Modernising physician resource planning: a national interactive web platform for Canadian medical trainees

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Research

Keywords: physician resource planning, health human resources, specialty choice, physician workforce

DOI: https://doi.org/10.21203/rs.3.rs-206889/v1

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Abstract

Background: Healthcare systems rely heavily upon human resources to ensure high-quality access to care for the general population. With significant health worker shortages predicted worldwide in the coming decades, maximizing the current workforce by means of a physician resource planning (PRP) strategy that ensures the right number, mix, and distribution of physicians to meet population needs is warranted. In Canada, there is an insufficient number of primary care providers, and disproportionately low numbers of specialist physicians in rural compared to urban regions. Currently, Canadian medical students are not effectively included in PRP strategy and lack the required information for career orientation to help rebalance the population's workforce needs. This paper aims to present the Health Human Resource (HHR) Platform, a comprehensive web tool that includes relevant workforce data to empower medical students in choosing a discipline based on both personal interests and social accountability.

Methods: Physician workforce data were amalgamated from national public agencies. Comments from Canadian residency program directors and useful resources for career planning were collected by the Canadian Federation of Medical Student's (CFMS) HHR Task Force. This information was consolidated to create the HHR Platform using a DigitalOcean server. The backend database utilizes MySQL, while the frontend utilizes React and Material UI, with additional aspects integrated through Leaflet and Google Charts.

Results: A national interactive platform was created that uses a map, comparison table, and trends graph to illustrate over 500,000 unique data points from 37 datasets, including specific information and resources spanning 62 medical specialties from 2015 onwards. There was a 24.6% response rate for program director comments. During the first four months of the HHR Platform launch, there were 2463 different users, of which 998 were returning, with an average of 20.2 users per day spending on average 3 minutes and 4 seconds on the platform.

Conclusions: The HHR Platform constitutes a bottom-up national approach to PRP informing medical students on the mix and distribution of physicians needed for a better alignment with residency positions, and ultimately meet the future healthcare demands of the Canadian population.

Background

Healthcare accounts for a significant portion of public expenditure in many countries globally, and human resources occupy a majority of this spending [1]. Imbalances in healthcare workforce supply and demand negatively impact the provision of health services and ultimately strain overall public expenditure [2–4]. Even under universal healthcare systems, such as the Canadian framework, these imbalances result in adverse sequelae. For example, between 2005 and 2019, the physician to 100,000 population ratio increased from about 190 to 240, representing one of the greatest rises of physician supply in Canadian history, while the proportion of Canadians without a family physician increased from 13.6–14.5% during this period [5–7]. This mismatch may be attributed to decades of overtraining specialist physicians, which has resulted in undersupply of family physicians [8]. Furthermore, there is a geographic dichotomy: only 10% of the total physician workforce and only 2% of specialized physicians practice in rural Canada where 18% of the population is situated [9].

To address this, Health Canada invested $1.8 million in 2010 to review postgraduate medical education in Canada [10]. One of their recommendations was to iteratively re-evaluate medical training programs to ensure the right "physician mix, distribution, and number” of generalist and specialist positions to serve the Canadian population. Part of the solution, therefore, must address medical students’ specialty choice and its effect on society. At a national level, Canadian medical residency training has historically seen a deficit of students applying to primary care programs, such as family medicine, resulting in unfilled training positions. Meanwhile, there has been an enormous difficulty maintaining access to primary care services due to the lack of trained individuals within this field [11–14]. In 2020, there were 169 unfilled training positions in family medicine after the first iteration of the residency match [15]. In contrast, a 2019 survey showed that 66% of the total specialists physicians surveyed were unable to secure employment within 12–17 months of graduation [16].

Reduced access to essential health services is simply one consequence of the physician supply-demand mismatch. Attrition or underemployment of highly trained physicians due to unfavourable job prospects results in a decreased return on investment in the health sector, as medical training is heavily subsidized by Canadian taxpayers [17]. Additionally, a population whose health needs are critically underserviced experiences poorer health outcomes which is more costly in other facets of public spending, such as those related to illness and disability [8, 18, 19].

Health human resource (HHR) planning is a necessary endeavour to optimize the quantity and skillset of our healthcare workforce, which in turn ensures that population health needs are adequately serviced [2]. Within the Canadian context, not only is HHR planning beneficial from a population health perspective, but it is the most sustainable approach to procuring long-term stability of our universal healthcare system. Physician resource planning (PRP), a subset of HHR strategy, aims to optimize physicians' available supply to meet population demands. Canada's universal healthcare system is provincially governed; thus, many elements of care delivery such as healthcare coverage, physician licensure, physician reimbursement, and referral logistics are typically moderated within provincial boundaries [20]. However, provincially mandated healthcare results in difficulties with evolving physician practice habits, such as interprovincial locums and telemedicine providers who tend to serve remote populations [20].

Many nations, including Canada, are predicted to face critical deficits in physician supply over the next thirty years [21]. The quality of a nation’s HHR planning and PRP are reflected in patient outcomes: morbidity and mortality are known to rise when supply of care providers does not match population needs [22–24]. The goal is not to simply train a set number of physicians, but rather to train the right types of physicians based on population needs. This avoids the present circumstance of simultaneously having too many physicians, and yet, not enough. These shortages may be effectively overcome by improving PRP strategies for domestically trained physicians to close gaps in attrition and supply-demand mismatch [8]. However, due to the paucity of concerted national PRP efforts, Canadian medical trainees are not equipped to make evidence-informed decisions regarding specialty choice, and thus, the cycle persists [25]. Medical training is an arduous, lengthy, and costly process that can—and should—be optimized by a national PRP strategy.
Currently, there are two main checkpoints in the medical training process that affect the number, mix, and distribution of future physicians; thus, acting as a component of national PRP strategy. First, undergraduate medicine admissions; second, postgraduate residency admissions. These checkpoints represent top-down approaches to PRP, such that admissions decisions are made to steer the future physician workforce to match societal demand. These checkpoints attempt to direct medical trainees towards specific specialties and practice locations, but have yet to deliver a supply of physicians that sustainably meets the Canadian population demand. However, to the best of our knowledge, there are no national bottom-up approaches to PRP targeting Canadian undergraduate medical trainees—whereby students make an evidence-informed decision regarding their specialty choice to match societal demand. Our objective was to create an interactive web-based tool, the HHR Platform, for medical trainees as a bottom-up national PRP strategy within the Canadian context. Our tool empowers future physicians with the technology and data to make evidence-informed decisions regarding specialty choice. This work was undertaken by the Canadian Federation of Medical Students’ (CFMS) HHR Task Force with the goal of shifting the decision-making process for Canadian medical trainees towards both personal interests and social accountability.

Methods

The HHR Platform was created by FireNet Designs (FireNet Designs, Winnipeg, AB, CA) on a DigitalOcean (DigitalOcean Inc, New York City, NY, US) server to host the backend database using MySQL (Oracle Corp., Redwood Shores, CA, US). Construction of the platform spanned from November 2019 to September 2020. The backend is composed of a comma separated value (CSV) parser application used for adding data to the database, and flexible application programming interface (API) endpoints for querying data. The frontend is constructed using React (Facebook Inc, Menlo Park, CA, US) to manage user functionality and Material UI (Material-UI SAS, Paris, FR) to simplify data processing. Lastly, Leaflet (Vladimir Agafonkin, Kyiv, UA) and Google Charts (Google LLC, Menlo Park, CA, US) are utilized for the map and graph views, respectively. Geographic representation was aided by a public API acquired from the Environmental Systems Research Institute (ESRI) (ESRI, Redlands, CA, USA). The HHR Platform is hosted publicly and free-of-cost on the CFMS website [26].

The HHR Platform coalesces data from the following Canadian agencies: Canadian Institute for Health Information (CIHI), Canadian Medical Association (CMA), Canadian Post-MD Education Registry (CAPER), Canadian Resident Matching Service (CaRMS), Ontario Medical Students’ Association (OMSA), and ESRI. Appropriate permissions and data-sharing contracts were obtained prior to construction of the platform. The unique datasets obtained from these agencies are categorized in Table 1. The delimiters included in the HHR Platform are categorized in Table 2. Aside from Ontario, program directors of all Canadian residency programs were identified via the CaRMS and Royal College websites and contacted via a standardized email template for their feedback regarding physician needs pertaining to their specialty and region of practice. Program director responses from Ontario in 2019 had already been collected by OMSA, and were accordingly shared with the CFMS. Consent was obtained to share their de-identified responses publicly. Members of the HHR Task Force—comprising nine medical students from across Canada—also performed a standardized search on the public domain for specialty-specific resources, which were amalgamated and included as part of the HHR Platform. Google analytics was integrated to demonstrate the utilization of the HHR platform in the first four months following the day of its official launch.

| Agency | Data obtained |
|--------|--------------|
| Canadian Institute for Health Information (CIHI) | Number of working physicians <br> Physician to 100,000 population ratios <br> Physicians by age groups <br> Gross wage <br> Number and rural and urban <br> Number and male and percentage female |
| Canadian Medical Association (CMA) | Number of vacancies <br> Number of working physicians <br> Physicians by age group <br> Number of male and female |
| Canadian Post-MD Education Registry (CAPER) | Number of residents exits per year <br> Number of fellow exits per year <br> Percentage of residents pursuing fellowship training <br> Number of physicians working in province 2 years after having graduated in the same province |
| Canadian Resident Matching Service (CaRMS) | Number of CMG seats (school-specific) <br> Number of CMG distinct applicants (Canadian region-specific) <br> Number of CMG applicants who ranked discipline as first choice (Canadian region-specific) |
| Ontario Medical Students’ Association (OMSA) | All Ontario program director comments |
| Environmental Systems Research Institute (ESRI) | Hospitals map layer 2016 population census map layer |
Table 2
Datasets generated from CIHI, CMA, CAPER, CaRMS, OMSA, and ESRI.

| Dataset | Class | Subclass |
|---------|-------|----------|
| Specialties | Non-surgical disciplines | Anatomical pathology |
|          |       | Anesthesiology |
|          |       | Cardiology |
|          |       | Clinical immunology and allergy |
|          |       | Clinical pharmacology and toxicology |
|          |       | Critical care medicine |
|          |       | Dermatology |
|          |       | Diagnostic radiology |
|          |       | Emergency medicine |
|          |       | Endocrinology and metabolism |
|          |       | Family medicine - Care of the elderly |
|          |       | Family medicine - Emergency |
|          |       | Family medicine - General practice |
|          |       | Family medicine - Palliative care |
|          |       | Family medicine - Total |
|          |       | Gastroenterology |
|          |       | General internal medicine |
|          |       | General pathology |
|          |       | Geriatrics |
|          |       | Hematology |
|          |       | Infectious diseases |
|          |       | Medical genetics |
|          |       | Medical microbiology |
|          |       | Medical oncology |
|          |       | Nephrology |
|          |       | Neuropathology |
|          |       | Nuclear medicine |
|          |       | Pain medicine |
|          |       | Palliative medicine |
|          |       | Pediatrics - Adolescent medicine |
|          |       | Pediatrics - Clinical immunology and allergy |
|          |       | Pediatrics - Developmental |
|          |       | Pediatrics - Emergency medicine |
|          |       | Pediatrics - Endocrinology and metabolism |
|          |       | Pediatrics - Gastroenterology |
|          |       | Pediatrics - General |
|          |       | Pediatrics - Hematology-oncology |
|          |       | Pediatrics - Infectious diseases |
|          |       | Pediatrics - Neonatal-perinatal medicine |
|          |       | Pediatrics - Nephrology |
|          |       | Pediatrics - Neurology |
| Dataset | Class | Subclass |
|---------|-------|---------|
|         | Pediatrics - Respirology |
|         | Physical medicine and rehabilitation |
|         | Psychiatry |
|         | Public health and preventive medicine |
|         | Radiation oncology |
|         | Rheumatology |
| Surgical disciplines | Cardiac and thoracic surgery |
|         | Neurosurgery |
|         | Nuclear medicine |
|         | Obstetrics and gynecology |
|         | Ophthalmology |
|         | Orthopedic surgery |
|         | Otolaryngology - Head and neck surgery |
|         | Plastic surgery |
|         | Urology |
|         | Vascular surgery |

| Jurisdictions | Provinces and territories | Health regions |
|---------------|---------------------------|----------------|
|               | Newfoundland and Labrador | Eastern Health |
|               |                           | Central Health |
|               |                           | Western Health |
|               |                           | Labrador–Grenfell Health |
|               | Prince Edward Island      | Health PEI |
|               | Nova Scotia               | Western Zone |
|               |                           | Northern Zone |
|               |                           | Eastern Zone |
|               |                           | Central Zone |
|               | New Brunswick             | Zone 1 (Moncton Area) |
|               |                           | Zone 2 (Saint John Area) |
|               |                           | Zone 3 (Fredericton Area) |
|               |                           | Zone 4 (Edmundston Area) |
|               |                           | Zone 5 (Campbellton Area) |
|               |                           | Zone 6 (Bathurst Area) |
|               |                           | Zone 7 (Miramichi Zone) |
|               | Québec                    | Bas-Saint-Laurent Region |
|               |                           | Saguenay–Lac-Saint-Jean Region |
|               |                           | Capitale-Nationale Region |
|               |                           | Mauricie et Centre-du-Québec Region |
|               |                           | Estrie Region |
|               |                           | Montréal Region |
|               |                           | Outaouais Region |
|               |                           | Abitibi-Témiscamingue Region |
|               |                           | Côte-Nord Region |
|               |                           | Nord-du-Québec Region |
| Dataset | Class | Subclass |
|---------|-------|----------|
| Gaspésie–Îles-de-la-Madeleine Region |
| Chaudière-Appalaches Region |
| Laval Region |
| Lanaudière Region |
| Montérégie Region |
| Nunavik Region |
| Terre-Cries-de-la-Baie-James Region |
| Ontario | Erie St. Clair LHIN |
| South West LHIN |
| Waterloo Wellington LHIN |
| Hamilton Niagara Haldimand Brant LHIN |
| Central West LHIN |
| Mississaug Halton LHIN |
| Toronto Central LHIN |
| Central LHIN |
| Central East LHIN |
| South East LHIN |
| Champlain LHIN |
| North Simcoe Muskoka LHIN |
| North East LHIN |
| North West LHIN |
| Manitoba | Winnipeg Regional Health Authority |
| Prairie Mountain Health |
| Interlake–Eastern Regional Health Authority |
| Northern Health Region |
| Southern Health — Santé Sud |
| Saskatchewan | Sun Country Health Region |
| Five Hills Health Region |
| Cypress Health Region |
| Regina Qu’Appelle Health Region |
| Sunrise Health Region |
| Saskatoon Health Region |
| Heartland Health Region |
| Kelsey Trail Health Region |
| Prince Albert Parkland Health Region |
| Prairie North Health Region |
| Mamawetan Churchill River Health Region |
| Keewatin Yatthé Health Region |
| Athabasca Health Authority |
| Alberta | South Zone |
| Calgary Zone |
| Central Zone |
| Dataset                | Class       | Subclass                                                                 |
|------------------------|-------------|--------------------------------------------------------------------------|
| British Columbia       | Edmonton Zone| North Zone                                                              |
|                        | East Kootenay HSDA | Kootenay–Boundary HSDA                                                  |
|                        | Kootenay–Boundary HSDA | Okanagan HSDA                                                          |
|                        | Thompson/Cariboo HSDA | Fraser East HSDA                                                        |
|                        | Fraser East HSDA | Fraser North HSDA                                                        |
|                        | Fraser North HSDA | Fraser South HSDA                                                        |
|                        | Fraser South HSDA | Richmond HSDA                                                            |
|                        | Richmond HSDA | Vancouver HSDA                                                            |
|                        | Vancouver HSDA  | North Shore/Coast Garibaldi HSDA                                          |
|                        | North Shore/Coast Garibaldi HSDA | South Vancouver Island HSDA                                               |
|                        | South Vancouver Island HSDA | Central Vancouver Island HSDA                                            |
|                        | Central Vancouver Island HSDA | North Vancouver Island HSDA                                              |
|                        | North Vancouver Island HSDA | Northwest HSDA                                                          |
|                        | Northwest HSDA | Northern Interior HSDA                                                    |
|                        | Northern Interior HSDA | Northeast HSDA                                                           |
| Yukon Territory         | Yukon Territory | Yukon Territory                                                          |
| Northwest Territory     | Northwest Territory | Northwest Territory                                                     |
| Nunavut                | Nunavut  | Nunavut                                                                  |

**Data sets**

**Gender demographics**

- Number of physicians
- Number male
- Number female
- Number sex unknown
- Percentage female
- Percentage male

**Age demographics**

- Average age
- Median age
- Age group: younger than 30
- Age group: 30–39
- Age group: 40–49
- Age group: 50–59
- Age group: 60–64
- Age group: 65–69
- Age group: 70–74
- Age group: 75–79
- Age group: 80 and older
- Age group: Unknown

**Location distribution**

- Number in rural areas
- Number in urban areas
- Number unknown urban or rural
- Percentage rural
| Dataset | Class                      | Subclass                                                                 |
|--------|----------------------------|--------------------------------------------------------------------------|
|        | Percentage urban           |                                                                           |
| Training metrics | Number of CMG seats |                                                                           |
|         | Number of CMG applicants   |                                                                           |
|         | Number of CMG applicants who ranked specialty as first choice |                                                                           |
|         | Number of 2 year post graduates working in same province |                                                                           |
|         | Number of resident exits per year |                                                                           |
|         | Number of fellow exits per year |                                                                           |
|         | Percentage of residents pursuing fellowship training |                                                                           |
|         | Ratio of number of CMG applicants who ranked specialty as first choice to number of CMG seats | |
| Employment metrics | Number of vacancies |                                                                           |
|         | Number of graduates from province 2 years ago |                                                                           |
|         | Ratio of number of graduates from province 2 years ago to number of 2 year post graduates working in same province | |
|         | Ratio of number of vacancies to number of physicians |                                                                           |
|         | 5 year projected need      |                                                                           |
|         | 10 year projected need     |                                                                           |
|         | Physician-to-100,000 population ratio |                                                                           |
|         | Gross wage |                                                                           |
| Additional resources | Program director responses |                                                                           |
|         | Specialty resources        |                                                                           |
|         | Provincial resources |                                                                           |

Sustainability was a key consideration in determining the backend database architecture. Thus, we prioritized construction of the database to be flexible such that new datasets may be added on an annual basis and that complex datasets may be promptly queried. Data presented in the platform was unmanipulated with one exception: data were averaged if the same metric was provided by multiple separate sources; averaged data were indicated by parentheses next to the values to indicate the number of sources contributing to the presented data. The range of the data is available in the graph view. Additionally, per CMA privacy policy, cells with fewer than five data points were suppressed. Specialties on the HHR Platform are defined per CIHI's catalogue. Specialties represented in the platform are shown in Table 2. Jurisdictions are computed on the basis of provincial boundaries and further subclassified by regional health authorities. Further information regarding data construction and considerations may be found in the HHR Platform user guide, which supplements the web tool [27].

Results

The HHR Platform includes information and resources for 62 specialties with over 500,000 unique numerical data points obtained from 37 datasets. Data summarized in the HHR Platform is from 2015 onwards, with succeeding data added on an annual basis. There were 96 program director comments in 2019, representing 24.6% of the total individuals contacted. In the first four months (September 20, 2020, to January 20, 2021) of the HHR Platform being hosted publicly on the CFMS website, there were an average of 20.2 users per day with a total of 2463 different users, of whom 998 returned to the platform. The average time spent on the platform was 3 minutes and 4 seconds. The HHR Platform was designed to present data in a customized fashion, whereby users select their preferred view between a map, table, or graph view. Each view utilises the same database but provides a unique purpose based on user needs.

**Table View**

Table view allows for comparative visualization of granular data (Figure 1). "Step 1" allows the user to select their preferred view. In "Step 2," the user selects the year for which wish to access data. "Step 3" allows the user to decide whether they wish to compare multiple specialties across one jurisdiction (compare specialty), or multiple jurisdictions for one specialty (compare jurisdiction). In "Step 4" and "Step 5," the user selects their jurisdiction(s) and specialty(ies) of interest, respectively. "Step 6" allows the user to choose between the various available datasets.

**Figure 1:** Table view from the HHR Platform showing general pathology compared between selected jurisdictions.

**Graph View**

Graph view allows for visualization of trends (Figure 2). This view uses the same steps as above for the table view. A single dataset is chosen over a selected range of time. Hovering over the error bars demonstrate the range of the data coming from the different sources.
In Canada, medical school admissions represent the number of physicians who will be eligible to practice medicine within the next decade—barring minor exceptions such as visa trainees, immigration or emigration of graduated students, and attrition from medical training. Increasing the total number of medical school positions results in a greater supply of physicians. The decision to add or remove these positions is a result of complex processes between the provincial Ministry of Health and their health authorities, the faculties of medicine, and the respective provincial and territorial medical association [28].

Historically, the medical school admissions process has affected the physician workforce composition in two ways. First, individuals originally from a rural region are more likely to stay and practice medicine in a rural region [29–31]. Following this concept, the Northern Ontario School of Medicine (NOSM) was established to train students from Northern Ontario to respond to the region’s need for physicians in rural, Francophone, and Indigenous communities [32]. The school was established in 2005, and consistently above 90% of each incoming class are individuals from Northern Ontario [33]. In 2020, the rate of medical students pursuing residency programs at NOSM and then practicing in Northern Ontario averaged 40% and 94%, respectively, with similar rates for the past ten years. Several other institutions have similar admissions pathways for individuals from underserved or rural communities [34].

Secondly, individuals who share similarities with a particular demographic tend to practice and stay in these communities [29]. Therefore, quotas reserved for applicants meeting certain characteristics, such as indigenous and/or lower socioeconomic status, have been applied in some Canadian medical faculties. Additionally, the admission selection process now includes coefficients accounting for diversity and/or criteria for Black and refugee applicants in some schools [35]. In 2017, seven schools had a set number of seats allocated for indigenous students, and now all 17 Canadian medical faculties ensure a minimum number of indigenous students are admitted [36]. At least six institutions have constructed admissions pathways to recruit historically underrepresented and/or culturally diverse individuals, with many more institutions formally dedicated to developing similar streams [37]. Improving access to high-school and undergraduate mentorship is also an essential component to many of these initiatives. There is presently a paucity of data for the admissions outcomes of such initiatives due to their recency [38]. However, the University of Toronto’s Black Student Admission Program, which was launched in 2017, has shown promising early outcomes. In 2020, there were 20 Black medical students among a cohort of 259 learners—compared to one Black medical student in 2016—despite Black Canadians comprising 10% of Toronto’s population [39]. The overarching goal of such initiatives is to restructure the composition of our physician workforce to better reflect and serve the Canadian population.

The checkpoint of admissions into medical school has an influence on PRP in regards to determining the anticipated number of physicians, as well as their distribution by utilising quotas and geographical location of training sites. There are currently no mechanisms in place at this level that have been shown to impact specialty choice. Canadian medical students, therefore, begin medical school with the possibility of pursuing a residency in any discipline offered as part of the CaRMS.

**PRP via admissions to residency**
The CaRMS is a service that aims to match medical students to Canadian residency training positions through a Nobel prize winning algorithm [40]. The service centralizes all available Canadian residency training positions into one portal. A small minority of programs have also instituted return-of-service agreements upon completion of training in exchange for a residency position [41]. Once a student is matched to a residency program via the CaRMS, they are legally bound to that program. This helps to ensure an equitable and accountable system for residency program matching. Overall, the CaRMS represents residency admissions and affirms the importance of PRP as it pertains to the quota of residency positions and mix of specialties required by the Canadian population.

While PRP via residency and medical school admissions have helped to improve physician-based HHR in Canada, there remain critical gaps in this approach. The CaRMS match outcomes are a testament to the shortcomings of the current top-down PRP strategy. The most recent example is the significant rise in the number of unmatched Canadian medical graduates (CMG), reaching a peak of 169 in 2018 after both iterations of the match [16,42]. Estimates place the tax-base investment at approximately $260,000 per medical graduate prior to entering residency, representing at least $43.9M of unrealized investment in 2018 alone [17]. This has led to important advocacy efforts in 2018 and action in the following year whereby the Nova Scotia Health Ministry added 25 new spots at Dalhousie University as well as $23 million invested over six years for new positions in Ontario [42,43]. Concurrently, the number of unmatched CMGs has dropped to 98 in 2019 and 67 in 2020 [44]. Whether this is a direct result of the addition of these new positions has not been studied. Nonetheless, each unmatched CMG represents ineffective use of health human resources and subsequent loss of return-on-investment of Canadian taxpayers.

While the unmatched CMG phenomenon is multifactorial, a factual observation is that certain specialties are more competitive than others, as represented by the ratio of positions divided by applicants’ first choice discipline, thus correlating with medical student interests. In the 2020 residency match, the most competitive specialty was ophthalmology with a ratio of 0.51, and the least competitive specialty was general pathology with a ratio of 4.5 [44]. Family medicine was the sixth least competitive specialty with a ratio of 1.65. Even now, two years after the unmatched CMG peak, the interests of medical students have remained largely similar to what they were five years ago [15]. Importantly, these competitive specialties are not necessarily those that correlate to the highest population demand, which currently comprise family medicine and geriatrics [9,45].

One example of a bottom-up approach was the Québec Health Ministry’s rearrangement of their available residency positions in 2018 to reflect 55% of seats reserved for family medicine, and 45% to all other specialties [46]. In that year alone, there were 65 vacant positions following both iterations of CaRMS Québec family medicine programs [47,48]. In response, the Fédération Médicale Étudiante du Québec (FMEQ) promoted family medicine education under the pretense that disinterest in family medicine stems from the medical students’ lack of knowledge about this specialty [49]. In the following year, there was a drop to 23 vacancies, combined with a greater interest in family medicine demonstrated by an increase from 373 to 440 matched applicants between 2018-2019 in the first iteration [47,50]. The FMEQ approached PRP by targeting and educating medical students about the mix and demand of specialties, particularly with respect to the need for family physicians in the Quebec population, with promising outcomes.

Altogether, it could be argued that the strategy to add residency positions after the unmatched CMG peak in 2018 imparted a positive impact on the numbers, but contributed little in terms of addressing the PRP challenges of specialty mix and distribution. Therefore, there is a need to reimagine new PRP strategies after the checkpoint of admission into medical school but prior to participating in the CaRMS match. The goal is to cultivate an interest among medical trainees to choose a specialty which aligns with the quota depicted by the CaRMS checkpoint for admissions to residency.

**Role of HHR Platform**

Despite efforts occurring at the admissions checkpoints surrounding medical school, which mostly represent top-down PRP approaches, strategies aimed at informing medical students’ specialty choice remains a largely untapped area for effective and large-scale PRP at the national level. Differentiation of the physician body occurs during medical training, thus the decisions made by medical trainees regarding specialty choice have a substantial impact on their nation’s health workforce composition. This in turn impacts physician attrition, resource allocation, system sustainability, and favours adequate access to care. The HHR Platform is a bottom-up approach towards improving transparency regarding population health needs and associated practice opportunities to guide medical student specialty choice to be concordant with population health needs.

For example, a medical student user of the HHR Platform who is interested in job prospects for diagnostic radiology in Nova Scotia may notice the decreasing trend for number of physicians and number of job vacancies with higher saturation in the central health region of Nova Scotia. Knowing this type of information for multiple specialties of interest is important in making an informed decision on specialty choice that meets personal needs and those of the population.

The CFMS has approximately 8,300 active medical student members across Canada. With over 2,400 different users in the first four months of the HHR Platform launch, and over 20 daily users on average, there is significant outreach and interest shown by aspiring physicians. The HHR Platform has been designed to become increasingly comprehensive over time, therefore functioning as a reliable and up-to-date Canadian resource for career planning among medical trainees. Future directions include incorporating subspecialty data, additional information about workforce composition and demographics, predictive modelling of physician supply-demand dynamics, and inclusion of allied health professionals into the HHR Platform. Future analyses may be performed to explore how the HHR Platform and population-needs data specifically inform medical student specialty decision-making. The HHR Platform is currently equipped for and awaiting datasets for the projected demand of specialties in 5 or 10 years. This is likely the most anticipated and relevant dataset to inform medical students of societal needs prior to choosing a specialty, and continued advocacy for its public availability is warranted [51].

**Limitations**

The data amalgamated in the HHR Platform is limited by the inclusion and exclusion criteria of the original datasets, which does not allow for exact comparability. For example, the collection of the datasets are undertaken at different points in time depending on the organization, while in the HHR Platform,
they are grouped per annum. Furthermore, the datasets that are available nationally are a result of provincial data collection and sharing, which is not standardized between provinces, and is inconsistent across the various population demographics within Canada [52]. However, the primary limitation remains that the HHR Platform depends on continued public release and sharing of data by the collaborating organizations in a format that is compatible with their previous releases.

**Conclusion**

There is mounting evidence that Canadian medical students have limited information and data on the determinants of PRP, thereby lacking the tools to inform their specialty decision to be socially accountable based on population needs [53–55]. The purpose of the HHR Platform is to provide a bottom-up approach to PRP which informs undergraduate medical trainees on the number, mix, and distribution of physicians to meet population health needs of Canadians. Modernising health data delivery by depicting the workforce needs of the population to medical students prior to making their specialty choice may function to improve the utilisation of current human resources, thus alleviating the impending shortage of health workers. Given the worldwide physician shortage, such a platform may be modelled in other countries as well with the goal of optimizing their physician workforce composition to better align with the needs of their population.

**Declarations**

*Ethics approval and consent to participate*

Not applicable

*Consent for publication*

Not applicable

*Availability of data and material*

The data generated or mentioned in study are included on the HHR Platform publicly available at https://www.cfms.org/resources/health-human-resources-platform/. For the datasets regarding website activity, they are available from the corresponding author on reasonable request.

**Competing interests**

The authors declare that they have no competing interests

**Funding**

Funding was provided by the Canadian Federation of Medical Students, which is a non-for-profit organisation representing medical students in Canada.

**Authors’ contributions**

DB, BC, and ST contributed in the conception and design of the HHR Platform, contributed to the results interpretation, and were major contributors in writing the manuscript. MB and AS contributed to the design of the HHR Platform, data collection and results interpretation. SM and AD contributed to the design of the HHR Platform and data collection. MB contributed to the literature review, data collection, results interpretation, and writing the manuscript. HM and GP contributed to the literature review and results interpretation. All authors read and approved the final manuscript.

**Acknowledgements**

We would like to acknowledge all the members of the CFMS Atlantic Task Force who have contributed to the work leading up the production of the HHR Platform.

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