

REVIEW

Open Access



Medical education interventions influencing physician distribution into underserved communities: a scoping review

Asiana Elma¹, Muhammadhasan Nasser², Laurie Yang², Irene Chang², Dorothy Bakker^{1,3} and Lawrence Grierson^{1,3,4*} 

Abstract

Background and objective: Physician maldistribution is a global problem that hinders patients' abilities to access healthcare services. Medical education presents an opportunity to influence physicians towards meeting the health-care needs of underserved communities when establishing their practice. Understanding the impact of educational interventions designed to offset physician maldistribution is crucial to informing health human resource strategies aimed at ensuring that the disposition of the physician workforce best serves the diverse needs of all patients and communities.

Methods: A scoping review was conducted using a six-stage framework to help map current evidence on educational interventions designed to influence physicians' decisions or intention to establish practice in underserved areas. A search strategy was developed and used to conduct database searches. Data were synthesized according to the types of interventions and the location in the medical education professional development trajectory, that influence physician intention or decision for rural and underserved practice locations.

Results: There were 130 articles included in the review, categorized according to four categories: preferential admissions criteria, undergraduate training in underserved areas, postgraduate training in underserved areas, and financial incentives. A fifth category was constructed to reflect initiatives comprised of various combinations of these four interventions. Most studies demonstrated a positive impact on practice location, suggesting that selecting students from underserved or rural areas, requiring them to attend rural campuses, and/or participate in rural clerkships or rotations are influential in distributing physicians in underserved or rural locations. However, these studies may be confounded by various factors including rural origin, pre-existing interest in rural practice, and lifestyle. Articles also had various limitations including self-selection bias, and a lack of standard definition for underservedness.

Conclusions: Various educational interventions can influence physician practice location: preferential admissions criteria, rural experiences during undergraduate and postgraduate medical training, and financial incentives. Educators and policymakers should consider the social identity, preferences, and motivations of aspiring physicians as they have considerable impact on the effectiveness of education initiatives designed to influence physician distribution in underserved locations.

*Correspondence: grierson@mcmaster.ca

¹ Department of Family Medicine, Faculty of Health Sciences, David Braley Health Sciences Center, McMaster University, 100 Main St. W., Hamilton, ON L8P 1H6, Canada

Full list of author information is available at the end of the article



© The Author(s) 2022. **Open Access** This article is licensed under a Creative Commons Attribution 4.0 International License, which permits use, sharing, adaptation, distribution and reproduction in any medium or format, as long as you give appropriate credit to the original author(s) and the source, provide a link to the Creative Commons licence, and indicate if changes were made. The images or other third party material in this article are included in the article's Creative Commons licence, unless indicated otherwise in a credit line to the material. If material is not included in the article's Creative Commons licence and your intended use is not permitted by statutory regulation or exceeds the permitted use, you will need to obtain permission directly from the copyright holder. To view a copy of this licence, visit <http://creativecommons.org/licenses/by/4.0/>. The Creative Commons Public Domain Dedication waiver (<http://creativecommons.org/publicdomain/zero/1.0/>) applies to the data made available in this article, unless otherwise stated in a credit line to the data.

Keywords: Medical education, Undergraduate medical education, Graduate medical education, Selection criteria, Practice location, Health Workforce

Introduction

Inequitable distribution of physicians is a global problem [1, 2]. Half of the world's population resides in rural areas but are served by less than a quarter of the physician workforce [1]. Consequently, rural-residing individuals have lower access to primary healthcare services [3–6], which contributes to higher incidence of chronic disease, injury, and mortality [7–9]. These disparities are even more pronounced amongst vulnerable and minority populations, including Indigenous and Francophone populations [10, 11]. Challenges of accessing primary care are also experienced in urban areas by individuals who are unhoused [12], recent immigrants [13–15] from certain ethnic or racial backgrounds [14, 16, 17], with low socioeconomic status [13–15, 18], individuals who are uninsured [19] and/or without full-time employment [14, 20].

There are few levers to encourage physicians to arrange practices in a way that offsets this maldistribution; however, medical education does present an opportunity. In the past, a variety of policy interventions have been implemented in response to the health disparities that are exacerbated by physician maldistribution. These include investments in ehealth and telemedicine to overcome communication and distance barriers in remote communities [5], increases in health human resources such as nurse practitioners and physician assistants, and the introduction of financial incentives to attract and retain physicians working in rural regions. However, evidence of the effectiveness of interventions such as these are limited [21, 22]. It is essential to find effective ways to address inequitable physician distribution, especially as the number of people challenged in accessing primary care continues to rise [23, 24].

There has been much discussion about the role health professions education can play in responding to healthcare and health system challenges. For instance, the World Health Organization (WHO) champions the importance of social accountability in medical schools, which it defines as “*the obligation to direct their education, research, and service activities towards addressing the priority health concerns of the community, region, and/or nation they have a mandate to serve. The priority health concerns are to be identified jointly by governments, health care organizations, health professionals and the public*” [25]. Accordingly, over the last two decades, the Canadian government has worked to expand medical school enrollment, assuming that graduating more physicians will improve overall access to care [26]. This

has been accompanied by support for distributed medical education (DME) that accommodates the influx of new learners while also enhancing their exposure to authentic community-based learning environments in rural, remote, and other underserved areas [27]. Nevertheless, the challenge of access to primary care physicians persists.

Canadian medical education needs to expand its approach to influencing physician distribution and numerous interventions have been suggested [28]: the development of pipeline programs, enhanced admissions pathways, diversified learning contexts, and an increased emphasis on generalism throughout all stages of training [27, 29]. Many of these approaches have been tried and developing a strong understanding of those that are successful in influencing physician distribution is crucial. The objective of this scoping review is thus to understand the current literature pertaining to medical education initiatives designed to promote the uptake of family physicians in underserved areas. Through this review we intend to describe the education interventions that have been reported, their outcomes with respect to downstream physician practice in underserved areas, and any prevailing research gaps related to the relationship between education and physician distribution. This work differentiates from previous literature reviews, which were constrained to undergraduate training interventions [30, 31] or geographic regions [32, 33], inclusive of all types of primary care physicians [34], or relevant to the choice of family medicine specialty [35]. Specifically, this review adopts a global perspective considerate of interventions relevant to all stages of the medical training and maintains a specific focus on the distribution of family physicians.

Methods

We employed Levac and colleagues' [36] interpretation of Arksey and O'Malley's scoping review framework [37] which is useful for covering a body of literature, identifying knowledge gaps, and informing future research or practice implications [38, 39]. The Preferred Reporting Items for Systematic Reviews and Meta-Analyses extension for Scoping Reviews (PRISMA-ScR) checklist guided translation of the results [40].

Stage 1: defining the research objective

This scoping review describes medical education interventions implemented to promote family physician

distribution in underserved rural, remote, or urban locations, and their outcomes.

Stage 2: identifying relevant studies

When conducting scoping reviews, a balance needs to be struck between reviewing the vast and comprehensive literature that is available and the resources available to support the conduct of the study [36]. Accordingly, Inclusion and exclusion criteria were developed to ensure the scope of the search was appropriate for the research objective (Table 1).

Types of participants and studies

Studies reporting on family physicians or “general practitioners” who a) provide longitudinal, continuous, and comprehensive care for patients experiencing common or long-term illnesses across all life stages and b) understand professional accountability to community health needs were included [41–44]. Studies on “primary care physicians”, comprising various specialties—including internal medicine, obstetrics and gynaecology, geriatrics, pediatrics, and family medicine—were excluded if they reported broadly on these practitioners without explicit mention of family physicians. We included all

peer-reviewed articles that generated empirical evidence via any methodology (Table 1).

Underservedness of practice location

The review did not operationalize a standardized definition for underservedness. Given the global perspective, definitions of underservedness were expected to vary as a function of local contexts. Therefore, all definitions of underservedness were accepted.

Outcomes

Studies reporting on downstream practice locations and/or intentions to practice in underserved areas were included. Intention to practice in underserved areas was an outcome of interest as it is a proximal determinant of future behaviour [45].

Our search strategy was developed with support from an expert librarian. Database searches were conducted on Medline via Ovid, Web of Science, and Google Scholar. The strategy applied MeSH terms and keywords related to concepts of family physician, medical training, interventions, and practice location (Table 2). References were managed on Mendeley [46] and Covidence review management software was used for data extraction [47].

Table 1 Inclusion and exclusion criteria

Inclusion:	Exclusion:
1. Participants are Family Physicians, with ‘Family Medicine’ as their core specialty in practice and can be inclusive of those with enhanced skill or focused practice	1. Physicians from any other specialties or other allied healthcare professionals
2. Participants that are completing undergraduate, postgraduate medical training and education, and/or working in Family practice	2. Studies looking at outcomes relating to choosing medical specialty, or any other outcomes other than practice location, practicing in urban and/or rural areas, or intention to practice in underserved areas
3. Studies that report on outcomes related to practice locations, practicing in underserved areas or intention to practice in underserved areas	3. Single papers that are published as commentaries, editorials, literature reviews, conference abstracts, doctoral theses
4. Educational interventions in the context of the medical professional development trajectory (e.g., undergraduate, postgraduate medical education). Interventions can be inclusive of but not limited to preferential medical school admissions policies and selection criteria, undergraduate and postgraduate clinical placements that are described to influence the practice location decisions to underserved areas for participants	4. Studies in any other languages except English
5. Studies written in the English language	5. Studies that include participants that are Primary Care Physicians but do not specify if it is inclusive of Family Physicians
6. Studies conducted in any country	6. Studies reporting on outcomes relating to perceptions, attitudes and/or preferences toward practicing in underserved settings
7. All types of literature including case studies that employ all types of methodologies, such as qualitative, quantitative, mixed methods	

Table 2 Search strategy

Search Terms	1
“Physicians, Family” [MESH] OR “Physicians, Primary Care” [MESH] OR “General Practitioners” [MESH] OR “General Practitioners” [MESH] OR “General Practice” [MESH] OR “General practitioner*” [keyword] OR “Family practitioner*” [keyword] OR “Primary care practitioner*” [keyword] OR “Family physician*” [keyword] OR [Primary care physician*” [keyword] OR “family doctor*” [keyword] OR “Primary care doctor*” [keyword] OR “General practice physician*” [keyword] OR “general practice doctor” [keyword] AND “Education, Medical, Undergraduate” [MESH] OR “Education, Medical, Graduate” [MESH], “Residency training” [keyword] OR “Medical training” [keyword], OR “Clinical Clerkship” [MESH], OR “Family Medicine education” [keyword] OR “Preceptorship” [MESH] OR “Medical school admissions” [keyword] OR “School Admission Criteria” [MESH] AND “Professional Practice Location” [MESH] OR “practice location” [keyword] OR “rural practice*” [keyword] OR “urban practice*” [keyword]	2

Stage 3: study selection

Each eligible study was screened via a two-stage process involving four reviewers (AE, MN, LY, IC). Reviewer discrepancies were resolved through regular team discussions.

Stage 4: charting the data

A standard data extraction form was developed, piloted, and revised by the research team (Additional File 1). Extraction was completed by four team members (AE, MN, LY, IC).

Stage 5: collate, summarize and report the results

Our analysis led to articulations of study characteristics, settings, definitions of underservedness, interventions, and main findings. We present frequency counts of study location and type characteristics. We also engaged in focused and open coding of the extracted data [48], developing general categories of education interventions according to their type, duration (where applicable), and location in the medical education professional development trajectory (e.g., undergraduate, postgraduate). We then constructed general definitions for each intervention category and summarized the associated findings pertaining to influencing practice or practice intentions in underserved areas.

Stage 6: consultation exercise

We engaged our institution's community and rural medical education leader (DB) as a co-author. As recommended by Levac and colleagues (2010), this individual offered an analytic consultation. This involved overview of our initial findings and feedback concerning the relevance and constraints of the reviewed literature with respect to known approaches to promoting an adequate geographic disposition of physicians. Subsequent analysis was then refined to reflect alignment with these insights.

Results

Database searching was completed in June 2021, identifying 692 potentially relevant articles. After duplicate removal, screening, and addition of new references, 130 eligible articles were included (Fig. 1).

Study characteristics

The largest number of studies occurred in the United States, followed by Australia, Canada, and others (Table 3).

The vast majority of studies employed a cohort study design. Cross-sectional, mixed-methods, qualitative, and case-control designs were also employed (Table 4).

Studies reporting on practice location outcomes relied primarily on single cohort or cross-sectional designs, which used administrative records or self-reported survey data to develop models of association between the educational intervention and practice outcomes. Mixed-methods studies relied on interview and self-reported survey data. Studies reporting on practice intentions predominantly used cross-sectional or qualitative designs, with few employing a cohort or mixed-methods design.

Definitions of underservedness

Definitions of '*underservedness*' varied considerably across all studies. In some cases, it was defined in terms of the proportion of residents from various ethnic or cultural backgrounds [49–55], with low-socioeconomic status [49, 51, 52, 56–58], who live in poverty [54, 58–61], or who are of older age [52]. Australian studies particularly used the Index of Relative Socioeconomic Advantage and Disadvantage classification system to capture the economic and social conditions of people residing in a particular area [62, 63]. American studies also employed the constructs of the Health Professions Shortage Area (HPSA; defined as an area with less than 1 primary care physician per 3,500 population) [52, 54, 58, 59, 64–72], and the medically underserved area (MUA; defined as areas, where 40% of patients receive Medicaid or are uninsured) [52, 58, 64, 70–73].

Although the review was inclusive of educational interventions designed to promote practice in any type of underserved community, the vast majority of studies reported on outcomes pertaining to practice in rural areas, which were defined in numerous ways. Several Australian studies used the Australian Standard Geographical Classification [55, 62, 63, 71, 74–79], the Rural Remote Metropolitan Area (RRMA) [80–85] or used the Modified Monash Model (MMM) [86–88]. Other studies used population metrics or distances from metropolitan areas to define rural areas. For example, Rolfe and colleagues (1995) defined major metropolitan areas as having populations greater than 100,000 people and remote areas by their distance from metropolitan areas [89]. Canadian studies also used various definitions. Rourke (2018) and Mathews (2017) used Statistics Canada's population-based definition of rural areas [53, 90], while Barrett and colleagues defined rurality according to both population size and proximity to an urban center [32]. Studies from the United States used Rural–Urban Continuum Area Codes (RUCAC) [69, 70, 91–101], non-metropolitan Statistical Areas [102–108], and the number of individuals who lack access to care due to cultural and economic factors [54] to index rurality. Japanese studies defined rurality in terms of municipalities with five or less

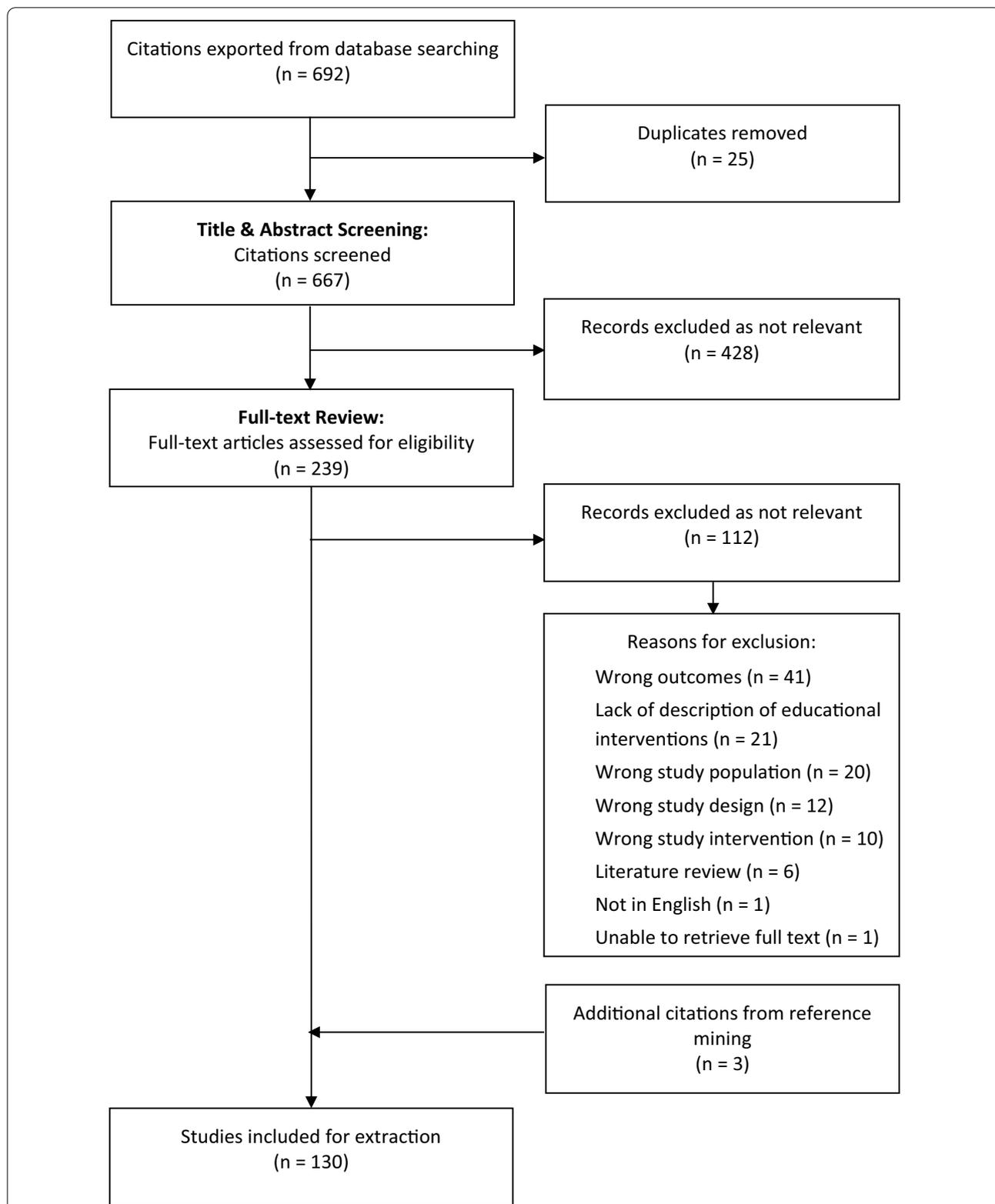


Fig. 1 PRISMA flow chart depicting articles included and excluded throughout the screening stage

Table 3 Number and percentage of included studies according to study location

Study characteristics	Included studies (n = 130)
Study location	No. (%)
United States	75 (57.7)
Australia	22 (16.9)
Canada	22 (16.9)
Japan	3 (2.3)
New Zealand	2 (1.5)
Interregional*	2 (1.5)
Botswana	1 (0.8)
Germany	1 (0.8)
Ghana	1 (0.8)
South Africa	1 (0.8)

*Interregional: Studies that have been conducted across multiple countries. One (n = 1) was conducted in Australia and Canada and one (n = 1) study was conducted across five countries including Australia, South Africa, Sudan, Belgium, and Philippines

Table 4 Number and percentage of included studies according to study design

Study characteristics	Included studies (n = 130)
Study design	No. (%)
Cohort	56 (43.1)
Cross-sectional	52 (40.0)
Mixed methods	8 (6.2)
Qualitative	8 (6.2)
Case control	3 (2.3)
Other	3 (2.3)

physicians, municipalities with a 5–100 000 physician-to-population ratio, or municipalities with population under 20,000 and a less than 100–100 000 physician-to-population ratio [63, 109].

In a small number of studies, the concepts of rurality and underservedness were treated as separate entities [70, 72, 110].

Types of interventions

Educational interventions described as influencing practice location or intention to practice in underserved areas aligned with four categories: preferential admissions criteria, undergraduate training in underserved areas, postgraduate training in underserved areas, and financial incentives. A fifth category was constructed to reflect initiatives comprised of various combinations of these four interventions (Table 5).

Preferential admissions criteria

Three studies investigated the independent influence of medical school admissions policies that contemplate the selection of applicants with certain socio-cultural backgrounds and/or who are from targeted underserved areas on eventual practice location [62, 111] or intention to practice in underserved areas [49]. A WHO study revealed that aspiring physicians selected via admissions policy that favoured those with a rural small-town background and/or who expressed specific desire to practice rural family medicine were significantly more likely to practice rural family practice than those not selected under this policy (RR 3.9, CI 2.7–5.7, $P < 0.001$) [111]. Similarly, an Australian study revealed students selected on the basis of Indigenous identity, rural upbringing, or socioeconomic disadvantage demonstrated a twofold increase in the odds of practicing in a socioeconomically disadvantaged community [62]. An interregional study reported that students selected from Indigenous, African, or rural populations reported greater intention to practice with underserved populations in rural or remote areas after graduation ($p = 0.000$) [49].

Undergraduate training experiences in underserved areas

Thirty-six studies reported on the relationship between undergraduate training in underserved areas and eventual practice location [50, 51, 56, 57, 63, 71, 74, 75, 80, 86, 87, 91, 92, 110, 112–124] or intentions to practice in underserved areas [52, 81, 93, 123–130]. This included training at medical education institutions in an underserved location (usually rural) [91, 128], shorter opportunities for medical students to participate in clerkships, internships, externships, or placements in any such practice setting (e.g., hospital, family practice) for any duration [50–52, 56, 57, 63, 71, 75, 80, 81, 86, 87, 92, 110, 112–116, 118–121, 125, 127, 129, 130], and combinations of clinical placements with specific non-clinical curricula [50, 57, 113, 122].

Most studies in this category demonstrated a positive effect on practice outcomes in underserved areas [50, 51, 56, 57, 63, 71, 75, 86, 91, 92, 110, 112–117, 119, 120, 130], although two studies reported equivocal findings [74, 117]. For example, an Australian cohort study reported that graduates who spent at least 1 year at a rural clinical school were significantly more likely to practice in rural areas than those who did not (27 vs. 7%) [75]. Notably, the duration of rural undergraduate training varied across studies, ranging from 6 weeks to more than 1 year, with some reporting that associations with eventual practice in underserved locations were stronger the longer the duration of the placement [86, 87].

Table 5 Number and percentage of the different types of medical education interventions

Education interventions	Included studies (n = 130) No. (%)
Singular interventions	86/130 (66.2)
Preferential admissions	3 (3.5)
Rural undergraduate training	37 (43.0)
Rural postgraduate training	42 (48.8)
Financial incentives	4 (4.7)
Multiple interventions	44/130 (33.8)
Admissions and rural undergraduate training	11 (25.0)
Rural undergraduate and postgraduate training	11 (25.0)
Admissions, rural undergraduate training, and financial incentives	9 (20.5)
Admissions, rural undergraduate, and postgraduate training	6 (13.6)
Rural postgraduate training and financial incentives	3 (6.8)
Admissions, rural undergraduate and postgraduate training and financial incentives	2 (4.5)
Rural postgraduate training and financial incentives	1 (2.3)
Rural undergraduate and postgraduate training and financial incentives	1 (2.3)

The majority of studies reporting on the effect of rural undergraduate training on intentions to practice described positive outcomes [53, 81, 122, 123, 127–130]. An American cross-sectional study indicated that students placed in underserved locations had greater odds of reporting intention to work in such communities at graduation (OR 9.40, 95% CI 4.66–19.96) [52]. However, one Canadian study reported low impact of these types of interventions [125] and others reported equivocal impact on practice location intentions [93, 123, 124, 126].

Postgraduate training experience in underserved areas

Forty-two studies reported on the relationship between postgraduate training in underserved areas and eventual practice location [41–77, 82, 89, 90, 94, 95, 102, 131–138, 140–154], practice intentions [67, 83, 155, 156] or both [157]. This training included enrollment in postgraduate training at a rural campus location [58, 64, 69, 76, 90, 94, 95, 131, 132, 134–136, 138, 139, 144–146, 149, 151, 154, 155] and opportunities for residents to participate in rotations, internships, externships, or placements in any practice setting (e.g., hospital, family practice) in an underserved area for short-term (2–3 weeks), intermediate (4 weeks to 1 year) and long-term (≥ 1 year) durations [58, 59, 65, 66, 77, 82, 83, 89, 102, 133, 137, 140, 141, 146–148, 150, 152–154, 156, 157].

Largely, these studies indicated a positive association between completing residency or postgraduate training experiences in underserved areas and eventual practice in underserved locations [58, 65, 66, 77, 82, 89, 90, 131–133, 136, 137, 140–150, 152–154, 157]. Notably, several studies found that graduates of rural residency programs practice in close proximity to where they completed their postgraduate training [90, 131, 132, 136, 144–146, 149, 151]. For example, a cohort study of family practice residency programs in various regions in the United States indicated that most graduates (76.8%) practice within 100-mile radius of their residency program [151]. Another American study reported that this relationship is greater for more recent cohorts relative to earlier cohorts [136]. Two studies demonstrated equivocal findings [59, 102]. One Canadian qualitative study reported a potential negative relationship, where graduates who participated in rural family medicine describe practicing in urban areas with no intention to move to a rural practice location, despite positive experiences with their training [139].

Five studies described the impact of rural postgraduate training experiences on practice location intentions [67, 83, 155–157], reporting equivocal findings. One study reported that graduates who completed rural rotations during residency expressed greater intentions to practice in rural areas [157], while another study reported that they did not [82]. One study reported that a significant association between rural education and rural practice intentions was more likely for senior than junior residents [155].

Financial incentives

Four studies reported on educationally relevant financial incentives provided during medical training and designed to promote practice in underserved areas [60, 96, 158, 159]. Specifically, three studies reported on tuition and living expenses provided to medical learners via the United States' National Health Services Corps (NHSC), which conveys in exchange for 2 years of service in an underserved community [96, 158, 159]. These studies report that the program is influential in encouraging physicians to work in underserved communities; however, the participants' commitment to serving the assigned communities beyond the formal obligation varied. When these physicians began practicing at their assigned practice, 14% of the NHSC physicians anticipated remaining in that location longer than 5 years, whereas 70% of the non-NHSC physicians intended to continue practicing in underserved areas for longer than 5 years (OR 0.07, $P < 0.001$) [159]. One study reported that most learners left their assigned practices within months of concluding their obligation [96].

Combinations of interventions

Forty-four studies reported on the influence of two or more of the above-described interventions on eventual practice location or intended practice locations [53–55, 61, 68–70, 72, 73, 78, 79, 82, 83, 88, 96–100, 102–108, 160–177]; See Table 4]. Several of these studies reported that a combination of preferential admissions criteria and opportunities for rural training experience at both the undergraduate and postgraduate levels is influential in physicians choosing rural practice [53–55, 85, 173, 174]. Two studies posited that the specific combination of selecting students from rural areas and providing opportunities for clinical training in rural areas during the third year of medical school was the most influential in promoting eventual rural practice [69, 84]; however, these results are potentially confounded insofar that the students involved may have had a pre-existing interest in rural practice.

Discussion

This review mapped the literature reporting on educational interventions designed to influence family physicians to practice in underserved areas. The review highlights that many training institutions around the world have made such efforts—with a particular focus on increasing the uptake of practitioners in rural areas. Summarily, the literature outlines preferential admissions policies, placements in relevant practice settings during undergraduate and postgraduate training, financial support in exchange for time-limited-service agreements, and various combinations of these approaches as relevant. Overall, the majority of studies report positive outcomes associated with these interventions.

The review highlights that allocating medical school seats to those from or predisposed to practice in underserved areas may be an effective approach to promoting practice in these areas; but also, that this may not be entirely sufficient. Specialized non-clinical curriculum focusing on rural-residing or traditionally underserved patients [50, 92], workshops and seminars [57], training at a rural medical school [86, 87], and rural experiences provided through short-term and long-term placements, were all also influential in promoting practice in rural and underserved areas. Through these interventions, students may develop positive perceptions about practice in underserved communities, develop the appropriate skills to do so [137], and receive important mentorship from those who have expertise in these communities [57, 119]. The review suggested that combinations of admissions, undergraduate and postgraduate placement, and financial incentives may be particularly effective; however, did not indicate which combination of interventions is most effective in graduating physicians into underserved areas.

It is important to highlight that learning experiences may also discourage students from practice in underserved areas. For instance, they may develop perceptions that the work and lifestyle are overly challenging [50, 57, 74]. Personal reasons, such as those related to family planning and spousal preferences, may also push learners away from these practice locations [126]. Given this, medical schools should consider the interaction between educational and personal factors when developing experiences for learners. In this regard, the simple introduction of interventions can be thought of as having a potential positive effect on the *hidden curriculum* of medical education [178]. When experiences in rural and underserved communities are prioritized within admissions and teaching activities, supported by knowledgeable mentors, and encouraged with funding, this type of practice may be perceived as more valuable.

The review also elucidates how evaluations of these educational interventions are largely situated within the medical education context and do not consider how they interact with healthcare initiatives or policies that operate outside of the training environment. For instance, numerous underserved communities mount their own projects to influence physician recruitment and retention, including monetary and lifestyle incentives, offsetting overhead costs, housing support, and fundraising activities for recruitment campaigns [179–183]. Future research may consider how these grassroots programs interact with educational interventions to promote the uptake of family physicians in underserved communities. Similarly, many medical schools now have admissions policies that contemplate applicant selection with respect to their equity, diversity, and inclusion commitments, with minimal focus on resolving the physician maldistribution challenge. In Canada, some examples include admissions pathways for Black [183–187] and Indigenous [189–195] applicants. With respect to the evidence demonstrating a relationship between physician social identity characteristics and eventual practice location or practice intentions [196–200], there may be an unintended downstream relationship between these admissions processes and the practice intentions or locations of the matriculants. In this regard, we encourage evaluations of these policies to extend beyond the diversity of resulting medical school classes so as to also formally consider the eventual impacts on physician distribution. Considerations for medical schools to design and adopt mission statements that reflect the social responsibility of graduating physicians into underserved communities present another potential avenue for influencing the health workforce outcomes as medical schools' social mission content was reported to be a significant predictor of physician output in medically

underserved areas and populations [201]. However, it is unclear if this effect was a result of the institution's orientation or if medical learners were predisposed to work in the underserved areas and subsequently self-selected into institutions that align with their practice intentions. The review also revealed that a vast majority of the studies have a singular focus on educational interventions situated to influence physician disposition in rural or remote areas, with less consideration for underserved communities in urban areas. Future program evaluations should consider designing curricula and medical education initiatives that expose learners to working in underserved urban communities as populations with certain ethnic, cultural and/or socioeconomic backgrounds residing in urban locations experience challenges with accessing primary care [12–18, 20].

The review has some notable limitations. Included studies were heterogeneous with respect to designs, interventions, and definitions of underservedness. Accordingly, our findings were summarized on a broader level, which inherently suppresses some of the unique features of different approaches. Second, numerous studies were single cohort or cross-sectional in design and many used self-reported survey data. We recommend researchers in this area conduct more longitudinal studies [202]. This would strengthen the overall quality of the evidence. Furthermore, many studies did not account for student background or pre-existing interest in practicing in underserved areas, making it challenging to understand the true, independent impact of interventions. Finally, our review may also be beset by considerable publication bias. It is likely that the strong representation of positive findings emanates from a tendency for medical education scholars to only seek publication of evaluations that reveal positive outcomes vis-à-vis programmatic objectives. In this case, instances where educational interventions were not successful may not be captured within this review.

Conclusions

Medical education may play an important role in addressing the challenges underserved communities face in accessing primary care family physicians. Various educational interventions can influence physician practice location: preferential admissions criteria, rural experiences during undergraduate and postgraduate medical training, and financial incentives. Effective strategies must also consider the social identity, preferences, and motivations of aspiring physicians as they have considerable impact on the effectiveness of education initiatives designed to promote practice in underserved settings.

Supplementary Information

The online version contains supplementary material available at <https://doi.org/10.1186/s12960-022-00726-z>.

Additional file 1. Data extraction template.

Acknowledgements

The authors would like to acknowledge the contributions of Denise Smith for guiding the development and refinement of the search strategy.

Authors' contributions

LG and AE contributed to the conception and design of the review. AE, LY, IC and MN were responsible for screening and data extraction. AE and LG synthesized and analyzed the data, with additional analytical input from DB. AE drafted the manuscript, which was critically revised by LG, MN, LY, IC, and DB. LG supervised all aspects of the study. All authors read and approved the final manuscript.

Funding

Family Medicine Associates of Hamilton, 2020-02, Lawrence Grierson.

Availability of data and materials

Data sharing is not applicable to this article as no data sets were generated or analysed during the current study.

Declarations

Ethics approval and consent to participate

Research ethics approval is not required as this is a scoping review. This work did not involve recruitment or data collection from human participants.

Consent for publication

Not applicable.

Competing interests

The authors declare that they have no competing interests.

Author details

¹Department of Family Medicine, Faculty of Health Sciences, David Braley Health Sciences Center, McMaster University, 100 Main St. W., Hamilton, ON L8P 1H6, Canada. ²Bachelor of Health Sciences Program, Faculty of Health Sciences, McMaster University, Hamilton, Canada. ³McMaster Community and Rural Education Program, McMaster University, Hamilton, Canada.

⁴McMaster Education Research, Innovation and Theory, Faculty of Health Sciences, McMaster University, Hamilton, Canada.

Received: 20 December 2021 Accepted: 24 March 2022

Published online: 07 April 2022

References

1. World Health Organization. Increasing access to health workers in remote and rural areas through improved retention: global policy recommendations. World Health Organization. 2010. <https://apps.who.int/iris/handle/10665/44369>. Accessed 17 Dec 2021.
2. Pitblado R. Geographical distribution of rural health human resources. Vancouver: UBC Press; 2012.
3. Dunlop S, Coyte C, McIsaac W. Socio-economic status and the utilisation of physicians' services: Results from the Canadian National Population Health Survey. *Soc Sci Med*. 2000;51(1):123–33. [https://doi.org/10.1016/S0277-9536\(99\)00424-4](https://doi.org/10.1016/S0277-9536(99)00424-4).
4. StatsCan. Access to a regular medical doctor, 2014: Statistics Canada; 2014. <http://www.statcan.gc.ca/pub/82-625-x/2015001/article/14177-eng.htm>. Accessed 17 Dec 2021.

5. Mitton C, Dionne F, Masucci L, Wong S, Law S. Innovations in health service organization and delivery in northern rural and remote regions: a review of the literature. *Int J Circumpolar Health*. 2011;70(5):460–72.
6. Tiepoh M, Reimer B. Global Influences on Rural and Urban Disparity Differences in Canada: Policy Implications for Improving Rural Capacity. Discussion Paper for NRE Annual Spring Workshop. 2005.
7. Herbert R. Canada's health care challenge: Recognizing and addressing the health needs for rural Canadians. *Lethbridge Undergrad Res J*. 2007;2(1):1–8.
8. MacMillan HL, Walsh CA, Jamieson E, Wong MYY, Faries EJ, McCue H, et al. The health of Ontario first nations people. *Can J Public Health*. 2003;94(3):168–72. <https://doi.org/10.1007/BF03405059>.
9. Bouchard L, Batal M, Imbeault P, Gagnon-Arpin I, Makandi E, Sedigh G. The health of Francophones in Ontario: a regional portrait from the Canadian Community Health Surveys. 2016. <https://kmb.camh.ca/eenet/resources/health-francophones-in-ontario-regional-portrait>. Accessed 17 Dec 2021.
10. Khandor E, Mason K, Chambers C, Rossiter K, Cowan L, Hwang SW. Access to primary health care among homeless adults in Toronto, Canada: results from the Street Health survey. *Open Med*. 2011;5(2):e94–103.
11. Hay C, Pacey M, Bains N, Ardal S. Understanding the unattached population in Ontario: evidence from the Primary Care Access Survey (PCAS). *Healthcare Policy*. 2010;6(2):33–47.
12. Shah TI, Bell S, Wilson K. Spatial accessibility to health care services: identifying under-served Neighbourhoods in Canadian urban areas. *PLoS ONE*. 2016;11(12):e0168208.
13. Talbot Y, Fuller-Thomson E, Tudiver F, Habib Y, McIsaac WJ. Canadians without regular medical doctors. Who are they? *Can Fam Physician*. 2001;47(1):58–64.
14. Huang Y, Meyer P, Jin L. Neighborhood socioeconomic characteristics, healthcare spatial access, and emergency department visits for ambulatory care sensitive conditions for elderly. *Prev Med Rep*. 2018;1(12):101–5. <https://doi.org/10.1016/j.pmedr.2018.08.015>.
15. Hussein M, Roux AV, Field RI. Neighborhood socioeconomic status and primary health care: usual points of access and temporal trends in a major US urban area. *J Urban Health*. 2016;93(6):1027–45. <https://doi.org/10.1007/s11524-016-0085-2>.
16. Brown EJ, Polsky D, Barbu CM, Seymour JW, Grande D. Racial disparities in geographic access to primary care in Philadelphia. *Health Aff*. 2016;35(8):1374–81. <https://doi.org/10.1377/hlthaff.2015.1612>.
17. Naylor KB, Tootoo J, Yakusheva O, Shipman SA, Bynum JP, Davis MA. Geographic variation in spatial accessibility of US healthcare providers. *PLoS ONE*. 2019;14(4): e0215016. <https://doi.org/10.1371/journal.pone.0215016>.
18. Streeter RA, Snyder JE, Kepley H, Stahl AL, Li T, Washko MM. The geographic alignment of primary care Health Professional Shortage Areas with markers for social determinants of health. *PLoS ONE*. 2020;15(4): e0231443. <https://doi.org/10.1371/journal.pone.0231443>.
19. Shi L. Type of health insurance and the quality of primary care experience. *Am J Public Health*. 2000;90(12):1848–55.
20. Mathews M, Edwards AC. Having a regular doctor: rural, semiurban and urban differences in Newfoundland. *Can J Rural Med*. 2004;9(3):166–72.
21. Soles TL, Wilson CR, Oandasan IF. Family medicine education in rural communities as a health service intervention supporting recruitment and retention of physicians: advancing rural family medicine: the Canadian Collaborative Taskforce. *Can Fam Physician*. 2017;63(1):32–8.
22. Duckett S, Bredon P. Access all areas: new solutions for GP shortages in rural Australia. Grattan Institute Report, September. 2013 Sep 29.
23. Statistics Canada. Access to a regular medical doctor. <http://www.statcan.gc.ca/pub/82-625-x/2015001/article/14177-eng.htm>. Accessed 17 Dec 2021.
24. Statistics Canada. Access to a regular family physician. <https://www150.statcan.gc.ca/t1/tbl1/en/tv.action?pid=1310048401>. Accessed 17 Dec 2021.
25. Boelen C, Heck JE, World Health Organization. Defining and measuring the social accountability of medical schools. Geneva: World Health Organization; 1995.
26. Council of Ontario Faculties of Medicine. Distributed Medical Education in Ontario: 2014 Report. 2014. <https://cou.ca/wp-content/uploads/2015/05/COU-Distributed-Medical-Education-Report.pdf>. Accessed 17 Dec 2021.
27. Bates J, Frost H, Schrewe B, Jamieson J, Ellaway R. 12 Distributed Education and Distance Learning in Postgraduate Medical Education. 2017. <https://afmc.ca/en/projects-resources/future-of-medical-education-of-canada-fmcec>. Accessed 17 Dec 2021.
28. Bosco C, Oandasan I. Review of Family Medicine Within Rural and Remote Canada: Education, Practice, and Policy. College of Family Physicians of Canada. 2016. https://www.cfpc.ca/CFPC/media/Resources/Rural-Practice/ARFM_BackgroundPaper_Eng_WEB_FINAL.pdf. Accessed 17 Dec 2021.
29. Farmer J, Kenny A, McKinstry C, Huysmans RD. A scoping review of the association between rural medical education and rural practice location. *Hum Resour Health*. 2015;13(1):1–5. <https://doi.org/10.1186/s12960-015-0017-3>.
30. Holst J. Increasing rural recruitment and retention through rural exposure during undergraduate training: an integrative review. *Int J Environ Res Public Health*. 2020;17(17):6423.
31. Barrett FA, Lipsky MS, Lutfiyya MN. The impact of rural training experiences on medical students: a critical review. *Acad Med*. 2011;86(2):259–63.
32. Ogden J, Preston S, Partanen RL, Ostini R, Coxeter P. Recruiting and retaining general practitioners in rural practice: systematic review and meta-analysis of rural pipeline effects. *Med J Aust*. 2020;213(5):228–36.
33. Lafortune C, Gustafson J. Interventions to improve recruitment and retention of physicians in rural and remote Canada. *UWOMJ*. 2019. <https://doi.org/10.5206/uwomj.v88i1.6184>.
34. Goodfellow A, Ulloa JG, Dowling PT, Talamantes E, Chheda S, Bone C, Moreno G. Predictors of primary care physician practice location in underserved urban and rural areas in the United States: a systematic literature review. *Acad Med*. 2016;91(9):1313. <https://doi.org/10.1097/ACM.0000000000001203>.
35. Shah A, Gasner A, Bracken K, Scott I, Kelly MA, Palombo A. Early generalist placements are associated with family medicine career choice: a systematic review and meta-analysis. *Med Educ*. 2021. <https://doi.org/10.1111/medu.14578>.
36. Levac D, Colquhoun H, O'Brien KK. Scoping studies: advancing the methodology. *Implement Sci*. 2010;5(1):1–9.
37. Arksey H, O'Malley L. Scoping studies: towards a methodological framework. *Int J Soc Res Methodol*. 2005;8(1):19–32. <https://doi.org/10.1080/1364557032000119616>.
38. Peters MD, Godfrey CM, Khalil H, McInerney P, Parker D, Soares CB. Guidance for conducting systematic scoping reviews. *JBI Evid Implement*. 2015;13(3):141–6. <https://doi.org/10.1097/XEB.0000000000000050>.
39. Daudt HM, van Mossel C, Scott SJ. Enhancing the scoping study methodology: a large, inter-professional team's experience with Arksey and O'Malley's framework. *BMC Med Res Methodol*. 2013;13(1):1–9.
40. Tricco AC, Lillie E, Zarin W, O'Brien KK, Colquhoun H, Levac D, Moher D, Peters MD, Horsley T, Weeks L, Hempel S. PRISMA extension for scoping reviews (PRISMA-ScR): checklist and explanation. *Ann Intern Med*. 2018;169(7):467–73. <https://doi.org/10.7326/M18-0850>.
41. Europe WO. The European definition of general practice/family medicine. Barcelona: WONCA Europe; 2002.
42. Gibson C, Arya N, Ponka D, Rouleau K, Woollard R. Approaching a global definition of family medicine: the Besroul Papers: a series on the state of family medicine in the world. *Can Fam Physician*. 2016;62(11):891–6.
43. Mash R, Reid S. Statement of consensus on Family Medicine in Africa. *Afr J Prim Health Care Fam Med*. 2010;2(1):1–4.
44. World Health Organization. Family medicine: report of a regional scientific working group meeting on core curriculum. In: Family medicine: report of a regional scientific working group meeting on core curriculum. 2003. <https://apps.who.int/iris/bitstream/handle/10665/205046/B3426.pdf?sequence=1&isAllowed=y>. Accessed 17 Dec 2021.
45. Ajzen I, Manstead AS. Changing health-related behaviours: an approach based on the theory of planned behaviour. In: The scope of social psychology. Psychology Press. <https://doi.org/10.4324/9780203965245-10>
46. Mendeley. Guides. [Internet]. Mendeley. <https://www.mendeley.com/guides>. Accessed 17 Dec 2021.
47. Covidence systematic review software, Veritas Health Innovation, Melbourne, Australia. www.covidence.org. Accessed 17 Dec 2021.

48. Sandelowski M. Whatever happened to qualitative description? *Res Nurs Health*. 2000;23(4):334–40.
49. Larkins S, Michielsen K, Iputo J, Elsanousi S, Mammen M, Graves L, Willems S, Cristobal FL, Samson R, Ellaway R, Ross S. Impact of selection strategies on representation of underserved populations and intention to practise: international findings. *Med Educ*. 2015;49(1):60–72.
50. McKillop A, Webster CS, Bennett W, O'Connor B, Bagg W. Encouragers and discouragers affecting remote graduates' choice of regional and rural practice locations. *Rural Remote Health*. 2017. <https://doi.org/10.22605/RRH4247>.
51. Mennin SP, Kalishman S, Friedman M, Pathak D, Snyder J. A survey of graduates in practice from the University of New Mexico's conventional and community-oriented, problem-based tracks. *Acad Med*. 1996;71(10):1079–89.
52. Ko M, Edelstein RA, Heslin KC, Rajagopalan S, Wilkerson L, Colburn L, Grumbach K. Impact of the University of California, Los Angeles/Charles R. Drew University Medical Education Program on medical students' intentions to practice in underserved areas. *Acad Med*. 2005;80(9):803–8.
53. Rourke J, Asghari S, Hurley O, Ravalia M, Jong M, Graham W, Parsons W, Duggan N, O'Keefe D, Moffatt S, Stringer K. Does rural generalist focused medical school and family medicine training make a difference? Memorial University of Newfoundland outcomes. *Rural Remote Health*. 2018;18(1):4426.
54. Lang F, Ferguson KP, Bennard B, Zahorik P, Sliger C. The Appalachian preceptorship: over two decades of an integrated clinical–classroom experience of rural medicine and appalachian culture. *Acad Med*. 2005;80(8):717–23.
55. Woolley T, Sen Gupta T, Murray R, Hays R. Predictors of rural practice location for James Cook University MBBS graduates at postgraduate year 5. *Aust J Rural Health*. 2014;22(4):165–71.
56. Tavernier LA, Connor PD, Gates D, Wan JY. Does exposure to medically underserved areas during training influence eventual choice of practice location? *Med Educ*. 2003;37(4):299–304.
57. Roy V, Hurley K, Plumb E, Castellan C, McManus P. Urban underserved program. *Fam Med*. 2015;47(5):373–7.
58. Bade E, Baumgardner D, Brill J. The central city site: an urban underserved family medicine training track. *Fam Med*. 2009;41(1):34–8.
59. Cashman SB, Savageau JA, Ferguson WJ, Lasser DH. Community dimensions and HPSA practice location: 30 years of family medicine training. *Family Medicine and Community Health*. 2009. https://escholarship.umassmed.edu/fmch_articles/125. Accessed 17 Dec 2021.
60. Pathman DE, Konrad TR, King TS, Spaulding C. Medical training debt and service commitments: the rural consequences. *J Rural Health*. 2000;16(3):264–72.
61. Matsumoto M, Inoue K, Kajii E. Characteristics of medical students with rural origin: implications for selective admission policies. *Health Policy*. 2008;87(2):194–202.
62. Puddey IB, Playford DE, Mercer A. Impact of medical student origins on the likelihood of ultimately practicing in areas of low vs high socioeconomic status. *BMC Med Educ*. 2017;17(1):1–3.
63. Playford D, Puddey IB. Interest in rural clinical school is not enough: Participation is necessary to predict an ultimate rural practice location. *Aust J Rural Health*. 2017;25(4):210–8.
64. Morris CG, Johnson B, Kim S, Chen F. Training family physicians in community health centers: a health workforce solution. *Fam Med*. 2008;40(4):271.
65. Rosenthal TC, McGuigan MH, Osborne J, Holden DM, Parsons MA. One-two rural residency tracks in family practice: are they getting the job done? *Fam Me*. 1998;1(30):90–3.
66. Rosenthal TC, McGuigan MH, Anderson G. Rural residency tracks in family practice: graduate outcomes. *Fam Me*. 2000;32(3):174–7.
67. Ogunyemi D, Edelstein R. Career intentions of US medical graduates and international medical graduates. *J Natl Med Assoc*. 2007;99(10):1132.
68. Kallail KJ, McCurdy S. Scholars in Rural Health: outcomes from an assured admissions program. *Fam Med*. 2010;42(10):729–31.
69. Wendling AL, Phillips J, Short W, Fahey C, Mavis B. Thirty years training rural physicians: outcomes from the Michigan State University College of Human Medicine rural physician program. *Acad Med*. 2016;91(1):113–9.
70. Edwards JB, Wilson JL, Behringer BA, Smith PL, Ferguson KP, Blackwelder RB, Florence JA, Bennard B, Tudiver F. Practice locations of graduates of family physician residency and nurse practitioner programs: considerations within the context of institutional culture and curricular innovation through Titles VII and VIII. *J Rural Health*. 2006;22(1):69–77.
71. Playford DE, Nicholson A, Riley GJ, Puddey IB. Longitudinal rural clerkships: increased likelihood of more remote rural medical practice following graduation. *BMC Med Educ*. 2015;15(1):1–9.
72. Blondell RD, Mason JS, Looney SW, James TC. The results of 20 years of family practice residency training at the University of Louisville. *J Ky Med Assoc*. 1993;91(7):285–9.
73. Brooks RG, Mardon R, Clawson A. The rural physician workforce in Florida: a survey of US-and foreign-born primary care physicians. *J Rural Health*. 2003;19(4):484–91.
74. Eley DS, Synnott R, Baker P, Chater B. A decade of Australian Rural Clinical School graduates—where are they and why? *Rural Remote Health*. 2012. <https://doi.org/10.22605/RRH1937>.
75. Shires L, Allen P, Cheek C, Wilson D. Regional universities and rural clinical schools contribute to rural medical workforce, a cohort study of 2002–2013 graduates. *Rural Remote Health*. 2015;15(3):3219. <https://doi.org/10.22605/RRH3219>.
76. McGrail MR, Russell DJ, Campbell DG. Vocational training of general practitioners in rural locations is critical for the Australian rural medical workforce. *Med J Aust*. 2016;205(5):216–21.
77. Kwan MM, Kondalsamy-Chennakesavan S, Ranmuthugala G, Toombs MR, Nicholson GC. The rural pipeline to longer-term rural practice: general practitioners and specialists. *PLoS ONE*. 2017;12(7):e0180394.
78. Sen Gupta T, Murray R, Hays R, Woolley T. James Cook University MBBS graduate intentions and intern destinations: a comparative study with other Queensland and Australian medical schools. *Rural Remote Health*. 2013;13:1.
79. Lewis MJ, Ellis R, Adusumilli SK, Cameron I. Twenty-five years on: outcomes of a longitudinal evaluation of the NSW Rural Resident Medical Officer Cadetship Program. *Rural Remote Health*. 2016;16(4):1–2.
80. Stagg P, Greenhill J, Worley P. A new model to understand the career choice and practice location decisions of medical graduates. *Rural Remote Health*. 2009;9(4):1245. <https://doi.org/10.22605/RRH1245>.
81. Lee YH, Barnard A, Owen C. Initial evaluation of rural programs at the Australian National University: understanding the effects of rural programs on intentions for rural and remote medical practice. *Rural Remote Health*. 2011;11(2):1602.
82. Peach HG, Trembath M, Fensling B. A case for more year-long internships outside metropolitan areas? *Med J Aust*. 2004;180(3):106–8.
83. Bayley SA, Magin PJ, Sweatman JM, Regan CM. Effects of compulsory rural vocational training for Australian general practitioners: a qualitative study. *Aust Health Rev*. 2011;35(1):81–5.
84. Henry JA, Edwards BJ, Crotty B. Why do medical graduates choose rural careers? *Rural Remote Health*. 2009;9(1083):1–3.
85. Wilkinson D, Laven G, Pratt N, Beilby J. Impact of undergraduate and postgraduate rural training, and medical school entry criteria on rural practice among Australian general practitioners: national study of 2414 doctors. *Med Educ*. 2003;37(9):809–14.
86. O'Sullivan BG, McGrail MR. Effective dimensions of rural undergraduate training and the value of training policies for encouraging rural work. *Med Educ*. 2020;54(4):364–74.
87. Campbell DG, McGrail MR, O'Sullivan B, Russell DJ. Outcomes of a 1-year longitudinal integrated medical clerkship in small rural Victorian communities. *Rural Remote Health*. 2019;19(2):4987.
88. O'Sullivan B, McGrail M, Russell D, Walker J, Chambers H, Major L, Langham R. Duration and setting of rural immersion during the medical degree relates to rural work outcomes. *Med Educ*. 2018;52(8):803–15.
89. Rolfe IE, Pearson SA, O'Connell DL, Dickinson JA. Finding solutions to the rural doctor shortage: the roles of selection versus undergraduate medical education at Newcastle. *Aust N Z J Med*. 1995;25(5):512–7.
90. Ryan D, Asoka Samarasena MD. Early-career work location of Memorial University medical graduates: Why the decline in rural practice? *Can J Rural Med*. 2017;22(2):54.
91. Crump WJ, Fricker RS, Ziegler CH, Wiegman DL. Increasing the rural physician workforce: a potential role for small rural medical school campuses. *J Rural Health*. 2016;32(3):254–9.

92. Fuglestad A, Prunuske J, Regal R, Hunter C, Boulger J, Prunuske A. Rural family medicine outcomes at the University of Minnesota Medical School Duluth. *Fam Med*. 2017;49(5):388–93.
93. Taylor J, Goletz SE. Using area health education centers to promote interest in rural practice. *Rural Remote Health*. 2016;16(3):3934. <https://doi.org/10.22605/RRH3934>.
94. Chen F, Fordyce M, Andes S, Hart LG. Which medical schools produce rural physicians? A 15-year update. *Acad Med*. 2010;85(4):594–8.
95. Nelson GC, Gruca TS. Determinants of the 5-year retention and rural location of family physicians. *Fam Med*. 2017;49(6):473–6.
96. Rosenblatt RA, Saunders G, Shreffler J, Pirani MJ, Larson EH, Hart LG. Beyond retention: National Health Service Corps participation and subsequent practice locations of a cohort of rural family physicians. *J Am Board Fam Pract*. 1996;9(1):23–30.
97. Crump WJ, Fricker RS, Ziegler C, Wiegman DL, Rowland ML. Rural track training based at a small regional campus: equivalency of training, residency choice, and practice location of graduates. *Acad Med*. 2013;88(8):1122–8.
98. Wheat JR, Leeper JD, Murphy S, Brandon JE, Jackson JR. Educating physicians for rural America: validating successes and identifying remaining challenges with the Rural Medical Scholars Program. *J Rural Health*. 2018;34:s65–74.
99. Matsumoto M, Inoue K, Kajii E. Policy implications of a financial incentive programme to retain a physician workforce in underserved Japanese rural areas. *Soc Sci Med*. 2010;71(4):667–71.
100. Rabinowitz HK, Petterson S, Boulger JG, Hunsaker ML, Diamond JJ, Markham FW, Bazemore A, Phillips RL. Medical school rural programs: a comparison with international medical graduates in addressing state-level rural family physician and primary care supply. *Acad Med*. 2012;87(4):488–92.
101. MacDowell M, Glasser M, Hunsaker M. A decade of rural physician workforce outcomes for the Rockford Rural Medical Education (RMED) Program. *University of Illinois Academic Medicine*. 2013;88(12):1941–7.
102. Liaw W, Bazemore A, Xierali I, Walden J, Diller P, Morikawa MJ. The association between global health training and underserved care. *Fam Med*. 2013;45(4):263–7.
103. Rabinowitz HK. Recruitment, retention, and follow-up of graduates of a program to increase the number of family physicians in rural and underserved areas. *N Engl J Med*. 1993;328(13):934–9.
104. Rabinowitz HK. Evaluation of a selective medical school admissions policy to increase the number of family physicians in rural and underserved areas. *N Engl J Med*. 1988;319(8):480–6.
105. Rabinowitz HK, Diamond JJ, Markham FW, Rabinowitz C. Long-term retention of graduates from a program to increase the supply of rural family physicians. *Acad Med*. 2005;80(8):728–32.
106. Rabinowitz HK, Diamond JJ, Markham FW, Hazelwood CE. A program to increase the number of family physicians in rural and underserved areas: impact after 22 years. *JAMA*. 1999;281(3):255–60.
107. Rabinowitz HK, Paynter NP. The role of the medical school in rural graduate medical education: pipeline or control valve? *J Rural Health*. 2000;16(3):249–53.
108. Rabinowitz HK, Diamond JJ, Markham FW, Paynter NP. Critical factors for designing programs to increase the supply and retention of rural primary care physicians. *JAMA*. 2001;286(9):1041–8.
109. Matsumoto M, Inoue K, Kajii E. A Contract-Based training system for rural physicians: follow-up of Jichi Medical University graduates (1978–2006). *J Rural Health*. 2008;24(4):360–8.
110. Phillips JP, Wendling AL, Fahey CA, Mavis BE. The effect of a community-based medical school on the state and local physician workforce. *Acad Med*. 2018;93(2):306–13.
111. Rabinowitz HK, Diamond JJ, Markham FW, Santana AJ. The relationship between entering medical students' backgrounds and career plans and their rural practice outcomes three decades later. *Acad Med*. 2012;87(4):493–7.
112. Harris DL, Ebbert PJ. Effects of clinical preceptorship on career and practice site choices. *West J Med*. 1983;138(2):276.
113. Halaas GW, Zink T, Finstad D, Bolin K, Center B. Recruitment and retention of rural physicians: outcomes from the rural physician associate program of Minnesota. *J Rural Health*. 2008;24(4):345–52.
114. Kane KY, Quinn KJ, Stevermer JJ, Porter JL, Webb WD, Williamson HA Jr, Burdin J. Summer in the country: changes in medical students' perceptions following an innovative rural community experience. *Acad Med*. 2013;88(8):1157–63.
115. Zink T, Center B, Finstad D, Boulger JG, Repesh LA, Westra R, Christensen R, Brooks KD. Efforts to graduate more primary care physicians and physicians who will practice in rural areas: Examining outcomes from the University of Minnesota-Duluth and the Rural Physician Associate Program. *Acad Med*. 2010;85(4):599–604.
116. Ramsey PG, Coombs JB, Hunt DD, Marshall SG, Wenrich MD. From concept to culture: the WWAMI program at the University of Washington School of Medicine. *Acad Med*. 2001;76(8):765–75.
117. Woloschuk W, Tarrant M. Does a rural educational experience influence students' likelihood of rural practice? Impact of student background and gender. *Med Educ*. 2002;36(3):241–7.
118. Orzanco M, Lovato C, Bates J, Slade S, Grand'Maison P, Vanasse A. Nature and nurture in the family physician's choice of practice location. *Rural Remote Health*. 2011;11(3):1849. <https://doi.org/10.22605/RRH1849>.
119. Landry M, Schofield A, Bordage R, Bélanger M. Improving the recruitment and retention of doctors by training medical students locally. *Med Educ*. 2011;45(11):1121–9.
120. Rourke JT, Incitti F, Rourke LL, Kennard M. Relationship between practice location of Ontario family physicians and their rural background or amount of rural medical education experience. *Can J Rural Med*. 2005;10(4):231.
121. Stratton TD, Geller JM, Ludtke RL, Fickenscher KM. Effects of an expanded medical curriculum on the number of graduates practicing in a rural state. *Acad Med*. 1991;66(2):101–5.
122. Moffatt J. Does a mandatory rural exposure change medical students' rural practice intent? *Educ Prim Care*. 2017;28(1):10–5.
123. Jones AR, Oster RA, Pederson LI, Davis MK, Blumenthal DS. Influence of a rural primary care clerkship on medical students' intentions to practice in a rural community. *J Rural Health*. 2000;16(2):155–61.
124. Delport R, Beckett N. Expectations and experiences of final-year medical students regarding family medicine rural rotations: Influence on intention to practise in a rural setting. *Afr J Health Prof Educ*. 2019;11(1):3–5.
125. Mateen FJ. Future practice location and satisfaction with rural medical education: survey of medical students. *Can Fam Physician*. 2006;52(9):1106–7.
126. Roseamelia C, Greenwald JL, Bush T, Pratte M, Wilcox J, Morley CP. A Qualitative Study of Medical Students in a Rural Track. *Fam Med*. 2014;46(4):259–66.
127. Amalba A, van Mook WN, Mogre V, Scherpier AJ. The effect of Community Based Education and Service (COBES) on medical graduates' choice of specialty and willingness to work in rural communities in Ghana. *BMC Med Educ*. 2016;16(1):1–7.
128. Cathcart-Rake W, Michael Robinson AP. From infancy to adolescence: The Kansas University School of Medicine–Salina: a rural medical campus story. *Acad Med*. 2017;92(5):622.
129. Holst J, Normann O, Herrmann M. Strengthening training in rural practice in Germany: new approach for undergraduate medical curriculum towards sustaining rural health care. *Rural Remote Health*. 2015;15(4):3563. <https://doi.org/10.22605/RRH3563>.
130. Smucny J, Beatty P, Grant W, Dennison T, Wolff LT. An evaluation of the rural medical education program of the State University of New York Upstate Medical University, 1990–2003. *Acad Med*. 2005;80(8):733–8.
131. Denton DR, Cobb JH, Webb WA. Practice locations of Texas family practice residency graduates, 1979–1987. *Acad Med*. 1989;64(7):400–5.
132. Switzer R, VandeZande L, Davis AT, Koehler TJ. Are Michigan State University medical school (MSU-CHM) alumni more likely to practice in the region of their graduate medical education primary care program compared to non-MSU-CHM alumni? *BMC Med Educ*. 2018;18(1):1–7.
133. Beach DA, Jong MK. Appropriate training for northern physicians. *Int J Circumpolar Health*. 1998;57:75–8.
134. Glenn JK, Hofmeister RW. Rural training settings and practice location decisions. *J Fam Pract*. 1981;13(3):377–82.
135. Jamieson J, Kernahan J, Calam B, Sivertz KS. One program, multiple training sites: does site of family medicine training influence professional practice location? *Rural Remote Health*. 2013;13:2496. <https://doi.org/10.22605/RRH2496>.

136. Fagan EB, Gibbons C, Finnegan SC, Petterson S, Peterson LE, Phillips RL. Family medicine graduate proximity to their site of training. *Fam Med*. 2015;47(2):124–30.
137. Whiteside C, Mathias R. Training for rural practice. Are graduates of a UBC program well prepared? *Can Family Physician*. 1996;42:1113.
138. Lee J, Walus A, Billing R, Hillier LM. The role of distributed education in recruitment and retention of family physicians. *Postgrad Med J*. 2016;92(1090):436–40.
139. Pong RW, Chan BT, Crichton T, Goertzen J. Big cities and bright lights: rural-and northern-trained physicians in urban practice. *Can J Rural Med*. 2007;12(3):153.
140. Petransy SM, Gress T. Comparison of academic and practice outcomes of rural and traditional track graduates of a family medicine residency program. *Acad Med*. 2013;88(6):819–23.
141. Gray JD, Steeves LC, Blackburn JW. The Dalhousie University experience of training residents in many small communities. *Acad Med*. 1994;69(10):847–51.
142. Ross R. Fifteen-year outcomes of a rural residency: aligning policy with national needs. *Fam Med*. 2013;45(2):122–7.
143. Norris TE, Acosta DA. A fellowship in rural family medicine: program development and outcomes. *Fam Med*. 1997;29(6):414–20.
144. Carek PJ, Abercrombie S, Baughman O, Buehler J, Goforth G, Hester W, Lammie J, Snape P. Graduate survey of the South Carolina Area Health Education Consortium family practice residency programs. *J S C Med Assoc*. 2001;97(6):250–3.
145. Robinson M, Slaney G. Choice or chance! The influence of decentralised training on GP retention in the Bogong region of Victoria and New South Wales. *Rural Remote Health*. 2012;13(1):2231. <https://doi.org/10.22605/RRH2231>.
146. Nash LR, Olson MM, Caskey JW, Thompson BL. Outcomes of a Texas family medicine residency rural training track: 2000 through 2007. *Tex Med*. 2008;104(9):59–63.
147. Ferguson WJ, Cashman SB, Savageau JA, Lasser DH. Family medicine residency characteristics associated with practice in a health professions shortage area. *Family Medicine and Community Health Publications*. 2009. https://scholarship.umassmed.edu/fmch_articles/123 Accessed 17 Dec 2021.
148. Bowman RC, Penrod JD. Family practice residency programs and the graduation of rural family physicians. *Fam Med*. 1998;30:288–92.
149. Raghavan M, Fleisher W, Downs A, Martin B, Sandham JD. Determinants of first practice location: among Manitoba medical graduates. *Can Fam Physician*. 2012;58(11):e667–76.
150. Petransy SM, Crespo R. The accelerated residency program: the Marshall University family practice 9-year experience. *Fam Med*. 2002;34(9):669–72.
151. Schmittling G, Black RR, Stern TL, Clinton C. Practice locations of family practice residency graduates. *J Med Educ*. 1981;56(9 Pt 1):709–16.
152. Norris TE, Norris SB. The effect of a rural preceptorship during residency on practice site selection and interest in rural practice. *J Fam Pract*. 1988;27(5):541–4.
153. Heng D, Pong RW, Chan BT, Degani N. Graduates of northern Ontario family medicine residency programs practise where they train. *Can J Rural Med*. 2007;12(3):146.
154. Szafran O, Myhre D, Torti J, Schipper S. Factors perceived to influence rural career choice of urban background family physicians: a qualitative analysis. *Can Med Educ J*. 2020;11(3):e21.
155. Shannon CK, Gunel E. A study of the future practice location intent of family medicine residents in West Virginia. *W V Med J*. 1999;95(5):261–4.
156. Norris TE. The Montana Family Practice Residency Satellite Program: a unique solution to multiple problems. *Fam Med*. 1985;17(6):259–61.
157. Rosenthal TC. Outcomes of rural training tracks: a review. *J Rural Health*. 2000;16(3):213–6.
158. Pathman DE, Konrad TR, Ricketts TC. The comparative retention of National Health Service Corps and other rural physicians: results of a 9-year follow-up study. *JAMA*. 1992;268(12):1552–8.
159. Pathman DE, Konrad TR, Ricketts TC. The National Health Service Corps experience for rural physicians in the late 1980s. *JAMA*. 1994;272(17):1341–8.
160. Poole P, Stoner T, Verstappen A, Bagg W. Medical students: where have they come from; where are they going. *NZ Med J*. 2016;129(1435):59–67.
161. Wheat JR, Brandon JE, Leeper JD, Jackson JR, Boulware DW. Rural health leaders pipeline, 1990–2005: case study of a second-generation rural medical education program. *J Agromedicine*. 2008;12(4):51–61.
162. Chan BT, Degani N, Crichton T, Pong RW, Rourke JT, Goertzen J, McCready B. Factors influencing family physicians to enter rural practice: does rural or urban background make a difference? *Can Fam Physician*. 2005;51(9):1246–7.
163. Moores DG, Woodhead-Lyons SC, Wilson DR. Preparing for rural practice Enhanced experience for medical students and residents. *Can Fam Physician*. 1998;44:1045.
164. Wenghofer EF, Hogenbirk JC, Timony PE. Impact of the rural pipeline in medical education: practice locations of recently graduated family physicians in Ontario. *Hum Resour Health*. 2017;15(1):1–6.
165. Woolley T, Hogenbirk JC, Strasser R. Retaining graduates of non-metropolitan medical schools for practice in the local area: the importance of locally based postgraduate training pathways in Australia and Canada. *Rural Remote Health*. 2020;20(3):5835.
166. Easterbrook M, Godwin M, Wilson R, Hodgetts G, Brown G, Pong R, Najgebauer E. Rural background and clinical rural rotations during medical training: effect on practice location. *CMAJ*. 1999;160(8):1159–63.
167. Stageman JH, Bowman RC, Harrison JD. An accelerated rural training program. *J Am Board Fam Pract*. 2003;16(2):124–30.
168. Potter JM. Characteristics of Alaskan family physicians as determinants of practice location. *Alaska Med*. 1995;37(2):49–52.
169. Tate RB, Aoki FY. Rural practice and the personal and educational characteristics of medical students: survey of 1269 graduates of the University of Manitoba. *Can Fam Physician*. 2012;58(11):e641–8.
170. Arscott-Mills T, Kebaabetswe P, Tawana G, Mbuka DO, Makgabana-Dintwa O, Sebina K, Kebaeste M, Mokgathe L, Nkomazana O. Rural exposure during medical education and student preference for future practice location—a case of Botswana. *Afr J Prim Health Care Fam Med*. 2016;8(1):1–6.
171. Rabinowitz HK, Diamond JJ, Markham FW, Santana AJ. Increasing the supply of women physicians in rural areas: outcomes of a medical school rural program. *J Am Board Fam Med*. 2011;24(6):740–4.
172. Rabinowitz HK, Diamond JJ, Markham FW, Santana AJ. Increasing the supply of rural family physicians: recent outcomes from Jefferson Medical College's Physician Shortage Area Program (PSAP). *Acad Med*. 2011;86(2):264–9.
173. Hogenbirk JC, Timony PE, French MG, Strasser R, Pong RW, Cervin C, Graves L. Milestones on the social accountability journey: family medicine practice locations of Northern Ontario School of Medicine graduates. *Can Fam Physician*. 2016;62(3):e138–45.
174. Boulger JG. Family medicine education and rural health: a response to present and future needs. *J Rural Health*. 1991;7(2):105–16.
175. Quinn KJ, Kane KY, Stevermer JJ, Webb WD, Porter JL, Williamson HA Jr, Hosokawa MC. Influencing residency choice and practice location through a longitudinal rural pipeline program. *Acad Med*. 2011;86(11):1397–406.
176. Pacheco M, Weiss D, Vaillant K, Bachofer S, Garrett B, Dodson WH III, Urbina C, Umland B, Derksen D, Heffron W, Kaufman A. The impact on rural New Mexico of a family medicine residency. *Acad Med*. 2005;80(8):739–44.
177. Brown SR, Birnbaum B. Student and resident education and rural practice in the Southwest Indian Health Service: a physician survey. *Fam Med*. 2005;37(10):701.
178. Hafferty FW, O'Donnell JF, editors. *The hidden curriculum in health professional education*. Lebanon: Dartmouth College Press; 2015.
179. The Municipality of Kincardine. *Physician Recruitment*. <https://www.kincardine.ca/en/living-here/physician-recruitment.aspx> (2019). Accessed 17 Dec 2021.
180. Cameron PJ. *Physician retention in four rural communities in Alberta: a collective case study*. Calgary: University of Calgary; 2008.
181. Koska MT. Community participation drives rural recruiting campaigns. *Hospitals*. 1991;65(22):26–8.
182. Melton N. Recruitable Community Program: a plan of action for community involvement and revitalization. *W V Med J*. 2013;109(4):81–2.
183. Shannon CK. A community development approach to rural recruitment. *J Rural Health*. 2003;19(5):347–53.

184. University of Toronto. Black Student Application Program. University of Toronto: MD Program. <https://applymd.utoronto.ca/black-student-application-program>. Accessed 17 Dec 2021.
185. University of Alberta. Black Applicant Admissions Process. University of Alberta Faculty of Medicine. <https://www.ualberta.ca/medicine/programs/md/applying-to-medicine/before-you-apply/black-applicants.html>. Accessed 17 Dec 2021.
186. University of Ottawa. Black Student AP. University of Ottawa: Faculty of Medicine Undergraduate Medical Education. <https://med.uottawa.ca/undergraduate/admissions/information-applicants/bsap>. Accessed 17 Dec 2021.
187. McGill. Black Candidate Pathway. McGill Faculty of Medicine and Health Sciences: Office of Admissions. <https://www.mcgill.ca/medadmissions/applying/categories/mcgill-black-candidate-pathway>. Accessed 17 Dec 2021.
188. Queen's University. Black Medical Students at Queen's University. Queen's University Faculty of Health Sciences – School of Medicine. <https://meds.queensu.ca/academics/undergraduate/black-medical-students-queens-university>. Accessed 17 Dec 2021.
189. McMaster University. Indigenous Applicants. McMaster University. <https://mdprogram.mcmaster.ca/md-program-admissions/who-should-apply/aboriginal-applicants>. Accessed 17 Dec 2021.
190. University of Toronto. Indigenous Student Application Program. University of Toronto MD Program. <https://applymd.utoronto.ca/indigenous-student-application-program>. Accessed 17 Dec 2021.
191. University of Saskatchewan. Indigenous Admissions Pathway. University of Saskatchewan College of Medicine. <https://medicine.usask.ca/students/undergraduate/indigenous-admissions.php>. Accessed 17 Dec 2021.
192. University of Alberta. Indigenous Applicants. University of Alberta Faculty of Medicine. <https://www.ualberta.ca/medicine/programs/md/applying-to-medicine/before-you-apply/indigenous-applicants.html>. Accessed 17 Dec 2021.
193. McGill University. Indigenous Candidate Pathway. McGill Faculty of Medicine and Health Sciences: Office of Admissions. <https://www.mcgill.ca/medadmissions/applying/categories/indigenous>. Accessed 17 Dec 2021.
194. University of British Columbia. Indigenous Pathway. University of British Columbia. Faculty of Medicine MD Undergraduate Program. <https://mdprogram.med.ubc.ca/admissions/before-you-apply/eligibility/indigenous-pathway/>. Accessed 17 Dec 2021.
195. Schulich School of Medicine & Dentistry. Indigenous Pathway. https://www.schulich.uwo.ca/med_dent_admissions/medicine/indigenous_applicants.html. Accessed 17 Dec 2021.
196. Cantor JC, Miles EL, Baker LC, Barker DC. Physician service to the underserved: implications for affirmative action in medical education. *Inquiry*. 1996;33:167–80.
197. Komaromy M, Grumbach K, Drake M, Vranizan K, Lurie N, Keane D, Bindman AB. The role of black and Hispanic physicians in providing health care for underserved populations. *N Engl J Med*. 1996;334(20):1305–10.
198. Rabinowitz HK, Diamond JJ, Veloski JJ, Gayle JA. The impact of multiple predictors on generalist physicians' care of underserved populations. *Am J Public Health*. 2000;90(8):1225.
199. Walker KO, Moreno G, Grumbach K. The association among specialty, race, ethnicity, and practice location among California physicians in diverse specialties. *J Natl Med Assoc*. 2012;104(1–2):46–52.
200. Clithero-Eridon A, Crandall C, Ross A. Future medical student practice intentions: the South Africa experience. *BMC Med Educ*. 2020;20:434.
201. Morley CP, Mader EM, Smilnak T, Bazemore A, Petterson S, Rodriguez JE, Campbell KM. The social mission in medical school mission statements: associations with graduate outcomes. *Fam Med*. 2015;47(6):427–34.
202. Larkins S, Johnston K, Hogenbirk JC, Willems S, Elsanousi S, Mammen M, Roy KV, Iputo J, Cristobal FL, Greenhill J, Labarda C, Neusy A. Practice intentions at entry to and exit from medical schools aspiring to social accountability: findings from the Training for Health Equity Network Graduate Outcome Study. *BMC Med Educ*. 2018;18:261.

Publisher's Note

Springer Nature remains neutral with regard to jurisdictional claims in published maps and institutional affiliations.

Ready to submit your research? Choose BMC and benefit from:

- fast, convenient online submission
- thorough peer review by experienced researchers in your field
- rapid publication on acceptance
- support for research data, including large and complex data types
- gold Open Access which fosters wider collaboration and increased citations
- maximum visibility for your research: over 100M website views per year

At BMC, research is always in progress.

Learn more biomedcentral.com/submissions

