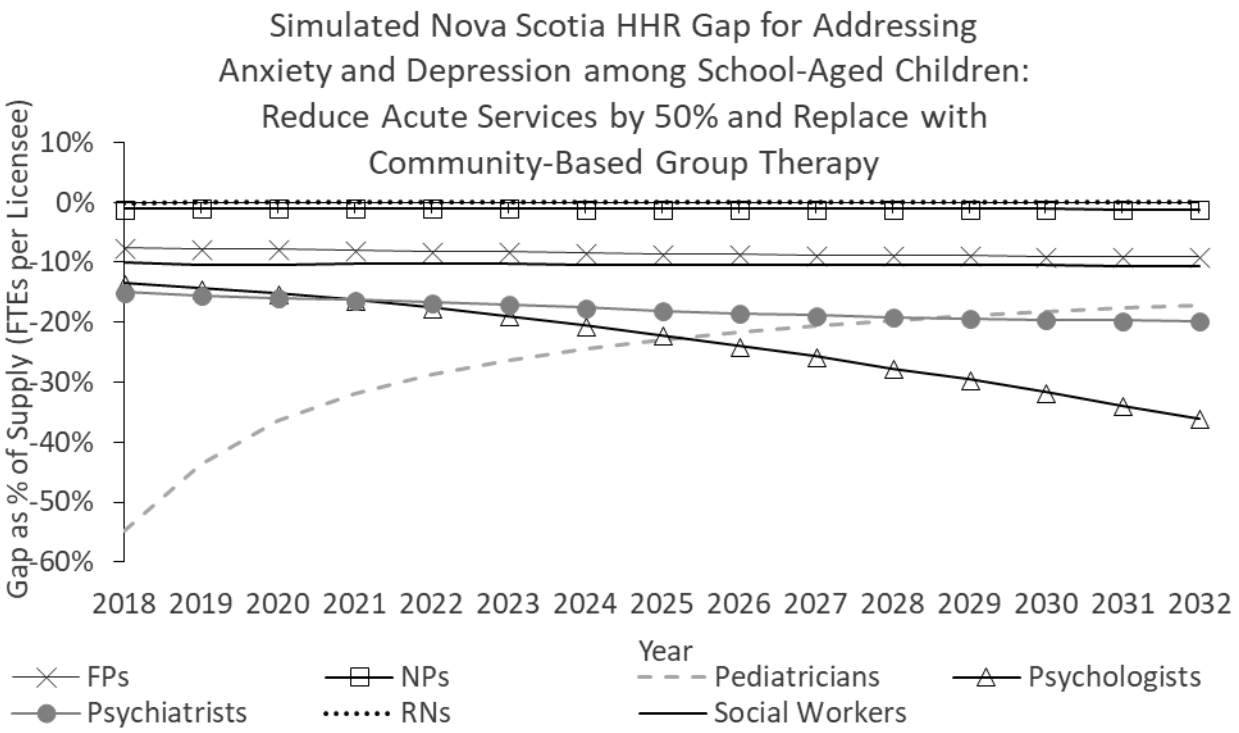


Figure 4.5b



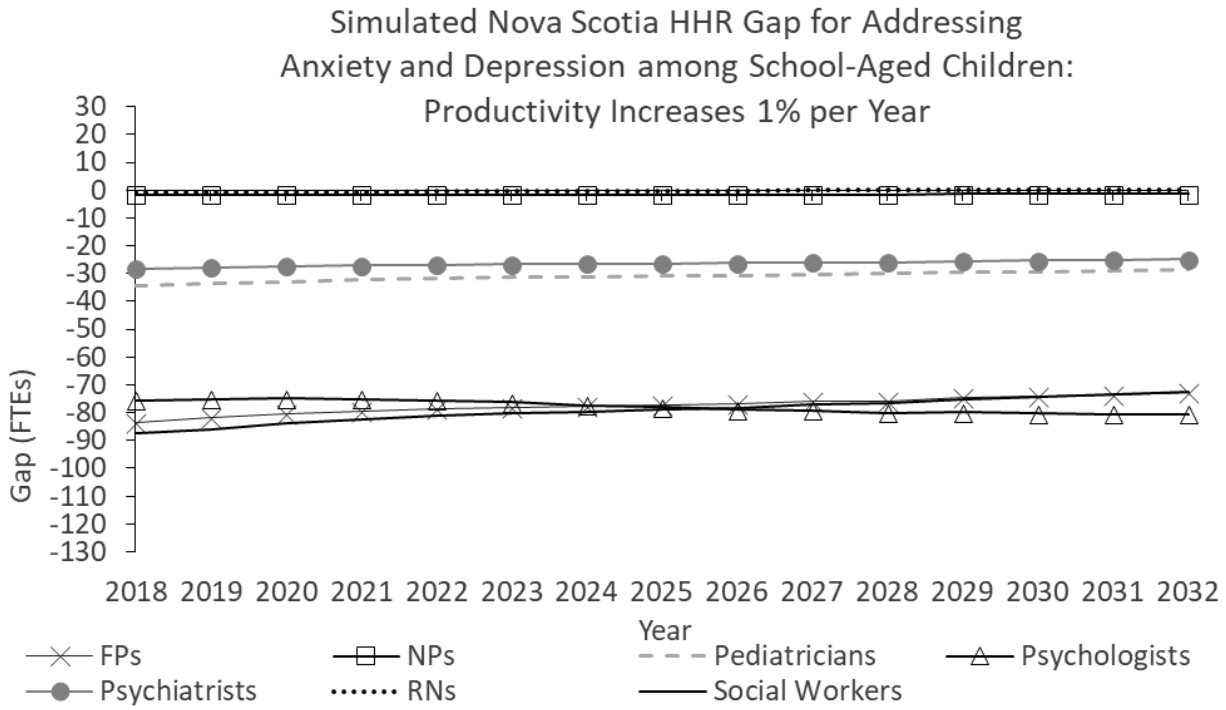
The effect of this change on each profession is to reduce requirements for professions who provide acute care and increase them for professions who provide community-based group therapy. As such, it has a relatively small impact on FPs and NPs, increases the simulated future shortages of pediatricians, psychiatrists, psychologists, and social workers, and turns the shortage of RNs to a surplus.

Productivity Scenarios

Figures 4.6a, 4.6b, 4.7a, and 4.7b show the simulated Nova Scotia HHR gap for addressing anxiety and depression among school-aged children under a scenario in which all model parameters are held constant for the duration of the study period except

population and productivity. In these scenarios, beginning in 2019, the rate at which members of each profession can be reasonably expected to perform each type of service[7] included in the model increases (in Figures 4.6a and 4.6b) and decreases (in Figures 4.7a and 4.7b) by 1% per year.

Figure 4.6a



[7] The productivity of different types of HHR has been found to be influenced – both positively and negatively – by a wide range of factors (Evans, Schneider, & Barer, 2010). Examples include care delivery models (McDonnell, Carpenter, Jacobsen, & Kadish, 2015) and processes (Sullivan, Soefje, Reinhart, McGeary, & Cabie, 2014), incentive structures (Brocklehurst, et al., 2013), and workplace culture (Dewa, Loong, Bonato, Thanh, & Jacobs, 2014).

Figure 4.6b

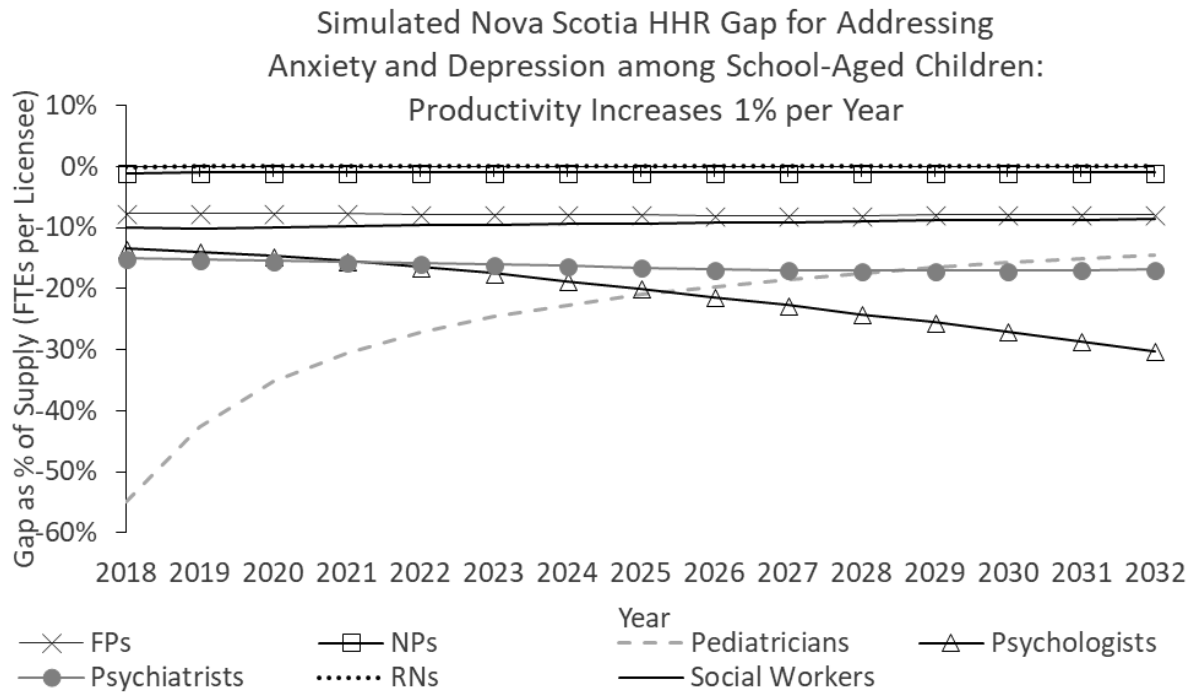


Figure 4.7a

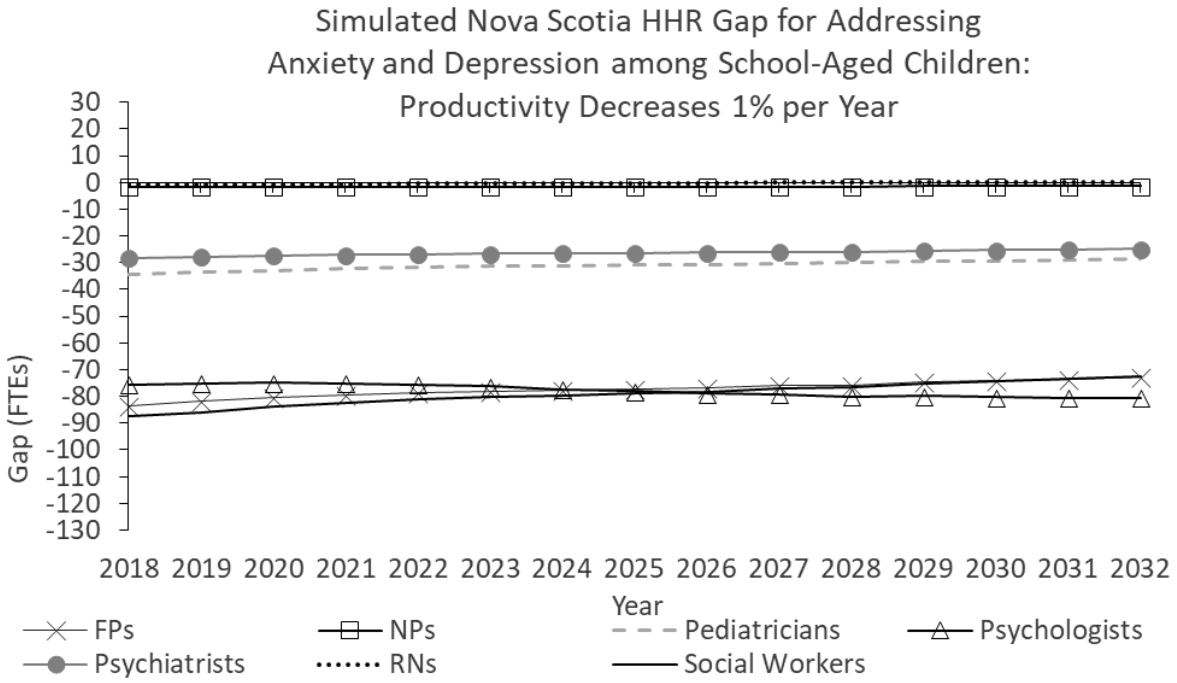
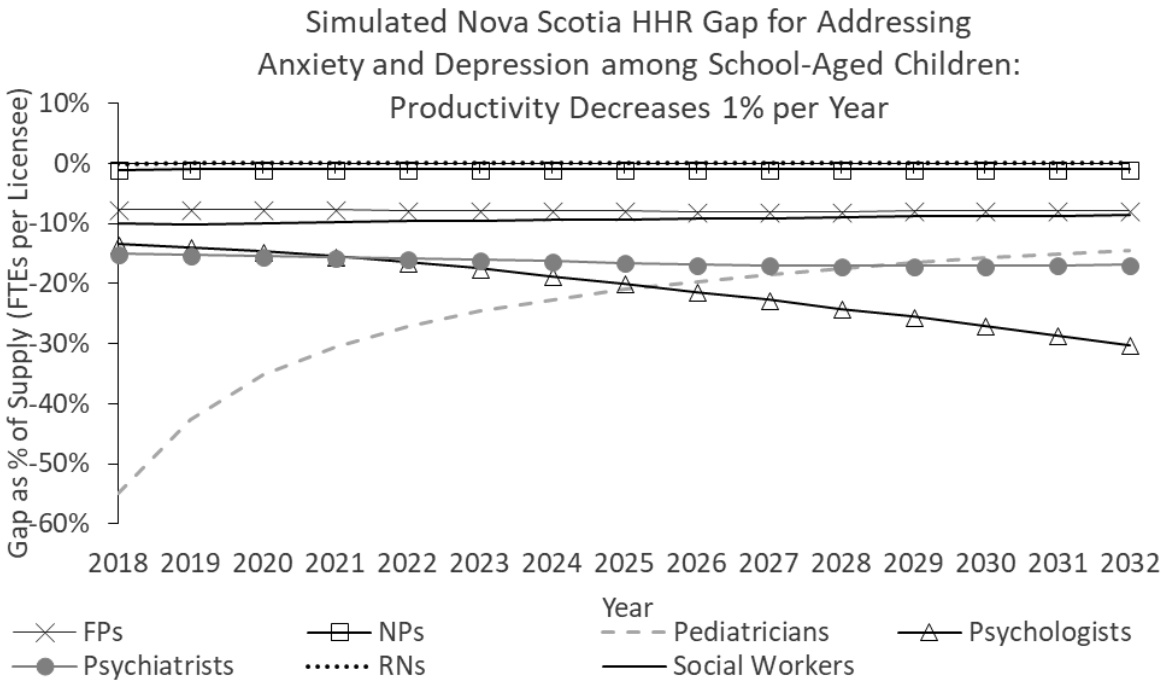


Figure 4.7b



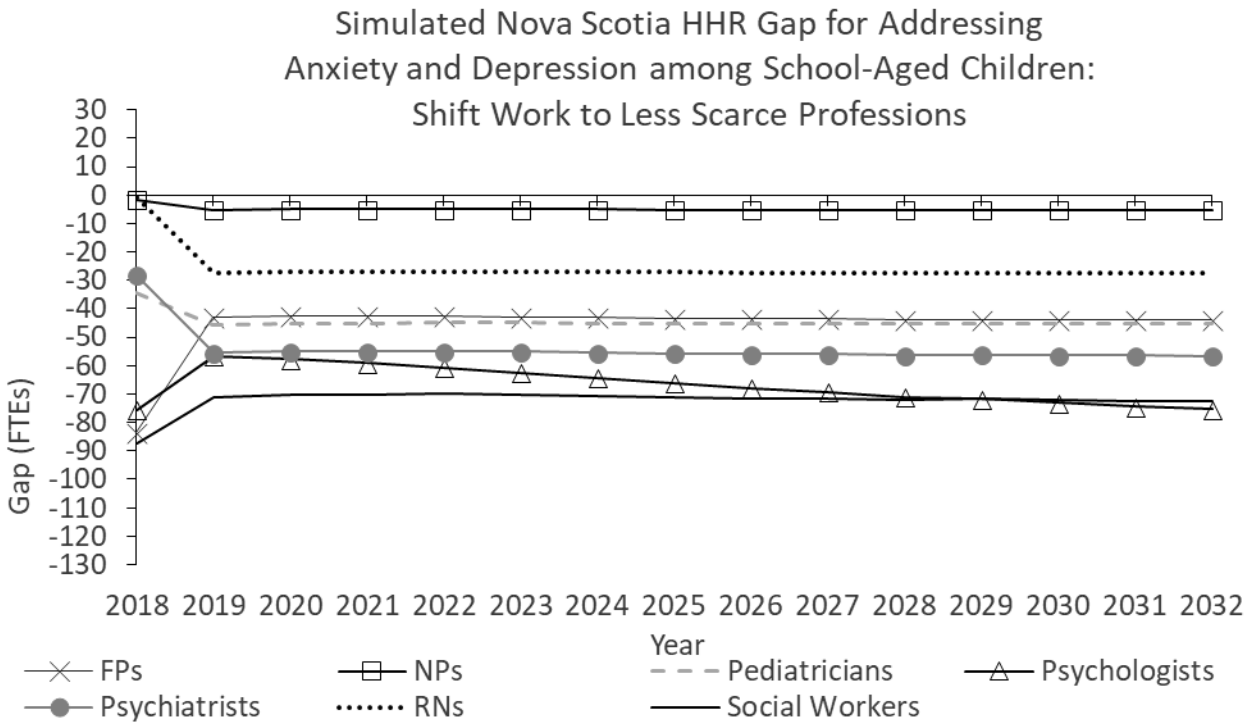
The effects of this change have the same magnitude but opposite direction in the two scenarios. In both cases, the size of the effect on the gap for each profession varies according to the proportion of the included services to be delivered by each profession; hence it has little impact on NPs and RNs. In Figures 4.6a and 4.6b, where productivity is increased, the effect is to reduce the size of simulated future shortages of each profession by 1-16 FTEs over the simulation period compared to the 'baseline' scenario.

In Figures 4.7a and 4.7b, where productivity is decreased, the effect is to increase the size of simulated future shortages of each profession – or, in the case of pediatricians, to decrease the size of the simulated future surplus – by 1-16 FTEs over the simulation period compared to the 'baseline' scenario.

Division of Work Scenarios

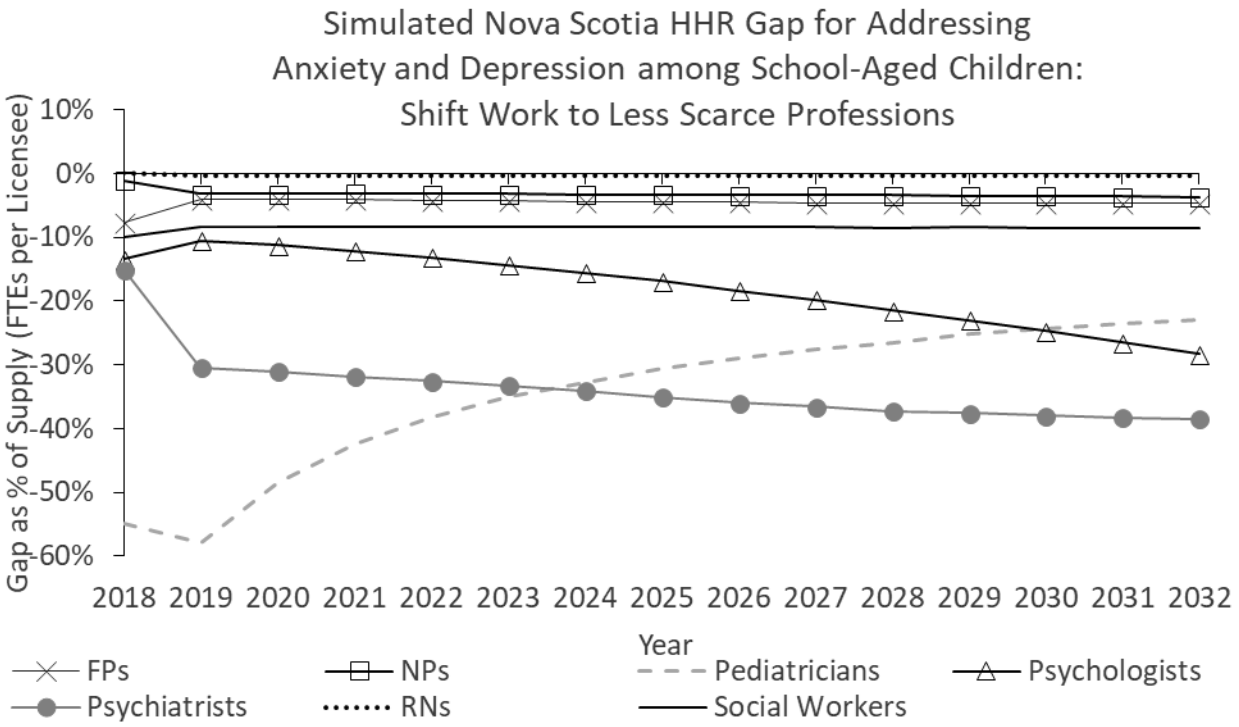
Figures 4.8a and 4.8b show the simulated Nova Scotia HHR gap for addressing anxiety and depression among school-aged children under a scenario in which all model parameters are held constant for the duration of the study period except population and division of work.

Figure 4.8a



In this scenario, beginning in 2021, the division of work for several services are shifted from relatively 'scarce' professions – physicians, psychologists, and social workers – to nurses, who are available in greater numbers.

Figure 4.8b



More specifically:

- Instead of 60% of diagnostic assessments being performed by psychiatrists and 20% each by psychologists and social workers, 10% are performed by family physicians, 5% by NPs, 10% by pediatricians, 40% by psychiatrists, 25% by psychologists, and 10% by social workers.
- RNs take on 40% of clinical assessments, reducing the proportions to be performed by FPs (from 15% to 10%), pediatricians (from 20% to 10%), psychiatrists (from 15% to 5%), psychologists (from 10% to 5%) and social workers (from 35% to 25%).

- Nurses take on 45% of care plan development (40% for RNs, 5% for NPs), reducing the proportions to be provided by FPs (from 10% to 5%), pediatricians (from 15% to 5%) and social workers (from 45% to 15%).
- Psychiatrists and pediatricians take on larger proportions (increasing from 1% and 9%, respectively, to 15% each) of individual psychotherapy sessions, reducing the proportions to be provided by FPs (from 30% to 15%) and psychologists (from 25% to 20%)[8].

Note that each of the services listed above are within the respective scopes of practice of the various professions to whom they are being shifted (Nova Scotia Department of Health, 2013). These changes have the effect of reducing the simulated future shortages of family physicians, psychologists, psychiatrists, and social workers, and increasing those of NPs, pediatricians, and RNs.

Figures 4.9a and 4.9b show the simulated Nova Scotia HHR gap for addressing anxiety and depression among school-aged children under a scenario in which all model parameters are held constant for the duration of the study period except population and division of work.

[8] As noted in the methods section, data on this parameter is not systematically collected in the province except for physicians. These values are intended as an example of a how the model can be used to simulate the implications of changes in how services are allocated across different types of HHR.

Figure 4.9a

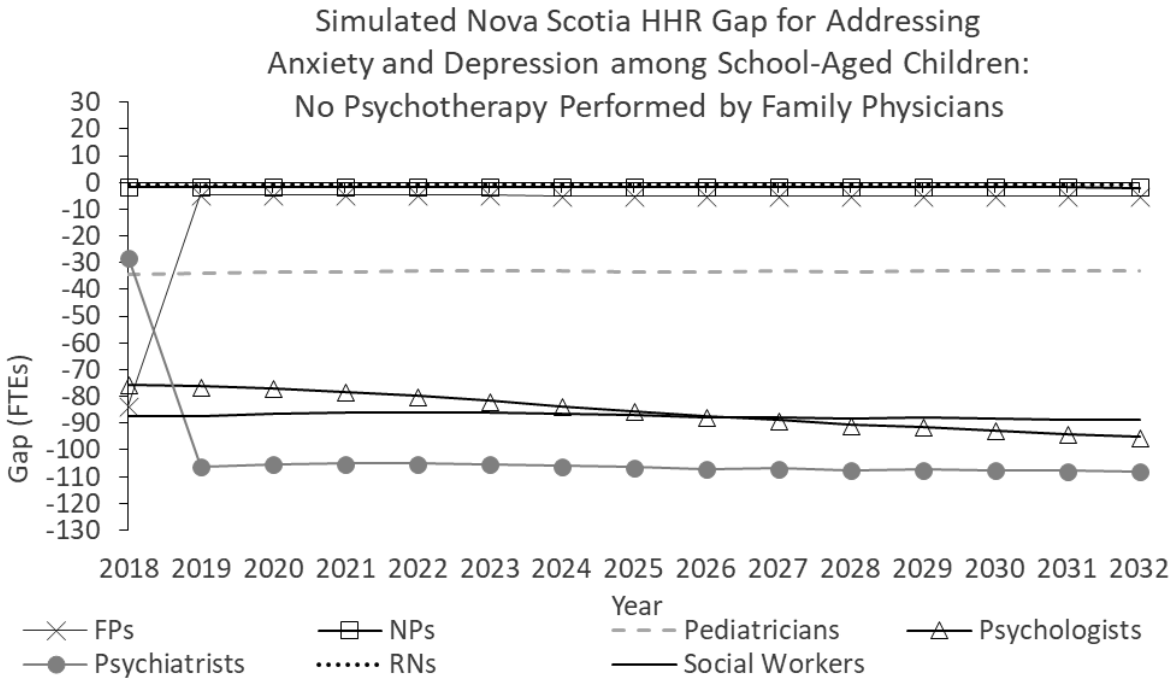
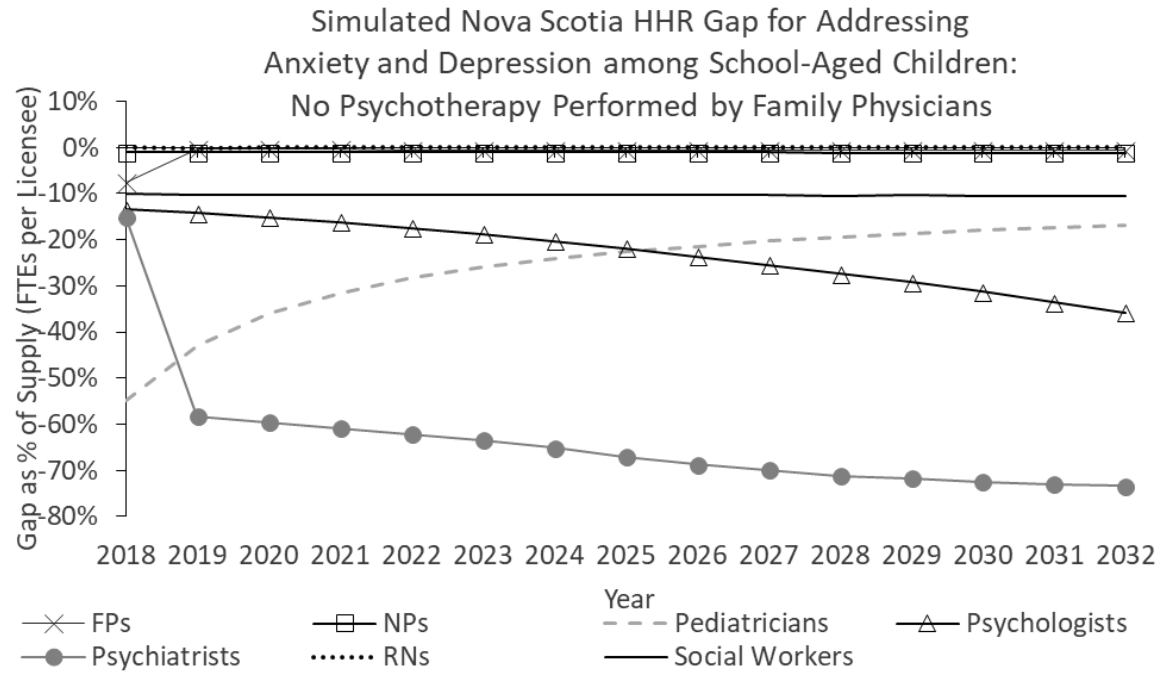


Figure 4.9b



In this scenario, beginning in 2019, the psychotherapy services performed by family physicians in the baseline scenario are instead performed by psychiatrists. Such a policy change may conceivably be made to ensure these services are delivered by physicians with specialized training in mental health care.

This has the effect of reducing the simulated future shortages of family physicians while increasing the simulated future shortage of psychiatrists. There is no effect on the other professions because the services they are expected to provide remain the same as in the 'baseline' scenario.

Clinical Focus Scenarios

Figures 4.10a and 4.10b show the simulated Nova Scotia HHR gaps for addressing anxiety and depression among school-aged children under a scenario in which all model parameters are held constant for the duration of the study period except population and clinical focus. In this scenario, the clinical focus of all professions except social workers are increased. More specifically, levels of clinical focus are increased from 0.4% to 2% for FPs, from 0.1% to 2% for NPs, from 1.8% to 10% for pediatricians, from 4.1% to 10% for psychiatrists, from 9.3% to 15% for psychologists, and from 0.1% to 1% for RNs.

Figure 4.10a

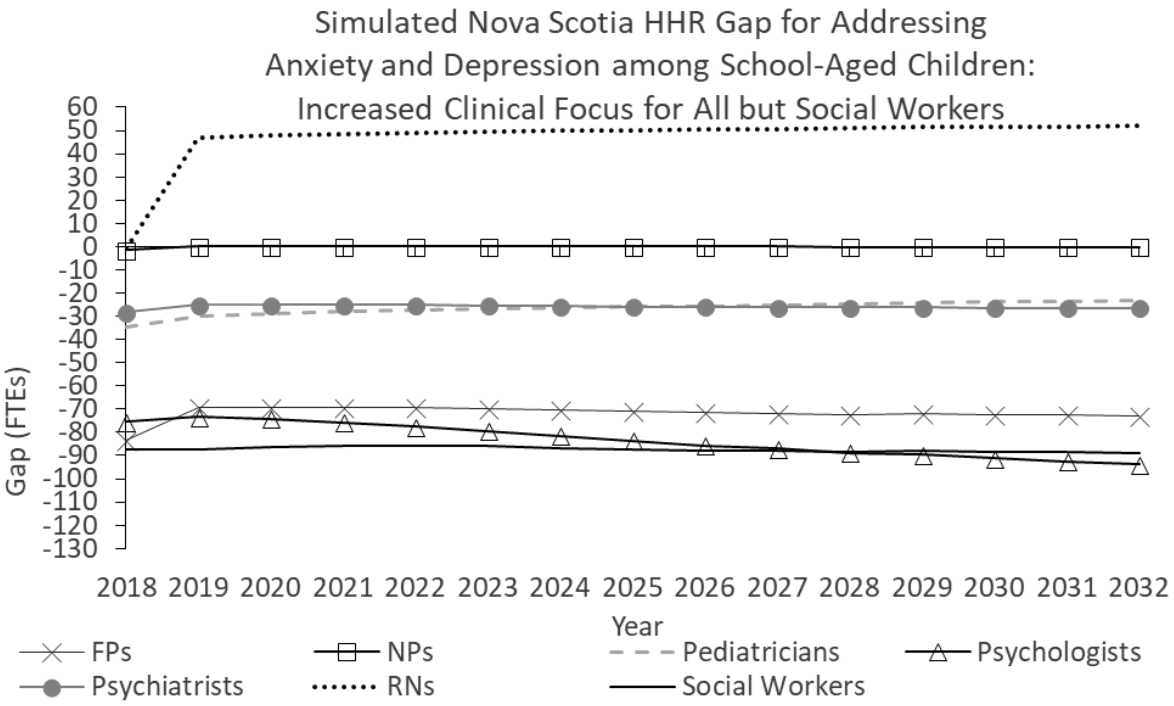
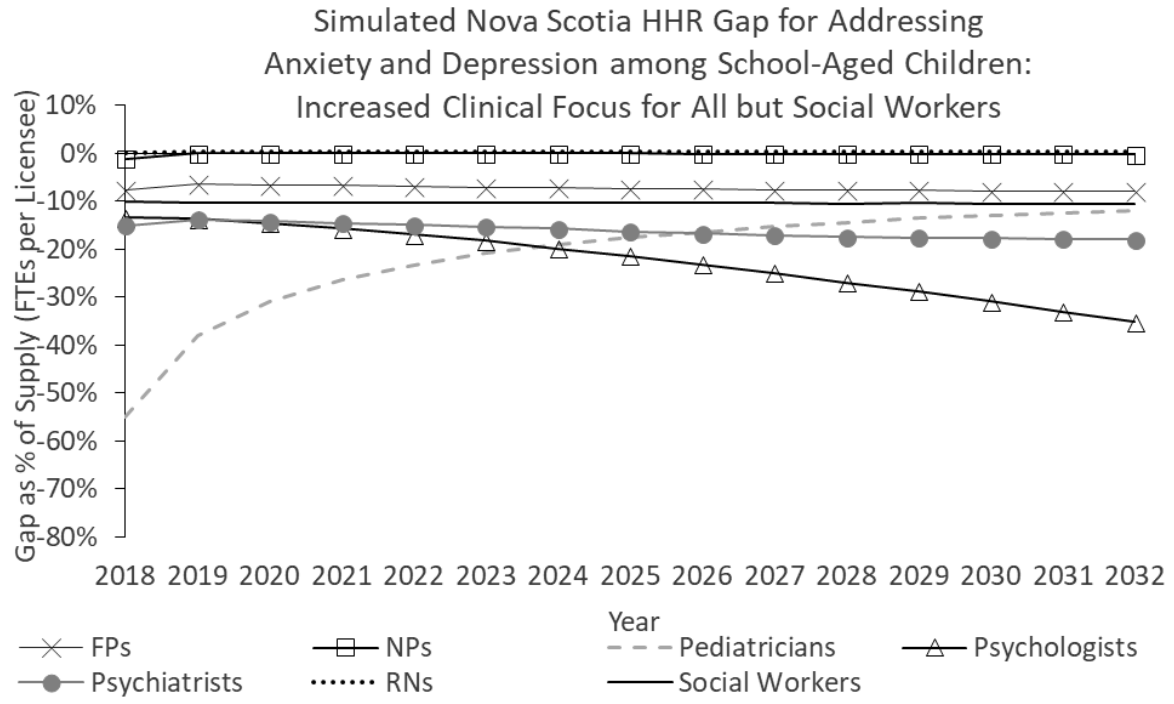


Figure 4.10b



The effect of these changes is to reduce the simulated future shortages of each of these professions. In the case of RNs, the simulated future shortage becomes a simulated future surplus.

Figures 4.11a and 4.11b show the simulated Nova Scotia HHR gap for addressing anxiety and depression among school-aged children under a scenario in which all model parameters are held constant for the duration of the study period except population and clinical focus. In this scenario, the clinical focus of social workers is reduced from 10% to 5% beginning in 2019. Such a policy change may be implemented, for example, to accommodate growing need for social workers' services outside the health care sector (Stratford, 2017).

Figure 4.11a

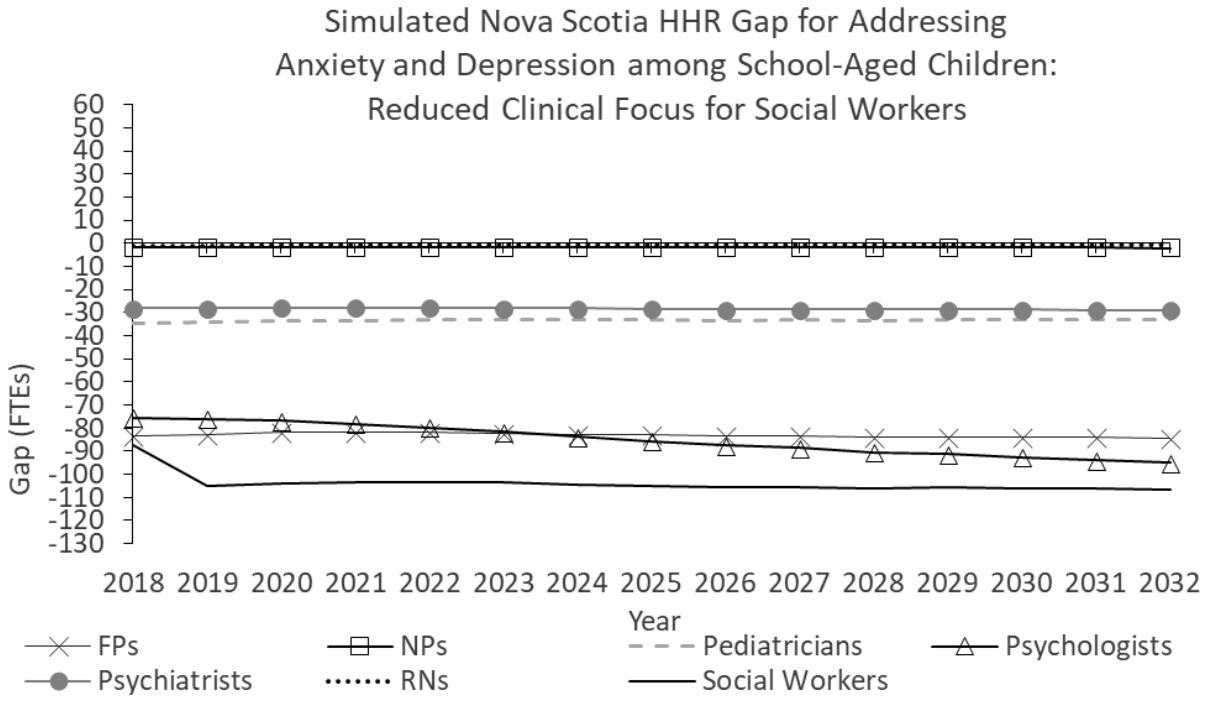
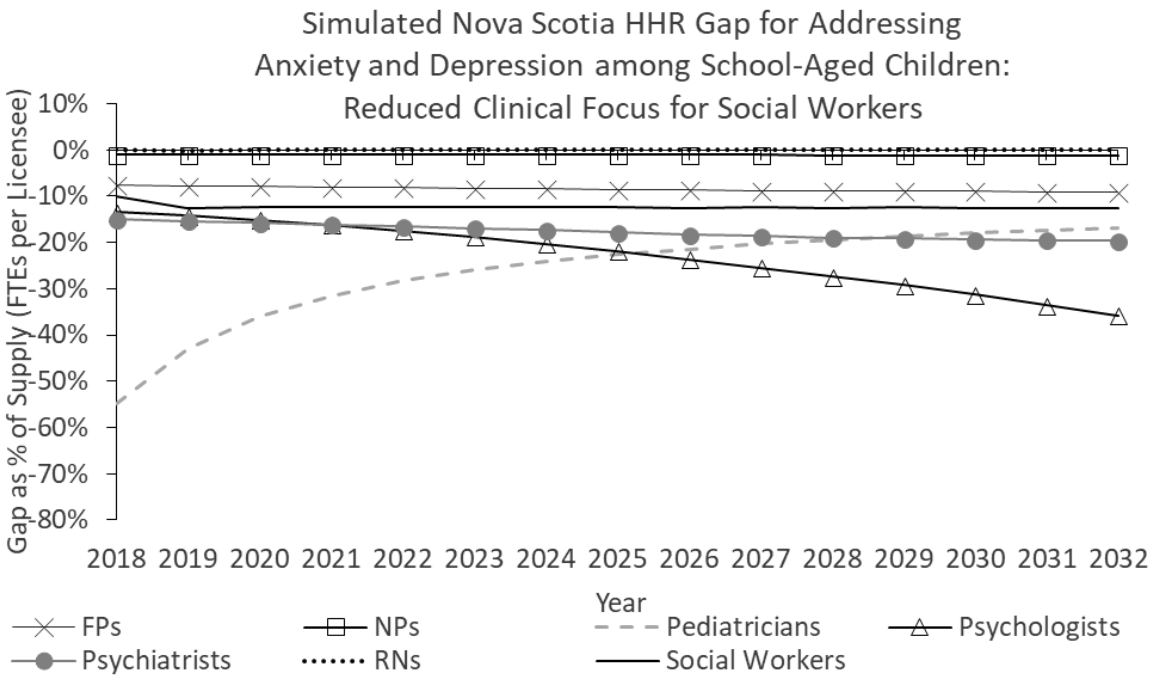


Figure 4.11b



This change increases the simulated future shortage of social workers from 89 to 107 FTEs compared to the 'baseline' scenario. The simulated gaps for the other professions are not affected.

Cumulative Scenario

Figures 4.12a and 4.12b show the simulated Nova Scotia HHR gap for addressing anxiety and depression among school-aged children under a scenario in which all model parameters are held constant for the duration of the study period except population, health status, level of service, division of work, and clinical focus.

Figure 4.12a

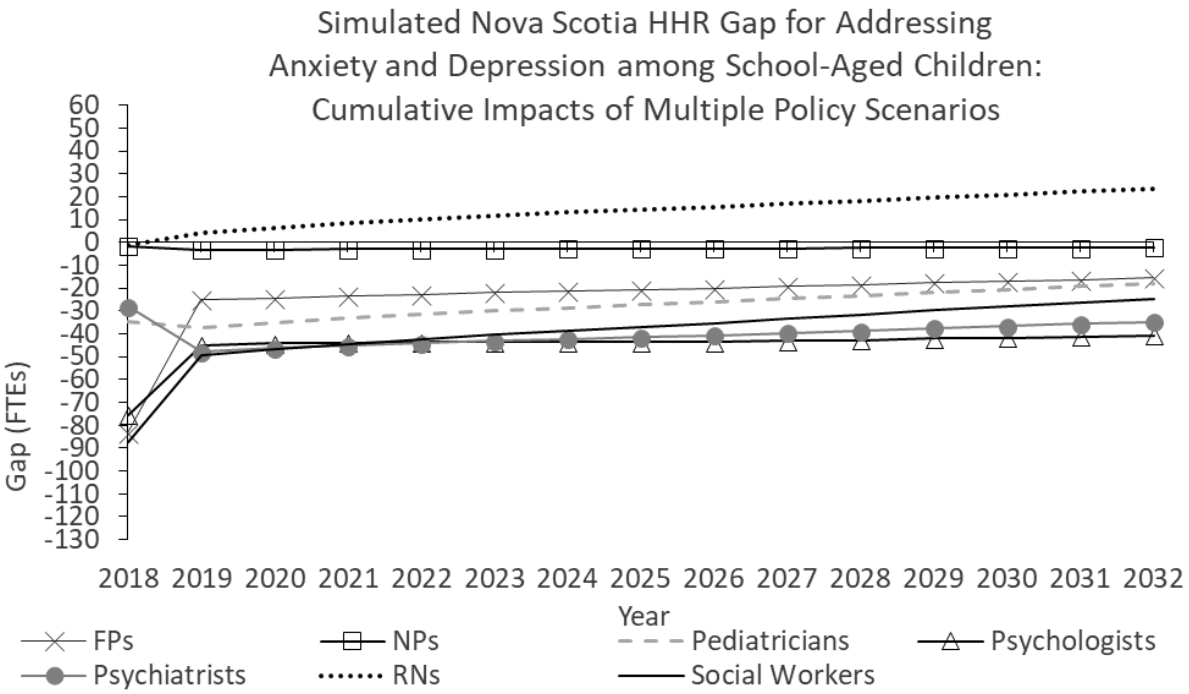
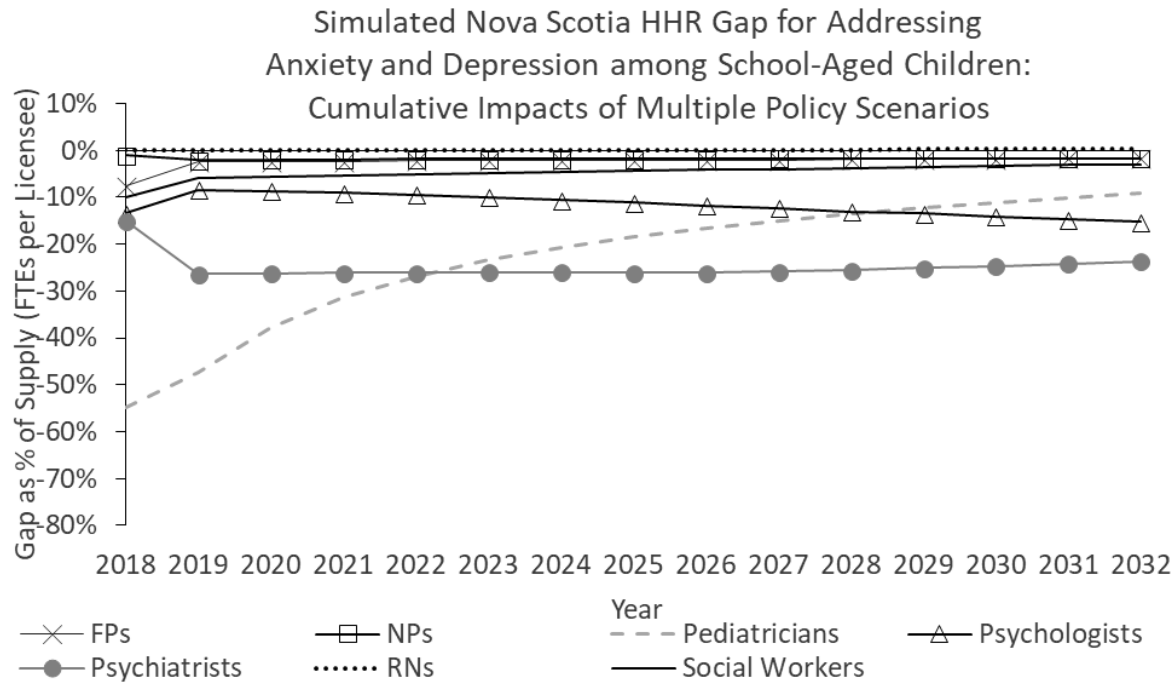


Figure 4.12b



This scenario combines the changes shown in figures 4.2, 4.3, 4.8, and 4.10. The cumulative effects of these changes are to reduce the simulated future gaps for each included profession to a larger degree than demonstrated by any of the individual scenarios presented above. Further, each shortage is trending toward a balance between supply and requirements, whereas in the 'baseline' scenario these shortages were either stable or increasing.

Summary of Quantitative Findings

The results presented above indicate that Nova Scotia currently lacks sufficient HHR to address anxiety and depression among its school-aged children using recommended standards of care. They further demonstrate how, without changes to the present value of key HHR planning parameters, existing shortages of family physicians, nurse practitioners, pediatricians, psychiatrists, psychologists, registered nurses, and social workers will increase through 2032.

More broadly, the simulations above show how the estimated future supply of and requirements for HHR can vary considerably depending on the assumed future values of key HHR planning parameters. They also demonstrate how, depending on the assumed set of future values for each planning parameter, these respective 'gaps' for these professions may range from substantial shortages to substantial surpluses. Finally, the results demonstrate how a multi-faceted set of policy changes could substantially reduce even large estimated future shortages of multiple professions.

Interview Results

As noted in the previous chapter, five Nova Scotia HHR planners were interviewed and asked the following questions:

1. Thinking about this model, are there features of it that you think would a) facilitate its use by your organization to inform HHR planning? b) make it difficult for your organization to use to inform HHR planning?
2. Thinking instead about the existing tools and procedures that currently make up your organization's HHR planning process, are there aspects of these that you think a) could be strengthened by incorporating this model? b) would make it difficult for your organization to incorporate this model?
3. Do you have any other comments about this model from the perspective of someone involved in HHR planning at the provincial level?

The presentation of the results of these interviews begins with a description of the technical and political factors participants identified as generally affecting the choice of models used in HHR planning in Nova Scotia. Next, the factors participants identified as facilitating the uptake of this planning model specifically into HHR planning in Nova Scotia are described. This is followed by a description of factors identified by participants as hindering its uptake.

Factors Affecting Choice of HHR Planning Model in Nova Scotia

Participants identified several inter-related technical and political factors that, in their respective experiences, combined to determine which models are used in HHR

planning in Nova Scotia. The balance between the relative complexity of the model and its comprehensiveness was identified as important for both technical and political reasons. This was identified as a technical factor because models of a certain complexity may require a degree of analytical capacity to understand and operate the model beyond what government and health authority partners have available to them. It was identified as a political factor because a relatively complex model may be too difficult to explain clearly to the various stakeholder groups with which HHR planners must work regularly, whereas a very simple model may be perceived as insufficiently comprehensive by these same stakeholders.

Two other technical factors identified by participants as affecting the choice of HHR planning model were the input data and software and/or hardware required to run a given model. It was noted that planners may be reluctant to adopt a model that requires input data to which they may not have direct access, or which may not be systematically collected in Nova Scotia. They may also hesitate to adopt a model that requires relatively expensive computer hardware, proprietary software, and/or ongoing licensing fees to use it.

Related to this point, participants also emphasized the importance of the technical and political capacities of provincial government and health authority personnel in determining the choice of HHR planning models they use. More specifically, limited technical capacity was identified as prompting decision-makers to rely on privately developed, outsourced HHR planning models rather than investing in an in-house approach. Further, limited political capacity to lead changes to HHR (and, more broadly,

health services) planning was identified as prompting planners to use simpler, more traditional approaches, regardless of their flaws. In contrast, higher levels of technical and political capacity on the parts of government and health authority personnel were identified as enabling investment in an approach such as the one described in this thesis.

The overarching political factor identified by participants as affecting the choice of HHR planning model in Nova Scotia was the buy-in of key stakeholder groups, particularly those representing the province's physicians. As noted above, stakeholder buy-in was viewed as being affected by the perceived complexity and comprehensiveness of the model; it was also identified as being affected by the degree to which the model's structure and components were perceived be consistent with stakeholders' respective experience with and understanding of the health care system in Nova Scotia. An additional consideration was the clarity with which the model's results or output were displayed. No participants suggested that any political party may have a preference for a particular type of HHR planning model.

Factors Hindering Uptake

Technical factors identified by participants as potentially hindering the uptake of the model used in the present study by HHR planners in Nova Scotia were its relative complexity, the large amount of data required to populate it, and the longer planning horizon it incorporates compared to those currently being used. A schematic of the model was described as 'potentially visually intimidating' to those used to comparatively simpler approaches; it was noted that potential could be mitigated by introducing and

explaining the model's components one at a time, using practical examples. One participant also questioned the model's applicability to planning for small populations (such as single communities) or programs (such as a single hospital unit).

Participants also identified several political factors as potentially hindering the use of this model for HHR planning in Nova Scotia. It was conjectured that its relative technical complexity, noted above, might also make it difficult to obtain buy-in from key stakeholders for the model's broad application. More specifically, it was noted that many stakeholders would not be familiar with directly incorporating concepts such as levels of service provision, division of work, productivity, and clinical focus into HHR planning processes.

Related to this point, participants noted that the types of questions the model is designed to answer, and its consequent structure, are fundamentally different from those of more traditional HHR planning approaches, and Nova Scotia's health care system is as resistant to change as any other. One participant cautioned that the potential advantages of such a model relative to simpler approaches currently in use may be lost on individuals not already familiar with the complexity of HHR planning, which they indicated would include the majority of health care policy-makers in the province. They reported that mental health service providers in the provinces in particular 'live and breathe poor workforce planning', and that a reliance on 'history, habit, and tradition' has been prevalent in planning for these services to date.

Participants also cautioned that the model and the application of it through the present study highlight several issues that some health care stakeholders may be reluctant to confront. These include:

- Several types of data important for HHR and health system planning – including but not limited to the actual benefits (if any) of most of the health care services provided in the province – are not systematically collected;
- There is widespread variation across the province in the amount and type of health care services available, as well as in the way clinicians choose to treat the same health conditions, and these variations are not systematically monitored; and
- The future in general – and the state of the province's HHR specifically – cannot be estimated with certainty. On this latter point, a participant noted that some of the province's health care stakeholders may be accustomed to treating the future as knowable because of past experience with simpler planning models that implicitly assume that much of the status quo will continue. The participant speculated that planners used to working with such models may find discussions of future uncertainty to be uncomfortable and, as such, 'static models may be more appealing' to such individuals.

Factors Supporting Uptake

The comprehensiveness of the model was identified by participants as, on the whole, a technical factor likely to contribute to its uptake by HHR planners. The inclusion of parameters typically absent from more traditional models – population

health, levels of service, productivity, division of work, and clinical focus – was described as an advantage over existing approaches, which typically do not explicitly account for any of these parameters. The inclusion of these parameters was described as making plans more 'executable'. The capacity to integrate planning for multiple professions was repeatedly cited by participants as a gap in existing approaches because, as one noted, the days of planning for one profession at a time must end if the health care system is to function optimally.

Participants also described a graphic representation of the model as being useful for communication purposes – specifically for illustrating various determinants of the supply of and requirements for HHR and the relationships between them. One participant specifically identified the transparency of the model structure, and the ability of technical personnel to update input data, as advantages over other, existing approaches whose inner workings are unknown. Another suggested development of a "child's guide" to the model for new users, explaining overarching concepts first followed by more detail on the specific parameters and the relationships between them.

Although, as noted above, participants cautioned that some health care stakeholders may be resistant to change of any nature, they also noted that the need for change is widely acknowledged – particularly the need to move HHR planning from planning for single professions in isolation to planning for team-delivered care. Hence they indicated that the difference in this model's structure would be, on balance, a technical and political strength rather than a hindrance. Moreover, participants reported that the more comprehensive structure of the model, and the degree to which it captures

more key planning parameters, would allow for the necessary political buy-in from key health care stakeholders. Practical application of the model, such as that occurring through the present study, was described as being likely to further support this buy-in. Overall, participants reported viewing the model positively, describing it as 'timely and helpful' and 'fundamentally sound', for example.

Summary of Qualitative Findings

Participating HHR planners identified several political and technical factors they expected to influence the degree to which the HHR planning model used in the present study might be adopted to inform HHR planning processes in the province. These largely had to do with the structure and complexity of this model relative to those traditionally used for this purpose. Participants reported the view that, overall, the model would be appealing to key health stakeholder groups in the province, and that incorporation of it into existing processes would help to improve HHR planning. In particular, participants highlighted the incorporation of key planning parameters, the transparent structure of the model, and the capacity to integrate planning for multiple professions as important strengths of this approach.

Summary of Results

The quantitative results identify some specific policy circumstances under which Nova Scotia's supply of HHR will – and will not – be adequate to address anxiety and depression among its school-aged children. In particular, adjusting levels of service

provision, division of work, and clinical focus are shown to have the largest impacts in reducing HHR shortages.

More broadly, they highlight the inherent uncertainty that must be considered in planning for the future, and specifically in planning for HHR to address anxiety and depression among school-aged children in Nova Scotia. Furthermore, they illustrate the implications of even modest changes to the future value of key planning parameters for the adequacy of the provincial HHR supply.

The qualitative findings confirm information presented in earlier chapters that existing HHR planning processes lack the capacity to consider – and thus to plan for – potential future changes to these parameters. This lack of capacity calls into question whether, if existing methods of HHR planning in the province are not changed, the policy circumstances needed to ensure the future adequacy of Nova Scotia's HHR supply – such as those illustrated in the quantitative results – can be articulated and implemented. The qualitative findings also suggest some specific knowledge translation strategies – such as explaining the model's components one by one, and using a specific application of the model as an example – that may be employed to increase the likelihood of such change being brought to bear.

In combination, the qualitative and quantitative findings identify the key technical and political factors determining the feasibility of applying this approach to HHR planning in Nova Scotia. Both the quantitative and qualitative findings highlight the lack of systematic data collection pertaining to key HHR and health system planning parameters as a barrier to applying any approach, including but not limited to the model

described in this thesis. Specifically, applying the model to achieve the first objective highlighted inadequate systematic data collection on population health status, levels of service provision, HHR productivity, division of work, and clinical focus, while the interviewees noted gaps in data for these parameters as a likely hindrance to its implementation.

The quantitative methods further identify important limitations of existing sources of planning data. The qualitative findings identify additional technical factors affecting the feasibility of applying this model – such as its associated hardware and software requirements – that were not evident from the quantitative findings. The qualitative findings further identify political factors affecting the feasibility of applying this approach – such as the perceived complexity and comprehensiveness of the model and associated buy-in of key health care stakeholders – that were likewise outside the scope of the quantitative methods. More broadly, the qualitative findings indicate that the political factors they identified are at least as important as the technical factors identified by the quantitative and qualitative methods.

CHAPTER 5: DISCUSSION AND CONCLUSIONS

Overview

This chapter begins by articulating the contributions of this thesis to the existing knowledge base regarding HHR planning methods, referencing relevant prior studies. Next, the limitations of the thesis are listed and their implications discussed. The implications for child and adolescent mental health services in Nova Scotia and for HHR planning more broadly are then presented. Areas for further study are outlined next. Finally, the conclusions of the thesis are presented.

Contributions

Providing access to health care services based on need is an objective of many publicly funded health care systems, including Canada's (Tomblin Murphy, Birch, MacKenzie, & Rigby, 2016). The degree to which this objective is achieved by a particular jurisdiction is directly related to the models chosen to plan its health care system. For example, widespread unmet needs for health care are to be expected if those needs are not considered in planning for service delivery. More than a decade ago, the importance of comprehensive planning models that determine health system and HHR requirements based on population health needs was recognized by Canada's federal, provincial, and territorial governments (Advisory Committee on Health Delivery and Human Resources, 2007) when they identified a needs-based conceptual framework as the potential basis for eventual pan-Canadian HHR planning (O'Brien-Pallas, Tomblin Murphy, & Birch, 2001). This framework provides the theoretical basis for this thesis.

Despite this recognition, and the availability of increasingly comprehensive planning models, the continued use of fundamentally flawed approaches to HHR planning remains the norm across Canada and worldwide (Cameron Health Strategies Group, 2009; MacKenzie, Birch, & Tomblin Murphy, 2012; Ono, Lafortune, & Schoenstein, 2013; Tomblin Murphy, Birch, MacKenzie, Bradish, & Elliott Rose, 2016). This thesis addresses this problem in two ways. First, it demonstrates the practical application of a more comprehensive planning model than others currently in use, one which builds on the existing methodological base already available to HHR planners (e.g., (Tomblin Murphy, Birch, MacKenzie, & Rigby, 2016; Tomblin Murphy, Birch, MacKenzie, Rigby, & Langley, 2017). In the process, applying this model also revealed strengths and weaknesses of existing data sources to support health system and HHR planning in Nova Scotia. Second, it provides evidence as to why HHR planners may have been reluctant to adopt such approaches and what factors might support their adoption going forward.

A more comprehensive HHR planning model

This thesis represents the only known application of a dynamic, multi-professional, needs-based HHR planning model to a specific health care context, despite the importance of such approaches for HHR planning for reasons that have been articulated in more detail in previous chapters. Briefly, dynamic approaches are needed to enable planners to anticipate the potential impacts of changes to planning parameters over time. This capacity is absent from, for example, the multi-professional, needs-based models described by Thomas, Konrad and colleagues (Konrad, Ellis, Thomas, Holzer, &

Morrissey, 2009; Thomas, Ellis, Konrad, Holzer, & Morrissey, 2009; Thomas, Ellis, Konrad, & Morrissey, 2012) and by Tomblin Murphy, Birch and colleagues (Tomblin Murphy, et al., 2006; Tomblin Murphy, et al., 2013; Tomblin Murphy, et al., 2013; Goma, et al., 2014; Tomblin Murphy, Birch, MacKenzie, Rigby, & Langley, 2017). Multi-professional models are needed because, as available health promotion strategies, and treatments and individual patients' health care needs become more complex, addressing those needs increasingly requires the services of more than one type of health care provider. More broadly, health care is increasingly being provided through team-based approaches (Reeves, Lewin, Espin, & Zwarenstein, 2010, p. 26; Curson, Dell, Wilson, Bosworth, & Baldauf, 2010; Jones, Bhanbhro, Grant, & Hood, 2013; Morgan, Pullon, & McKinlay, 2015; Klaasen, Bowman, & Komenda, 2016; Nova Scotia Health Authority, 2017). The capacity to incorporate planning for multiple professions in a single model is absent from, for example, the dynamic, needs-based models described by Tomblin Murphy, Birch and colleagues (Birch, et al., 2004; Tomblin Murphy, et al., 2006; Tomblin Murphy, Alder, Pelletier, & MacKenzie, 2007; Tomblin Murphy, Alder, & MacKenzie, 2008; Tomblin Murphy, et al., 2009; Guy-Walker, et al., 2011) (Tomblin Murphy, et al., 2012; Tomblin Murphy, MacKenzie, Walker, & Guy-Walker, 2014; Tomblin Murphy, Birch, MacKenzie, & Rigby, 2016). Finally, models that estimate health care service requirements as a function of population health needs 1) are consistent with the overarching purpose of the Canadian health care system (Health Canada, 2012); 2) allow for the explicit consideration of potential inefficiencies in the allocation of HHR relative to population health needs (Birch, et al., 2007; Lewis, 2013; Birch, Mason,

Sutton, & Whittaker, 2013; Birch, Tomblin Murphy, MacKenzie, & Cumming, 2015; Tomblin Murphy, Birch, MacKenzie, & Rigby, 2016; Tomblin Murphy, Birch, MacKenzie, Rigby, & Langley, 2017); and 3) are consistent with calls from multiple key health care stakeholder groups in Canada to better align health care system and HHR planning with population health needs (CNA & CMA, 2005; Nova Scotia Department of Health, 2005; Nunavut Health and Social Services, 2005; Health Action Lobby, 2006; Advisory Committee on Health Delivery and Human Resources, 2007; HealthForce Ontario, 2008)(Saskatchewan Ministry of Health, 2011; British Columbia Ministry of Health, 2012; British Columbia Ministry of Health, 2015; Government of Newfoundland and Labrador, 2015). The capacity to account for differences in need for care and associated service requirements within populations and/or over time is absent from most existing HHR planning models.

As noted in earlier chapters, each model parameter can be thought of as a potential policy ‘lever’ for aligning HHR supply and requirements. The model parameters vary in the degree to which they affect the estimates of HHR supply and requirements it produces. On the requirements side, since each parameter is effectively 'multiplied' by the other to yield a number of required FTEs, the parameters are of equal mathematical importance. On the supply side, the further back up the 'production' line a parameter is, the less immediate impact it has on the estimate of available FTEs. For a given profession, this 'lag' in impact is directly determined by the duration of the educational programs for that profession - the effects of changes to entry-to-practice training on supply do not begin to materialize until (at least) the duration of that training has elapsed,

so changes to, say, a two-year program (such as family medicine residency) affect the gap sooner than changes to a five-year program (such as psychology).

As noted in the literature review, the approach published by Gallagher and colleagues (Gallagher, Kleinman, & Harper, 2010; Gallagher, Lim, & Harper, 2013) is, like the present approach, both dynamic and multi-professional. Limitations of both approaches include that they do not explicitly incorporate contextual factors such as political or environmental variables that influence both care delivery and the need for care, and that they lack feedback mechanisms.

The reports by Gallagher and colleagues on the application of their approach mention challenges with data availability similar to several of those encountered in the present study. Given that accurate information on such parameters as the range of services provided by different professions, and the working patterns of those professions, have implications far beyond HHR planning, improvements to the availability of data are needed not only to support more comprehensive HHR planning but more comprehensive health system planning overall. The approach described by Gallagher and colleagues appears to have the capacity to function as a needs-based model, though no application of it in this manner appears to have been published. An advantage it offers over the present approach is that it includes estimates of costs (though how it arrives at these estimates is not explained) and the capacity to optimize the mix of care providers relative to these costs. A disadvantage of their approach is that it does not explicitly account for the various determinants of HHR stock, instead assuming constant annual inflows and outflows based on historical data. This means that their approach is less able to consider

and compare the potential impacts of changes to, for example, international recruitment programs or the size of enrolments in health professional education programs. Both of these types of policy changes are frequent topics among HHR planners in Nova Scotia (Walsh, 2017; Province of Nova Scotia, 2018).

Evidence on factors affecting choice of HHR planning model

As illustrated in the literature review, the question of what factors affect the choice of HHR planning models has received little attention from the research community. The bulk of existing literature on this topic is in the form of opinion pieces, with most of the remainder consisting of manuscripts written by separate sets of planners from Alberta Health Services in Canada (Bloom, Duckett, & Robertson, 2012), the United Kingdom's Centre for Workforce Intelligence (United Kingdom Centre for Workforce Intelligence, 2012), the Netherlands Institute for Health Services Research (Van Greuningen, Batenburg, & Van der Velden, 2012), Health Workforce New Zealand (Gorman, 2015), and Health Workforce Australia (Crettenden, et al., 2014). Each of these reports is primarily aimed at communicating the structure and outputs of the planners' respective HHR planning models, and only briefly explains the planners' rationales. The exception seems to be an evaluation of the New Zealand approach by Naccarella and colleagues, whose focus was more broadly on the perceived effectiveness of the process; the focus of the paper was not on the structure and outputs of the New Zealand approach or the reasons for the selection of this approach (Naccarella, Greenstock, & Wraight, 2013). The empirical evidence provided through this thesis as to the factors affecting the

choice of planning model by HHR planners in Nova Scotia is therefore a rare contribution to the existing base. Some of the findings presented here are consistent with views published previously, while others are not. These similarities and differences are outlined below.

In the former category, participants emphasized the importance of relationships between planners and key stakeholders as a potential mechanism for supporting that buy-in. This echoes the views expressed by Tejada-de-Rivero and by Mejía and Fülöp forty years ago (Tejada-de-Rivero, 1978; Mejía & Fülöp, 1978) as well as those reported by planners in Alberta (Bloom, Duckett, & Robertson, 2012), the United Kingdom (United Kingdom Centre for Workforce Intelligence, 2012), and New Zealand (New Zealand Ministry of Health, 2014) more recently. Tomblin Murphy and colleagues have also highlighted the importance of an HHR planning approach that can accommodate scenarios of interest to planners and other stakeholders (Tomblin Murphy, et al., 2012; Tomblin Murphy, MacKenzie, Walker, & Guy-Walker, 2014). Participants' perceptions of the influence of physicians over the choice of HHR planning models align with views expressed by numerous authors over the past several decades, as outlined below.

The importance of planning capacity among HHR decision-makers highlighted by participants is consistent with the views of Mejía and Fülöp (Mejía & Fülöp, 1978) as well as Hall and Kleczkowski (Hall & Kleczkowski, 1978). Related to this, participants' highlighting the importance of decision-makers' capacity and willingness to consider and, potentially, lead policy change is consistent with factors identified by Mejía and Fülöp (Mejía & Fülöp, 1978), the UK's Centre for Workforce Intelligence (United

Kingdom Centre for Workforce Intelligence, 2012), and Health Workforce New Zealand (New Zealand Ministry of Health, 2014). In past applications of their needs-based HHR planning approaches, Tomblin Murphy and colleagues have repeatedly emphasized the importance of building capacity among HHR planners (Tomblin Murphy, et al., 2009; Tomblin Murphy, et al., 2010; Guy-Walker, et al., 2011).

Mejía and Fülöp identified the natural complexity of its health care systems as influencing the approach to HHR planning used in a given jurisdiction (Mejía & Fülöp, 1978), while Hall indicated that an HHR planner's choice of model would ultimately be dictated by the degree to which they felt the model was consistent with their view of how the system functioned (Hall T. , 1978). The UK Centre for Workforce Intelligence selected its planning model in part because of the degree to which it logically represented the relationships between key planning parameters (United Kingdom Centre for Workforce Intelligence, 2012). Comments by participants that the model's complexity relative to others, and the degree to which it more comprehensively incorporates relevant planning parameters and the relationships between them, will be important in determining its uptake are consistent with these views.

Several participants cautioned that the availability of data to populate the model used in the present study might affect its uptake among HHR planners. This is consistent with data availability being used to guide the choice of model used by Health Workforce Australia (McCarty & Fenech, 2012; Crettenden, et al., 2014). The implications of gaps in the health system planning data available in Nova Scotia are discussed later in this chapter.

Lastly, the degree to which planning models facilitate communication with key stakeholder groups was noted as being an important factor in its uptake by planners in the UK (United Kingdom Centre for Workforce Intelligence, 2012), New Zealand (Naccarella, Greenstock, & Wraight, 2013; New Zealand Ministry of Health, 2014), and Germany (Kuhlman, Lauxen, & Larsen, 2016). Tomblin Murphy and colleagues have repeatedly highlighted the importance of their approach as a communication tool for facilitating a common understanding of key planning parameters among diverse groups of health care stakeholders (Tomblin Murphy, Alder, Pelletier, & MacKenzie, 2007; Tomblin Murphy, et al., 2010; Tomblin Murphy, et al., 2012; Tomblin Murphy, MacKenzie, Walker, & Guy-Walker, 2014). This view was echoed by participants in the present study.

There were several factors identified by other authors as influencing the choice of models by HHR planners that were not raised by participants in the present study. The national political structure, legislative environment, type of society, and public expectations were identified by Hall and Kleczkowski (Hall & Kleczkowski, 1978) as potentially determining uptake of a particular planning model, and predictive power was identified as being important in the Netherlands context (Van Greuningen, Batenburg, & Van der Velden, 2012; Van Greuningen, Batenburg, & Van der Velden, 2013). None of these issues was raised by participants during interviews for the present study.

Limitations

The limitations of the qualitative methods are presented first, followed by those of

the quantitative methods.

Qualitative Limitations

A limitation of the qualitative methods used is the fact that the interviewer was known by the participants to be the person responsible for developing the model whose potential to inform planning they were being asked to help assess. There is therefore potential for participants' comments to be biased – consciously or unconsciously – toward positive assessments of the model's potential (Creswell, 2009, pp. 120-121).

Another limitation of the qualitative methods stemmed from the choice not to record the interviews, which meant that they could not be transcribed. Transcription would have enabled a more fulsome analysis that may have revealed more subtle relevant points in – and perhaps across – interviewees' responses that were not immediately apparent during the interviews themselves (Creswell, 2009, pp. 175-178) .

Quantitative Limitations

An overarching limitation of the use of models to plan for the future is that no future value of any planning parameter can be estimated with certainty. Further, the uncertainty inherent in such estimates increases the further in the future they are conducted.

A structural limitation of the model used in this study is that it does not include all the components that make up the conceptual framework from which it has been derived. More specifically, the model is less comprehensive than the conceptual framework in

four ways. 1) The broader contextual factors – social, political, environmental, economic, and technological – that affect not only population health needs but also shape both the health care system's response to those needs as well as outcomes at the patient, provider, and system levels – are not represented as model components. This is because the exact nature of the relationships between these contextual factors and existing model parameters have not been quantified to the degree that they can be expressed deterministically. 2) The model is applied at the provincial level and does not specify how many of which type of HHR are available or required in different parts of the province. 3) Although some provider- (e.g., exits) and system-level (i.e. HHR shortages) outcomes are included in the model, these reflect only a subset of those relevant to HHR planning. More broadly, the model parameters represent a small subset of the wide range of factors influencing the labour market for HHR (Vujicic & Zurn, 2006; McPake, et al., 2013; Buchan, Twigg, Dussault, Duffield, & Stone, 2015; Amick, McLeod, & Bültmann, 2016). No patient-level outcomes are included in the model. 4) The model does not include feedback mechanisms between any of its parameters as is standard in system dynamics methods (Sobolev, Sanchez, & Kuramoto, 2012, p. 56). Examples of feedback relationships known to exist in reality between model parameters include those between:

i. The supply of HHR (and, by extension, the availability of health care resources) and population health status: A minimum supply of HHR is required to deliver basic public health services such as obstetrical care, childhood vaccinations, and the treatment of infectious and chronic diseases (World Health Organization, 2006). In the absence of these resources

population health worsens, while an increase in the availability of HHR tends to result in an increase in population health (Raphael, 2009, p. 7);

ii. Levels of HHR activity and HHR exit rates: Empirical research has found that nurses working longer and more frequent shifts experienced greater burnout and were more likely to leave the nursing profession (Hayes, et al., 2012); and

iii. Levels of HHR productivity and required levels of service provision: A systematic review of research in acute care found that the more patients nurses were required to care for, the more likely those patients were to experience adverse effects (such as hospital-acquired infections or cardiac arrest) that resulted in the patients requiring additional (often intensive) care (Kane, Shamliyan, Mueller, Duval, & Wilt, 2007).

In addition to these limitations of the model structure, there are several limitations in the data available to inform HHR planning in Nova Scotia that reduce the ability of planning models in general to accurately estimate HHR supply and requirements. These limitations are itemized below by model parameter and then by profession.

- Health status: None of the data sources available are ideal for measuring the health status of Nova Scotia's population, including but not limited to the prevalence of anxiety and depression among school-aged children.
    - Administrative data pertain only to individuals who can and do obtain services from a physician, and a growing proportion of Nova Scotia's population faces substantial challenges in doing this (Asbridge & Langille, 2013; LaRoche, 2017). In addition, although there is evidence that

administrative data may be useful for the surveillance of mental health issues as a group (Kisely, et al., 2009), other studies have suggested that anxiety and depression, specifically, are difficult to distinguish from one another using diagnostic codes attached to physician billing reports (Kisely, et al., 2009; Marrie, et al., 2014). This may be at least partially because existing case definitions based on administrative data have low sensitivity (Feist, et al., 2014).

  - Although population-based, data from surveys provide lower estimates of disease prevalence than those based on administrative data (O'Donnell, et al., 2016). Further, the most recent population-based estimates of the prevalence of anxiety and depression among school-aged children in Nova Scotia come from surveys conducted in 2007 (depression) and 2010 (anxiety) that were restricted to respondents aged 12 and over, and these analyses did not include estimates of the comorbidity of anxiety and depression (Asbridge, Pauley, Langille, Kisely, & Whipp, 2011).
  - These limitations mean that the true prevalence of anxiety and depression among school-aged children in Nova Scotia is not known.

- Level of service: Apart from services provided by physicians, data on the number and type of services performed by other types of HHR for patients of a given level of need are not systematically captured at the provincial level in Nova Scotia. In addition, physician billing data capture only such services for which a) a billing code exists and b) a physician bills. This means that any services physicians

provide for which no billing code exist (as is often the case with coordination activities, for example) or for which physicians do not complete a billing report (which is increasingly likely as more Nova Scotia physicians shift from fee-for-service to salaried payment models) are not captured in billing data. This means that existing levels of service provision in Nova Scotia cannot be measured comprehensively with existing data. Specific to the present study, because billing data were extracted based in part on their attached diagnostic codes identifying anxiety and/or depression as the associated diagnosis, any services provided by physicians for anxiety and depression that identify other conditions (e.g., abdominal pain) as the diagnosis would be missed in the analysis of levels of service provision for these conditions.

- The Nova Scotia Department of Health and Wellness has announced that a new, standard model of service for integrated mental health and health care delivery for the province's youth population is to be developed (Nova Scotia Department of Health and Wellness, 2017), but at present no such model exists.
- There are published guidelines on the treatment of pediatric anxiety and depression (Katzman, et al., 2014; National Collaborating Centre for Mental Health, 2015), but these are not specific to the unique context of Nova Scotia and pertain mainly to specific types of psychotherapy and prescription drugs as opposed to other types of health care services which provincial role descriptions identify as being important in pediatric mental

health, such as care planning, nursing care, and occupational therapy (IWK Health Centre, 2013).

    - As noted above, because of the high degree of variability in mental health service provision for children and adolescents across the province (Nova Scotia CAPA Evaluation Working Group, 2016; Auditor General of Nova Scotia, 2017), specific average levels of service were estimated based on the CAPA structure (United Kingdom Child and Adolescent Mental Health Services, 2017) and input from a panel of pediatric mental health clinicians. Although drawn from participants' clinical training, first-hand experience, and knowledge of research evidence, it is possible that these recommendations were subject to various professional biases.

- Productivity
    - HHR productivity is not specifically measured by any existing data source in Nova Scotia.
        - Although physician productivity was estimated from billing records as described above, these data do not fully capture the nature of services performed by physicians, and as such do not allow for a comprehensive measurement of physician productivity.
        - For other professions, estimates of productivity were collected from a multidisciplinary clinician panel. The estimates provided through this panel may be subject to measurement and recall bias.
- Division of Work

- In the absence of a provincial model of service delivery for pediatric anxiety and depression, the planned allocation of specific services across specific types of HHR is not known.
    - For professions other than physicians (for which division of work can be estimated to some extent using billing data as described above), provincial standardized role descriptions (Nova Scotia Department of Health, 2013), and health care legislation pertaining to certain Protected Acts and other specific services provide some information on which services *may* be provided by which types of HHR. There is no known source of definitive information, however, on which services *should* be provided by which types of HHR.
    - In the absence of this information, values of division of work were obtained from a multi-disciplinary clinician panel. Although drawn from first-hand experience and knowledge of research evidence, it is possible that these recommendations were subject to various professional biases possible these recommendations were subject to various professional biases

- Stock:
    - According to the Canadian College of Family Physicians, family physicians are qualified as GPs but have additional, specialized training in family medicine (Canadian College of Family Physicians, 2017).

However, 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, family physicians and GPs treated as a single, combined stock.

- Clinical Focus:
    - Physician billing data do not fully capture the ways in which physicians spend their direct care time; as such, they do not comprehensively measure the degree to which physicians allocate their time to a given population or condition. In the absence of other data about clinical focus among physicians, the estimates described above were taken to be correct.
    - Several provincial health professional regulatory colleges collect data on their respective members' areas of specialization, but these measures tend to refer to specific populations or types of conditions but not both, and not specific conditions.
        -
- Activity:
    - As noted above, physician billing data do not fully capture the ways in which physicians allocate their time; as such they do not allow for a precise measurement of levels of physician activity. In the absence of

other sources of data on physician activity, however, the estimates described above were taken as correct.

    - Several regulatory colleges collect data on the employment status of their members in terms of full- versus part-time. For a number of reasons these designations may not correspond to actual hours worked (e.g., individuals employed in full-time positions may, in practice, work fewer than full-time hours, while some in part-time positions may work more than full-time hours) (Tomblin Murphy, et al., 2009). In the absence of other sources of data on activity, however, full-time employment was assumed to equate to full-time equivalence (i.e. 1.0 FTE), and part-time employment was assumed to equate to half-time equivalence (i.e. 0.5 FTE).

- Psychologists:
    - Clinical focus for this profession was estimated as the proportion of APNS members who indicate offering treatment a) to children and adolescents and b) for anxiety or depression, as indicated on the APNS website.
- Social Workers:
    - The NSCSW maintains data on social workers in the province, but its structure does not allow for estimation of how the provincial supply has changed over time. To illustrate the application of the model, it was assumed that 5% of social workers exit the provincial stock each year.

As demonstrated above, limitations in the data available to populate the model necessitated the use of several proxy measures and assumed values. To illustrate the sensitivity of the model to these assumptions, results based on multiple alternative values for each parameter are provided in the next chapter and in Appendix I. As updated or improved data become available, future research using this model can incorporate these.

Implications for Child and Adolescent Mental Health Services in Nova Scotia

Improving access to mental health services for children and adolescents is a priority of the Nova Scotia Department of Health and Wellness (Nova Scotia Department of Health and Wellness, 2017) as well as the Nova Scotia Health Authority (Nova Scotia Health Authority, 2017) and the IWK Health Centre (IWK Health Centre, 2018). The province's capacity to achieve this priority is directly contingent on the availability of HHR. The results presented in the previous chapter indicate that the province does not currently have an adequate number or mix of HHR to address anxiety and depression among its school-aged children, and that this problem will worsen in the future without intervention. The largest estimated current shortages are for family physicians, psychiatrists, psychologists, and social workers.

Nova Scotia's health care professionals devote relatively little of their time to addressing anxiety and depression among school-aged children. For none of the seven professions included in the quantitative analyses was the estimated clinical focus greater than 10%. For all but psychologists and social workers it was less than 5%. Given the stated prioritization of mental health services – particularly those for children and

adolescents – by the provincial government and health authorities (Nova Scotia Department of Health and Wellness, 2017; Nova Scotia Health Authority, 2017; IWK Health Centre, 2018), and given that anxiety and depression are the most common mental health problems among the province's children and adolescents (Asbridge, Pauley, Langille, Kisely, & Whipp, 2011; Cummings, Caporino, & Kendall, 2014), it will be important for decision-makers to explore the potential for increasing the clinical focus of the province's HHR on school-aged children with these conditions. Low estimated levels of clinical focus are the primary reason that, for example, the simulated future increase in the number of pediatricians in the province has little impact on the absolute pediatrician gap and a large impact on the relative gap. It is also the primary reason that recently announced funding for additional family medicine residency seats (Nova Scotia Department of Health and Wellness, 2018) and additional capacity for Dalhousie University's Nurse Practitioner program (Nova Scotia Department of Health and Wellness, 2018) have little impact on the simulated future HHR shortages pertaining to anxiety and depression among school-aged children.

The simulated current and future shortages of pediatricians and psychiatrists shown in the previous chapter are different from those produced by Nova Scotia's Physician Resource Plan, which were arrived at using considerably different methods and assumptions (Social Sector Metrics Inc., Health Intelligence Inc., 2012). The most recently published projections by the provincial Physician Resource Plan indicate that Nova Scotia requires a total of 9 additional FTE child and adolescent psychiatrists and 19 generalist pediatricians between 2016 and 2025, and that these would be needed

exclusively to replace retiring or migrating physicians (as opposed to accommodating any change in population health need, levels of service provision, physician activity, etc.). In contrast, the simulations in the previous chapter indicate the province would have a shortage of roughly 30 FTEs of each type of physician by 2025 under the 'baseline' scenario. Moreover, the province's existing physician resource plan gives no indication of any current shortage in either profession (Nova Scotia Department of Health and Wellness, 2016).

Nurses are the most numerous regulated health profession in Nova Scotia (Nova Scotia Department of Health and Wellness, 2018). Although nurses play important roles in addressing other mental health needs in the province, they are currently utilized little in addressing anxiety and depression among school-aged children. The potential for shortages of other professions to be reduced by giving a larger role to NPs and RNs is demonstrated in the previous chapter. This is not to say that other professions could not also be leveraged to reduce the shortages of family physicians, psychiatrists, psychologists, and social workers simulated in the previous chapter – nurses were used as an example here in part because the province produces more of them each year than any other regulated health profession, and because data collected for the study suggested they may be being underutilized in pediatric mental health services relative to their scopes of practice. Making greater use of currently underutilized types of HHR is precisely the type of policy scenario this approach was developed to help inform.

Of all the professions included in these analyses, the limitations in available data for social workers were greatest. In particular, as noted in the methods chapter, the

member database maintained by the provincial regulatory body for social workers lacks the capacity to systematically track flows in and out of the provincial supply over time. Because of this limitation, the results provided for social workers should be interpreted as simply an illustration of the model's capacity to facilitate planning for this profession. As with each of the other model parameters for each of the other included professions, the results can be updated if and when newer or more accurate data become available. Irrespective of the limitations of the available quantitative data, comments from participants in the multi-professional panel discussions, which were corroborated by information offered by HHR planners in interviews, provide insight into the reason for the large simulated shortage of social workers in the province. These data indicate that there is a disagreement between provincial health authorities and the province's only social worker education program at Dalhousie University regarding the relative importance of different competencies among the program's graduates, specifically the clinical competencies of interest to the health authorities. In practice this has meant that the health authorities have recently experienced particular challenges in identifying candidates for vacant social worker positions with the competencies they desire them to have. Should this situation continue unresolved, the simulated shortages of social workers provided in the previous chapters may turn out to be underestimates.

Scenarios presented in the previous chapter demonstrate how the simulated future shortages of these professions could be substantially reduced by a multi-faceted set of policy interventions aimed at several policy parameters. In the example shown in the previous chapter, these parameters include population health needs, levels of service

provision, division of work, and clinical focus. Reducing the prevalence of anxiety and depression among Nova Scotia's school-aged children would likewise reduce shortages of HHR required to address these conditions. As noted in the literature review chapter, there is a substantial evidence base regarding a wide range of interventions for preventing anxiety and depression among school-aged children. Although universal models based on psychological interventions delivered by teachers are supported by the strongest evidence, interventions involving educational and physical activity components have also been found to be effective (Stockings, et al., 2016). Incorporation of such programs into the province's existing efforts to promote mental health may strengthen these efforts.

As noted in the literature review chapter, the number and type of services provided to address mental health issues in Nova Scotia is in a state of considerable flux. This is likely to continue as efforts to implement the Choice and Partnership Approach across the province's child and adolescent mental health programs progress (Nova Scotia CAPA Evaluation Working Group, 2016; Auditor General of Nova Scotia, 2017). As planned levels of service provision evolve for these and other (e.g., advancements in treatment evidence) reasons, the model can be updated to quantify the HHR required to deliver different levels of service. The modeling results provide examples of how specific changes to these levels of service could potentially reduce current and future HHR shortages without compromising care. In these instances, this is done two ways: First, by providing some of the psychotherapy for children whose anxiety or depression are mild or moderate in group as opposed to individual sessions – thereby providing more of the care required with the same resources; and, second, by reallocating resources to providing

community-based preventative and primary care from acute inpatient care – using the former services to reduce the need for the latter. Consideration of these and other changes to existing levels of service provision may help to increase access to mental health services for Nova Scotia's school-aged children by making more effective use of existing HHR.

Implications for HHR Planning

The first two chapters of this thesis reviewed the arguments by various stakeholders for the importance of HHR planning in Nova Scotia (and in other jurisdictions where care is to be provided according to need) being based on models that are dynamic, account for population health needs, and integrate planning for multiple professions. The third chapter explains the conceptual basis for such a model (O'Brien-Pallas, Tomblin Murphy, & Birch, 2001) and describes its functioning. The results chapter demonstrates how such an approach can be applied to an existing problem, using the example of anxiety and depression among school-aged children in Nova Scotia. In the process, the application of this model underscored several problems with the data available in Nova Scotia for health system planning overall and HHR planning specifically. Existing sources of data on population health status, levels of service provision, division of work, and levels of HHR productivity, activity, and clinical focus do not allow for these parameters to be estimated with precision. As demonstrated in the results section, estimates of HHR requirements are highly sensitive to changes in each of these parameters. It is particularly unfortunate for HHR planners in Nova Scotia that

existing sources of information on these parameters are either severely flawed or non-existent. These shortcomings mean that the province's health system and HHR planners each lack accurate information on which to base their policy- and decision-making, hindering their ability to make effective policies and decisions. Investments in systematically collecting data on each of these parameters – population health needs, levels of service provision according to levels of need, division of work, and levels of HHR productivity, activity, and clinical focus - are needed to help Nova Scotia make the most effective possible use of its scarce health care resources. While an exhaustive evaluation of Nova Scotia's existing health information systems is beyond the scope of this thesis – and warrants a separate, comprehensive analysis of its own – perhaps the most concerning of these data gaps is that pertaining to population health needs. Despite references to meeting the health needs of Nova Scotians being nearly ubiquitous in communications by the provincial government and health authorities, the health of Nova Scotia's population is not systematically measured in any way that lends itself to health service planning. Provincial vital statistics data track mortality rates, but by the time someone has died it is too late for the health care system to help them. As articulated in the methods chapter, administrative databases fail to accurately capture health system planning parameters for a variety of reasons, and national health surveys lack the sample size to allow for planning for specific services or populations below the provincial level.

Two examples of potential strategies to address these gaps are a regular, Nova Scotia-specific population health survey – one was last completed in 1995 (MacLean & Scott, 1995) – and existing efforts to expand the use of electronic health records (EHRs)

in the province (Nova Scotia Department of Health and Wellness, 2016). The former could be designed and implemented in such a way as to address the small Nova Scotia sample size of national surveys like the Canadian Community Health Survey, with questions and/or instruments targeted to gather data on specific health care needs. Compared to physician billing records, EHRs in use in Nova Scotia are much more comprehensive in capturing both the health status of individuals and the number and range of services provided to them, allowing for much more accurate measurements of health needs, levels of service provision, and levels of provider productivity, activity, and clinical focus. Major current limitations of EHRs as inputs into health system planning are that they have only been implemented in some care settings (and thus are likely to provide biased estimates that do not apply to the broader provincial population) and that there are multiple different types of EHRs whose compatibility with each other is uncertain.

The benefits of investments in more systematic collection of data on the above topics will go beyond HHR planning to health system planning more broadly. Continued failure to make such investments will mean the province's health system and HHR planners must continue to do their work in the absence of systematic knowledge of the health care needs of Nova Scotians and, as such, Nova Scotians will continue to have their health care needs go unnecessarily unmet. More broadly, as noted above, the study's qualitative findings echo findings elsewhere that concerns over the availability of data are often a key determinant in the choice of HHR planning model. As Tomblin Murphy, Birch, and colleagues have repeatedly argued (Tomblin Murphy, et al., 2012; Tomblin

Murphy, Birch, MacKenzie, Bradish, & Elliott Rose, 2016; Birch, Tomblin Murphy, MacKenzie, Whittaker, & Mason, 2017), however, problems with data are not avoided by adopting or reverting to the conceptually invalid models most commonly used by HHR planners worldwide, especially when these have been recognized as inadequate for decades (World Health Organization, 1971; Lomas, Stoddart, & Barer, 1985; Lavis & Birch, 1997) and have resulted in the shortages and inefficiencies in HHR allocation being experienced worldwide. The continual refinement of the application of a conceptually valid approach is superior to adopting conceptually invalid approaches based on the availability of data (Tomblin Murphy, et al., 2012). The methods and findings presented here represent one more addition to a growing evidence base produced by Birch, Tomblin Murphy, Gallagher, Segal, and others over decades demonstrating that reliance on fundamentally flawed traditional HHR planning models is unnecessary and counter-productive.

The study's qualitative findings also highlight several limitations of existing HHR and health system planning processes in Nova Scotia that may shed light on why HHR planners may be reluctant to abandon methods they know to be fundamentally flawed. Planners who participated in interviews referred to a lack of HHR planning capacity in the organizations responsible for health care planning and delivery in the province, including but not limited to a lack of understanding by some stakeholders of the complicated nature of HHR planning and a mo reluctance to even acknowledge – let alone plan for – the inherent uncertainty of the future.

The qualitative findings also illustrate how the present model can help to address each of these limitations. The schematic that accompanies the model provides a visual representation of the relationships between various planning parameters to aid in understanding dynamic aspects of the health care system most relevant to HHR planning; indeed, past applications of similar approaches by Tomblin Murphy and colleagues suggest that using such an approach as the basis for a dedicated capacity building program can increase the competencies of HHR planners (Tomblin Murphy, et al., 2010). The implementation of the model in a spreadsheet format compatible with free and open-source software, and the accompanying graphical output, allows planners to test and visualize the impacts of different degrees of changes to each parameter – either alone or in combination with others – on simulated HHR gaps, allowing for better understanding of their relative importance. Further, the model's dynamic capacity provides planners with a mechanism to quantify the impact of potential future changes to planning parameters, providing a means for them to 'rehearse' how they might mitigate future gaps and test potential policy responses to them.

Areas for Further Study

Future work related to increasing the feasibility of this approach for HHR planning will include several areas of study highlighted in earlier parts of this thesis. These include the simulation of alternative policy scenarios, the potential expansion of the model to incorporate other parameters and feedback loops, and broadening its application to other sectors, professions, populations, and contexts.

As noted previously, the specific planning scenarios included in this thesis represent a subset of an infinite number that could be simulated using the model. These already demonstrate the potential for substantial changes in the status quo of mental health service provision in Nova Scotia to address HHR shortages. Ongoing consultations with mental health stakeholders such as clients and their families – including but not limited to those occurring through presentation and publication of this thesis – are expected to yield other scenarios of interest, which can in turn be simulated. Such scenarios can incorporate more dramatic changes to existing mental health service provision, including making greater use of providers whose contributions to mental health may be underappreciated, such as peer counsellors, midwives, and school counsellors. The model can also accommodate changes to the estimated mental health status of the population to be served should the actual prevalence of anxiety and depression be found to be higher through, for example, greater use of health care sentinels.

The lack of feedback loops and explicit incorporation of environmental, political, economic, and other contextual factors are acknowledged limitations of the HHR planning model used in this thesis. Potential research streams to address these limitations include expansion to include financial parameters, which could at a minimum be incorporated by multiplying enrollment numbers by average costs per student and multiplying provider numbers by average annual wages (salaries plus benefits). Other financial considerations that would be more complicated to incorporate would be costs associated with provider turnover, recruitment from outside the province and outside the

country, orientation of new providers, and initiatives aimed at improving, for example, retention or productivity. Incorporation of these parameters would begin to account for the economic considerations necessary to HHR planning. More broadly, as the wider health and health services research evidence base pertaining to the quantitative relationships between political, environmental, and other contextual factors and the need for and provision of health care, the potential to include parameters representing these factors, and their associated feedback loops, will increase. Of particular importance will be evidence on the benefits (e.g. emergency department visits or justice system encounters avoided) and other outcomes of mental health services. Although these are seldom systematically tracked in Nova Scotia, and as such the relationships between pediatric mental health service provision and outcomes of those services at the individual, family, system, and societal levels are largely unknown, consideration of these factors is required to inform decisions around which services are most important.

The applicability of the model to circumstances other than anxiety and depression among school-aged children in Nova Scotia will be considered. Although anxiety and depression are the most common, they are far from the only mental health challenges facing the province's children and adolescents. Adults, too, have unmet mental health needs that could be mitigated through improved HHR planning. Within Nova Scotia, the other top priority clinical service areas are primary health care and continuing care. Other Canadian and international jurisdictions could likewise benefit from the application of a more comprehensive HHR planning approach.

More broadly, the study's principal investigator now has the opportunity to learn first hand, having taken on the role of Manager of Health Workforce Planning for the Nova Scotia Department of Health and Wellness, how feasible implementing this approach will be. As a researcher becoming embedded as a member of the community of HHR planners in Nova Scotia, and working with counterparts in other Canadian jurisdictions, the opportunity exists to use alternative methods, such as ethnographic qualitative research, to study this issue in a depth not possible for an external researcher.

Conclusions

This thesis aimed to assess the feasibility of using a dynamic, multi-professional, needs-based simulation model to inform HHR planning. Within that broad aim, its specific objectives were to estimate the supply of and requirements for HHR to address anxiety and depression among school-aged children in Nova Scotia through 2032 and to identify technical & political factors affecting the choice of HHR planning models in Nova Scotia.

The results suggest that Nova Scotia's current supply of HHR is less than is required to address anxiety and depression among its school-aged children, and that this situation will not improve without some policy intervention. The results also provide an example of a multi-faceted policy intervention of modest changes to several planning parameters that could substantially reduce HHR shortages in the future. The division of work across different types of HHR, and the degree of clinical focus among HHR on pediatric anxiety and depression were shown to be two planning parameters with particular potential for

intervention to reduce HHR shortages.

Application of the model identified specific limitations of existing sources of data that must be addressed to strengthen HHR and health system planning in the province. In the absence of this data, continued inefficiency in these plans is inevitable. Interviews with the province's HHR planners identified multiple technical and political factors that affect the choice of HHR planning model. Chief among these was the buy-in of key stakeholders – particularly physicians – which was noted to be closely tied to the complexity of the model and the degree to which those stakeholders felt it was consistent with the functioning of the health care system. Other critical factors pertained to capacity. These included the capacity of system leaders and other stakeholders to change historical structures and processes, and the capacity of governments and health authorities to operationalize a – necessarily, in participants' views – more complicated planning model than has been used in the past.

More broadly, the findings of this thesis suggest that using the present model to inform HHR planning in Nova Scotia is feasible provided that stakeholder engagement and communication to ensure the requisite political support accompany its technical implementation. As the study underlying this thesis was nearing completion, the author accepted the position of Manager of Health Workforce Planning with the Nova Scotia Department of Health and Wellness, and, in that role, will have the opportunity to validate that proposition first-hand on an ongoing basis.

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Zigmond, A., & Snaith, R. (1983). The hospital anxiety and depression scale. *Acta Psychiatrica Scandianvica, 67*(6), 361-370.

Zung, W. (1971). A rating instrument for anxiety disorders. *Psychosomatics, 12*(6), 371-379.

Zung, W., Richards, C., & Short, M. (1965). Self-Rating Depression Scale in an Outpatient Clinic: Further Validation of the SDS. *JAMA Psychiatry, 13*(6), 508-515.

APPENDIX I: ADDITIONAL QUANTITATIVE RESULTS

This appendix provides the results of simulation modeling conducted to demonstrate the sensitivity of the model to different values of planning parameters other than those featured in Chapter 4. As in that chapter, each scenario is accompanied by a pair of graphs showing, for each profession included in the model, how the difference (or 'gap') between the number of full-time equivalents (FTE) required and available varies by year throughout the study period. A negative value indicates that the number required exceeds the number supplied (i.e. a shortage), whereas a positive value indicates that the number available exceeds the number required (i.e. a surplus). The first figure for each scenario shows the absolute gaps for each profession. The second figure shows the relative gaps – with the absolute values divided by the head count of licensed providers in the provincial supply.

Population Scenarios

Figures A.1a and A.1b show the simulated Nova Scotia HHR gap for addressing anxiety and depression among school-aged children under a scenario in which all model parameters are held constant for the duration of the study period except population. In these scenarios, instead of changing according to Statistics Canada's medium growth projections, the size and age-sex structure of the provincial school-aged population changes according to Statistics Canada's low growth projections (Statistics Canada, 2017).

Figure A.1a

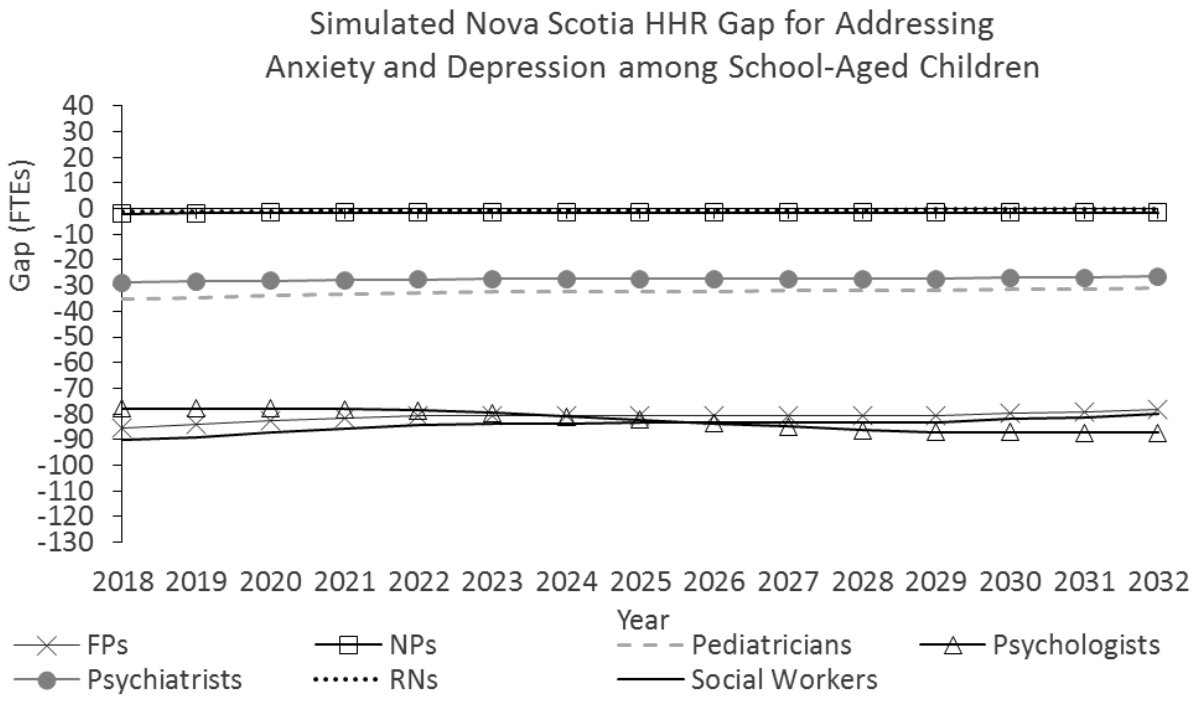
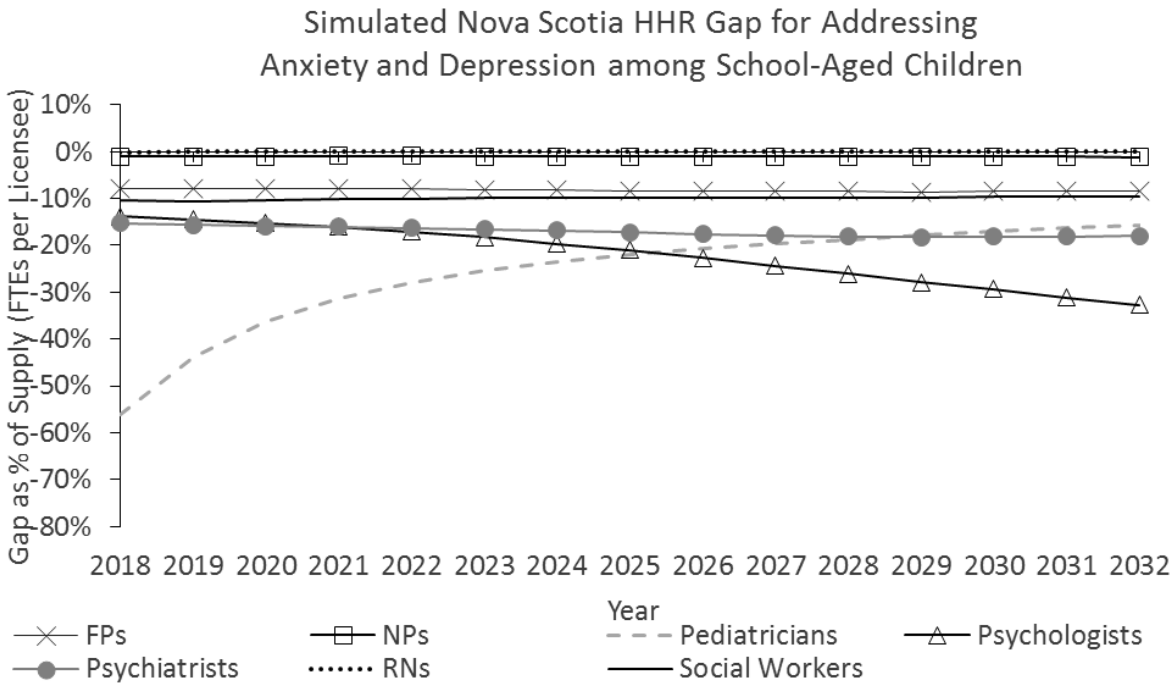


Figure A.1b



In this scenario, Nova Scotia's future school-aged population is smaller than in the baseline scenario shown in Chapter 4. As such, requirements for HHR to address anxiety and depression in this population are lower, as are the gaps in each profession.

Figures A.2a and A.2b show the simulated Nova Scotia HHR gap for addressing anxiety and depression among school-aged children under a scenario in which all model parameters are held constant for the duration of the study period except population. In these scenarios, instead of changing according to Statistics Canada's medium growth projections, the size and age-sex structure of the provincial school-aged population changes according to Statistics Canada's high growth projections (Statistics Canada, 2017).

Figure A.2a

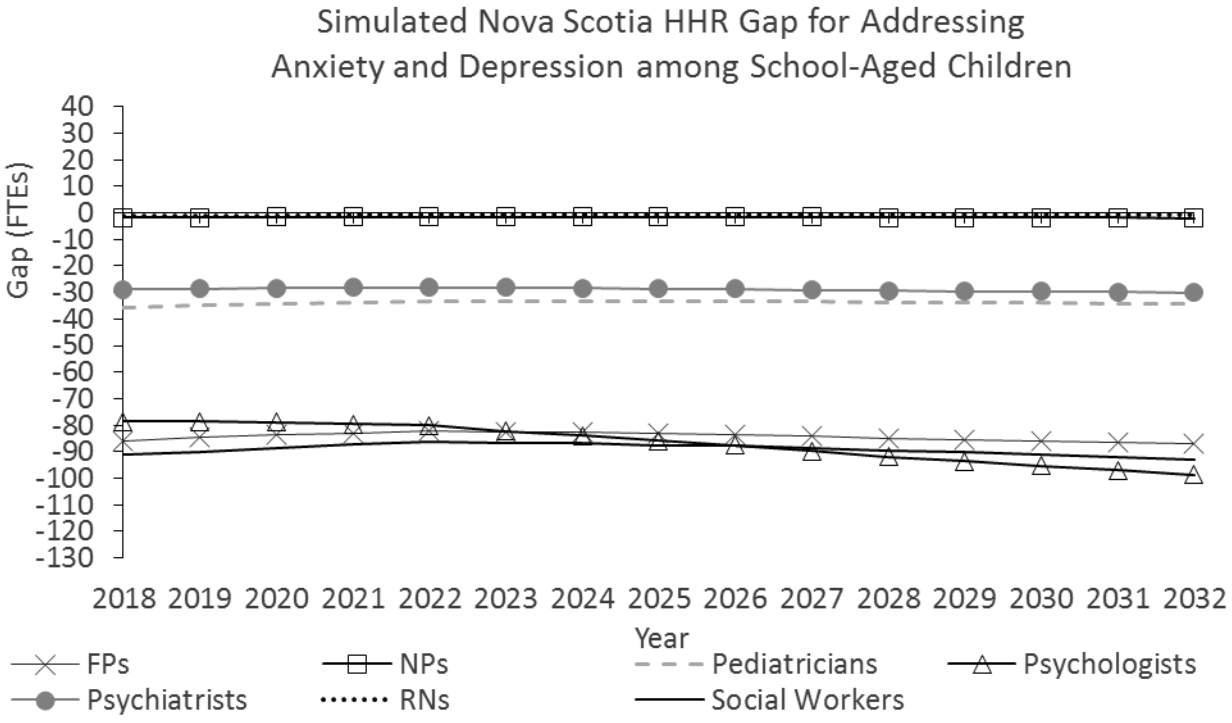
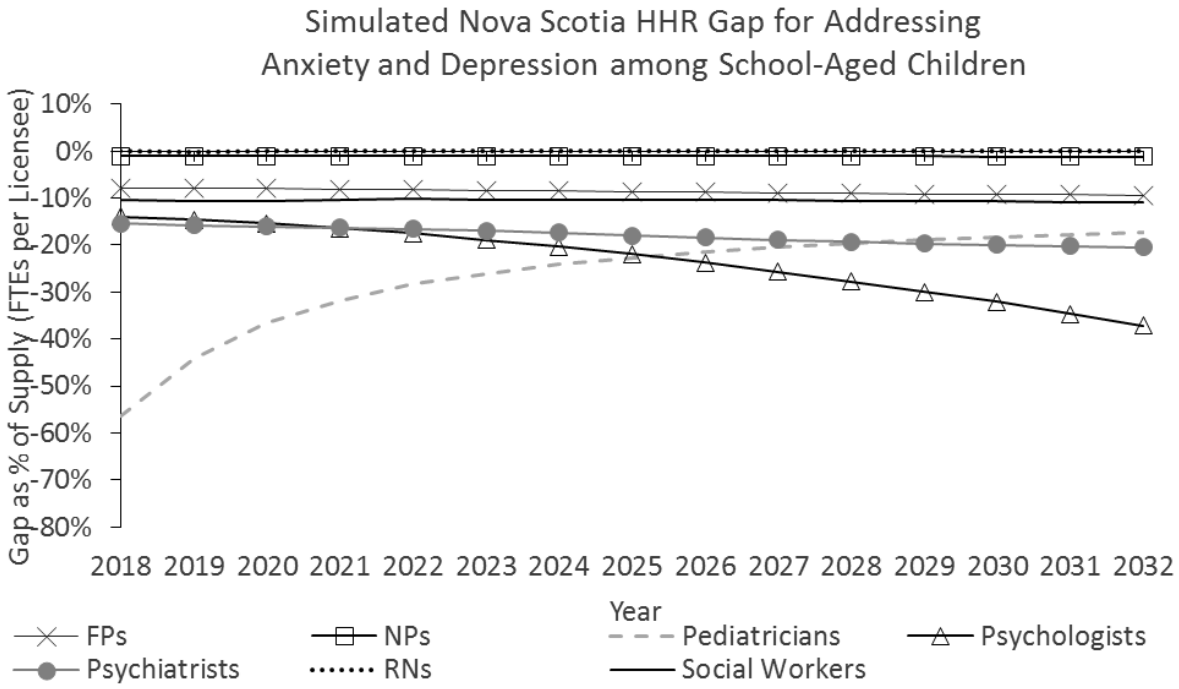


Figure A.2b



In this scenario, Nova Scotia's future school-aged population is larger than in the baseline scenario shown in Chapter 4. As such, requirements for HHR to address anxiety and depression in this population are higher, as are the gaps in each profession.

Seats Scenarios

Figures A.3a and A.3b and A.4a and A.4b show the simulated Nova Scotia HHR gap for addressing anxiety and depression among school-aged children under a scenario in which all model parameters are held constant for the duration of the study period except population and the number of seats in provincial HHR entry-to-practice education programs. In these scenarios, beginning in 2021, the number of seats for each profession

is increased by 20% (in Figures A.3a and A.3) or decreased by 20% (in Figures A.4a and A.4b).

Figure A.3a

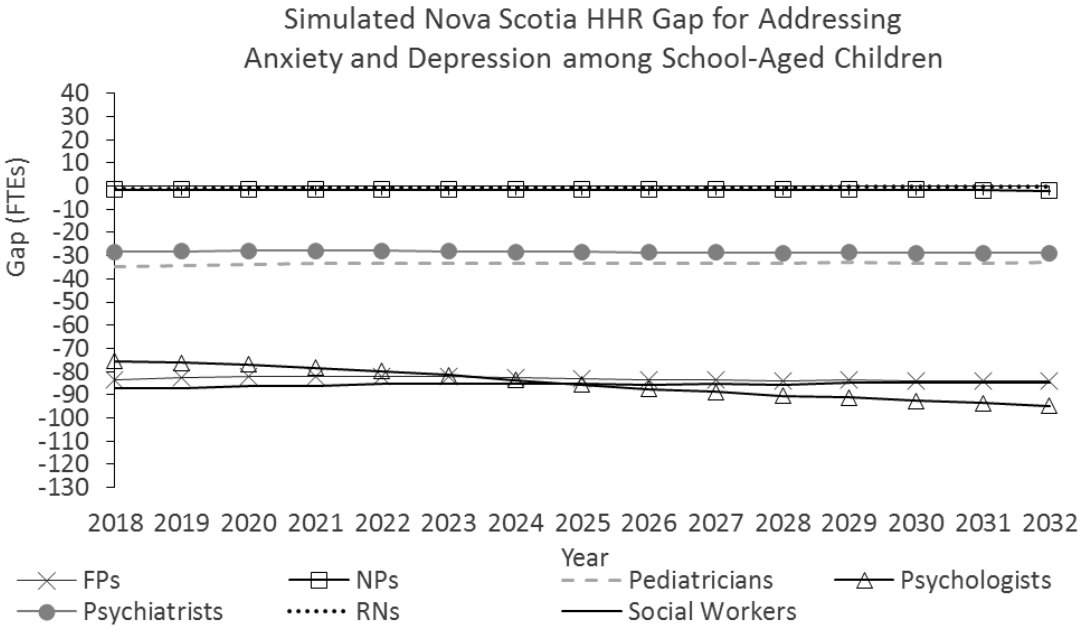


Figure A.3b

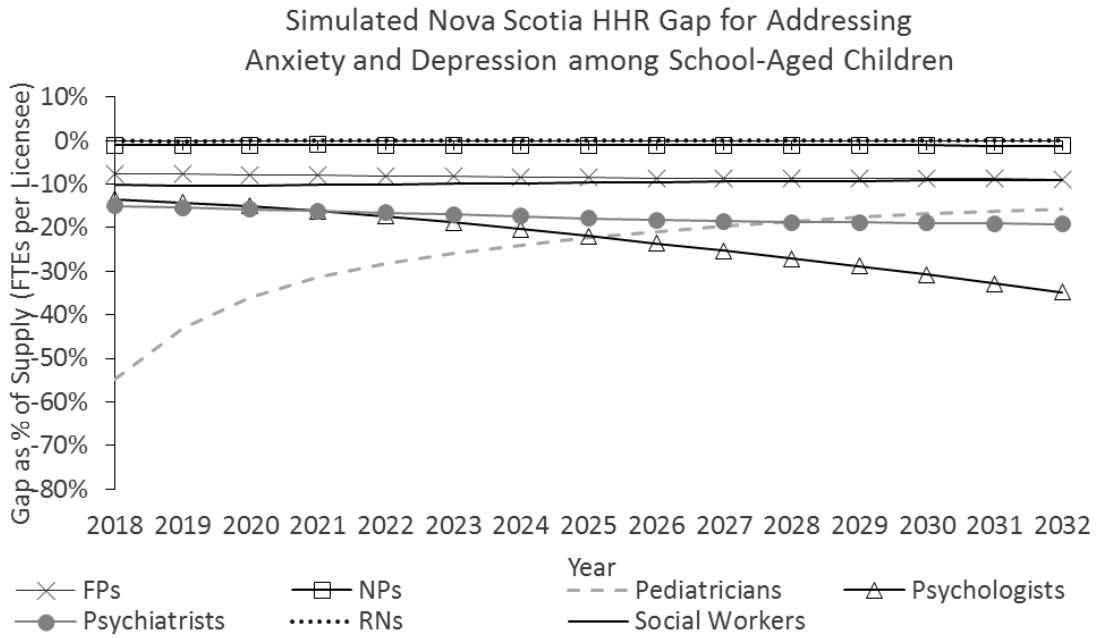


Figure A.4a

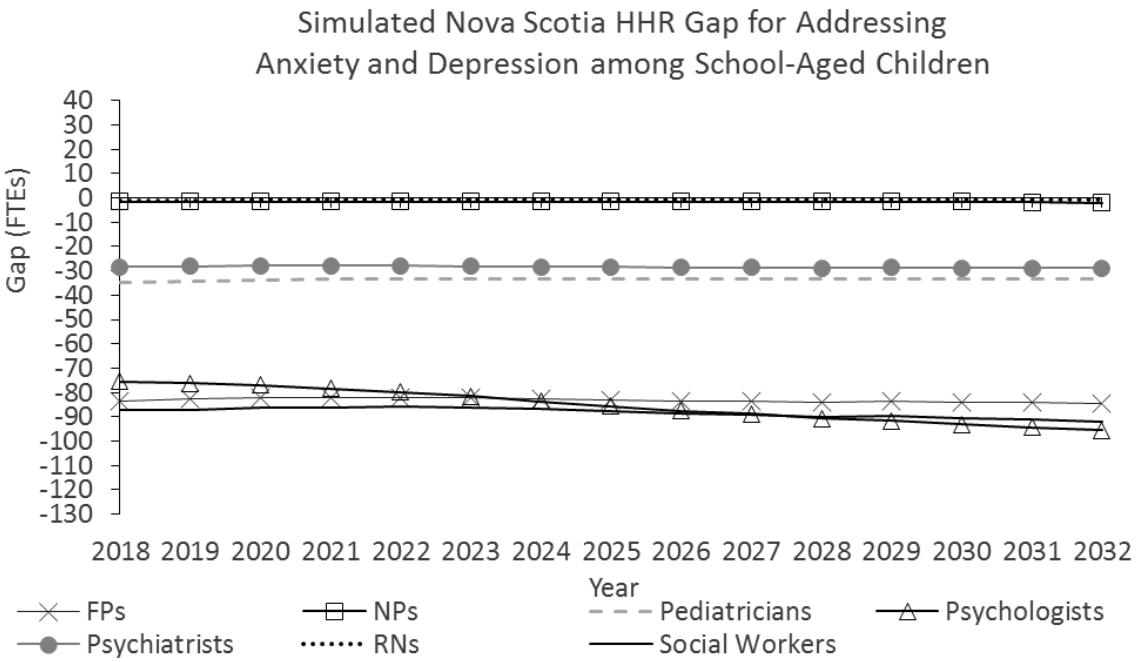
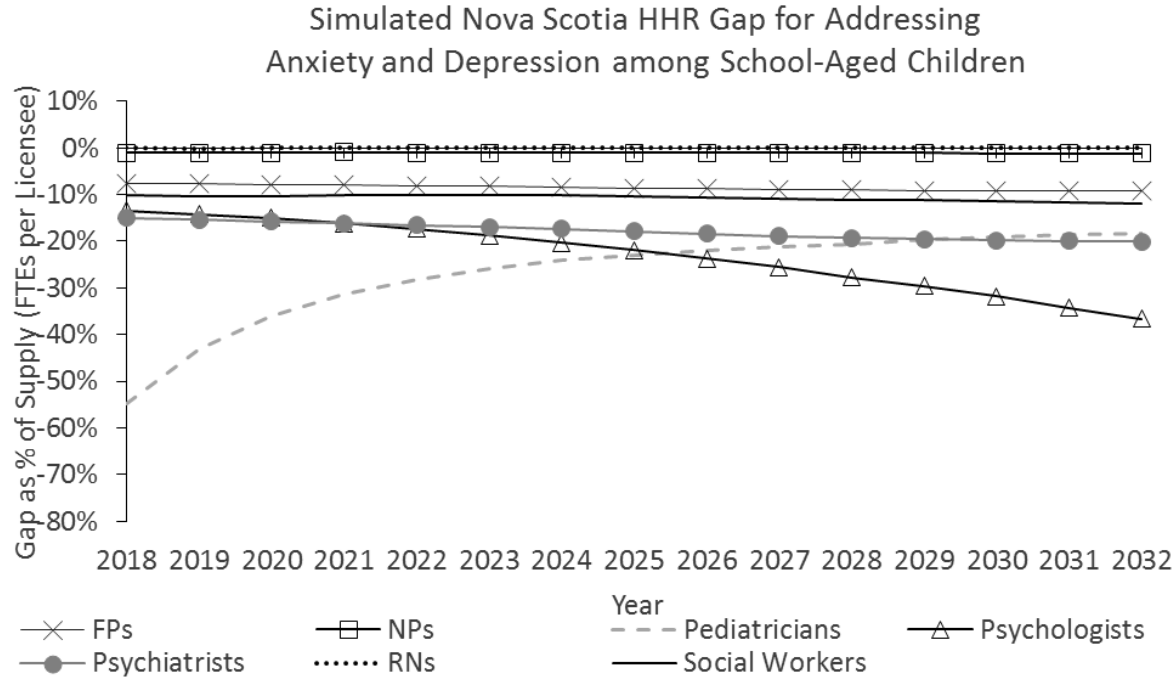


Figure A.4b



The increases and decreases in enrollment in these scenarios have the effect of decreasing and increasing, respectively, the simulated future shortages of each included profession. These impacts are relatively small for several reasons. First, the numbers of students enrolling in these programs each year is relatively small compared to their existing supplies. Second, not all students who enter the programs complete them. Third, not all graduates remain in the province after completing these programs. Fourth, any 'extra' or 'fewer' new graduates associated with these enrollment changes would not be evident for the duration of the respective programs; for example, an increase in enrollment in Dalhousie's 5-year PhD clinical psychiatry program beginning in 2021 would produce no 'extra' graduates until 2026.

Program Attrition Scenarios

Figures A.5a and A.5b and A.6a and A.6b show the simulated Nova Scotia HHR gap for addressing anxiety and depression among school-aged children under a scenario in which all model parameters are held constant for the duration of the study period except population and the level of attrition in provincial HHR entry-to-practice education programs. In Figures A.5a and A.5b, beginning in 2021, program attrition is reduced the lowest recorded level over the past 5 years for professions on which data are available and 5% for those for which they are not. In Figures A.6a and A.6b, beginning in 2021, program attrition is increased to the highest level recorded over the past 5 years for professions on which data are available and 40% for those for which they are not.

Figure A.5a

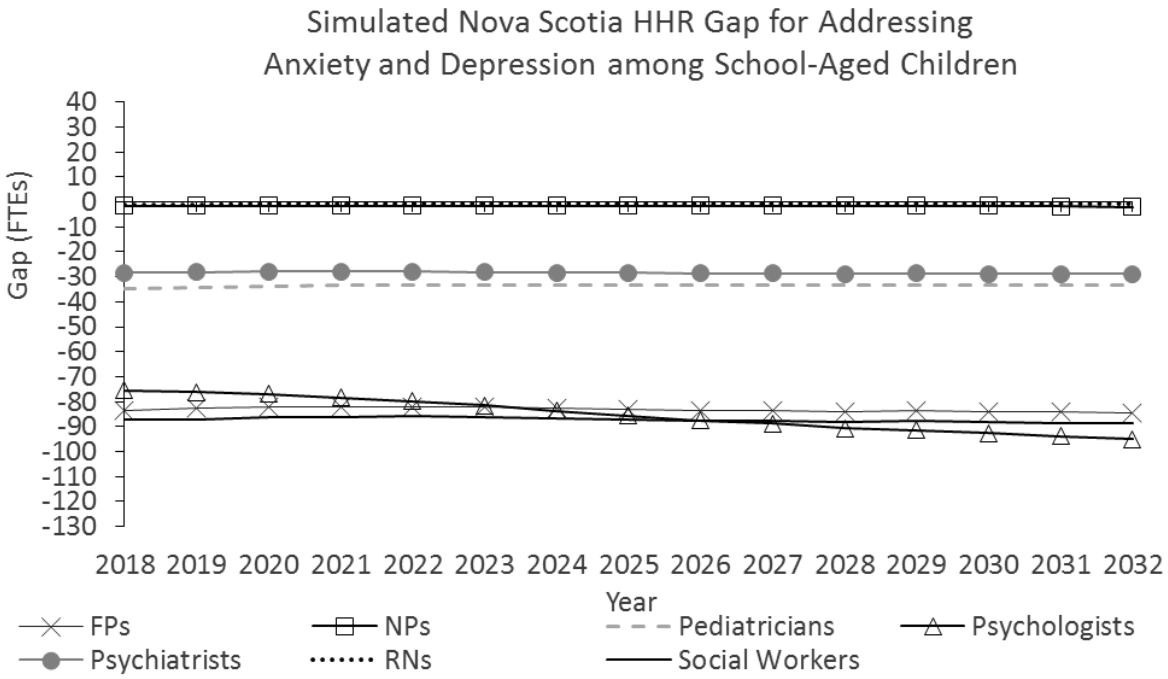


Figure A.5b

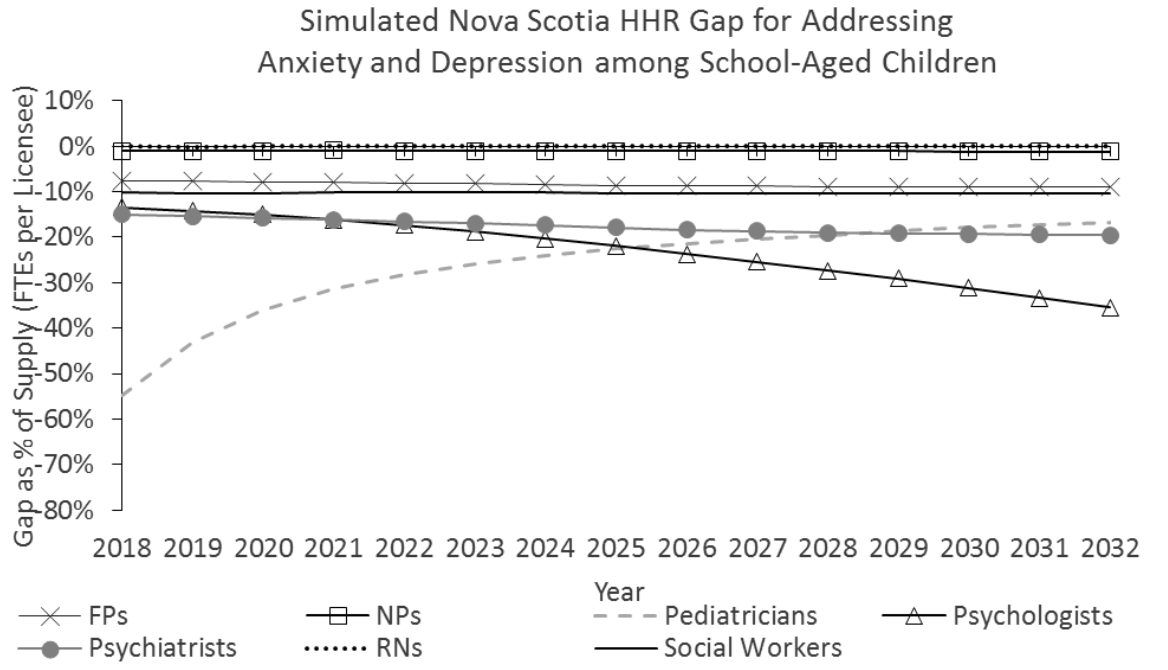


Figure A.6a

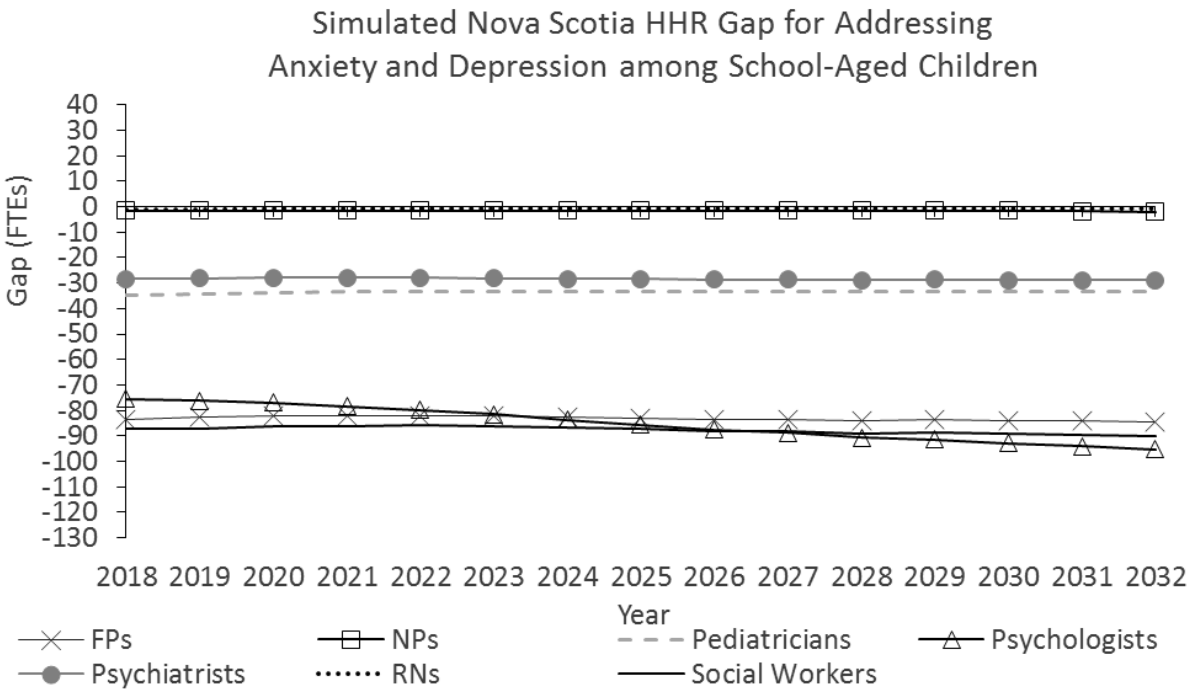
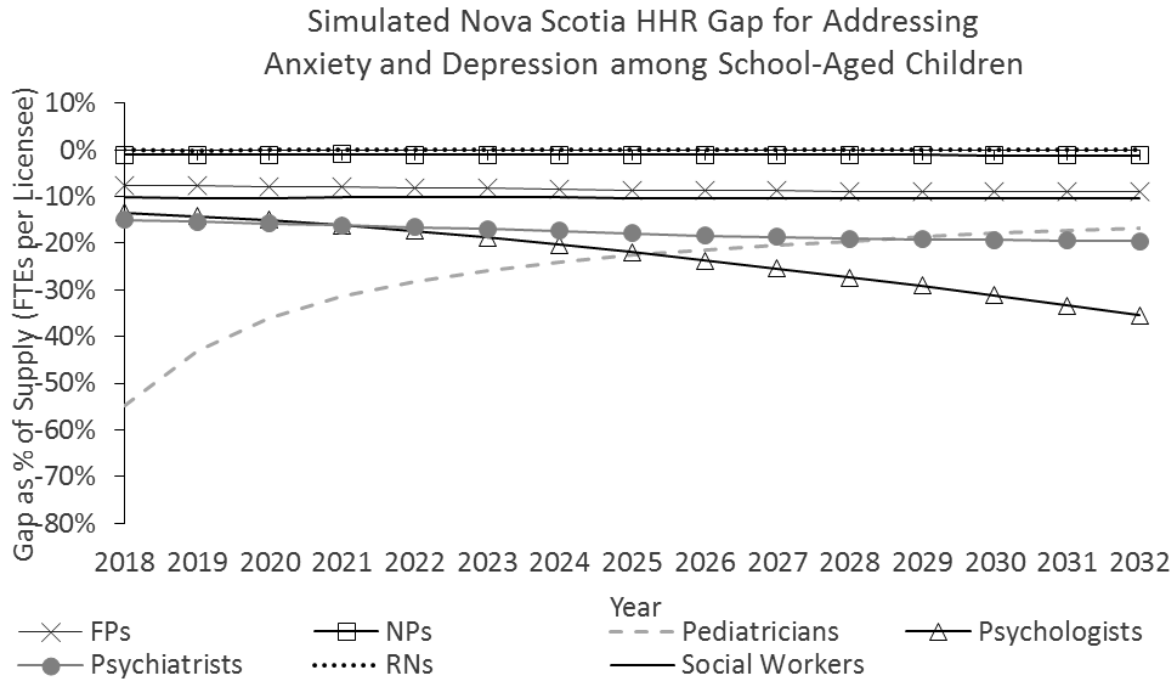


Figure A.6b



As Figures A.5a, A.5b, A.6a, and A.6b show, the impact of these changes to program attrition on the simulated future gaps is very small. This is because, historically, attrition from the programs that produce these types of HHR has been low, so the difference between relatively low and high levels of attrition for them is small. This is particularly true for NP and post-graduate medicine programs, from which most students graduate once they have begun. The province's BScN programs have the most variable levels of program attrition, but as is noted in the main body of this thesis, RNs have a low level of clinical focus on anxiety and depression among school-aged children, so changes to their education have little impact on the gap for this profession. In contrast, Social Workers have a higher level of clinical focus, and the social work program at Dalhousie University also has more variable program attrition compared to the other professions, so the impact of these changes is most evident for this profession.

Grad Out-Migration Scenarios

Figures A.7a and A.7b and A.8a and A.8b show the simulated Nova Scotia HHR gap for addressing anxiety and depression among school-aged children under a scenario in which all model parameters are held constant for the duration of the study period except population and the proportion of graduates from the province's entry-to-practice education programs who remain in the province to practice after graduation. In Figures A.7a and A.7b, beginning in 2021, graduate out-migration is reduced. For those for the medical professions – for which Nova Scotia is home to the only entry-to-practice training program in the region – this value is set at 40%. For the other professions the low

is set at 10%. In Figures A.8a and A.8b, beginning in 2021, levels of graduate out-migration is increased to 60% for physicians and to 40% for nurses, psychologists, and social workers.

Figure A.7a

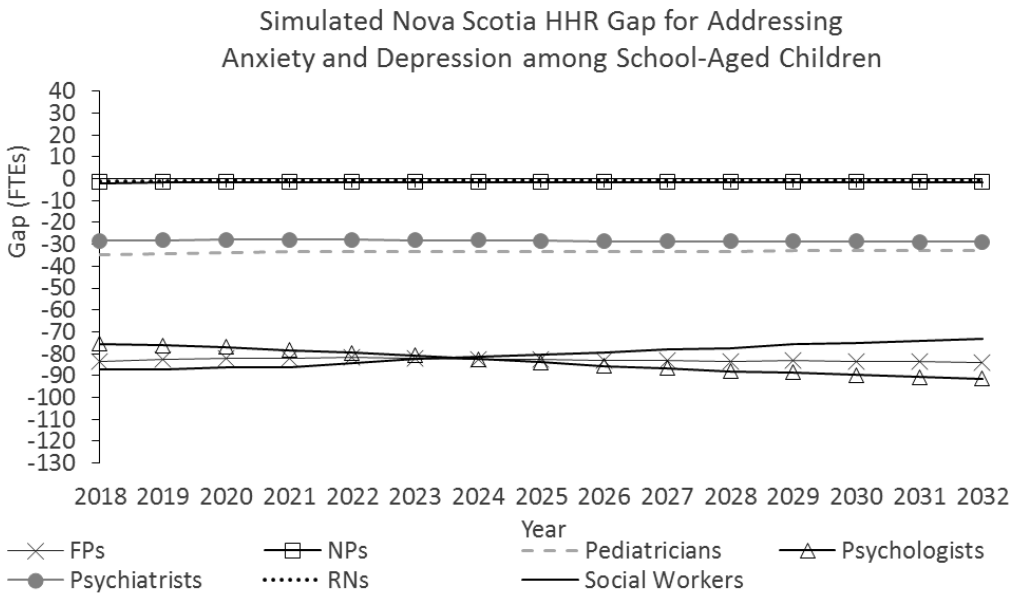


Figure A.7b

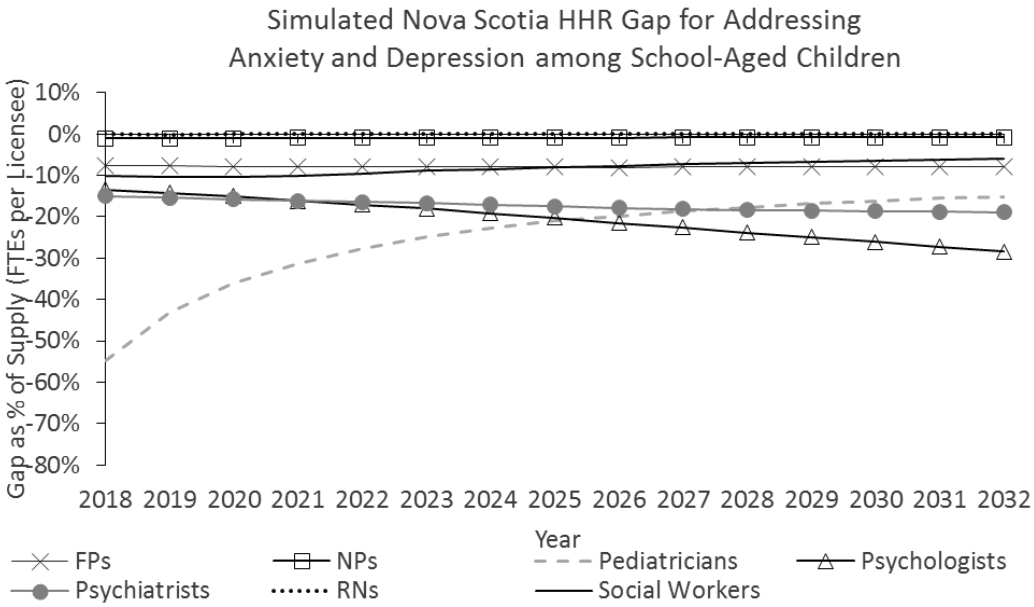


Figure A.8a

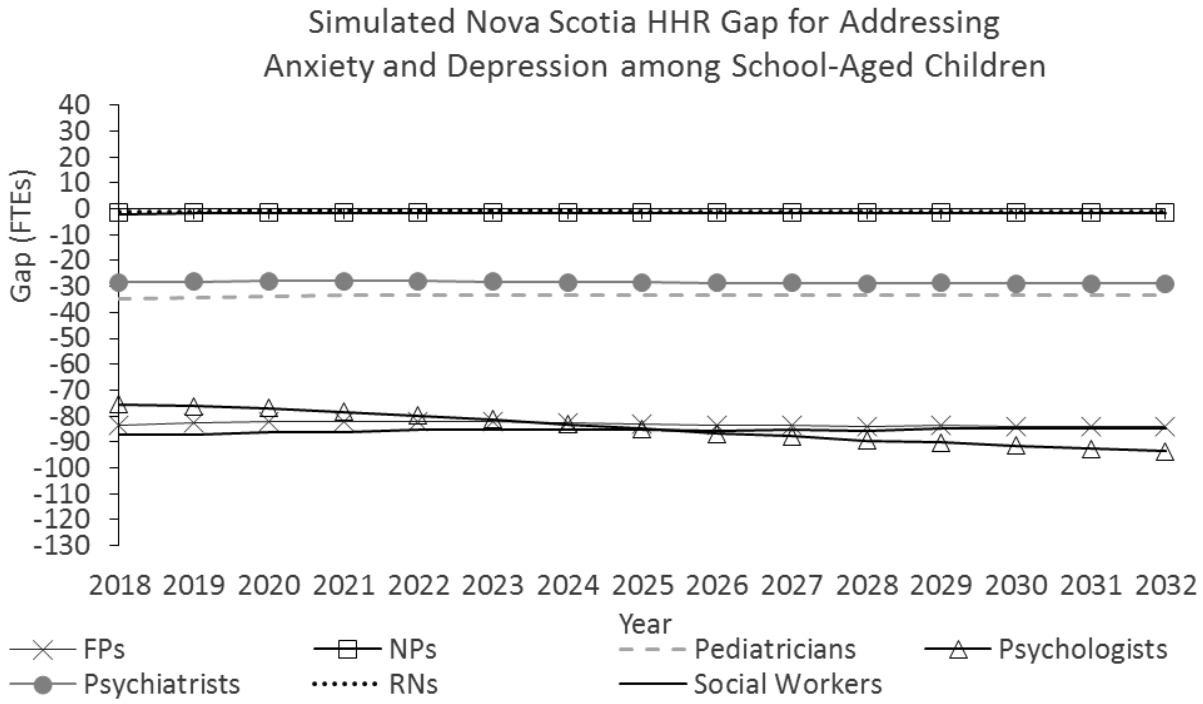
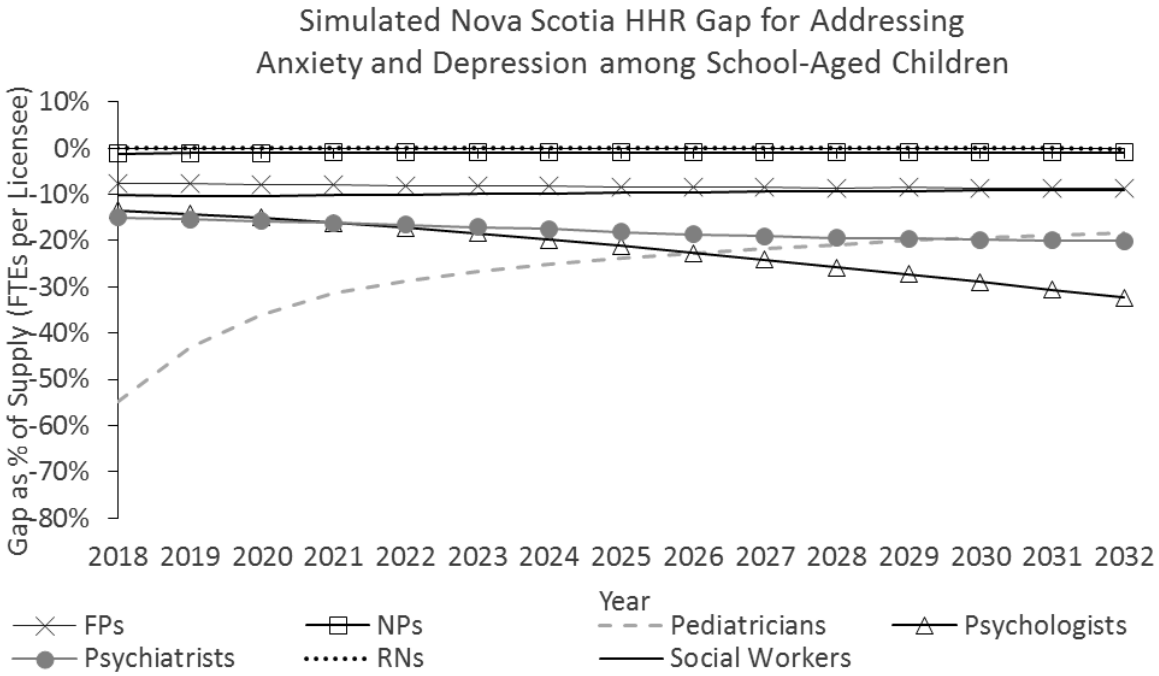


Figure A.8b



As Figures A.7a, A.7b, A.8a, and A.8b indicate, the impact of this change is relatively small. This is because of several factors already outlined above -namely the relatively small sizes of graduating classes relative to existing stocks for each profession, and the low levels of clinical focus among the included professions. The impact is most noticeable for psychologists and social workers.

In-Migration Scenarios

Figures A.9a and A.9b and A.10a and A.10b show the simulated Nova Scotia HHR gap for addressing anxiety and depression among school-aged children under a scenario in which all model parameters are held constant for the duration of the study period except population and in-migration. In Figures A.9a and A.9b, levels of in-migration for each profession increase by 20%. In Figures A.10a and A.10b, levels of in-migration for each profession decrease to 0.

Figure A.9a

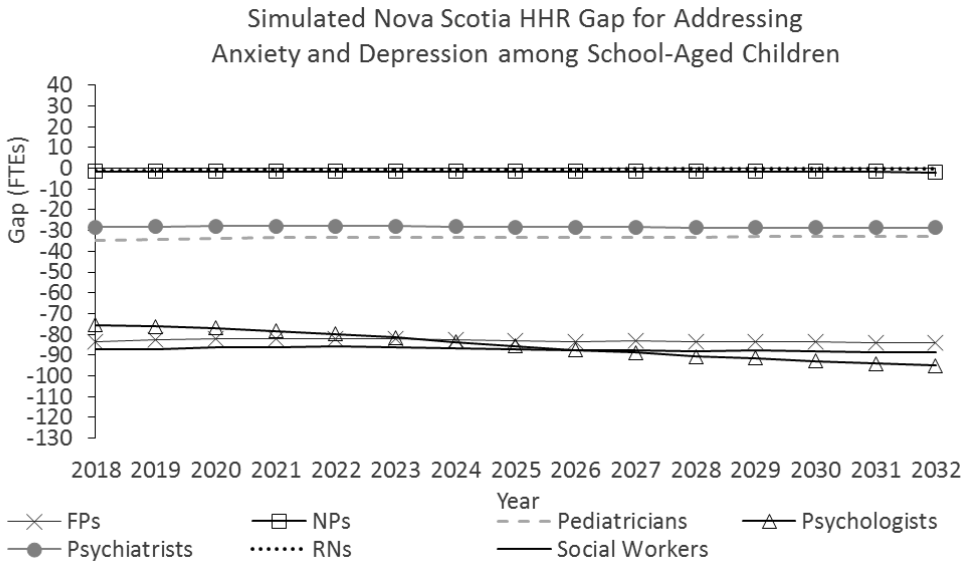


Figure A.9b

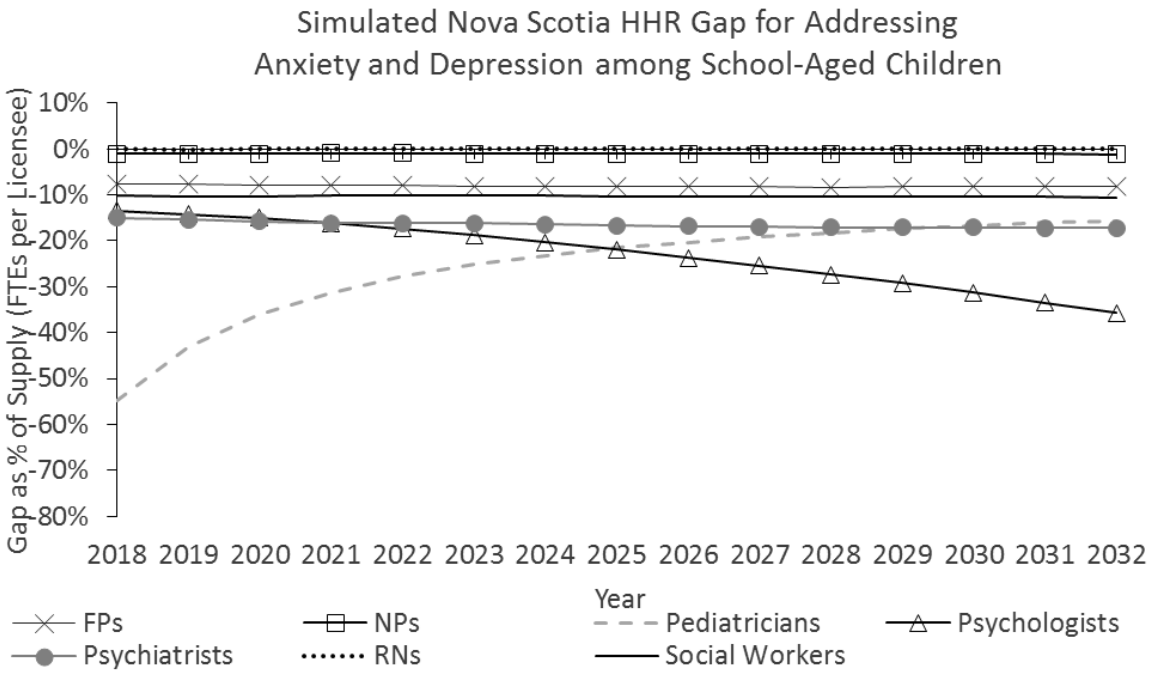


Figure A.10a

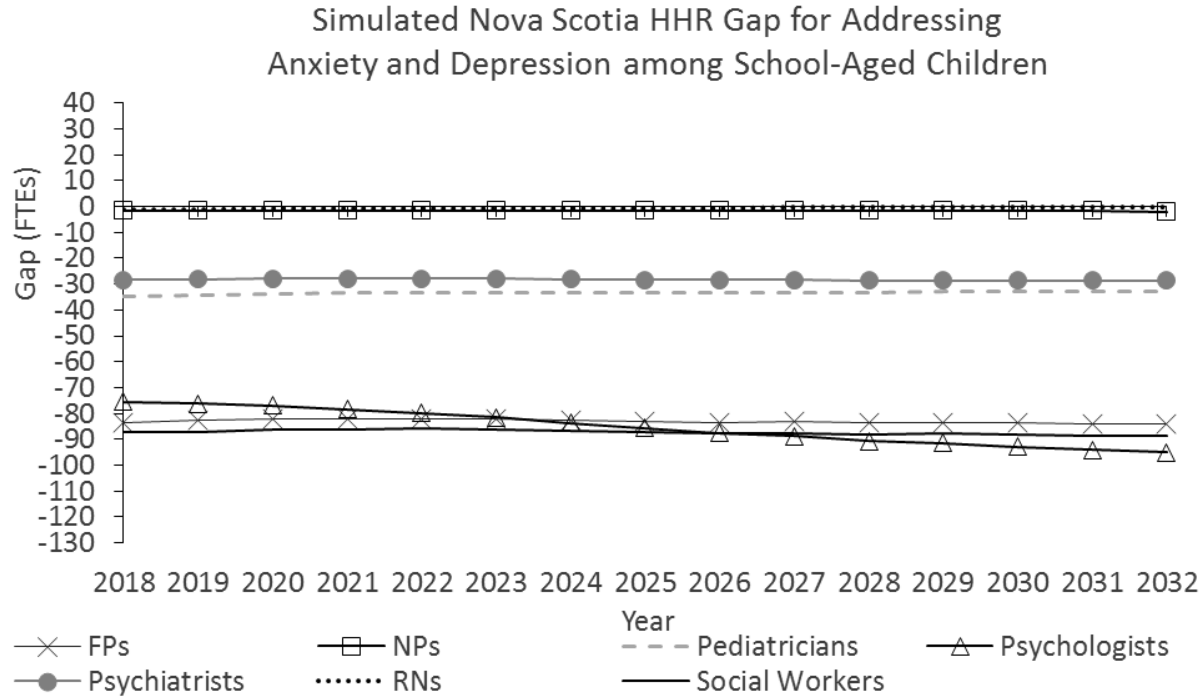
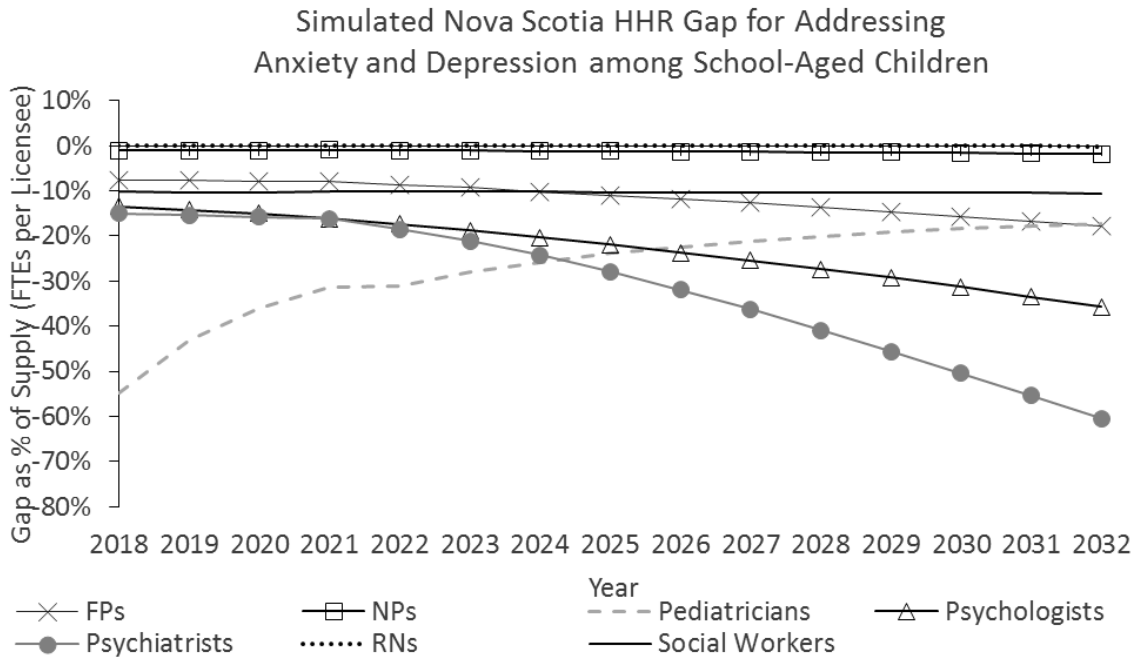


Figure A.10b



As Figures A.9a, A.9b, A.10a, and A.10b indicate, changes to in-migration have relatively little impact on the absolute gaps for any profession but a substantial impact on the relative gaps for some professions – particularly family physicians, pediatricians, psychiatrists, psychologists, and social workers. This is because, in these scenarios, these professions have the largest roles in addressing anxiety and depression among school-aged children in the province – i.e. the division of work parameter is generally higher for these professions.

Exit Rates Scenarios

Figures A.11a and A.11b and A.12a and A.12b show the simulated Nova Scotia HHR gap for addressing anxiety and depression among school-aged children under a

scenario in which all model parameters are held constant for the duration of the study period except population and exit rates. In Figures A.11a and A.11b, exit rates increase to match those of the profession with the highest average exit rates over the most recent five-year period for which data are available (psychiatrists). In Figures A.12a and A.12b, exit rates decrease to match those of the profession with the lowest exit rates over the most recent five years (NPs).

Figure A.11a

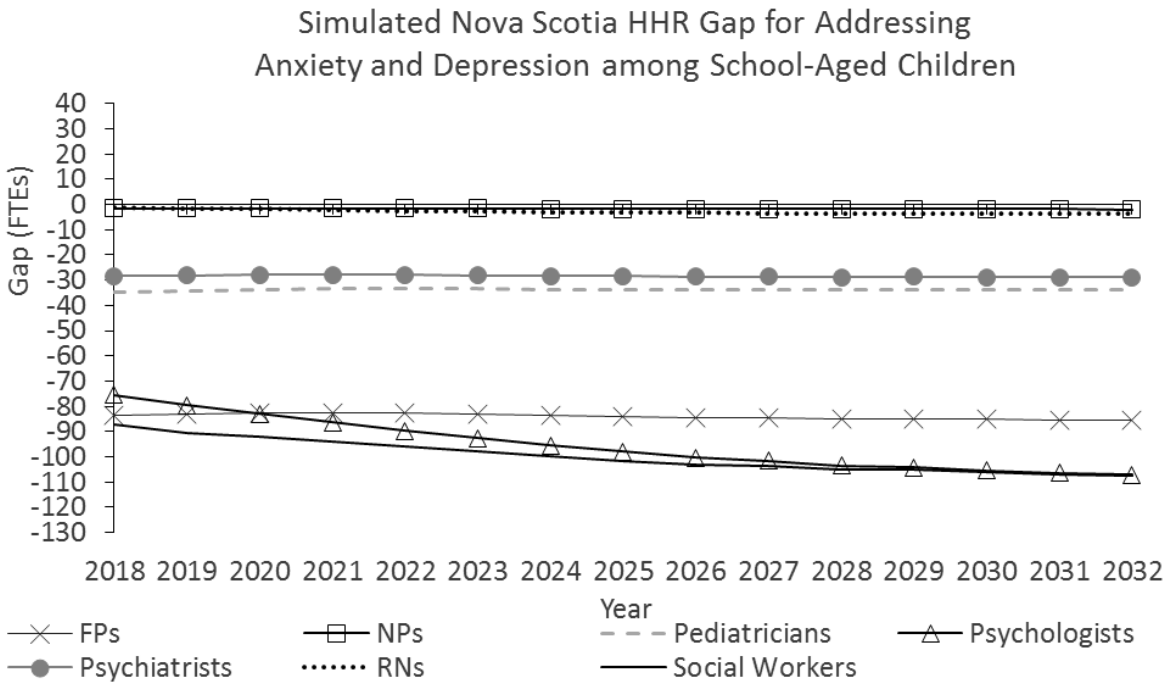


Figure A.11b

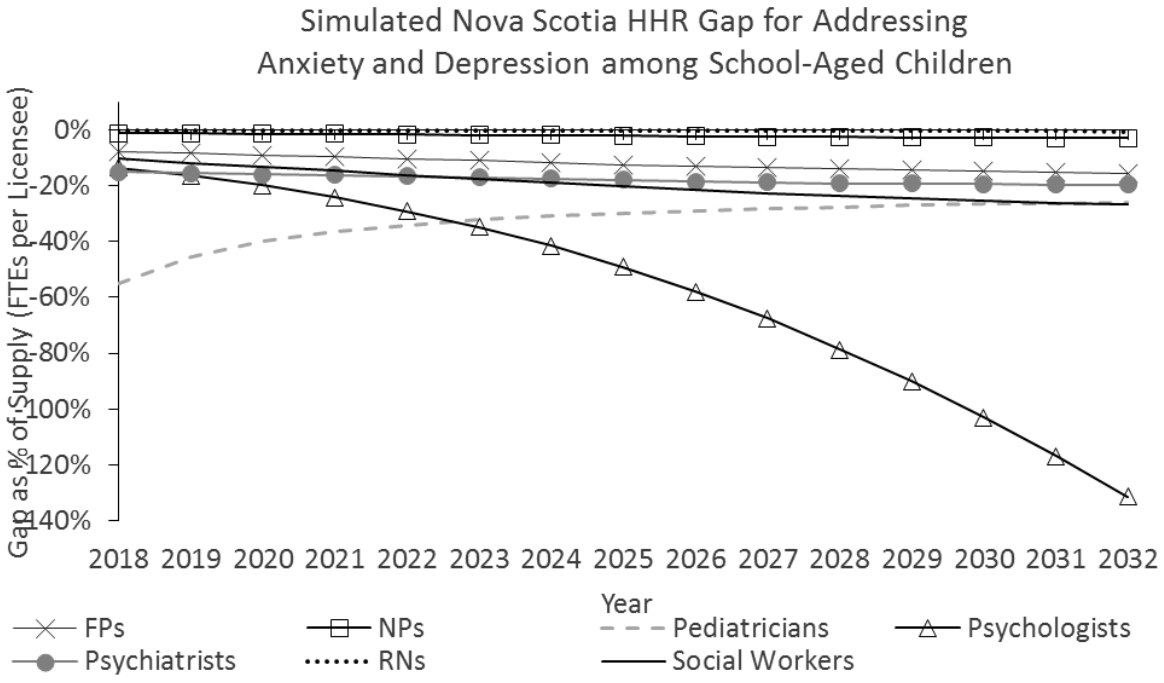


Figure A.12a

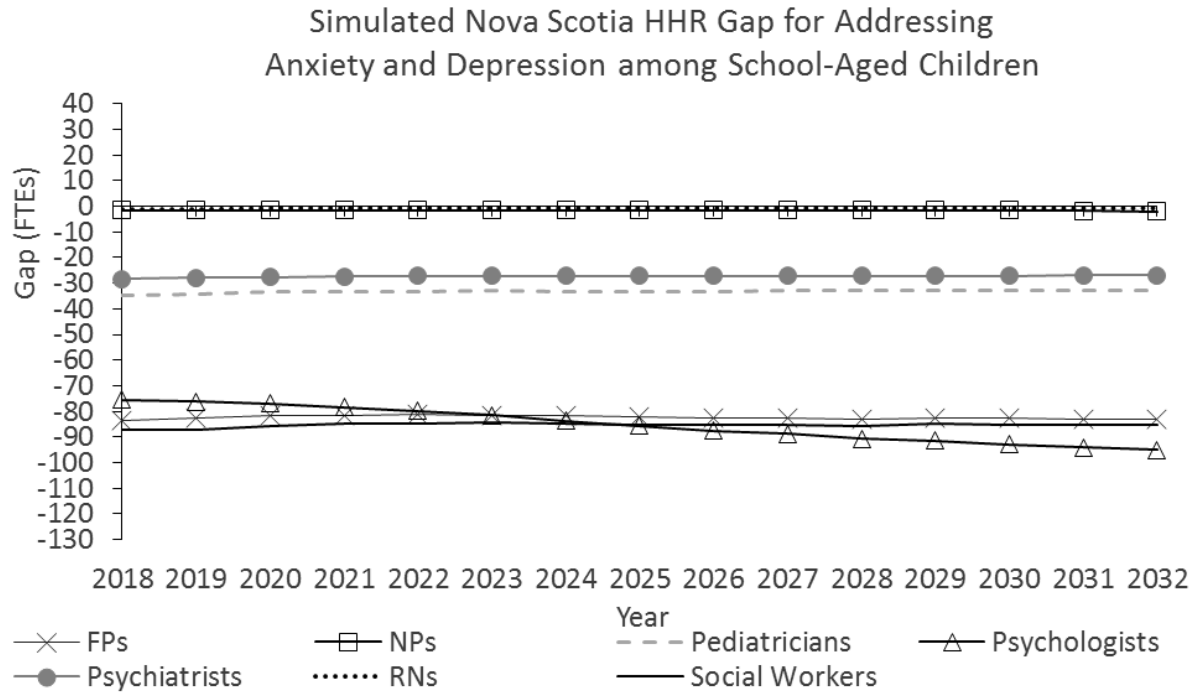
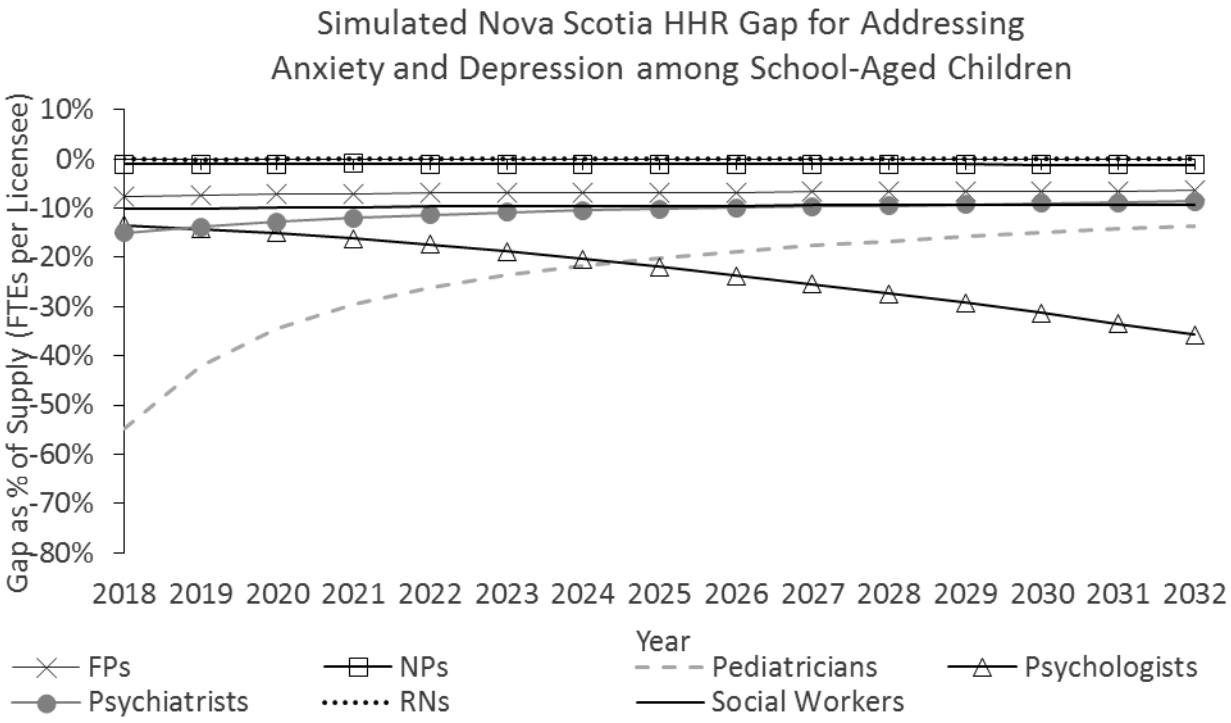


Figure A.12b



Figures A.11a, A.11b, A.12a, and A12b demonstrate how increasing and decreasing exit rates increases and decreases, respectively, the simulated future gaps for each included profession. Increasing exit rates in this scenario has more of an impact because the exit rates for psychiatrists are so much higher than those for the other professions; exit rates for the other professions are much closer to those for NPs.

Activity Scenarios

Figures A.13a and A.13b and A.14a and A.14b show the simulated Nova Scotia HHR gap for addressing anxiety and depression among school-aged children under a scenario in which all model parameters are held constant for the duration of the study

period except population and the mean level of activity within each included profession. In Figures A.13a and A.13b, beginning in 2021, activity increases by 10%, while in Figures A.14a and A.14b, beginning in 2021, activity decreases by 10%.

Figure A.13a

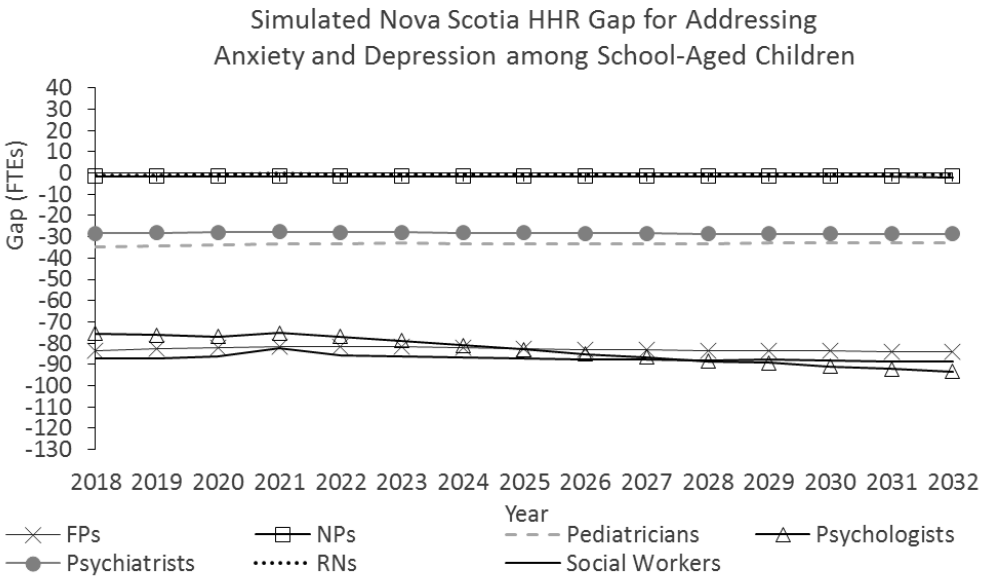


Figure A.13b

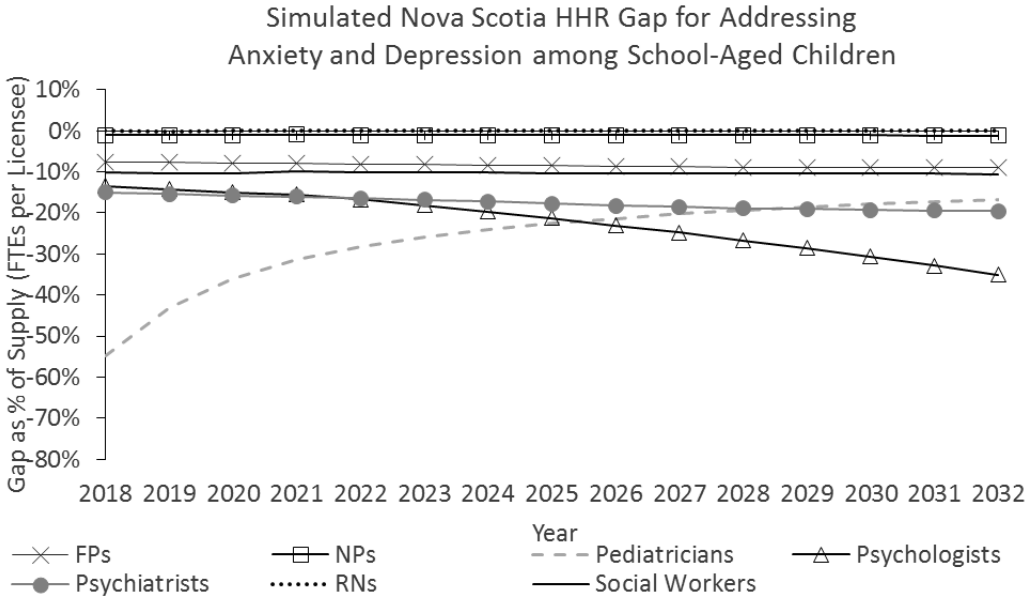


Figure A.14a

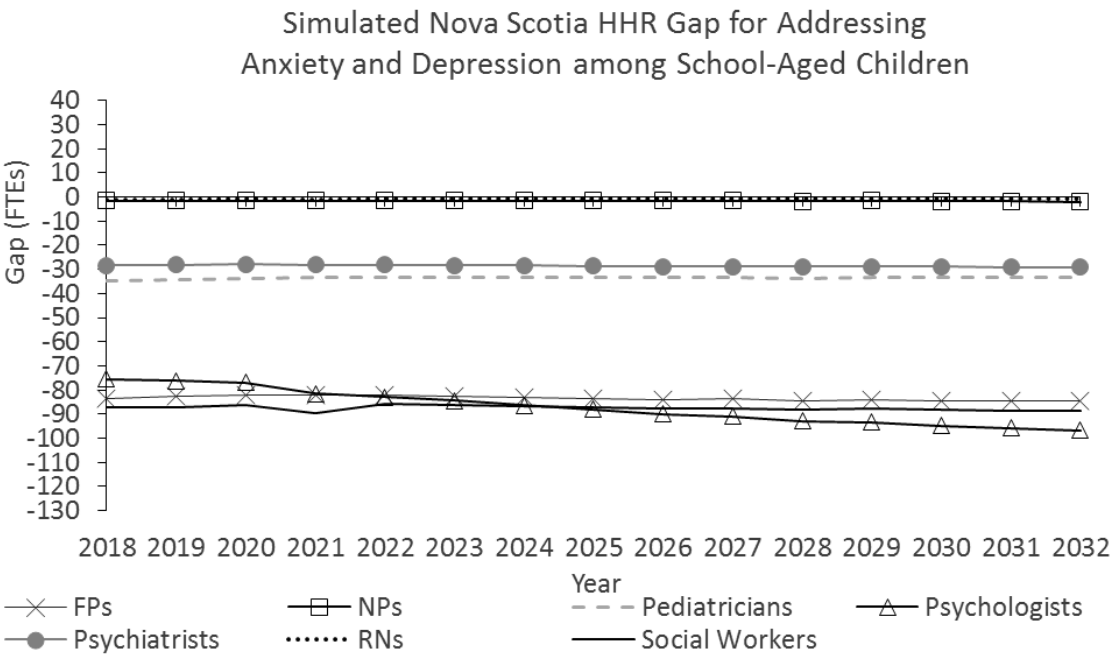
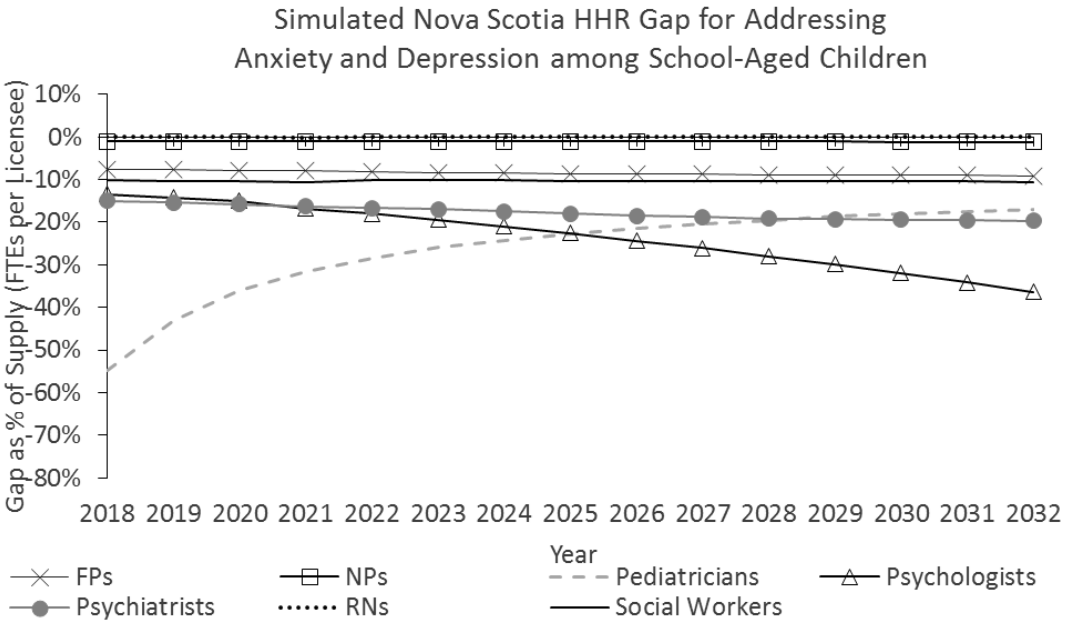


Figure A.14b



Figures A.13a, A.13b, A.14a, and A.14b demonstrate how increasing and decreasing the levels of activity among the included professions decreases and increases, respectively, the simulated gaps for each profession. As above, the effect is greatest for those professions who have the largest division of work in these scenarios – pediatricians, psychologists, psychiatrists, and social workers.