HEALTH WORKFORCE AND LABOUR MARKET DYNAMICS IN OECD HIGH-INCOME COUNTRIES: A SYNTHESIS OF RECENT ANALYSES AND SIMULATIONS OF FUTURE SUPPLY AND REQUIREMENTS

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Abbreviations

AG     Advisory Group
DALY   disability-adjusted life years
FTE    full-time equivalent
GHWA   Global Health Workforce Alliance
HRH    human resources for health
OECD   Organisation for Economic Co-operation and Development
PAHO   Pan American Health Organization
Introduction

Human resources for health (HRH) are a core element of health systems. Their availability, accessibility, quality and performance directly impact the effectiveness and equity of health-care services. Planning for HRH therefore has a central role in health-care systems. HRH planning remains a major challenge in many countries despite its centrality to the success of global campaigns such as the Millennium Development Goals. The adoption by the World Health Assembly of the Global Strategy on Human Resources for Health: Workforce 2030 for the period 2016–2030 reflects the growing recognition of the importance of HRH planning. To inform the development of this strategy, the WHO/ Pan American Health Organization (PAHO) Collaborating Centre on Health Workforce Planning and Research at Dalhousie University was commissioned to conduct a rapid review of recent analyses of HRH requirements and labour market dynamics in high-income countries who are members of the Organisation for Economic Co-operation and Development (OECD), to identify a methodology to determine future HRH requirements for these countries, and, on the basis of this methodology, to provide simulations of the future supply of and need-based requirements for midwives, nurses and physicians in the included countries to the year 2030.

Methods

Synthesis of current evidence

Multiple steps were taken to obtain all possible relevant analyses of HRH requirements and labour market dynamics used in the last decade for the target countries. These included a systematic search of published peer-reviewed literature, targeted searches of key HRH websites, and multi-stage mining of the references of documents obtained through these means. This analysis was undertaken in collaboration with colleagues in the WHO’s Health Workforce department, who contributed to the development of the search parameters, helped identify potential relevant websites, and invited prospective members to join an international Advisory Group of key HRH researchers.

Simulation of future supply and requirements

Based on the criteria identified through the synthesis of existing evidence, a simulation of future HRH supply in terms of head counts was produced using a stock-and-flow approach, which entails adjusting current HRH stocks according to expected flows in (e.g. new graduates, inward migration) and out (e.g. retirements, attrition to other sectors, outward migration etc.) of each country’s stock. These head counts were then adjusted according to levels of participation (providing direct patient care) and activity (proportion of full-time hours spent providing direct patient care) for different types of HRH. Costs of producing and maintaining these stocks can then be simulated based on average training costs and wages.

To inform the process of estimating HRH requirements, a review of the objectives of each included country’s health-care system, as described in documents obtained for the first report, was conducted. Ensuring equitable access to health-care services and maintaining and/or promoting the health of their respective populations were the objectives shared across most of the included countries. As such, service requirements were simulated according to different levels of health within countries and existing levels of service provision by those levels of health. These service requirements were then converted to simulated HRH requirements based on estimates of the productivity of different types of HRH. This approach is consistent with that described in several previous studies.

In this way, the supply of and requirements for midwives, nurses and physicians were simulated for each included country in 2030. The simulations were based on data that were readily available, either from existing public online sources (e.g. OECD or WHO indicator databases) or through documents gathered as part of Phase 1. In the time available it was not possible to engage with the various HRH stakeholder groups in the included countries to obtain additional information or to do targeted internet searches for information on each individual country and profession. HRH planners and other relevant stakeholder groups within the included countries would likely be better positioned to obtain this information. In aggregate, 35% of the data elements required to implement the estimation approach were found. Analysis was focused only on three types of HRH — midwives, nurses and physicians — due to these data limitations.

1 According to World Bank designations.
2 Included countries: Australia, Austria, Belgium, Canada, Chile, the Czech Republic, Denmark, Estonia, Finland, France, Germany; Greece, Hungary, Iceland, Ireland, Israel, Italy, Japan, Luxembourg, the Netherlands, New Zealand, Norway, Poland, Portugal, Republic of Korea, Slovakia, Slovenia, Spain, Sweden, Switzerland, the United Kingdom and the United States of America.
In the absence of reliable data on the future values of various model variables, all except the size and age-sex distribution of the population were held constant for the production of the baseline simulations. However, univariate and multivariate sensitivity analyses were conducted modulating the assumptions on each individual model parameters, as well as on several parameters simultaneously, to explore and illustrate how the results produced can change according to different scenarios. These analyses were based on actual variation in parameter values found within Canada, which was used as an example because that was the country for which the most complete data was found, and as such allowed for the best empirical evidence to guide sensitivity analyses.

**Results**

**Synthesis of current evidence**

Although over 200 relevant documents were reviewed in detail, collectively they do not include sufficient information to provide a clear picture of the expected future HRH situation in these countries. At best, it can be said that the HRH supply in these countries is generally expected to grow; because different analyses reach different conclusions about future HRH requirements in these countries, it is not clear whether that growth will be adequate to meet health system objectives in the future. Although most analyses suggest that the numbers of physicians and nurses required in the included countries are likely to increase in the future, this view varies across analyses depending on the methods and assumptions used. Further, most analyses for professions other than nurses and physicians suggest that the numbers required are likely to decrease in the future. The implications of these projected respective surpluses and shortages in terms of meeting health system objectives are not clear.

Several recurring themes regarding factors of importance in HRH planning were evident across the documents reviewed. These included: ageing populations and health workforces; changes in disease patterns, models of care delivery, scopes of practice, regulatory structures and technologies in health care; migration; incentives; data quality; the distribution of resources; interprofessional education and practice; stakeholder engagement; and balancing the public and private sectors. They also included important inconsistencies in the use of key HRH planning terms, which in turn affected the choice of methods in different documents for HRH planning.

Different approaches to HRH planning will be appropriate for different jurisdictions depending on their respective contexts and the objectives of their health-care systems and hence the policy questions being faced. Based on these objectives, methods need to be adopted that produce relevant answers for the precise HRH questions facing policy-makers in their particular contexts. The results of this review suggest, however, that rarely have explicit policy questions been identified to guide HRH research methods and analyses; instead available methods have been adopted with policy “interests” (as distinct from “questions”) made to fit these methods.

In an attempt to inform improvements to this situation, seven criteria for identifying an HRH planning approach appropriate to a given jurisdiction have been presented. Although none of the approaches found through the review met all of these criteria, several – from Australia, Canada and New Zealand – met all but one. Examples of other approaches which met each individual criterion have also been identified so that planners can explore different options depending on the relative importance of these criteria given their respective circumstances and health system objectives.

**Simulations of future supply and requirements**

These simulations suggest that, if the current HRH situations in the included countries continue to 2030, most of the included countries could face shortfalls of one or more types of HRH; that is, holding constant all the parameters included in the model except population, they would not have enough HRH available to continue to provide their current levels of health-care services to their respective populations. In contrast, some countries may experience surpluses of some types of HRH; that is, they would have more than the number needed to continue to provide current levels of health-care services to their respective populations. In total, these simulations in the baseline scenarios sum to shortfalls of over 45 000 midwives, 1.1 million nurses and 754 000 physicians across the 31 included countries for 2030. These simulated shortfalls are the collective result of simulated future supplies of 157 000 midwives, 6.8 million nurses and 2.4 million physicians against simulated requirements of 202 000 midwives, 7.9 million nurses and 3.2 million physicians.

The sensitivity analyses demonstrated the degree to which the simulated future physician gap in Canada varied according to different assumed values for various planning parameters, including population growth, population health status, average levels of service provision, HRH productivity, and the training, participation, retention and activity of HRH. The results of these analyses showed simulations of future HRH gaps are highly sensitive to even modest changes in the assumed future values of different planning parameters. In these examples, the simulated future physician gap ranged from a large shortfall – equivalent to 47% of the future supply – to an almost equally large surplus equivalent to 43% of the future supply. It is important to reiterate that these divergent scenarios are not based on hypothetical values of planning variables, but on actual values that represent real variations within a single country.
If the same level of variability found in the sensitivity analyses for Canadian physicians is applied to the aggregate gaps simulated for all 31 included countries, these could range from shortfalls of 74,000 midwives, 3.2 million nurses and 1.2 million physicians (47% less than supply) to surpluses of 67,000 midwives, 2.9 million nurses and 1.0 million physicians (43% greater than supply) by 2030. Thus, the results of these simulations should not be interpreted as predictions of what will happen; instead they are meant to serve as compass bearings, showing the directions in which the HRH situations in the included countries are heading, and may continue if their current situations (measured as completely as possible with the time and resources available) remain as they are.

Discussion

Although online resources such as the OECD’s indicator database provide a great deal of data relevant to HRH planning in member countries, a more comprehensive approach, fully consistent with the criteria outlined in the methodology section, would require additional information as well as direct engagement with the relevant stakeholder groups in the respective countries. In the absence of this information and engagement, several assumptions regarding the current and future values of some planning parameters were required; these assumptions, and their implications in terms of interpreting the results, are discussed in detail in the main body of this report.

It is important to note that these scenarios have been presented for illustrative purposes. For some countries the assumptions described above may be very close to reality; for others they may be quite different. With access to more accurate and comprehensive country-specific information, planners in individual countries can easily replace these assumptions with relevant data to better reflect their actual HRH situations. Further, despite the above limitations, considerable effort was put into estimating the current or “baseline” value of the various parameters used to simulate HRH supply and requirements for midwives, nurses and physicians in the included countries. However, it is not possible to accurately predict what values these parameters will take on in the future.

The simulations of the supply of and requirements for midwives, nurses and physicians suggest that the trajectory of HRH situations varies considerably by profession and by country. Rather than serving as predictions of the future HRH situations in these countries, the results illustrate the opportunities and the policy levers that decision-makers have to influence the supply of and requirements for HRH and the potential consequences of failing to take timely action.

These results also underscore the importance of several factors critical to effective HRH planning, each of which have been repeatedly identified by earlier analyses of HRH planning worldwide. First, HRH planning must be conducted iteratively, recognizing the constantly evolving nature of population health needs, health-care practices and regulatory structures, and health labour markets, and incorporating ongoing monitoring and evaluation. Second, HRH planning must be conducted by engaging with the relevant stakeholders. Third, HRH planning must be based on appropriate data, and this includes measures of both the health levels of the population as well as the health-care services planned to respond to those health levels, together with characteristics of the health workforce and the broader economic, sociopolitical, environmental and technological contexts in which the planning is being done.

Conclusions

The objective of this report was to simulate the supply of and requirements for midwives, nurses and physicians in high-income OECD countries up until 2030, to inform global policy dialogue and strategic planning at both international and national levels, such as that occurring as part of the development of the global strategy on HRH. This was carried out using publicly available data and using assumptions about the values of the various determinants of supply and requirements, aside from population projections, remaining constant throughout that time period. Despite the limitations resulting from challenges obtaining some of the necessary data in the time available, the results demonstrate the potential to apply an approach to simulating HRH supply and requirements in a manner more comprehensive than most of those currently being used in many countries. HRH planners in individual countries, who have more direct access to data on the relevant planning parameters, are best placed to implement such an approach working with their respective stakeholder groups.

The results of these simulations suggest that the trajectories of HRH supplies and requirements vary widely across countries and professions, with some potentially headed for large surpluses, while others may be moving toward large shortfalls. These findings reinforce the concern highlighted by the WHO (2015b) in its Global Strategy on Human Resources for Health: Workforce 2030 that many high-income countries are challenged with matching supply and requirements for HRH under existing and future affordability and sustainability constraints, and often experience periodic swings between perceived shortfalls and oversupply. The analysis reported here provides evidence that can also inform a global policy dialogue on international imbalances and mobility patterns across countries. The type of HRH planning approach described here also allows the identification of the policy levers with the greatest potential to affect trends and prevent the emergence of future gaps, thereby informing policy options that may alleviate or avoid these gaps, such as changes to models of care delivery or to HRH training and/or regulatory structures.
The sensitivity analyses demonstrate that these simulations are highly dependent on the assumptions on current and future values of the various variables that determine HRH supply and requirements. These findings highlight the importance of HRH planning that is iterative, based on a valid methodology, and engages the relevant stakeholder groups. Further, it is imperative that these stakeholders collaborate to ensure that the types of data necessary for such methodologies are regularly collected and analysed to inform HRH planning.
1. Introduction

The backbone of any health-care system is the human resources who deliver care. Thus, human resources for health (HRH) planning has a direct impact on the functioning of health-care systems, which are critical to ensuring a healthy population. According to one of the early seminal texts on the subject, HRH 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. Such planning also involves specifying who is going to do what, when, where, how, and with what resources for what population groups or individuals so that the knowledge and skills necessary for the adequate performance can be made available according to predetermined policies and time schedules. This planning must be a continuing and not a sporadic process, and it requires continuous monitoring and evaluation.” (Mejía & Fülöp, 1978).

Effective HRH planning entails matching the HRH supply with the requirements for HRH necessary to satisfy health-care system objectives. In many publicly funded health-care systems these objectives relate to meeting the health-care needs of the population and involve replacing traditional measures of demand for HRH (determined by a population’s ability and willingness to pay for the services HRH provide) with measures of the HRH required to support service planning and delivery in ways that address a population’s need for care. Under such an approach, the quantity and type of services planned to respond to those needs must be determined in the context of a government’s capacity to fund care. It may be that not all needs for care can be met, or that care levels are less than “gold-standard” or evidence-based levels because of resource limitations, but health-care services, and the HRH required to deliver them, are still planned in relation to the levels and distribution of needs for care in the population. This is distinct from more common approaches where estimates of HRH requirements are based simply on service levels observed by demographic characteristics in the population.

HRH planning remains a major challenge in many countries (Dussault et al., 2010; Matrix Insight, 2012; Ono et al., 2013; Campbell et al., 2013) despite its centrality to the success of global campaigns such as the Millennium Development Goals (Campbell et al., 2014). Recent efforts by the World Health Organization (WHO), the Global Health Workforce Alliance (GHWA) and partner organizations to facilitate the development of a global HRH strategy for the period 2016–2030 (Campbell et al., 2014) reflect the growing recognition of the importance of HRH planning. These efforts build on a number of activities undertaken by the WHO to promote evidence-based HRH planning among member countries. For example, the HRH Observer series, published by WHO, has included technical issues on tools for modelling HRH supply and requirements (Dal Poz et al., 2010), measuring inequalities in the distribution of HRH (Anand, 2010), and analysing HRH labour markets in developing countries (Scheffler et al., 2012), among other topics relevant to HRH planning.

To inform this process, the WHO/Pan American Health Organization (PAHO) Collaborating Centre on Health Workforce Planning and Research at Dalhousie University was asked to conduct a rapid review of recent analyses of HRH requirements and labour market dynamics in high-income countries who are members of the Organisation for Economic Co-operation and Development (OECD) (referring hereafter as the “included countries”) and to identify criteria and a methodology to determine future HRH requirements for these countries. On the basis of these criteria, simulations of the future supply of and needs-based requirements for midwives, nurses and physicians in the included countries to the year 2030 were developed.

1.1 Objectives

The specific objectives of this report were as follows:

**Synthesis of evidence**

1. Identify all analyses of HRH requirements and health labour market dynamics for high-income OECD countries published within the past 10 years.

2. Categorize the analyses according to the type(s) of models used to estimate requirements, the professions included, the timeframes over which they apply, any labour market trends identified, and any assumptions on which they were based.
3. Identify key themes and trends in these analyses that may be emerging over time.

4. Identify and report gaps in the knowledge base formed by these analyses to inform the development of a global HRH strategy.

5. Identify a methodology to project future HRH requirements in OECD countries. This may be an aggregate method taking into account economic, demographic and epidemiologic factors from various approaches used in the past to develop similar estimates.

**Development of simulations of future supply and requirements**

6. Provide simulations of the future supply of and needs-based requirements for midwives, nurses and physicians in the included countries to the year 2030 using a methodology as consistent as possible with the criteria identified through the synthesis of evidence.
2.1 Synthesis of evidence

Multiple steps were taken to obtain all possible relevant analyses of HRH requirements and labour market dynamics used in the last decade for the target countries. These included a systematic search of published peer-reviewed literature, targeted searches of key HRH websites, and multi-stage mining of the references of documents obtained through these means. This analysis was undertaken in collaboration with colleagues in the WHO’s Health Workforce unit, who contributed to the development of the search parameters, helped identify potential relevant websites and invited prospective members to join an international Advisory Group (AG) of key HRH researchers.

The search of the peer-reviewed literature targeted several electronic databases, including Pubmed, Informa HealthCare, Web of Science, EconLit, ABI/Inform and CINAHL. These were searched for articles whose titles or abstracts contained terms from each of two groups:

1. Any of (health human resources, HHR, human resources for health, HRH, health workforce, health workers, health manpower, doctors, physicians, nurses, midwives, pharmacists, dentists); and

2. Any of (planning, forecasting, modelling, requirements, needs, demand, gaps, shortage, supply, oversupply, labour market, dynamics, horizon scan, Australia, Austria, Belgium, Canada, Chile, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Israel, Italy, Japan, South Korea, Luxembourg, the Netherlands, New Zealand, Norway, Poland, Portugal, Slovakia, Slovenia, Spain, Sweden, Switzerland, UK, USA, OECD, high-income).

Websites of multiple national organizations such departments of health, bureaux of statistics and HRH-specific planning bodies were searched, as well as those of international organizations such as the WHO, the GHWA, the OECD and the World Bank. When search functions were available for website content, the relevant search terms presented above were used. If search functions were not available, sections of these websites titled “Publications”, “Reports”, or similar, were searched for documents pertaining to HRH analyses. A full list of the websites searched is included as Annex 1.

The database and website searches yielded over 1000 documents deemed to be potentially relevant. The titles, abstracts and/or executive summaries of these documents were then reviewed to ensure that they were published in English between March 2005 and March 2015 and included primary analysis of HRH requirements or labour market dynamics in one or more included countries. Based on these criteria, 181 documents were selected for full-text review. Although it was not possible within the allotted time to mine the reference lists of all 181 documents, a selection of 30 that cited multiple other potentially relevant works were mined for additional documents. This initial list of documents was then circulated to the AG with the request that they identify any relevant works they felt had not yet been included.

Despite these efforts to assemble a complete set of HRH analyses, the limited resources available to perform the review meant that relevant documents may have been missed, for any of the following reasons:

- It was not possible to include documents written in languages other than English. This is a particularly important limitation given that English is not an official language for some countries included in the review.
- Not all potentially relevant websites could be included in the review, and those that were included could not be searched exhaustively.
- It was not possible to mine the references of every relevant document.
- Some relevant peer-reviewed publications may not have been part of the databases searched and/or may not have included any of the search terms used in their titles or abstracts. This may be due to variations in the use of headings and subcategories in the various databases or in the language used to describe HRH research and planning (see results section for examples).

In total, 224 documents were included in the review. A data extraction tool was created to facilitate summarization of key features of each of these documents in terms of their scopes, methods, conclusions, and any major issues or themes identified. A copy of this tool is presented in Annex 2.

2. Methods
2.2 Development of simulations of future HRH supply and requirements

The criteria identified as part of the first phase were as follows:

1. The approach is consistent with the objectives of the health system.
   a. HRH requirements are derived from service requirements;
   b. Those service requirements are aligned with system objectives (e.g. addressing population needs for care arising from various diseases or other health problems).

2. The approach considers HRH requirements in the context of production functions for health services (i.e. dependent upon the availability or use of facilities and other non-human inputs to service production and on models of care to be used).

3. The approach explicitly considers the role and determinants of productivity (i.e. units of service per hour of work).

4. HRH supply is measured in terms of time devoted to service delivery (i.e. flow generated by a stock of HRH as opposed to focussing only on the HRH stock (numbers of HRH)).

5. The approach considers the determinants of flow (e.g. hours worked) and stock (entries/exits) as policy variables.

6. The approach considers:
   a. The cost implications of HRH plans; and
   b. The extent to which HRH plans are aligned with health system financial planning.

Based on these criteria, a simulation of future HRH supply in terms of head counts was produced using a stock-and-flow approach, which entails adjusting current HRH stocks according to expected flows in (e.g. new graduates, inward migration) and out (e.g. retirements, attrition to other sectors, outward migration etc.) of each country’s stock. (e.g. Barber & González López-Valcárcel, 2010; Buchan & Seccombe, 2013; Dall et al., 2015). In line with criteria 5 and 6, these head counts are then adjusted according to levels of participation (providing direct patient care) and activity (proportion of full-time hours spent providing direct patient care) for different types of HRH. Several documents reviewed as part of the first paper used such adjustments in estimating HRH supply (e.g. Artoisenet & Delliège, 2006; Health Workforce Australia, 2014a; Centre for Workforce Intelligence, 2015c). Costs of producing and maintaining these stocks can then be simulated based on average training costs and wages (criterion 7); although several of the documents reviewed in the first paper considered HRH remuneration in estimating HRH supply and associated costs (e.g. Aiken & Cheung, 2008; WHO, 2010; Marvasti, 2014), none included analyses that also considered training costs.

To inform the process of estimating HRH requirements, and in keeping with criterion 1, a review of the objectives of each included country’s health-care system, as described in documents obtained for the first report, was conducted. The primary source for this information was the set of health system reviews published by the European Observatory on Health Systems and Policies (2016) in their Health Systems in Transition series, which provide detailed descriptions of the health-care systems in most of the included countries. Where possible this information was supplemented by cross-references with original source documents (such as strategic plans, legislation or referenced journal articles) or searches on individual national health ministry websites. A table summarizing the objectives of each of the included countries’ health-care systems, as described in these documents, is provided in Annex 3.

Ensuring equitable access to health-care services and maintaining and/or promoting the health of their respective populations were the objectives shared across most of the included countries. As such, service requirements were simulated according to different levels of health within countries and existing levels of service provision by those levels of health. This means that this approach differentiates between, for example, the number of physician visits a 75-year-old woman in poor health would require as opposed to a 75-year-old woman with good health. Under more common utilization-based approaches, all 75-year-old women would be assumed to require the same number of physician visits, regardless of their level of health. These service requirements were then converted to simulated HRH requirements (to meet criterion 2) based on estimates of the productivity of different types of HRH (criterion 4). This approach is consistent with that described in several previous studies (e.g. Birch et al., 2007; Segal et al., 2008; New Zealand Ministry of Health, 2011a).

In this way, the supply of and requirements for midwives, nurses and physicians were simulated for each included country in 2030. The bulk of the data used to populate the models for each profession and country were obtained from the OECD’s indicator database (OECD, 2015a). Other data were obtained from other existing public online sources such as the WHO’s indicator database (WHO, 2015a) or through documents gathered as part of the first paper. In the time available it was not possible to engage with the various HRH stakeholder groups in the included countries to obtain additional information or to do targeted internet searches for information on each individual country and profession. HRH planners and other relevant stakeholder groups within the included countries would likely be better positioned to obtain this information.

Table 1.1 provides an overview of the data that were sought – and found – to inform the projections. The values in each cell indicate the number of countries, out of the 31 included in these simulations, for which input data were found for a given parameter, profession, and country.
In aggregate, 35% of the data elements required to implement the estimation approach were found. This should not be interpreted to mean that the data required to estimate HRH supply and requirements in a manner consistent with the above criteria do not exist. For example, there is information on acute care provision in Canada maintained by the Canadian Institute for Health Information (2015a) that can be adjusted for acuity and the intensity of care provided, but which could not be obtained within the timelines of this project. Planners within individual countries would be more familiar with potential local sources of the information required to provide a stronger base for the simulations.

In the absence of “gold standards” defining appropriate levels of health-care service provision by age, sex and health status, the values included in the model are based on current values. This is done for the purposes of demonstrating the model’s application and does not imply that these levels are optimal. Planners within individual countries can update these data (and any others they desire) to reflect planned levels of service provision within their respective jurisdictions. To illustrate this functionality, the impact of different values for the level of service parameter is shown in the results section.

Table 1.1 Overview of data availability by profession

<table>
<thead>
<tr>
<th>PLANNING PARAMETER</th>
<th>NUMBER OF COUNTRIES FOR WHICH DATA WERE FOUND</th>
</tr>
</thead>
<tbody>
<tr>
<td>Population characteristics</td>
<td></td>
</tr>
<tr>
<td>Population size and projections by age and sex</td>
<td>32</td>
</tr>
<tr>
<td>Health status by age and sex</td>
<td>31</td>
</tr>
<tr>
<td>Health-care system characteristics</td>
<td>Midwives model 2 2 2</td>
</tr>
<tr>
<td>Health-care provision by age, sex and health status</td>
<td>0 2 2</td>
</tr>
<tr>
<td>Service provision per FTE provider per year</td>
<td>32 29 29</td>
</tr>
<tr>
<td>Average total annual wages per FTE</td>
<td>0 28 27</td>
</tr>
<tr>
<td>Average training cost per graduate</td>
<td>0 0 0</td>
</tr>
<tr>
<td>Average replacement cost per FTE</td>
<td>0 1 0</td>
</tr>
<tr>
<td>Number of new graduates per year</td>
<td>31 32 32</td>
</tr>
<tr>
<td>Age distribution of new graduates</td>
<td>0 1 1</td>
</tr>
<tr>
<td>Number of in-migrants per year</td>
<td>3 22 24</td>
</tr>
<tr>
<td>Age distribution of in-migrants</td>
<td>0 0 0</td>
</tr>
<tr>
<td>Exits per year by age</td>
<td>1 1 1</td>
</tr>
<tr>
<td>Total yearly enrolment in training programmes</td>
<td>1 1 1</td>
</tr>
<tr>
<td>% of students completing training</td>
<td>0 1 1</td>
</tr>
<tr>
<td>% of graduates remaining in jurisdiction</td>
<td>0 1 1</td>
</tr>
<tr>
<td>Head count of current supply</td>
<td>31 32 32</td>
</tr>
<tr>
<td>Age distribution of current supply</td>
<td>3/31 3 29</td>
</tr>
<tr>
<td>% of licensed workforce providing any patient care</td>
<td>24 19 1</td>
</tr>
<tr>
<td>Average hours worked/week by participating workforce</td>
<td>0 1 1</td>
</tr>
</tbody>
</table>

Note: FTE – full-time equivalent.

This analysis was focused only on three types of HRH – midwives, nurses and physicians – due to data limitations. A more comprehensive HRH analysis would need to also take into account the role of and needs for all other types of HRH.

In the absence of reliable data on the future values of various model variables, all except the size and age-sex distribution of the population were held constant for the production of the baseline simulations. However, univariate and multivariate sensitivity analyses were conducted modulating the assumptions on each individual model parameter, as well as on several parameters simultaneously, to explore and illustrate how the results produced can change according to different scenarios. These analyses were based on actual variation in parameter values found within one of the included countries. Thus, the baseline simulations should not be interpreted as predictions of what will happen; instead they are meant to serve as compass bearings, showing the directions in which the HRH situations in the included countries are heading, and what policy levers may be used to move towards a better matching of HRH supply with population needs.
3. Results – synthesis of available evidence

3.1 Jurisdictional focus

The documents reviewed covered the 32 included countries specifically, with others looking at groups of countries (such as the European Union or WHO regions) or globally (Figure 3.1).

The United States of America was the jurisdiction covered by the most documents, with 53 (24% of all documents) specific to that country, followed by Canada with 27 (12%). Some 32 documents (14%) focused on multiple countries, most commonly the European Union and the OECD with seven documents (3%) each. Most of the documents focusing on individual countries were those where English is an official language – not surprising given the search parameters – although it is noteworthy that Belgium, Japan and the Netherlands were each the focus of at least five documents. Other countries for which more than one document was found included Finland (7), Germany (3), Iceland (2), Israel (2), Italy (2), Norway (3), Portugal (2), Scotland (4) and Wales (2).

3.2 Professions included

A diverse range of health professions were covered in the documents (Figure 3.2).

Some 75 documents were not specific to any particular health profession, instead analysing health-care system and labour market issues that affect all health professions to varying degrees. Among documents focusing on a single profession, 52 (23%) documents covered physicians, 29 (13%) covered nurses and 6 (3%) pharmacists. The only other professions to be the sole focus of more than one document were dentists (4), midwives (2) and physiotherapists (2).

Although 49 documents included analyses for more than one profession, the majority of these (38) considered those professions...
in isolation of each other. Only 11 of these included analyses that considered the interdependence between different professions.

### 3.3 Date of publication

Although the review spanned the years 2005–2015, 143 documents (64% of those included) were published in 2010 or later (Figure 3.3).

The number of documents published increased annually from 2005 to 2009, with the maximum of 32 published in 2012.

### 3.4 Analytical timeframes

The documents that provided quantitative analyses of HRH supplies or requirements did so over varying time periods (Figure 3.4).

Sixteen analyses were cross-sectional, providing HRH analyses for one particular point in time. The others varied widely in the length of time they covered, with 27 each documents each including projections one to five years ahead and 11–15 years ahead. Five documents included projections more than 30 years into the future, while eight used multiple projection periods in their analyses.

### 3.5 Types of models used

The main types of models used for HRH planning have been described repeatedly and thoroughly elsewhere, and differ chiefly in the methods they use for estimating HRH requirements (as opposed to HRH supply). Briefly, these fall into three categories: provider-based (sometimes referred to as supply-based); utilization-based (sometimes referred to as demand-based); and needs-based approaches. In utilization-based approaches, current or target utilization rates are multiplied by estimates of future population size, which are then converted to HRH requirements using productivity estimates. Under provider-based approaches, HRH requirements 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. Under needs-based approaches, HRH requirements are determined by applying estimated future distribution of health in the population to best practices (or current policy) for service provision in response to different levels of health. Provider requirements are then estimated from best-practice ways (or current productivity norms) of delivering those health-care needs.

A number of different types of models\(^5\) were used to perform the HRH analyses in the included documents (Figure 3.5).

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\(^5\) It should be noted that the models have been categorized here according to their characteristics and the typology referred to above opposed to how documents’ authors may have characterized them. See the results section for more detail on the different use of terms such as “need” and “demand” across documents.
Of the 224 documents reviewed, 130 described quantitative analytical methods and/or analyses of HRH supply or requirements (as opposed to, for example, focusing on qualitative discussion of HRH labour market or policy issues). Of these, 29 (22%) analysed HRH supply only – i.e. without contrasting it with HRH requirements. Among those documents analysing requirements, 49 (38%) used utilization-based approaches. Twenty-three (18%) used provider-based approaches while 18 (14%) used needs-based approaches. We were not able to determine which type of approach was used in eight documents (6%).

The approaches described in three documents (2%) did not fit any of these categories. The primary determinants of HRH requirements described in these documents included:

- “Local health board plans” (Scottish Executive, 2006).
- Health needs, willingness/ability to pay, regulatory structures (McPake et al., 2013).
- Demography, health needs, service levels, productivity, “clinical care microsystems”, “policy/governance/power”, “funds and support”, “individual response: behaviour biology” – several of these are identified as influencing both HRH supply and requirements (Masnick & McDonnell, 2010).

### 3.6 Assumptions described

A detailed analysis of the various assumptions used in each of these planning models is difficult because such assumptions are often implicit. However, the assumption most commonly articulated in these documents was that “the status quo will continue” – generally that the only model parameters whose values will change over time are those pertaining to population demographics, while other parameters such as service delivery models, practice patterns and productivity, and prevalence rates of various health conditions are assumed to remain constant. Three other explicit assumptions noted in multiple documents were:

- There are no unmet HRH requirements in the base (or first) year of the analysis (see for example United States Human Resources & Services Administration (HRSA), 2015b).
- Utilization of services is a proxy for demand (see for example Centre for Workforce Intelligence, 2012).
- The current ratio of HRH to population is adequate (see for example Tennant & Kruger, 2014).

Although the assumptions used in these analyses were often not stated explicitly, 13 documents (6%) included multiple scenarios to demonstrate the sensitivity of their results to different parameter values such as HRH retirements, population growth or productivity. Each of these demonstrated that projections of future HRH supply and requirements are highly sensitive to different assumptions about how various determinants would change over time.

### 3.7 Trends and issues identified

A number of trends and issues were raised repeatedly in these documents, many of which have been identified by other recent reviews of HRH studies (e.g. Dussault et al., 2010; Ono et al., 2013; Kuhlmann et al., 2013; Fellows et al., 2014). An exhaustive list of citations for documents in which each issue is raised would be prohibitively long, but for each of these recurring topics a few relevant documents are cited as examples. These recurring topics are listed below.

#### Ageing populations

The most frequently raised issue across these documents was the ageing of populations. For example, the population aged 65 and older across all OECD countries is expected to increase by over 70% from 208 million in 2015 to 355 million in 2050, while the number of those aged 80 and over is expected to increase from 56 million to 133 million over the same period (OECD, 2015b). This growth in older populations is expected to significantly increase requirements for health care in these countries, because older people tend to use more health care. However, this view conflates the relationships between ageing, population health and service requirements. While the probability of sickness increases with age, population ageing is partially reflective of improvements in the average level of health within each age group. As such, failure to account for this distinction between demographic and epidemiological shifts results in overestimates of HRH requirements (Tomblin Murphy et al., 2009, Birch et al., 2013; Mason et al., 2015).

#### Chronic disease and comorbidities

As people age, they are more likely to develop various chronic illnesses, each of which can exacerbate the other but which can often be treated with increasingly complex health-care interventions. Multiple documents identified a trend of increasing prevalence of multiple chronic conditions as likely to contribute to increased future requirements for HRH (e.g. Buske, 2007; Helsedirektoratet et al., 2013). Only a small minority of these, however, included empirical analyses of such trends and their potential impacts on HRH requirements (e.g. Birch et al., 2007; Singh et al., 2010; Tomblin Murphy et al., 2012). Others emphasize that this change in the complexity of health-care needs will require changes in the skill mix of available HRH (e.g. OECD, 2008) and/or the models of care delivery they use (e.g. Dussault et al., 2010; New Zealand Ministry of Health, 2011b; Ono et al., 2013), however, we found no documents that modelled the impacts of changes in needs and potential associated changes in skill mix or care models in terms of their impacts on HRH requirements.
Ageing workforces
The stock of available HRH is aging. For example, an average of one in three physicians in OECD countries is aged 55 or older (OECD, 2013). This has prompted concerns about large future HRH shortages, and a number of documents included specific analyses of the potential impacts of different retirement scenarios on HRH supply in their respective jurisdictions. In several documents it is suggested that strategies to encourage HRH to delay retirement be considered as a means of addressing HRH shortages (e.g. Centre for Workforce Intelligence, 2012).

Migration
HRH migration across countries is frequently raised as an issue in these documents, and in several cases is the primary focus of the analysis (e.g. Buchan, 2009; Ognyanova & Busse, 2011; Longley et al., 2012). Perspectives on migration differ across documents; for example, migration is variously identified as a leading cause of (e.g. Pantelli et al., 2011; Sigurgeirsdóttir et al., 2014) or an important solution to (e.g. Cooper, 2008; Health Workforce Australia, 2014a) existing and/or projected future shortages. Others, in contrast, examine the potential impacts of reducing in-migration from other countries, for example due to concerns about self-sufficiency and the ethics of international recruitment of HRH (e.g. Tomblin Murphy et al., 2012; Royal Australian College of Surgeons, 2011), or in response to perceived HRH surpluses (e.g. Aiken, 2007).

Inconsistent use of terms
Terminology differs across documents, with terms such as “need”, “demand” and “utilization” used almost interchangeably by some authors. Crettenden and colleagues (2014), for example, use utilization as a measure of demand, suggesting that their authors consider these to be equivalent. In fact, utilization represents the intersection of supply and demand and, unlike in most markets, demand for health care is not independent of supply thus creating market failure (Hall, 1978; Evans 1984; Birch, 1985; Markham and Birch, 1997; Birch et al., 2007; McPake et al., 2014). Similarly, the Centre for Workforce Intelligence (2012) describes its model as estimating demand but uses utilization to measure demand, and identifies a needs-based approach (Birch et al., 2007) as the basis for the model. Other documents, in contrast, emphasize that these are three distinct constructs, none of which can be considered a measure of the other (e.g. Birch et al., 2007; Holmes, 2012; McPake et al., 2014).

Similarly, the term productivity is used in some documents to describe the number of hours worked by various types of HRH (e.g. Polgreen et al., 2011; Yoji et al., 2012; Longley et al., 2012), despite this being strictly a measure of activity. Other analyses, in contrast, use the term to refer to the volume of services produced during those hours of work (e.g. Segal et al., 2008; Segal and Leach, 2011; Singh et al., 2010; Centre for Workforce Intelligence, 2014b, 2015c).

In addition, the term “shortage” is used to describe different HRH situations in different documents. For example, HRH shortages are defined in terms of vacant HRH positions (e.g. Crescent Management Consulting, 2009; Barber & González López-Valcarcel, 2010) or measured as the degree to which jurisdictional HRH requirements exceed supply (e.g. Oakley et al., 2008; Gallagher et al., 2010; HENSE, 2012; Health Workforce Australia, 2014a; Centre for Workforce Intelligence, 2013a). Similarly, the presence of any unemployment among HRH is deemed by some to reflect a surplus (e.g. Chaloff, 2008), whereas in others a surplus is considered to mean that the jurisdictional supply is greater than requirements (e.g. Takata et al., 2011; Bloom et al., 2012; Juraseck et al., 2012). In either case, it is often noted that estimated surpluses (or shortages) at one jurisdictional level (e.g. national) may mask shortages (or surpluses) at other (e.g. state or municipal) levels (e.g. United States Health Resources and Services Administration (HRSA), 2015a).

Distribution of resources
The planning models included in the review focus on optimizing the number of HRH at a particular jurisdictional level; ensuring those resources are appropriately distributed within the jurisdiction is a separate but important issue. Several types of HRH imbalances are discussed. Most often the imbalance noted is between urban and rural areas (e.g. Hawthorne, 2009; Chevreul et al., 2010; Toyokawa & Kobayashi, 2010; Pantelli et al., 2011; Campbell et al., 2013; New York Health Workforce Data System, Center for Health Care Workforce Studies, 2014a). Other types of imbalances described are those that occur across professions, sectors, and/or specialties, such as between the acute and primary care sectors (e.g.; Ide et al., 2009; Olejaz et al., 2012; Anell et al. 2012; Centre for Health Care Workforce Studies, 2014; Tennant & Kruger, 2014). However, some of the possible strategies identified to address these issues – for example providing incentives for HRH to practise in underserved areas, scarce professions or specialties or underserved sectors – lack any clear evidence base (Simoens & Hurst, 2006; McPake et al., 2014).

Interprofessional education and practice
As the complexity of health care services grows, it becomes increasingly likely that the services involved will require the competencies of more than one profession, so that systems must begin to rely increasingly on multi-professional teams of health-care providers (Dubois & Singh, 2009; Dussault et al., 2010; Scott et al., 2011; European Commission, 2012). A number of documents included in this review have identified that this growth in the use of multi-professional teams requires HRH planning models with the capacity for team-based planning as opposed to single professions planning in isolation (e.g. Dussault et al., 2010; Scott et al., 2011; Anell et al., 2012; Ono et al., 2013; Tennant & Kruger, 2014; New York Health Workforce Data System, Center for Health Care Workforce Studies, 2014b). However, only a few such
models – from Australia (Andrews & Titov, 2007; Segal et al., 2008; Segal & Leach, 2011; Segal et al., 2013), Canada (Tomblin Murphy et al., 2013a&b), and New Zealand (New Zealand Ministry of Health, 2011a-c, 2014) were found through this review.

**Changing care delivery models**

Many of the approaches reviewed assume that current care delivery models will continue in the future. In contrast, a number of documents (e.g. New Zealand Ministry of Health, 2006; Andrews & Titov, 2007; OECD, 2008; Segal et al., 2008; Segal & Leach, 2011; Health Education England, 2013; Tomblin Murphy et al., 2013a & b; Ireland Health Services Executive, 2014; New Zealand Ministry of Health, 2014) identify a need for HRH planning models that can incorporate or accommodate changes in care delivery models which may be required to address changes in health-care needs and/or more effective or efficient ways of addressing those needs.

**Changing practice patterns and scopes of practice**

Changing practice patterns or other provider behaviours are identified in some documents as determinants of HRH requirements. A frequently cited example of such a change is a reduction in the working hours (i.e. levels of activity, not levels of productivity) of physicians. Other things being equal, such reductions reduce the service flow per physician and hence the supply of the services they provide. Although decreases in physician working hours are frequently attributed to the growing proportion of female physicians (e.g. Buske, 2007; Goodyear & Janes, 2008; Koike et al., 2009; Chevreul et al., 2010; Health Workforce Australia, 2012; Johannessen & Hagen, 2012), other evidence indicates that this reduction in activity is occurring among all physicians, regardless of gender or age (Crossley et al., 2008; Stordeur & Léonard, 2010).

The issue of scopes of practice is addressed in several documents, specifically in terms of expanding scopes of different health professions over time (e.g. Dubois et al., 2006; Dussault et al., 2010; Holmes, 2012; Centre for Workforce Intelligence, 2013a-d; Dall et al., 2015). Although some approaches include the capacity to adjust for changes in scopes of practice (e.g. New Zealand Ministry of Health, 2011a; Segal et al., 2008; Segal & Leach, 2011; Tomblin Murphy et al., 2013a&b), similar to another recent review of HRH planning approaches (Ono et al., 2013), we found no examples of such changes actually being accounted for in modelling exercises. In none of the included documents were potentially contracting scopes of practice discussed.

**Evolving regulatory structures**

Changes to legislation and the other structures that govern the regulation, management and delivery of health care are identified as an issue in several documents. An example is the Affordable Care Act (ACA) in the United States of America; one estimate suggests that the ACA will substantially increase demand for nurses (Spetz, 2014). Other examples of regulatory developments likely to impact HRH labour markets are changes to retirement age in countries such as France (Ono et al., 2013), and policies aimed at regulating dual practice by physicians, which some argue reduce public sector HRH supply as physicians shift their practices entirely to the private sector (e.g. McPake et al., 2014). More broadly, it is becoming increasingly recognized that existing national regulatory structures require strengthening to ensure the adoption and implementation of effective HRH policies (e.g. McPake et al., 2013; Campbell et al., 2013; Stange, 2014).

**Stakeholder engagement**

To ensure the relevance, validity and uptake of HRH policies, effective engagement of stakeholder groups is essential. The planning approaches identified through this review are a mix of theoretical and applied methods. Among the latter, the importance of stakeholder engagement is acknowledged to varying degrees. Perhaps the most thoroughly documented examples of stakeholder engagement in HRH planning methods are the elicitation and horizon scanning efforts described by the United Kingdom’s Centre for Workforce Intelligence (2014a; 2015b), wherein multiple groups of stakeholders are engaged in a variety of activities at multiple stages of the analytical process to help planners identify current and potential HRH planning issues, articulate potential policy scenarios, supplement administrative data with professional opinions, and interpret and validate results based on their respective experiences.

**Incentives**

Some of the reviewed documents found (e.g. Baltagi et al., 2005; Dubois et al., 2006; Cox et al., 2008; Dubois & Singh, 2009; Jeon & Hurley, 2010; Buchan & Black, 2011; Spetz, 2014) acknowledge the importance of provider financial and other incentives as determinants of provider behaviour, but do not include any quantitative analyses of the relationships between these incentives and HRH supply (including levels of participation and activity) or requirements (as influenced by productivity rates). Some documents factor provider rates of pay into future HRH supply and requirements estimates (e.g. Spetz et al., 2006; WHO Western Pacific Regional Office, 2008; WHO, 2010; Gallagher et al., 2010); others explicitly investigate the relationship between different incentives and HRH outcomes such as labour force participation and activity (e.g. Aiken & Cheung, 2008; Buchan & Seccombe, 2013; Marvasti, 2014).

**Technological changes**

Many of the reviewed documents identified technological change as a factor likely to have a significant impact on HRH balance in their respective jurisdictions (e.g. New Zealand Ministry of Health, 2006; OECD, 2008; Dussault et al., 2010; Centre for Workforce Intelligence, 2013a; Health Education England, 2013; McPake et al., 2014). These
include changes in the technology used in health care – such as those allowing for less invasive surgeries (Matrix Insight, 2012) – as well as those used by health-care consumers, such as mobile phone apps for management of chronic conditions (e.g. Arnhold & Quade, 2014). The impacts of such changes in terms of HRH, however, are not clear from the analyses included in this review. Comparatively few documents directly incorporate consideration of technology changes into quantitative analyses. Among those that do, the exact nature of the changes in question is not clear (e.g. New Zealand Ministry of Health, 2006; Baumann & Kolotylo, 2010; Health Workforce New Zealand, 2010).

Balancing the private and public sectors
The health-care systems in included countries incorporate a mix of public and private service providers, and the relative size of these sectors varies considerably across and within countries. The public sector is the focus of the vast majority of the included analyses, although several documents emphasize the need for better data on, and coordination by national planners with, the private health care sectors (e.g. Oakley et al., 2008; Gallagher et al., 2010; Ono et al., 2013; Centre for Workforce Intelligence, 2013a). An example of the challenges in effectively managing both the public and private health-care systems is raised by McPake and colleagues (2014) who discuss the issue of dual-practising physicians – i.e. those who provide services in both the public and private sectors – noting that policies intended to dissuade physicians from devoting time to private practice may instead drive them to leave the public sector entirely.

Data quality
The validity of any HRH planning exercise is contingent upon the availability, relevance and accuracy of the data to which planners have access. Needs-based approaches in particular require comprehensive data on not only the supply of HRH but also on the health of the population, planned levels of service provision for different health problems, and HRH productivity, which may not be available in some cases. Despite significant improvements in HRH data collection in several high-income OECD countries and advancements in population health survey methods (McDowell & Newell, 2006, p. 12), almost every document included in this review articulated concerns about inadequacies in the data available to inform HRH planning (e.g. Dubois et al., 2006; Cameron Health Strategies Group, 2009; Matrix Insight, 2012; Gallagher et al., 2010; Campbell et al., 2013; Campbell et al., 2014).

Concerns about data are as long-standing as the study of HRH planning itself (WHO, 1971). As has been noted elsewhere, however (e.g. Birch et al., 2007), problems with data are not avoided by relying on conceptually invalid models that, for example, ignore fundamental health-care system objectives such as meeting population health needs by failing to incorporate these, or cannot account for potential future changes in factors such as productivity. It is better to base plans on appropriate concepts imperfectly measured than on inappropriate concepts that can be easily measured. If the available data are deemed to require some improvement to fully inform planning then investments should be made in improving the quality of the available data rather than in further entrenching the use of intrinsically flawed models. To that end, the identification and assessment of the data required to inform HRH planning should be based on the question of how many of what type of HRH are required to perform what services, for whom, and under what circumstances (Birch et al., 2007).

Iterative planning
Effective HRH planning requires appropriate methods and adequate data. But no matter how rigorous and comprehensive the methods or accurate the data, it is not possible to fully anticipate future developments in health care. Even demographic projections, which are the result of their own dedicated field of scientific study, are subject to significant inaccuracies, which have had profound implications for HRH planning decades after their publication (Evans, 2009). Many documents (e.g. Birch et al., 2007; Dubois et al., 2006; Dussault et al., 2010; Health Education England, 2013; Ono et al., 2013) emphasized the importance of HRH planning being conducted on an iterative, ongoing basis. This is not only so that planning models can be updated with the most current available data, but also so that the relevant stakeholders can be engaged, the validity of any necessary assumptions can be tested, and the effectiveness of implemented strategies can be regularly assessed.

Although many documents have been published describing various aspects of the HRH market in included countries, they do not collectively present a clear or consistent picture of what the HRH situation is expected to be across – or even within – these jurisdictions in the future. There are several reasons for this:

- The HRH research and/or policy question(s) to be answered by the various analyses are often not clear; different approaches may be required to answer different questions.

- As shown in Figure 3.2, the majority of the available studies focus on physicians and nurses; there is little evidence on supply of – let alone the requirements for – the other HRH that make up each country’s workforce.

- For most of the jurisdictions included in this review, no quantitative analyses of national-level HRH gaps – i.e. the difference between HRH supply and HRH requirements – were found. For others, only analyses of HRH supply (not requirements) were found, so it is not possible to present a picture of the HRH situation across the included countries here.
Even among those analyses that project HRH shortages or surpluses, these are measured in different units – for example, head counts as opposed to full-time equivalents (FTEs) in different studies – they span differing time periods, and are specific to a variety of different sectors (e.g. primary care, mental health services, long-term care etc.).

As outlined above, there are important differences in the various approaches used to conceptualize and measure HRH supply, requirements, shortages and surpluses across these countries. Some of these approaches, for example, describe their approach as measuring HRH requirements in terms of demand, even though demand in the market for health care is not independent of supply (Evans, 1984), while others do so in terms of need, which is independent of supply. Given these two fundamentally different concepts, estimates of HRH “demand” cannot be meaningfully combined with estimates of HRH needs, since they are likely to address significantly different policy questions and hence generate different conclusions about the adequacy of HRH supply relative to requirements.

Estimates of future HRH supply or requirements, however sophisticated, require numerous assumptions. As a number of the reviewed documents show, the estimated future HRH supplies and requirements are sensitive to differences in these assumptions. Even a few modest changes to these assumptions can mean the difference between a large estimated future shortage and a large estimated future surplus of HRH for a given jurisdiction and time period (e.g. Tomblin Murphy et al., 2012; Centre for Workforce Intelligence, 2013b).

To illustrate the implications of the above complexities, the substantial gaps in the available evidence, and the large qualitatively and quantitatively different conclusions reached by different HRH analyses, Table 3.1 summarizes the results of the reviewed documents pertaining to nurses. Although several of these documents included multiple scenarios in their estimates, in the interests of a minimal level of comparability the “status quo” scenario is cited below unless otherwise stated.

As shown in Table 3.1, for the majority of included countries, no estimates of the size of any future nurse shortage or surplus was found during this review. For the few jurisdictions for which such estimates were found, studies using different methods reached different conclusions. For example, Juraschek and colleagues (2012) projected a shortage of over 900,000 registered nurses (RNs) in the United States by 2030; meanwhile the United States Health Resources and Services Administration (HRSA) (2014b), using different methods and assumptions, estimated a surplus of over 300,000 RNs for 2025.

A similar table for physicians would be even more sparsely populated. Virtually all documents reviewed seemed to suggest that HRH supply is expected to increase. In contrast, as exemplified by the United States of America studies cited above, there are differing views about whether the requirements for different types of HRH are expected to increase or decrease in the future in different jurisdictions. Although most of the included analyses for nurses and physicians suggest that national-level shortages are likely in the next decade, several analyses for other non-physician health professions such as pharmacists and dentists suggest substantial surpluses are likely over this time period (e.g. United States Health Resources and Services Administration (HRSA), 2014c, 2015a).

Should these projections come to pass, the potential for substitution of different types of HRH would become an increasingly important policy issue; however, as noted above most of the approaches identified through this review lack the capacity to account for such substitution.

There has been a considerable amount of study devoted to the current and potential future states of the supply of and requirements for HRH in high-income OECD countries. Despite these efforts, however, no clear or consistent picture of the status of these countries’ HRH appears to exist. Some of the gaps in information are likely due to limitations in the various strategies used here to collect HRH analyses for this review. However, other recent studies, which did not have the same limitations (e.g. Ono et al., 2013), describe similar gaps in the information available. This is in partly the result of significantly different approaches to HRH planning being used across and within these countries. The appropriateness of different HRH planning approaches for given jurisdictions depends on the objectives of the health-care systems, the precise policy questions being asked for which they are planning, as well as the context in which that planning takes place.

### 3.8 A methodology for projecting HRH requirements in high-income OECD countries

The final objective of this review was to identify a methodology for projecting HRH requirements in high-income OECD countries, with the proviso that this may be a combination of existing approaches. To guide the selection of such a methodology, we developed a draft set of evaluation criteria which were circulated to the Advisory Group for their input, which was considered for the development of the list below:

1. **The approach is consistent with the objectives of the health system**

   This means, for example, that a system whose objective involves addressing the health-care needs of its population must use an HRH
planning method that estimates HRH requirements as a function of population health measures, so that resources can be planned in accordance with needs for health care. This means that resources are allocated between populations based on differences in needs between those populations and increased or decreased over time in accordance with increases or decreases in those needs, while allowing for changes in the way needs are to be met (e.g. using new technologies) and changes in the ways services are delivered (e.g. changes in health-care teams). Although meeting population health-care needs is a goal shared by many health care systems, the

<table>
<thead>
<tr>
<th>COUNTRY</th>
<th>DOCUMENT</th>
<th>PROJECTED 2025 SHORTAGE (-) OR SURPLUS (+)</th>
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<td>Australia</td>
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<td>-109 400 (includes RNs and ENs)</td>
</tr>
<tr>
<td></td>
<td>Health Workforce Australia, 2012</td>
<td>-80 142</td>
</tr>
<tr>
<td></td>
<td>Health Workforce Australia, 2014b</td>
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<tr>
<td>Canada</td>
<td>Tomblin Murphy et al., 2012</td>
<td>-60 000</td>
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<td></td>
</tr>
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</tr>
<tr>
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</tr>
<tr>
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<td></td>
</tr>
<tr>
<td>France</td>
<td>No gap analyses found</td>
<td></td>
</tr>
<tr>
<td>Germany</td>
<td>Maier &amp; Afentakis, 2013</td>
<td>-195 000 (includes RNs and ENs; estimated from graph)</td>
</tr>
<tr>
<td>Greece</td>
<td>No gap analyses found</td>
<td></td>
</tr>
<tr>
<td>Hungary</td>
<td>No gap analyses found</td>
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</tr>
<tr>
<td>Iceland</td>
<td>No gap analyses found</td>
<td></td>
</tr>
<tr>
<td>Ireland</td>
<td>Behan et al., 2009</td>
<td>-836 (for year 2020)</td>
</tr>
<tr>
<td>Israel</td>
<td>No gap analyses found</td>
<td></td>
</tr>
<tr>
<td>Italy</td>
<td>No gap analyses found</td>
<td></td>
</tr>
<tr>
<td>Japan</td>
<td>No gap analyses found</td>
<td></td>
</tr>
<tr>
<td>Luxembourg</td>
<td>No gap analyses found</td>
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<tr>
<td>Netherlands</td>
<td>No gap analyses found</td>
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<tr>
<td>New Zealand</td>
<td>No gap analyses found</td>
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<tr>
<td>Norway</td>
<td>No gap analyses found</td>
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<tr>
<td>Poland</td>
<td>No gap analyses found</td>
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<tr>
<td>Portugal</td>
<td>No gap analyses found</td>
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<tr>
<td>Republic of Korea</td>
<td>No gap analyses found</td>
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<tr>
<td>Slovakia</td>
<td>No gap analyses found</td>
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<tr>
<td>Slovenia</td>
<td>No gap analyses found</td>
<td></td>
</tr>
<tr>
<td>Spain</td>
<td>No gap analyses found</td>
<td></td>
</tr>
<tr>
<td>Sweden</td>
<td>No gap analyses found</td>
<td></td>
</tr>
<tr>
<td>Switzerland</td>
<td>No gap analyses found</td>
<td></td>
</tr>
<tr>
<td>United Kingdom</td>
<td>Centre for Workforce Intelligence, 2013d</td>
<td>-50 000 (for England only; estimated from graph; taken as midpoint of the range of demand and supply projection scenarios)</td>
</tr>
<tr>
<td>United States of America</td>
<td>Aiken &amp; Cheung, 2008</td>
<td>-1 016 900 (for year 2020; analysis from another study)</td>
</tr>
<tr>
<td></td>
<td>Juraschek et al., 2012</td>
<td>-918 232 (for year 2030)</td>
</tr>
<tr>
<td></td>
<td>United States Health Resources and Services Administration (HRSA), 2014b</td>
<td>+340 000</td>
</tr>
</tbody>
</table>

EN – enrolled nurse; RN – registered nurse
findings of this review indicate that few countries appear to be using needs-based methods for HRH planning. Instead, those HRH analyses we found appear to be using utilization- or supply-based approaches. For countries such as the United States of America, where the ability to pay for health-care services has traditionally been an important element of access to care, utilization-based approaches may be more relevant in addressing the policy questions facing decision-makers. Although some of these approaches (e.g. United States Health Resources and Services Administration (HRSA), 2014a; Dall et al., 2015) incorporate consideration of how population health needs affect service use, this is done within the context of the prevailing organization of services in the United States of America and hence are unlikely to represent how needs for care would be served in the absence of payment at the point of delivery, or via private insurance plans as a means of using care. For countries where meeting population health-care needs is a primary objective, however, failure to plan for HRH according to those needs means planning not to meet that system objective. Moreover, the use of supply- or utilization-based approaches will perpetuate and exacerbate existing efficiencies and inequalities in these systems (Birch et al., 2007; Evans, 2009).

Needs-based approaches to HRH planning are not new. Over 40 years ago the WHO (1971), for example, outlined a history of them dating back to at least the 1930s in the United States of America, also noting their widespread use in what are now former Soviet states. A more detailed description was provided by Hall (1978), and subsequently such approaches were also described in the 1980s and 1990s in the United Kingdom (Birch, 1985; Birch & Maynard, 1985) and Canada (Lavis & Birch, 1997; Markham & Birch, 1997). Several more recent examples from Australia (Andrews & Tilov, 2007; Segal et al., 2008; Segal & Leach, 2011), Canada (Birch et al., 2007; Tomblin Murphy et al., 2009, 2012, 2013a&b) and New Zealand (New Zealand Ministry of Health, 2011a; Naccarella et al., 2013) are included in this review.

2a. HRH requirements are derived from service requirements

2b. Those service requirements are aligned with system objectives

Requirements for HRH are a manifestation of requirements for the services they provide. Hence estimates of HRH requirements must be derived from estimates of the requirements for those services. This makes it possible to consider and plan for potential future changes in the way services are delivered resulting from new technologies, changes in scopes of practice and so on. The results of this review show, however, that HRH planning approaches which cannot account for such changes remain prevalent. This is unfortunate given that the major limitations of this approach have been extensively documented for decades. For example, the WHO noted over 40 years ago that such approaches may be appropriate in,

“…a country, whatever its stage of development, where professional judgement, backed by utilization studies, suggests that the current patterns of the organizations and delivery of health services [through] existing ratios do not present any anomalies or problems. Unfortunately, such situations are rare, and in any case this static view of society implies that the present situation cannot be significantly improved upon in the foreseeable future.”

“The exclusive use of health manpower: population ratios for the estimation of future health manpower requirements is increasingly difficult to justify in the developed countries where, depending on the specific characteristics of the health system, other and more refined criteria can be used to improve the country’s capacity to provide health care.” (WHO, 1971).

Other analyses found in this review use methods based on historical population-utilization ratios without any consideration of whether those ratios are consistent with the objectives of the health-care system in question. The use of these methods for planning future services, and hence HRH, perpetuates any current patterns of inappropriate use such as over-reliance on emergency departments instead of primary health care, or inadequate access to (and therefore use of) services by disadvantaged populations. The needs-based approaches from Australia, Canada and New Zealand do not have this limitation. In addition, some approaches from the United States of America such as the one described by Dall and colleagues (2015), although utilization- as opposed to needs-based, are designed to explicitly consider changes to service provision as a consequence, for example, of changes in health-care legislation or practice models.

3. The approach considers HRH requirements in the context of production functions for health services (i.e. dependent upon the availability or use of other inputs to service production)

Although the availability of HRH is important to the delivery of health-care services, other types of human and non-human resources, such as facilities, equipment and medications, are also necessary. Effective health systems planning approaches must recognize this dependency by considering how the availability (or lack thereof) of: a) other HRH; and b) non-human resources may affect their collective production of health-care services, including the potential for substitution of one type of resource for another. For example, the availability of operating theatre nurses or operating theatres may impact on the volume of surgeries
that surgeons can perform, even if the number of surgeons and the hours they work remain the same. The review found several examples of approaches that explicitly incorporated this potential for different types of HRH (e.g. Andrews & Titov, 2007; Segal et al., 2008; Segal & Leach, 2011; Scottish Government, 2010; New Zealand Ministry of Health, 2011a; Tomblin Murphy et al., 2013a & b). However, although documents sometimes acknowledged the influence of the availability of non-human resources on HRH requirements, the review found no analyses that directly incorporated this relationship.

4. The approach explicitly considers the role and determinants of productivity (i.e. units of service per hour of work)

In order to translate health-care service requirements into HRH requirements, HRH planners must consider the rate at which different types of HRH are able to provide those services per unit time – i.e. their productivity – under a given set of circumstances. In addition to the needs-based approaches referred to above, numerous other analyses found by the review (e.g. Artoisenet & Deliege, 2006; Oakley et al., 2008; Dill & Salsberg, 2008; Singh et al., 2010; Centre for Workforce Intelligence, 2015a-c) explicitly included productivity as part of their calculations. Although the contexts in which productivity was considered varied widely across these documents, they generally showed that projections regarding the future HRH situation are highly sensitive to even small changes to HRH productivity.

5. HRH supply is measured in terms of time devoted to service delivery (i.e. flow generated by a stock of HRH) as opposed to focusing only on the HRH stock (numbers of HRH)

The availability of health-care services is determined by a number of factors in addition to the raw “stock” or head count of different types of HRH available to provide them. Analyses in many countries have shown how changes or differences in these factors can have profound effects on the effective supply of HRH (e.g. Crossley et al., 2008; Koike et al., 2009; Johannessen & Hagen, 2012), and most of the HRH supply analyses found through the review considered at least one of these; most frequently hours worked. Several analyses (e.g. Landry et al., 2007; Barber & González López-Valcárcel, 2010; Capiciteits Orgaan, 2013), however, did not take any of these factors into account, and instead estimated HRH supply based solely on head counts.

6. The approach considers the determinants of flow (e.g. hours worked) and stock (entries/exits) as policy variables

The factors that determine the stock and flow of HRH supply, such as the amount of time spent providing patient care (activity levels), and the proportion of licenced HRH who are actively practising (participation levels), are sensitive – to varying degrees – to HRH policies such as education and payment models. Most of the analyses of HRH supply found through the review reflected this situation; in some cases, such factors were the primary focus of the analyses (e.g. Crossley et al., 2008; Jeon & Hurley, 2010; Buchan & Black, 2011; McPake et al., 2014).

7. The approach considers: a. The cost implications of HRH plans; and b. The extent to which HRH plans are aligned with health system financial planning

Essential to determining the relative appropriateness of any potential HRH policy is an understanding of its financial implications in the broader context of the jurisdictional fiscal situation. Although many of the documents included in the review acknowledged this point, comparatively few (e.g. Andrews & Titov, 2007; WHO Western Pacific Regional Office, 2008; Gallacher et al., 2010; WHO, 2010; Polgreen et al., 2011; Marvasti, 2014; Tennant & Kruger, 2014) explicitly incorporated financial considerations into their analyses.

Although over 200 documents discussing the HRH situations in included countries were reviewed as part of this study, it appears that none of these approaches to HRH planning meets all seven of the above criteria. However, several of the needs-based approaches described above meet all but one. The needs-based approaches described in Australia (Andrews & Titov, 2007; Segal et al., 2008; Segal & Leach, 2011; Segal et al., 2013), Canada (Tomblin Murphy et al., 2013a&b), and New Zealand (New Zealand Ministry of Health, 2011a-c, 2014), each identify specific service requirements based on population health needs and translate these into HRH requirements based on information on scopes of practice and standards of care delivery. However, the Australian and New Zealand approaches do not appear to explicitly consider the role and determinants of productivity, while the Canadian approach does not include considerations of cost implications. Further, as noted above, none of the identified approaches appears to account for the impact of non-human resources on HRH requirements.

An example of a methodology for projecting HRH requirements in the included countries, then, could build on these needs-based approaches. This would require augmenting them in two ways. First, the Canadian approach would need additional features to include consideration of cost implications, and the Australian and New Zealand approaches would need to be further developed to include consideration of the role and determinants of productivity. Second, both approaches would need further enhancements to include consideration of the impacts of the availability of non-human resources.

The second of these two improvements is evidently the more difficult to achieve, as no HRH planning approaches found through this review included consideration of the impacts of non-human resources. The
first of these improvements, however, has already begun. An analytical framework for such an approach has been developed by a team from Canada, Australia and New Zealand (Birch et al., 2015) that extends the needs-based methods used by Tomblin Murphy and colleagues (2013a&b) to include consideration of the implications of HRH and other health system policies on the system’s fiscal and sociopolitical sustainability. This framework has not yet been applied, and was not included in the review because it was published after its specified timeframe. Similar international collaborations may be one way of encouraging the continued advancement of HRH planning methods so that they are also able to account for the impacts of non-human resources in the future.
4. Results – development of simulations on future HRH supply and requirements

On the basis of the methodology and the criteria outlined above, the supply of and requirements for midwives, nurses and physicians in each included country were simulated for the period to 2030, together with the surplus or shortfall implied by these results. The simulated surpluses or shortfalls for each profession and country are provided in Table 4.1.

Table 4.1 Simulated HRH shortfalls or surpluses by profession and country for 2030 – based on demographic change alone

<table>
<thead>
<tr>
<th>Country</th>
<th>Profession</th>
<th>PROJECTED SHORTFALL (-) OR SURPLUS (+)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Australia</td>
<td>Midwives</td>
<td>-9068</td>
</tr>
<tr>
<td></td>
<td>Nurses</td>
<td>-144 654</td>
</tr>
<tr>
<td></td>
<td>Physicians</td>
<td>-23 393</td>
</tr>
<tr>
<td>Austria</td>
<td>Midwives</td>
<td>-238</td>
</tr>
<tr>
<td></td>
<td>Nurses</td>
<td>+13 505</td>
</tr>
<tr>
<td></td>
<td>Physicians</td>
<td>-12 584</td>
</tr>
<tr>
<td>Belgium</td>
<td>Midwives</td>
<td>-1428</td>
</tr>
<tr>
<td></td>
<td>Nurses</td>
<td>-65 590</td>
</tr>
<tr>
<td></td>
<td>Physicians</td>
<td>-5365</td>
</tr>
<tr>
<td>Canada</td>
<td>Midwives</td>
<td>-437</td>
</tr>
<tr>
<td></td>
<td>Nurses</td>
<td>-84 719</td>
</tr>
<tr>
<td></td>
<td>Physicians</td>
<td>+8108</td>
</tr>
<tr>
<td>Chile</td>
<td>Midwives</td>
<td>-4735</td>
</tr>
<tr>
<td></td>
<td>Nurses</td>
<td>-84 719</td>
</tr>
<tr>
<td></td>
<td>Physicians</td>
<td>-475</td>
</tr>
<tr>
<td>Czech Republic</td>
<td>Midwives</td>
<td>-544</td>
</tr>
<tr>
<td></td>
<td>Nurses</td>
<td>-31 975</td>
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<tr>
<td></td>
<td>Physicians</td>
<td>-9195</td>
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<tr>
<td>Denmark</td>
<td>Midwives</td>
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<td></td>
<td>Nurses</td>
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<td>Physicians</td>
<td>-475</td>
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<tr>
<td></td>
<td>Nurses</td>
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<td>-3375</td>
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<td>Finland</td>
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<td>Midwives</td>
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<td></td>
<td>Physicians</td>
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<td>Hungary</td>
<td>Midwives</td>
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<td>Iceland</td>
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<td>Ireland</td>
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<td></td>
<td>Physicians</td>
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<td>Israel</td>
<td>Midwives</td>
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<td>Physicians</td>
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<tr>
<td>Japan</td>
<td>Midwives</td>
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<td>Physicians</td>
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<tr>
<td>Luxembourg</td>
<td>Midwives</td>
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<tr>
<td></td>
<td>Nurses</td>
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<tr>
<td></td>
<td>Physicians</td>
<td></td>
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<tr>
<td>Netherlands</td>
<td>Midwives</td>
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<tr>
<td></td>
<td>Physicians</td>
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<td></td>
<td>Nurses</td>
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<tr>
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</tr>
<tr>
<td></td>
<td>Physicians</td>
<td>-13 057</td>
</tr>
</tbody>
</table>

6 These simulations are not to be taken as predictions about the future. Should large shortfalls or surpluses appear on the planning horizon, it is likely that substantial changes to these variables – such as increases or reductions in training capacity or levels of service provision – will be made; indeed the purpose of performing these simulations is to inform such planning.

7 The shortfalls or surpluses shown here are measured relative to any shortfalls or surpluses that may already exist for these professions in these countries.

8 In these simulations all other planning parameters are held constant. Analyses demonstrating the sensitivity of these simulations to changes in other planning parameters are provided elsewhere in this report.
These simulation results suggest that, if the current HRH situations in the included countries continue to 2030, most of the included countries could face shortfalls of one or more types of HRH; that is, holding constant all the parameters included in the model except population, they would not have enough HRH available to continue to provide their current levels of health-care services to their respective populations. In contrast, some countries may experience surpluses of some types of HRH; that is, they would have more than the number needed to continue to provide current levels of health-care services to their respective populations. In total, these simulations in the baseline scenarios sum to shortfalls of nearly 45 000 midwives, 1.1 million nurses, and 754 000 physicians across the 32 included countries for 2030. These simulated shortfalls are the collective result of simulated future supplies of 157 000 midwives, 6.8 million nurses, and 2.4 million physicians against simulated requirements of 202 000 midwives, 7.9 million nurses, and 3.2 million physicians.

Although providing detailed results in terms of the supply of and requirements for each of the three professions and country would require a prohibitively lengthy report, results for physicians in Canada are shown in Figures 4.1 and 4.2 as an illustration. Figure 4.1 shows the simulated supply of and requirements for physicians through 2030, measured in FTEs.

4.1 HRH supply vs. requirements

In this scenario, in which all planning variables except population are held constant at current levels, both the supply of and requirements for physicians in Canada increase to 2030, with supply increasing at a more rapid rate, resulting in a growing surplus (net of any existing gap) of just under 9000 FTEs by 2030. The difference or “gap” between the simulated supply of and requirements for physicians in Canada is shown in more detail in Figure 4.2.
As also noted above, many of these simulations are based on incomplete information regarding variables in the model. To demonstrate the sensitivity of these simulations to different variable values, several different scenarios are presented below. These begin with scenarios pertaining to the four factors used to determine HRH requirements – the productivity of the different types of HRH, the levels of service provision according to different levels of health status, the distribution of health status in the population by age and sex groups, and the size and age-sex distribution of the population.

In this way the potential impacts of each of these determinants of HRH requirements is demonstrated separately. Canada is used as the example because that was the country for which the most complete data were found, and as such allowed for the most complete application of the model as well as the best empirical evidence to guide sensitivity analyses.

### 4.2 Impacts of changes in HRH productivity

In the context of HRH planning, the term productivity refers to the number and type of services FTE HRH on average can be reasonably expected to provide at some basic standard of quality. For the purposes of these simulations, HRH productivity is measured in terms of numbers of consultations for physicians, hospital patient days for nurses, and births for midwives. There are substantial differences in the values of these measures across and even within countries and jurisdictions. Figure 4.3 shows the impact of different assumed values for productivity on the estimated physician gap for Canada. Each of the three curves begins with a productivity value set at the average number of consultations per FTE physician across the country as captured in administrative data collected by the Canadian Institute for Health Information (2015a&b). The middle or “baseline” curve shows how the simulated physician gap would change if this level of productivity remained at the national average level through 2030. The lower of the three curves represents the simulated gap should productivity decrease to the lowest currently found among Canadian provinces, while the upper curve shows how the estimates would change should productivity increase to the level found in the province with the highest average numbers of consultations per physician in the country.9

Figure 4.3 demonstrates the sensitivity of HRH estimates to different levels of productivity: if all Canadian physicians became, on average, as productive as those in the province with the highest reported productivity, this would result in a growing physician surplus by 2030, other things being equal. Alternatively, should Canadian physicians become, on average, as productive as those in the province with the lowest reported productivity levels, this would result in a growing physician shortfall of even larger magnitude over the same time period, other things being equal. The difference between these scenarios is approximately 55 000 FTEs, which would represent 70% the country’s current physician supply.

### 4.3 Impacts of changes in levels of service

Figure 4.4 shows the impact of different assumed future levels of service provision on the simulated physician gap in Canada. Levels

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9 Because the administration of health care is largely the responsibility of provincial and territorial (e.g. as opposed to the federal) governments in Canada, there are substantial differences in HRH remuneration and practice models across the country, which likely affect the numbers of consultations per physician.
of service, in this context, refers to the average number of physician consultations to be provided per person, given the person’s age, sex and health status. The higher the level of service — i.e., the greater the number of physician consultations to be provided — the more physicians are required to deliver those services, other things being equal. In the “average service levels” scenario, the required number of physicians is based on the average number of physician consultations by patient age, sex and health status across the country. In the “low service levels” scenario, physician requirements are simulated based on the average numbers of consultations reported by patients in the Canadian province whose residents report receiving the fewest physician consultations per person given their age, sex and health status in the country. In the “high service levels” scenario, requirements are based on the average numbers of consultations per patient in the province where the average number of reported physician consultations given their age, sex and health status is the highest in the country.

As Figure 4.4 shows, should the level of physician services in 2030 be lower than it is currently — that is, should fewer physician consultations be required for patients of a given age, sex and health status — the surplus of physicians would be higher than it would otherwise be. Similarly, should more physician consultations be required for a given level of health status by 2030, more physicians would be required to provide those consultations, and the surplus would be lower than otherwise. The difference in the assumed future levels of service provision equates to a difference in the simulated physician gap of over 1000 FTEs by 2030.

4.4 Impacts of changes in health status

The health status of the population to be served can also affect the requirements for HRH, since sicker people require more health-care services, other things being equal. Figure 4.5 illustrates examples of how changes in population health over time can impact the simulated “gap” in physicians.
The middle of the three curves shows the simulated physician gap (again, in this case a surplus) for Canada if the current average level of health across the country remains the same through 2030. The other two curves show the impact on the gap of worsening or improving health status. More specifically, the latter scenario shows the trajectory of the estimated physician gap should the average age- and sex-specific self-reported health status of Canadians improve to match that of province with the best self-reported health status.\(^\text{10}\)

Similarly, the former shows the trajectory of the estimated physician gap should the average age- and sex-specific health status of Canadians worsen to match that of the province with the worst self-reported health status. The difference between assumed future levels of health status in these scenarios translates into a difference in the projected physician gap of over 5000 FTEs by 2030.

### 4.5 Impacts of demographic changes

An additional factor affecting simulations of requirements for health-care services — and by extension the requirements for HRH — is the size and age-sex distribution of the population. Although considerable effort is put into developing estimates of the future population size and characteristics in many countries, predicting these features with accuracy remains difficult. Figure 4.6 shows the impact on the simulated Canadian physician gap of different assumed changes to population size. As Figure 4.6 demonstrates, the trajectory of the simulated physician gap is substantially affected by the assumed demographic trajectory of the population those physicians are to serve. The difference between the high and low population growth scenarios — each of which are is based on different projections developed by Statistics Canada — results in a difference of over 10 000 FTEs in the simulated physician gap by 2030.

### 4.6 Impacts of changes in HRH activity

The effective supply of HRH is dependent not only on the number of practising members of various personnel, but also on the time they collectively spend providing patient care. Figure 4.7 shows the impact of different assumed levels of physician activity on the simulated surplus.

The more time the average physician spends providing direct care to patients, the fewer physicians will be required, other things being equal. In Canada, there is substantial variation in the hours that physicians report spending on direct patient care. The middle curve in Figure 4.7 shows the trajectory of the projected physician surplus assuming the average Canadian physician spends the same number of hours on direct patient care in 2030 as reported by the average Canadian physician in 2014 – 39.6 hours per week, including direct care provided during on-call hours, according to self-reported data from the National Physician Survey (2015), which was developed by the Canadian Medical Association in partnership with several other national health-care stakeholder organizations. The upper curve shows how the estimated surplus would be greater if the average Canadian physician were to work as many hours as the average physician in the province with the highest reported number of hours spent providing direct patient care – 43.5 per week. Similarly, the lower curve shows how the estimated surplus would be reduced if the average Canadian physician were to work as many hours as the average physician in the province with the

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\(^{10}\) There are substantial differences across Canadian provinces and territories in various measures of health status (Statistics Canada, 2015).
lowest reported number of hours spent providing direct patient care – 38.0 per week. The difference between these scenarios equates to a difference in the projected physician surplus of over 1000 FTEs by 2030.

### 4.7 Impacts of changes in HRH training

In 2014 there were 2804 graduates of Canadian medical schools. This was the highest number of graduates in the country’s history and represents a 15% increase from the number of graduates in 2010 (2448). Figure 4.8 shows the impacts on the simulated physician gap of three different levels of annual physician graduation. In one, the level from 2014 is maintained through 2030. In the others, the number of graduates is decreased to the value from 2010 and increased another 15%.

Figure 4.8 illustrates the sensitivity of the simulated physician gap to different numbers of physician graduates. Although the changes take at least four years to have any impact (because of the duration of the training programmes), these substantial differences in medical school graduates result in substantially different simulated future physician gap, with a simulated difference between the “low” and “high” graduation scenarios of roughly 7000 FTEs by 2030.

### 4.8 Impacts of changes in HRH participation

According to the most recent results of the annual National Physician Survey, an estimated 95% of physicians in Canada report providing at least some direct patient care, while the remaining 5% work exclusively in other roles such as administration or education. This is a higher

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**Figure 4.7 Examples of simulated physician gap in different physician activity scenarios (Canada)**

![Graph showing simulated physician gap in different activity scenarios](image1)

- **Medium activity**
- **Low activity**
- **High activity**

**Figure 4.8 Examples of simulated physician gap in different physician graduation scenarios (Canada)**

![Graph showing simulated physician gap in different graduation scenarios](image2)

- **Graduate numbers maintained**
- **Low Graduate numbers reduced 15%**
- **Graduate numbers increased 15%**
level of participation than nurses in Canada, of whom 81% are actively practising according to the OECD indicator database. Figure 4.9 shows the impact of two different levels of participation on the simulated future physician gap in Canada. In one, the current level of 95% is maintained through 2030. In the other it is decreased to 90%.

As Figure 4.9 illustrates, the simulated physician gap is directly affected by different assumed values of future participation levels, with the modest difference between 90% and 95% participation resulting in a difference of roughly 500 FTEs in the simulated gap by 2015.

4.9 Impacts of changes in HRH retention

There is very high retention among physicians in Canada (Government of Canada, 2014); when physicians do exit the Canadian supply it is usually due to migration, retirement or death (Canadian Collaborative Centre for Physician Resources, 2013). Canada is a net recipient of migrating physicians, and has been for the past decade (Canadian Medical Association, 2015), and the most recent specific quantitative analysis of attrition among practising physicians reported that less than 1% of physicians in Canada either die or retire before age 65 (Pong, 2011). After age 65, the combined proportion of physicians retiring or dying each year increases with age; in recent years this proportion has varied between 2% and 12% per year (Pong, 2011). Figure 4.10 shows the impacts of three different exit rate scenarios on the simulated physician gap in Canada. In these, the proportion of physicians aged 65 and over exiting the Canadian supply each year is set at 2%, 7% and 12%.

The simulated physician gap is highly sensitive to different assumptions about the annual rates of exit from the supply. As Figure 4.10 indicates,
the difference between 2% and 12% of older physicians leaving per year is roughly 6000 FTEs by 2030.

### 4.10 Impacts of changes in multiple parameters

The scenarios above show the potential impacts of changes in individual planning variables over time. In reality, it is likely that more than one – and perhaps all – of the variables that affect estimated HRH supply and requirements will change to some degree between now and 2030. Figure 4.11 shows the potential cumulative impacts of each of the individual changes described in the earlier scenarios on the simulated physician gap in Canada in three scenarios. In the “status quo” scenario, no variables change except the population grows and ages according to Statistics Canada’s medium growth projections. In the “high requirements, low supply” scenario, the population grows and ages according to Statistics Canada’s “high growth” projections, the average age-specific health of Canadians worsens to that of its least healthy province, physician service levels increase to the highest in its provinces, exit rates among older physicians occur at the highest they have been in recent years, physician activity and productivity decrease to the lowest levels reported in its provinces, graduation is reduced to 2010 levels and participation reduced to 90%. In the “low requirements, high supply” situation, the population grows and ages according to Statistics Canada’s “low growth” projections, the average age-specific health of Canadians improves to that of its healthiest province, physician service levels are reduced to the lowest found in its provinces, exit rates among older physicians occur at the lowest they have been in recent years, physician activity and productivity increase to the highest levels in its provinces and graduation is increased 15%.

Figure 4.11 demonstrates that, depending on which assumed values are assigned to the various variables that determine HRH supply and requirements over time, the simulated physician gap in Canada for 2030 varies considerably. In these examples it may range anywhere from a shortfall of nearly 39 000 FTEs (47% less than the simulated supply) to a surplus of over 35 000 FTEs (43% greater than the simulated supply) – a difference of nearly 75 000 FTEs – depending on the assumptions made about the various factors that determine HRH supply and requirements.

If the same level of variability in the size of Canada’s physician gap relative to supply is applied to the aggregate gaps simulated for all 31 included countries, these could range from shortfalls of 74 000 midwives, 3.2 million nurses, and 1.2 million physicians (47% less than supply) to surpluses of 67 000 midwives, 2.9 million nurses, and 1.0 million physicians (43% greater than supply) by 2030.

**Figure 4.11 Cumulative impact of multiple parameter changes on simulated physician gap (Canada)**

<table>
<thead>
<tr>
<th>Year</th>
<th>Simulated shortage (-) or surplus (+)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2015</td>
<td>-50 000</td>
</tr>
<tr>
<td>2016</td>
<td>-40 000</td>
</tr>
<tr>
<td>2017</td>
<td>-30 000</td>
</tr>
<tr>
<td>2018</td>
<td>-20 000</td>
</tr>
<tr>
<td>2019</td>
<td>-10 000</td>
</tr>
<tr>
<td>2020</td>
<td>0</td>
</tr>
<tr>
<td>2021</td>
<td>10 000</td>
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<tr>
<td>2022</td>
<td>20 000</td>
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<tr>
<td>2023</td>
<td>30 000</td>
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<tr>
<td>2024</td>
<td>40 000</td>
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<td>2025</td>
<td>50 000</td>
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<td>2026</td>
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<td>2027</td>
<td>70 000</td>
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<tr>
<td>2028</td>
<td>80 000</td>
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<tr>
<td>2029</td>
<td>90 000</td>
</tr>
<tr>
<td>2030</td>
<td>100 000</td>
</tr>
</tbody>
</table>

- **Status quo continues**
- **Low requirements, high supply**
- **High requirements, low supply**
5. Discussion

5.1 Synthesis of evidence

This review sought to synthesize the findings of the past decade of published research on HRH requirements and labour market dynamics in high-income OECD countries. Although over 200 documents pertaining to these topics were reviewed in detail, collectively they do not include sufficient information to provide a clear picture of the expected future HRH situation in these countries. At best it can be said that the HRH supply in these countries is generally expected to grow; because different analyses reach different conclusions about future HRH requirements in these countries, it is not clear whether that growth will be adequate to meet health system objectives in the future. Although most analyses suggest that the numbers of physicians and nurses required in the included countries are likely to increase in the future, this view varies across analyses depending on the methods and assumptions used. Further, most analyses for professions other than nurses and physicians suggest that the numbers required are likely to decrease in the future. The implications of these projected respective surpluses and shortages in terms of meeting health system objectives are not clear.

Several recurring themes regarding factors of importance in HRH planning were evident across the documents reviewed. These included: ageing populations and health workforces; changes in disease patterns, models of care delivery, scopes of practice, regulatory structures and technologies in health care; migration; incentives; data quality; the distribution of resources; interprofessional education and practice; stakeholder engagement; and balancing the public and private sectors. They also included important inconsistencies in the use of key HRH planning terms, which in turn affected the choice of methods in different documents for HRH planning.

Different approaches to HRH planning will be appropriate for different jurisdictions depending on their respective contexts and the objectives of their health-care systems and hence the policy questions being faced. Based on these objectives, methods need to be adopted that produce relevant answers for the precise HRH questions facing policymakers in their particular contexts. The results of this review suggest, however, that rarely have explicit policy questions been identified to guide HRH research methods and analyses; instead available methods have been adopted with policy “interests” (as distinct from questions) made to fit these methods.

In an attempt to inform improvements to this situation, seven criteria for identifying an HRH planning approach appropriate to a given jurisdiction have been presented. Although none of the approaches found through the review met all of these criteria, several – from Australia, Canada and New Zealand – met all but one. Examples of other approaches which met each individual criterion have also been identified so that planners can explore different options depending on the relative importance of these criteria given their respective circumstances and health system objectives.

5.2 Simulations of future HRH supply and requirements

Limitations

Although online resources such as the OECD’s indicator database provide a great deal of data relevant to HRH planning in member countries, a more comprehensive approach consistent with the criteria outlined in the methodology section would require additional information as well as direct engagement with the relevant stakeholder groups in the respective countries. As such, the methods used have several important limitations that must be considered when interpreting the results:

- The need to rely on secondary descriptions of the included countries’ health systems means that a full understanding of their respective objectives may not have been achieved — in other words, criterion 1 may not have been fully met in all cases.

- During the review of existing analyses of HRH requirements conducted as part of Phase 1, no existing methods were found that explicitly incorporated determinants of productivity — i.e. that met criterion 3. Although such models have been described (e.g. Masnick & McDonnell, 2010; Birch et al., 2015), it was not possible to obtain the data necessary to incorporate this feature into the simulations. Instead, the sensitivity of the projections to different levels of productivity is demonstrated.

- Although the OECD indicator database includes information on average remuneration paid to general and specialist physicians...
as well as hospital nurses for many member countries, no multi-country source of information on training or recruitment costs was found. As a result, cost considerations are not incorporated into these simulations.

- As shown in Table 1.1, the information needed to perform simulations in accordance with the other criteria was not readily available for many countries. As such a variety of assumptions were made in order to produce the simulations:
  - For most countries, no information on how health care service provision is organized according to the objectives of their various health-care systems – beyond improving the health of their respective populations – was found. In fact, only for Canada and Australia was information on service provision according to different levels of health found. For the other countries, current Canadian levels of service provision according to different levels of health were used to estimate requirements.
  - The measure of health status available by age and sex for most included countries was self-assessed health status. This measure was used to simulate the requirements for nursing and physician services in each country.
    - This measure was available for all included countries except Chile. As such, simulations of the requirements for nurses and physicians in Chile could not be performed.
    - A more comprehensive approach to population needs-based planning would identify requirements by types of need/condition (e.g. Segal et al., 2008; Health Workforce New Zealand, 2011a; Tomblin Murphy et al., 2013a&b) and then aggregate over all needs/conditions. Although other measures such as the incidence or prevalence of specific health problems (e.g. HIV/AIDS, diabetes) are available for virtually every country, these are seldom presented by age and sex of patient. More complex measures such as disability-adjusted life years (DALYs) lost to poor health are also widely available at the country level, and could potentially be used to prioritize population health issues so that health-care resources (including HRH) can be allocated accordingly.
  - Data on the incidence of low birth weight in the included countries are available from the OECD indicator database. However, these data are not available by the age of mothers; as such, it was assumed that the incidence of low birth weight was equal across mother age groups within countries. For countries whose female populations are ageing, this would likely result in underestimates of the numbers of babies born underweight, while for countries whose female populations are becoming younger, this would likely result in overestimates of the numbers of babies born underweight.
  - As information on the proportion of pregnancies and births attended by midwives (as opposed to physicians, for example) was available across countries, it was assumed that these proportions for each country — whatever they may currently be — would be maintained throughout the simulation period.
  - The measures of service provision found for most countries — physician consultations, nights in hospital and numbers of births — were not presented by level of acuity, nor do they fully capture the wide range of services provided by midwives, nurses or physicians. However, they were the only measures of service provision found for most countries. As such, these relatively crude measures of service provision — and hence the productivity of the different professions — were used as proxies of overall service provision to simulate requirements.
  - As information on unmet need for health care was not found for most countries, the estimates are initialized using an initial HRH “gap” of zero. Hence the surpluses or shortages simulated represent changes to any existing imbalance between supply and requirements in each country. For cases where an existing shortfall or surplus has been documented and quantified, the model can be initialized at any value desired.
  - Both the WHO and OECD indicator databases provide relatively recent (usually from 2011 or later for the WHO database and 2013 or later for the OECD database) head counts of midwives, nurses and physicians for most member countries with the notable exception of Greece, for which no information on the supply of midwives or nurses since 2005 was found. In the absence of any recent information on the current supply of these professionals, simulations of the future supply of midwives or nurses in Greece could not be performed.
  - The OECD indicator database also provides breakdowns of countries' physician supplies by age. However, age breakdowns were not available for midwives or nurses from any multi-country source. For some countries age distributions of midwives and nurses were found in individual documents obtained as part of Phase 1. For other countries, in the absence of such information, the age distribution observed for those providers in Canada was used to illustrate the application of the model.
  - The OECD indicator database provides historical data on annual numbers of graduates for various health professions in most of the included countries. Where no information on numbers of midwifery graduates from Portugal was found, it was assumed that no new graduates from that profession in that country would join its supply during the simulation period. This assumption would likely bias the simulations toward underestimating future HRH supply in this case.
    - No multi-country source of information on the retention of new HRH graduates was found. As such, it was assumed that all graduates of different professions in individual
countries would enter their respective countries’ supplies. This assumption would likely bias the simulations toward over-estimating future HRH supply.

- The OECD indicator database also includes historical data on physician and nurse migration for most member countries. It does not include information on migration of midwives. For countries where no information on in-migrants of a particular profession was found it was assumed that no new members of that profession would join the respective stocks of these provider groups during the study period. This assumption would likely bias the simulations toward under-estimating future HRH supply in these cases.

- No multi-country source of information on retirements or other exits from the respective national supplies was found. For some countries this information was provided in documents obtained as part of Phase 1, but for countries and professions for which this information was not found, the simulations were run based on an assumption that 5% of the existing stock would exit each year.

- For most member countries, the OECD indicator database differentiates between the numbers of midwives and nurses licenced to practise and the numbers actively practising; for these countries this information provided the basis for estimating levels of participation by these professions. For the few countries where this information was not available, the average participation level of the other countries was used.

  - The OECD indicator database does not provide comparable participation information for physicians, nor does any other multi-country source found. For some countries information on physician participation levels was found in individual documents obtained as part of Phase 1. In the absence of this information, it was assumed that all licenced physicians are active in providing at least some direct patient care. This assumption would likely bias the simulations toward overestimating the future HRH supply in these cases.

- No multi-country data source found includes information on levels of activity (e.g. average hours worked per week) by HRH. For some countries this information was found in individual documents obtained as part of Phase 1. For countries where such information was not found, it was assumed that all members of these professions work full-time hours. This assumption would likely bias the simulations toward over-estimating the future HRH supply in these cases.

Interpretation

It is important to note that these scenarios have been presented for illustrative purposes. For some countries the assumptions described above may be very close to reality; for others they may be quite different. With access to more accurate and comprehensive country-specific information, planners in individual countries can easily replace these assumptions with relevant data to better reflect their actual HRH situations. Further, despite the above limitations, considerable effort was put into estimating the current or “baseline” value of the various parameters used to simulate HRH supply and requirements for physicians, nurses and midwives for the included countries. However, it is not possible to accurately predict what values these parameters will take on in the future.

The simulations of the supply of and requirements for midwives, nurses and physicians suggest that the trajectory of HRH situations varies considerably by profession and by country. Rather than serving as predictions of the future HRH situations in these countries, the results illustrate the opportunities and the policy levers that decision-makers have to influence the supply of and requirements for HRH and the potential consequences of failing to take timely action. They assume that current service provision practices and population health levels will not change before 2030. However, should large shortfalls or surpluses appear on the planning horizon, it is likely that substantial changes to these variables — such as increases or reductions in training capacity or levels of service provision — will be made; indeed, the purpose of performing these simulations is to inform such planning. The additional scenarios presented demonstrate the high degree of sensitivity of such simulations to differences in assumed values of the various determinants of HRH supply and requirements. It is important to note that these scenarios are not based on hypothetical values of variables, but on actual values that represent real variations within a single country. These results underscore the importance of several factors critical to effective HRH planning, each of which have been repeatedly identified by earlier analyses of HRH planning worldwide.

First, HRH planning must be conducted iteratively, recognizing the constantly evolving nature of population health needs, health-care practices and regulatory structures, and health labour markets, and incorporating ongoing monitoring and evaluation. Long-term simulations such as those included here are useful for showing the direction in which HRH situations may be heading, but as the results presented here demonstrate, they cannot be used to predict the future. As such, HRH plans must be regularly updated to accommodate changes in planning variables over time (e.g. WHO, 1971; Mejia, 1978; Dussault & Dubois, 2003; Stordeur & Léonard, 2010; Tomblin Murphy et al., 2012).

Second, HRH planning must be conducted by engaging with the relevant stakeholders (e.g. WHO, 1971; Mejia & Fülöp, 1978; Dubois et al., 2006; Stordeur & Léonard, 2010). This is necessary to ensure that the approach being used is relevant, that the information necessary to utilize a valid approach is made available, and that planning gives appropriate consideration to the perspectives of different stakeholder

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groups. Planners in individual countries would have direct access to these stakeholders, which was not possible for the analyses reported here.

Third, HRH planning must be based on appropriate data, and this includes measures of both the health levels of the population as well as the health-care services planned to respond to those health levels, together with characteristics of the health workforce and the broader economic, sociopolitical, environmental and technological contexts in which the planning is being done (e.g. WHO, 1971; Mejía & Fülöp, 1978; Lavis & Birch, 1997; O’Brien-Pallas et al., 2007; Vujicic & Zum, 2006; Kuhlmann et al., 2013). The relatively crude measures used for the simulations in this report were chosen because they were either the only measures available or the only ones provided for multiple countries from a single source. Comprehensive analyses of HRH supply and requirements can be conducted to inform national level HRH policies and strategies (e.g. Segal et al., 2008; Health Workforce New Zealand, 2011a; Tomblin Murphy et al., 2013a&b). It is important to note that the more comprehensive data required to support such analyses do in general exist in high-income countries; for example, the data collected for Canada, most of which is publicly available online, were much more complete than for other countries.

Other, more commonly used approaches to health workforce planning have been widely and repeatedly recognized as ineffective. Over 40 years ago the WHO (1971) noted that “The exclusive use of health manpower: population ratios for the estimation of future health manpower requirements is increasingly difficult to justify in the developed countries where, depending on the specific characteristics of the health system, other and more refined criteria can be used to improve the country’s capacity to provide health care”. Along similar lines, the UK House of Commons Health Committee (2007) commented on the “disastrous failure of (health) workforce planning” which it attributes to the fact that “little if any thought has been given to long term or strategic planning”. A report commissioned in response (UK Department of Health, 2008) called for workforce planning to “be based on service planning and ... reflect how health and social care will meet the needs of the local population planning”. More recently the Global Strategy on Human Resources for Health recommended that all countries “Build planning capacity to develop or improve HRH policy and strategies that quantify health workforce needs, demands and supply under different future scenarios” (WHO, 2015b). Consistent with such calls, the strength of the workforce planning approach presented here lies in its use of methods that are linked directly to service planning based on the needs of populations, but that can at the same time accommodate the uncertainty – and the opportunity for policy intervention – in relation to a range of health systems and health workforce parameters. The results of such approaches cannot be meaningfully compared with those generated by more commonly used workforce planning models which cannot account for differences in populations’ needs for care or the levels of services required to meet those needs. The approaches may produce very different results because they are addressing very different research or health policy questions implicit in the planning models being used.

The review and synthesis of recent analyses of HRH requirements in the included countries conducted as the first phase of this work found, however, that most of these focused primarily on measures of HRH supply and utilization. This is perhaps because these are more readily available; there were numerous data-related challenges encountered through this study that hindered efforts to simulate future HRH supply and requirements. However, as noted in the previous report, problems with data are not avoided by relying on more conceptually limited models. If the information available is inadequate to fully inform planning, then investments should be made in improving the quality of that information rather than in further entrenching the use of intrinsically narrower models. To that end, the identification and assessment of the data required to inform HRH planning should be based on the question of how many of what type of HRH are required to perform what services, for whom, and under what circumstances (e.g. Mejía & Fülöp, 1978; Birch et al., 2007; de Savigny & Adam, 2009). The HRH planning approach described in this report and its companion paper are designed to address this question and to overcome the limitations of more traditional approaches which have resulted in the numerous HRH challenges being experienced worldwide.

While the focus of this analysis was on high-income OECD countries, the analytical approach described can theoretically be applied in any jurisdiction where the required data are available. Similar approaches have already been applied, for example, in Guinea (Jansen et al., 2014), Jamaica (Tomblin Murphy et al., 2014), Thailand (Tianviwat et al., 2009), and Zambia (Goma et al., 2014).
6. Conclusions

The objective of this analysis was to review the evidence on and develop a methodology for producing simulations of the supply of and requirements for midwives, nurses, and physicians in high-income OECD countries until 2030, to inform global policy dialogue and strategic planning at both international and national levels, such as that occurring as part of the development of the global strategy on HRH. This was carried out using publicly available data and using assumptions about the values of the various determinants of supply and requirements, aside from population projections, remaining constant throughout that time period. Despite the limitations resulting from challenges obtaining some of the necessary data in the time available, the results demonstrate the potential to apply an approach to simulating HRH supply and requirements in a manner more comprehensive than most of those currently being used in many countries. HRH planners in individual countries, who have more direct access to data on the relevant planning parameters, are best placed to implement such an approach working with their respective stakeholder groups.

The results of these simulations suggest that the trajectories of HRH supplies and requirements vary widely across countries and professions, with some potentially headed for large surpluses, while others may be moving toward large shortfalls. These findings reinforce the concern highlighted by the WHO Global Strategy on Human Resources for Health: Workforce 2030 (2015b) that many high-income countries are challenged with matching supply and requirements for HRH under existing and future affordability and sustainability constraints, and often experience periodic swings between perceived shortfalls and oversupply. These can be particularly problematic from both domestic and international perspectives; for example, domestic underproduction and/or maldistribution of health workers can contribute to a disproportionate reliance on recruitment of foreign-trained health personnel. Historically, the included countries as a group have been the beneficiaries of the bulk of international migration of health workers from low- and middle-income countries, worsening deficits in these contexts, and that these mobility trends are likely to continue and even increase in future (OECD, 2015b). In this context, the analysis reported here provides evidence that can also inform a global policy dialogue on international imbalances and mobility patterns across countries. The type of HRH planning approach described here also allows the identification of the policy levers with the greatest potential to affect trends and prevent the emergence of future gaps, thereby informing policy options that may alleviate or avoid these gaps, such as changes to models of care delivery or to HRH training and/or regulatory structures.

The sensitivity analyses demonstrate that these simulations are highly dependent on the assumptions on current and future values of the various variables that determine HRH supply and requirements. These findings highlight the importance of HRH planning that is iterative, based on a valid methodology, and engages the relevant stakeholder groups. Further, it is imperative that these stakeholders collaborate to ensure that the types of data necessary for such methodologies are regularly collected and analysed to inform HRH planning. Evidence-based analyses of HRH situations requires reliable and regularly updated information on population health status, labour market dynamics, and health service configurations.
7. References


Arnhold M, Quade MKW (2014). Mobile applications for diabetics: a systematic review and expert-based usability evaluation considering the special requirements of diabetes patients age 50 years or older. *Journal of Medical Internet Research*, 16(4): e104.


Lavis J, Birch S (1997). The answer is …, now what was the question? Applying alternative approaches to estimating nurse requirements. *Canadian Journal of Nursing Administration, 10*(1): 24-44.


Annex 1: List of websites consulted

International

Global Health Workforce Alliance http://www.who.int/workforcealliance/
WHO Health Workforce http://www.who.int/hrwhome/resources/en/
OECD http://www.oecd.org/
European Observatory on Health Systems and Policies http://www.euro.who.int/en/about-us/partners/observatory
Joint Action on Health Workforce Planning and Forecasting http://healthworkforce.eu/
HRH Global Resource Centre http://www.hrhresourcecenter.org/
KIT https://www.kit.nl/
Health Cluster EU http://healthclusternet.eu
WHO collaborating centres focusing on HRH
- University of Western Cape http://www.uwc.ac.za/Faculties/CHS/soph/Pages/WHO-Collaborating-Center-.asp
- University of Illinois at Rockford http://hchrp.uic.edu/index.cfm?id=1031&b=1003&page=World%20Health%20Organization%20Collaborating%20Centre
- McMaster University http://nursing.mcmaster.ca/WHO_collaborating_centre.html
- WHO Collaborating Centre on Health Workforce Policy and Planning http://whoccworkforce.ihmt.unl.pt/

Country-specific

Australia

Austria
Ministry of Health http://bmg.gv.at/home/Schwerpunkte/
Gesundheitssystem_Qualitaetssicherung/
public

Belgium
Federal Ministry of Health (planning commission) http://www.health.belgium.be/eportal/Healthcare/Consultativebodies/
Planningcommission/index.htm#.VT5tVq3BzGc

Canada
Health Canada (human resources strategy) http://www.hc-sc.gc.ca/hcs- sss/hrh-rhs/strateg/index-eng.php
Canadian Health Human Resources Network (CHHRN) http://www.hrhrhs.ca/

Chile
Ministry of Health http://desal.minsal.cl/

Czech Republic
Ministry of Health http://www.mzcr.cz/Cizinci/

Denmark
Health and Medicines Authority http://sundhedsstyrelsen.dk/en

Estonia
Ministry of Social Affairs http://www.sm.ee/et

Finland
Human Resources for Health Observer

France
Ministry of Health, Social Affairs and Women’s Rights http://www.sante.gouv.fr/les-reseaux-de-sante.html
Institute for Research and Information in Health Economics http://www.irdes.fr/english/home.html

Germany
National Statistics Bureau https://www.destatis.de/DE/Startseite.html

Greece
Ministry of Health and Social Solidarity http://www.moh.gov.gr/

Hungary
Health Services Management Training Centre, Semmelweis University http://semmelweis.hu/emk/main/

Iceland
Directorate of Health http://www.landlaeknir.is/english/

Ireland
Expert Group on Future Skills Need http://www.skillsireland.ie/
Department of Health (Health Services Executive) http://www.hse.ie/eng/

Israel
Ministry of Health http://www.health.gov.il/Services/Publications/Pages/PublicationsSearch.aspx

Italy
Ministry of Health http://www.salute.gov.it/

Japan

Luxembourg
Ministry of Health (health information portal) http://www.sante.public.lu/fr/Index.html

Netherlands
Netherlands Institute for Health Services Research (NIVEL) http://www.nivel.nl/en

New Zealand
Health Workforce New Zealand http://healthworkforce.health.govt.nz/

Norway
Directorate of Health https://helsedirektoratet.no/English
Statistics Norway http://www.ssb.no/en/

Poland

Portugal
Health Information Portal http://www.min-saude.pt/portal [link not working, March 2017]

Republic of Korea

Slovakia
Ministry of Health http://www.health.gov.sk/Titulka

Slovenia

Spain

Sweden
Ministry of Health and Social Affairs http://www.government.se/sb/d/2061
National Board of Health and Welfare http://www.socialstyrelsen.se/english

Switzerland
Swiss Health Observatory http://www.obsan.admin.ch/bfs/obsan/en/index/01.html

United Kingdom
Centre for Workforce Intelligence http://www.cfwi.org.uk/
Health Education England https://hee.nhs.uk/
The Scottish Government http://www.gov.scot/Publications/
NHS Wales http://www.wales.nhs.uk/
Wales National Leadership and Innovation Agency http://www.nliah.wales.nhs.uk/

United States of America
HRSA National Center for Health Workforce Analysis https://bhw.hrsa.gov/health-workforce-analysis

Center for Health Workforce Studies http://depts.washington.edu/uwchws/chws-publications.php
Association of School and Programs of Public Health http://www.aspoh.org/
Association of American Medical Colleges https://www.aamc.org/data/workforce/reports/
Annex 2: Data extraction tool for peer and non-peer reviewed literature

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Annex 2: Data extraction tool for peer and non-peer reviewed literature
### Annex 3: Stated objectives of included countries’ health-care systems

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**Estonia**

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**France**

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**Greece**

**Iceland**

**Ireland**

**Israel**

**Italy**
Japan

Luxembourg

Netherlands


New Zealand

Norway

Poland

Portugal

Republic of Korea

Slovakia

Slovenia

Spain

Sweden

Switzerland


United Kingdom


United States of America

Other