



Characteristics of Medical Deserts and Approaches to Mitigate Their Health Workforce Issues: A Scoping Review of Empirical Studies in Western Countries



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Abstract

Background: Medical deserts are considered a problematic issue for many Western countries which try to employ multitude of policies and initiatives to achieve a better distribution of their health workforce (HWF). The aim of this study was to systematically map research and provide an overview of definitions, characteristics, contributing factors and approaches to mitigate medical deserts within the European Union (EU)-funded project “ROUTE-HWF” (a Roadmap OUT of mEdical deserts into supportive Health WorkForce initiatives and policies).

Methods: We performed a scoping review to identify knowledge clusters/research gaps in the field of medical deserts focusing on HWF issues. Six databases were searched till June 2021. Studies reporting primary research from Western countries on definitions, characteristics, contributing factors, and approaches were included. Two independent reviewers assessed studies for eligibility, extracted data and clustered studies according to the four defined outcomes.

Results: Two-hundred and forty studies were included (n=116, 48% Australia/New Zealand; n=105, 44% North America; n=20, 8% Europe). All used observational designs except for five quasi-experimental studies. Studies provided definitions (n=171, 71%), characteristics (n=95, 40%), contributing factors (n=112, 47%), and approaches to mitigate medical deserts (n=87, 36%). Most medical deserts were defined by the density of the population in an area. Contributing factors to HWF issues in medical deserts consisted in work-related (n=55, 23%) and lifestyle-related factors (n=33, 14%) of the HWF as well as sociodemographic characteristics (n=79, 33%). Approaches to mitigate them focused on training adapted to the scope of rural practice (n=67, 28%), HWF distribution (n=3, 1%), support/infrastructure (n=8, 3%) and innovative models of care (n=7, 3%).

Conclusion: Our study provides the first scoping review that presents and categorizes definitions, characteristics, contributing factors, and approaches to mitigate HWF issues in medical deserts. We identified gaps such as the scarcity of longitudinal studies to investigate the impact of factors contributing to medical deserts, and interventional studies to evaluate the effectiveness of approaches to mitigate HWF issues.

Keywords: Medical Desert, Health Workforce, Definition, Characteristics, Contributing Factors, Approaches

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Background

Medical deserts are known by many names. While the World Health Organization (WHO) defined “underserved areas” as “geographical areas where populations have limited access to qualified healthcare providers and quality healthcare services,”¹ such definition varies by country.² Also, the definition of “medical deserts”³ itself is not uniform, as countries differ in their geographical characteristics (eg, islands or mountain areas), what is considered as a “rural and remote area,”⁴ and in terms of the type of health workforce (HWF) that is undersupplied (eg, medical specialists, dentists, etc), respectively. Therefore, there is a lack of understanding on medical deserts in the absence of a clear definition and categorization – which causes confusion in both research and

policy discourse leading to misleading comparisons.⁵

Medical deserts are increasingly considered a problematic issue for many countries which try to employ a multitude of policies, actions and initiatives to achieve a better distribution of the HWF.⁶ WHO’s Regional Office for Europe underlined the severity of the problem in its recent European Programme of Work 2020-2025, and considered medical deserts as the main HWF priority for Europe.⁷

A maldistribution of the HWF can have severe negative effects. A systematic review confirmed this fact by finding strong evidence for an association between health outcomes and patient travel time: the further away patients lived from the healthcare facility they needed to attend, the worse were their health outcomes (eg, survival rates, length of stay in

hospital, and non-attendance at follow-up).⁸

Although many countries acknowledge the severity of medical deserts and take action, they do so without a strong rationale underlying the choice of specific policies and other measures.^{6,7} As an example, in the OECD (Organisation for Economic Co-operation and Development) Health Systems Characteristics Survey of 2012 and 2016, countries reported which policies they had in place to address physician supply problems. Half of the countries indicated to use financial incentives to correct perceived geographical maldistribution, while it is known from the literature that financial incentives alone are unlikely to attract HWF to underserved areas and are more effective if combined with other types of measures.⁹

Furthermore, when choosing a certain policy response or action, other contextual factors need to be taken into account. In the case of financial incentives, there are other reasons that should be considered that make physicians choose (not) to work in certain regions or possible legal barriers in place related to the choice of practice location.

The purpose of this scoping review was to systematically map the research done in the area of HWF issues in medical deserts, to provide an overview of the different definitions, characteristics of medical deserts as well as the contributing factors and approaches to mitigate their HWF issues. Based on the information gathered from this review we will identify knowledge clusters and gaps for further research, which also will allow defining recommendations for all potential end users such as policy-makers and different stakeholders involved in HWF issues in medical deserts.

This work was conducted as part of the "ROUTE-HWF" (a Roadmap OUT of mEdical deserts into supportive Health WorkForce initiatives and policies) project, a European Union (EU)-funded project that aims to reduce disparities in population's health within the EU by ensuring timely access to high-quality healthcare in all regions of the EU.

Methods

We registered the protocol of the scoping review prospectively in Open Science Framework on June 25, 2021 with doi:10.17605/OSF.IO/UEBXY and adhered to the Preferred Reporting Items for Systematic reviews and Meta-Analyses extension for Scoping Reviews (PRISMA-ScR) checklist¹⁰ for

reporting (Supplementary file 1).

We used Arksey and O'Malley¹¹ five-stage framework for scoping reviews: defining the research question, identifying relevant studies, study selection, data charting and collation and summarizing the results.

Defining the Research Question

The following research questions were formulated: (i) What are medical deserts, and what are their main characteristics? (ii) What are the factors that contribute to medical deserts and their HWF issues? and (iii) What are the approaches to mitigate them?

Identifying Relevant Studies

To identify relevant published studies, we searched the following bibliographic databases from inception to June 2021: Embase, Medline, CINAHL, Web of Science Core Collection, Google Scholar, and the Cochrane Library. The search strategies were drafted by the author team and further refined by an experienced biomedical information specialist and through discussion within the members of the research team. We followed PRESS Peer Review of Electronic Search Strategies recommendations.¹² The electronic search strategy for MEDLINE database is provided in Table 1.

The final search strategy as used for the electronic bibliographic databases can be found in Supplementary file 2.

In the review we included qualitative, quantitative, and mixed methods primary research studies addressing medical deserts with a focus on the definition, characteristics, contributing factors and approaches to mitigate the HWF issues in medical deserts.

Peer-reviewed journal papers were included if they were written in English or a language that one of the authors was proficient in, were situated in Europe, the United States, Canada, Australia or New Zealand. Excluded were case reports, editorials, and articles without details about methods and/or results (Table 2).

Furthermore, we searched for potential eligible studies that were not captured by our electronic database searches by checking the reference lists of included studies, relevant reviews, and by carrying out a cited reference search (forward citation tracking of the most relevant papers). Studies were

Table 1. Search Strategy in MEDLINE (Ovid)

Step. No.	Search Strategy in Medline
1	Health Personnel/ OR (nurse-patient-ratio* OR ((health* OR dental* OR care* OR medical* OR hospital* OR nursing) ADJ3 (personnel* OR workforce* OR labor-force* OR labour-force* OR manpower* OR work-force* OR resource*)) OR ((nurs* OR physician) ADJ3 (shortage*))).ab,ti,kf.
2	Rural Health/ OR Rural Health Services/ OR Rural Population/ OR (island* OR villager* OR ((rural* OR countryside* OR village*) ADJ3 (health* OR care* OR setting* OR area* OR population* OR communit* OR dweller* OR people* OR resident* OR societ* OR worker* OR nurs*)) OR medical-desert* OR ((underserv* OR remote* OR isolated OR mountain* OR far*) ADJ3 (area* OR neighborhood* OR neighbour* OR district* OR province*))).ab,ti,kf.
3	(taxonomy OR taxonomic* OR indicator* OR definition* OR defining* OR classificat* OR index* OR indice* OR scalogram* OR Gini).ab,ti,kf.
4	1 and 2 and 3
5	(exp animal/) NOT (human/)
6	4 not 5
7	(news OR congres* OR abstract* OR book* OR chapter* OR dissertation abstract*).pt.
8	6 not 7

Table 2. Inclusion and Exclusion Criteria

Inclusion Criteria	Exclusion Criteria
Publication type: Original research ie, quantitative (observational and interventional), qualitative, and mixed methods studies.	Books, editorials, correspondences, case reports, expert opinions, review articles, duplicative reports, study protocols, conference proceedings with unpublished results, and ongoing studies.
Population: HWF medical deserts (eg, due to shortage of physicians/nurses).	Studies outside of this population.
Outcomes: Definition and characteristics, contributing factors and approaches to mitigate/eliminate medical deserts.	Studies outside of these outcomes.
Restrictions: Western countries (ie, EU, the United States, Australia, and New Zealand).	Low- and middle-income countries. Asia, Africa, and South America.
Restrictions: Languages of publication restricted to Croatian, Dutch, English, Finnish, French, German, Polish, Spanish, Romanian, and Russian.	Studies outside of these languages.

Abbreviations: EU, European Union; HWF, health workforce.

included according to the same criteria as those found in the search of electronic databases.

Study Selection

The final search results of the electronic databases were exported into Endnote[®], and duplicates were removed by the biomedical information specialist. Document information was uploaded in Rayyan[®] after the removal of the duplicates. Three reviewers (AIGG, LEF, and JB) independently screened the title and abstracts. Disagreement among the three reviewers were resolved by consensus and discussion. To increase consistency, a calibration exercise of 50 studies was performed with the aim of achieving 80% of agreement between the three reviewers.¹³ The inclusion and exclusion criteria were reviewed during the calibration period. Two reviewers (AIGG and LEF) independently screened the full texts of the selected abstracts. Also, the full-texts disagreements on study selection were resolved by consensus and discussion. Furthermore, two reviewers (AIGG and LS) assessed the potential eligible studies gathered by other type of searches (eg, reference lists of already included studies) and included the ones that met the inclusion criteria.

Data Charting and Collation

A data charting form was jointly developed by two reviewers (AIGG and LEF) to determine which subjects and variables to extract. The two reviewers each charted half of the selected data. During the charting, the data form was updated in an iterative process between the two reviewers.

We extracted data on article characteristics (eg, country of origin), type of HWF addressed (eg, general practitioner [GP]), type of medical desert (eg, island) and 'outcome' (ie, definition, characteristics, contributing factors, and approaches to mitigate HWF issues in medical deserts). The studies were grouped by the type of outcomes analyzed (ie, definition, characteristics, contributing factors of medical deserts and approaches to mitigate their HWF issues) and summarized by type of HWF and study design for each group, along with broad findings.

Results

The primary search produced over 2000 records. After removal of duplicates, 979 records were left for further assessment based

on title and abstract resulting in 307 abstracts for retrieval of full texts. For 20 articles from the primary search, no full text could be retrieved. In total, 165 articles were excluded on the basis of the full-text, 105 reported about a population that was out of scope (eg, wrong country of origin), 59 did not meet the inclusion criteria, eight were not about medical deserts, seven were not about HWF and three were written in an excluded language. [Supplementary file 3](#) presents all excluded studies and reasons for exclusion.

One hundred and five studies were included in the scoping review after the electronic databases search and selection based on all inclusion and exclusion criteria ([Figure 1](#)). As 80% agreement between reviewers was achieved in the first calibration exercise, inclusion and exclusion criteria remained unchanged. Additionally, 135 studies were included after hand searching the reference lists of included studies and relevant reviews, and in addition by carrying out a cited reference search.

Key Characteristics of Included Studies

[Table 3](#) and [Supplementary file 4](#) show the key characteristics of the 240 articles that were finally included. Most were conducted in Australia and New Zealand (48%) and North America (44%). Eight percent of the articles were situated in Europe. Most studies were observational quantitative (80%) and focused on a variety of HWF groups, with a majority focusing on medical students and physicians (mostly GPs).

[Figure 2](#) shows detailed information about the number of studies found per country.

Of the included 240 articles, 71% (n=171) referred, used or described a definition of medical desert, 40% (n=95) described its characteristics, 47% (n=112) described contributing or associated factors for medical deserts and 36% (n=87) approaches to mitigate the HWF issues in medical deserts. These four themes will be further explored below.

Definition and Characteristics of Medical Deserts

Most studies considered medical deserts as rural areas, underserved areas or used a measure of distance/time to a facility or a combination of the three.

Of these, 69 studies did not define the term rural area.¹⁴⁻⁸³ Fifty-eight reported a definition of rural area and used a single criterion to define it:

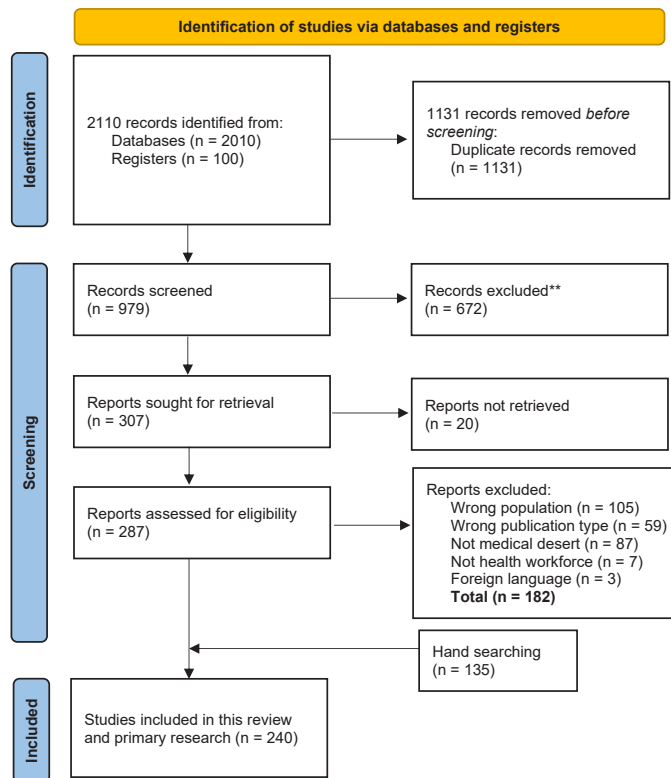


Figure 1. Flowchart of Review Search Strategy.

- the ratio between the population and the HWF,⁸⁴⁻⁹³
- the size of the population in an area,^{43,94-129}
- the distance to the HWF,¹³⁰⁻¹³⁶
- the distance to the nearest town,¹³⁷ or
- the number of hospital beds in the region.^{138,139}

Table 3. Descriptive Summary of Included Studies (n = 240)

Variable	Total, No. (%)
Study characteristics	
Geographical location*	
North America	105 (44)
Europe	20 (8)
Australia and New Zealand	116 (48)
Design	
Observational, quantitative	193 (80)
Observational, qualitative	28 (12)
Observational, mixed methods	14 (6)
Quasi-experimental	5 (2)
Data collection method*	
Existing databases	96 (40)
Survey/questionnaire	126 (52)
Interviews	30 (13)
Focus group	3 (1)
Participants' characteristics	
Type of HWF	
Medical students/other students	80 (33)
Physicians	85 (35)
Nurses	14 (6)
Allied HWF	23 (10)
Combination of HWF	27 (11)
Institutes/practices	11 (5)

Abbreviation: HWF, health workforce.

*Studies may be included in more than one category.

These criteria were mostly part of several more ‘formal’ definitions that were used by 78 studies as shown in [Supplementary file 5](#). Twenty studies used a combination of factors or criteria to define rural areas.^{36,140-158} All definitions, except the Rural Ranking scale, were defined from the perspective of the population. The Rural Ranking scale is a criterion that defines medical deserts from the perspective of GPs (see [Supplementary file 5](#)).

If we focus on the definitions from the perspective of the population, the following elements or criteria were identified:

- population size of the area,
- percentage of poverty in the area,
- percentage of population aged 65 and over,
- infant mortality rate in the area,
- mobility of the population in the area,
- health needs of the population in the area,
- number of HWF in the area,
- economic resources in the area,
- education and occupation options in the area,
- presence of a hospital or other health services in the area,
- population to provider ratio, and
- distance/time to facilities, distance/adjacent to metropolitan area.

These elements can be divided into four categories: (i) Size of the population, (ii) characteristics of the population, (iii) number of services in the area, and (iv) distance to services. Although all these elements seem relevant to define if an area is a potential medical desert, different definitions remain of how an ‘area’ is defined or demarcated as such. Therefore, it is not always possible to apply the definition elements presented

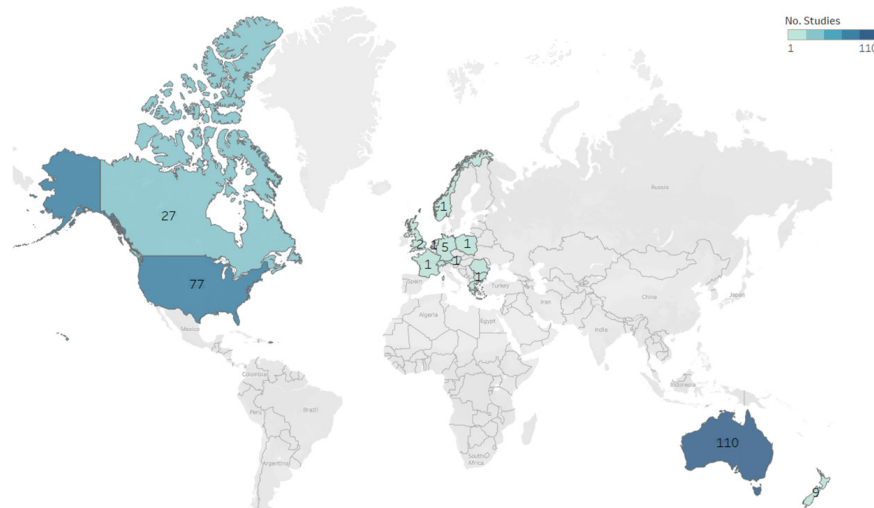


Figure 2. Number of Publications Per Country.

above in countries if a different area definition is applied. For example, some studies defined areas as a community, county, province, mountain or island, while one study defined an area as a square kilometer.¹²⁰ To define if an area is a medical desert, dividing a country in 'blocks' of a prespecified size might be an objective approach to compare countries on their medical desert areas and relevant criteria.

For studies that based their definition of a medical desert on the perspective of GPs (ie, the Rural Ranking scale), the definition elements are shown in [Supplementary file 5](#).¹⁵⁹

Contributing Factors to Medical Deserts

One hundred and twelve studies addressed contributing factors that may (have) enhanced or diminish medical deserts and their HWF issues. The factors extracted from the studies are presented below in four categories. Most factors were considered as both, positively as well as negatively influencing the workplace decision of HWE, depending on the individual preferences. Therefore, factors are described as influencing factors in general. In case that a factor was solely considered as positively or negatively influencing medical deserts, it is described as such within the results.

1. Work-Related Factors

Fifty-five studies identified work-related factors that could contribute positively or negatively to medical deserts and their HWF issues:

- Low level of *job satisfaction*^{24,27,31,50,59,102,160,161} and *burnout rates*^{27,31,53,102} were found to be associated with working location, in favor of working in rural versus urban placements.
- Higher *workload* (eg, patient list, working hours, patient-related hours, on-call arrangements)^{24,37,120} in rural areas was reported by seventeen studies^{24,27,31,35,37,41,52,59,70,118,120,137,162-166} and considered a worrisome issue, and therefore contributing negatively to the willingness of working in rural areas.
- *Working conditions* such as working atmosphere,^{34,40,46,50,84,161,164,166} having a single hand or group practice^{70,120,137,153} or full-time versus part time job,^{34,74,167} can have a

negative but as well a positive influence on the choice of working in a rural location, depending on personal preferences of the HWE.

- Furthermore, characteristics related to *the informal nature of rural practice* in general,^{22,50,53,99,118,161,168} travel hours,^{50,74,83} level of autonomy,^{41,74,99,162} and flexibility in practice structure¹⁶⁹ were identified as factors influencing the decision to work in rural or urban areas, depending as well on personal preferences of the HWE.
- The *work variety* of rural practices, along with other factors such as *closer doctor-patient relationship*, good team collaboration, multidisciplinary and student experiences, positively influenced the attitude of the HWF towards working in rural areas. This relationship was found by 11 studies.^{46,59,64,68,74,84,127,162,163,170,171}
- Five studies^{40,59,74,169,172} identified the lack of *personal recognition* and 22 *financial* issues such as lack of financial recognition, financial security, financial incentives and loan forgiveness^{18,23,24,31,34,40,41,46,52,59,66,84,99,100,110,112,118,124,127,149,169,173} when working in rural settings as a negative factor influencing the career choices of the HWF against working in rural.
- Lack of *career prospects*^{23,44,53,74,99,118,174} and *educational and professional development* opportunities,^{74,83,84,110,118,124,163,164} lack of professional support^{14,27,31,44,74,81,163,164,168,169} and *management support*^{53,83,110,164} and *professional isolation*^{27,81,83,137,162} as well as lack of access to *healthcare resources* (eg, equipment, personnel)^{14,40,74,124,157} were found as factors negatively associated with working in a rural setting.
- Furthermore, the lack of *availability of jobs*,^{34,161} the *length of employment* in the position (higher risk of turnover during the first six months),^{99,167} the lack of *intellectual challenge* (eg, scientific curiosity, complex care, research, procedural specialty),⁵⁰ the willingness to get *professional specialization* education^{141,175} as well as *personal traits*^{41,173} also were found as factors that negatively influenced the choice of working in rural locations.

2. Lifestyle-Related Factors

Thirty-three studies investigated lifestyle-related factors that may influence the recruitment and retention of HWF in medical deserts:

- Ten studies^{31,41,53,68,83,112,127,161,162,168} identified *rural lifestyle* in general as positively associated with the willingness to work in rural areas.
- *Work-life balance* was a positively influential factor described in three studies.^{107,166,174}
- *Family issues* such as finding employment for the spouse or good children education were as well considered as very relevant factors in 17 studies^{27,31,50,53,66,68,100,107,118,161–164,168,169,175,176} diminishing the willingness to work in rural areas.
- *Feelings of isolation*,^{27,70,162,166,170,177} lack of access to other *desirable services* such as internet¹⁷⁰ or *leisure activities*^{46,83} and *anonymity*^{23,157,172} were other relevant lifestyle-related factors described that influenced negatively the willingness to work in rural settings.
- Furthermore, *high costs of living* and *travelling* were considered as a significant incentive not to work and live in urban areas but in rural settings instead.^{64,83,108}

3. Migration

One study¹⁴⁸ from Romania identified *migration* of the HWF to other countries as a contributing factor to medical deserts. This single outcome is probably specific for Romania, known as a typical ‘source country’ in cross-border HWF mobility like some other Eastern European countries.

4. Socio-demographics or Other HWF Characteristics

Seventy-nine studies showed socio-demographic or other characteristics of the HWF that also may contribute to their career choices and subsequently influence HWF issues in medical deserts:

- *Age* was a factor described in nine studies^{18,72,99,147,153,166,167,178,179} influencing HWF turnover in rural areas; in some studies it was found that retirement due to aging of the HWF was not compensated by the inflow of health workers of younger age, because of their preference to work in urban placements.
- Both *male*^{126,153} and *female*^{104,147,149,180,181} (from 2014 onwards) health workers appear to be more willing to work in rural practice depending on the year of publication of the studies. Gender apparently has mixed effects on this career choice and therefore on HWF issues in medical deserts.
- Forty-five studies described^{18,22,29,30,46,52,54,64,69,71,72,75,95,103,104,106,113,118,121,122,124,126,127,150,161,173,176,177,181–195} *rural background* as a positive factor associated with working in a rural setting.^{30,182,183,192–194,196}
- Forty-seven studies described *rural training* as a factor positively associated with working in rural areas.^{18,22,29,33,34,43,52,54,56,57,64,68,69,75,95,103,104,106,111,113,121,122,127,136,147,153,156,161,168,170,175,176,182,187–190,192,193,195–201} One study though, showing controversial results.⁹⁵
- Furthermore, having a lower *socio-economic status*^{139,180,181} or *educational level*,¹⁵⁷ having a high medical school *admission*

- score*,¹⁵⁰ belonging to a *minority group*,^{72,147,149,157,191,196} having general *interest in rural practice*^{16,103,176,185,189,191,202} or specific professional *interest in primary care*,^{173,176,180,181,189,190,200,203} and getting *financial support* (ie, scholarships or funding)^{30,64,184,190,191,200} were all positively associated with working in a rural setting. Besides, *rural familiarity*^{23,68,118,126} and certain *character traits* (eg, altruism, self-confidence, curiosity, loyalty)^{27,46,68,107,127,150,168} were also found to positively influence the choice of working in rural practice.
- Finally, one study found that having a *non-English speaking background*, when working in English-speaking countries, was negatively associated with taking up rural practice.¹³⁹

The above mentioned four categories of factors (columns) involved in HWF issues in medical deserts (in most cases being defined as rural areas), are summarized in [Figure 3](#). Here the size of the bubbles indicates the number of studies reporting contributing factors, broken down by type of HWF (rows), and study design (by color). Characteristics of the HWF were found by the largest number of studies as contributing factors, next to work-related and lifestyle factors. Migration as a contributing factor was found by only one study. In addition, our extraction shows that the studies vary by the type of HWF that was subject of the study, as well as the type of study design.

Approaches to Mitigate Medical Deserts

We found eighty-three studies that described approaches to mitigate HWF issues in medical deserts. Comparable to our previous analysis, we present the approaches found in five categories.

1. Undergraduate Training Focused on Increased Rural Exposure

The following approaches were found in the studies that can be classified under this category:

- Seven studies^{42,55,93,197,201,204,205} assessed approaches that are executed by *university-based rural clinical schools* which emphasize rural recruitment. Results from these studies showed that such approach had a positive effect regarding the number of graduates that stay near or in the same rural areas where they attended undergraduate training.
- Twenty-two studies^{19,20,29,38,43,49,56,63,67,76,125,136,140,142,156,199,205–211} assessed the effect of *rural clinical rotations* (eg, rural internships, rural immersion programs) during undergraduate training on the intentions to work in rural settings or actual recruitment and retention rates of the rural HWF. These studies can be broken down in two subcategories:
 - Twelve studies^{19,20,29,38,49,67,75,76,140,206,208,209} evaluated the effect of such programs on the intention of students to practice in rural areas. Eight studies^{19,20,29,38,67,140,206,209} showed that an extended rural placement influenced medical and health science graduates’ intentions towards a rural career. The longer the clinical rotation, the more effective this was to increase the eventual choice of workplace location and future interest in a rural career.^{19,209} Williamson et al⁷⁶ reported that the positive effects of a seven-week rural undergraduate

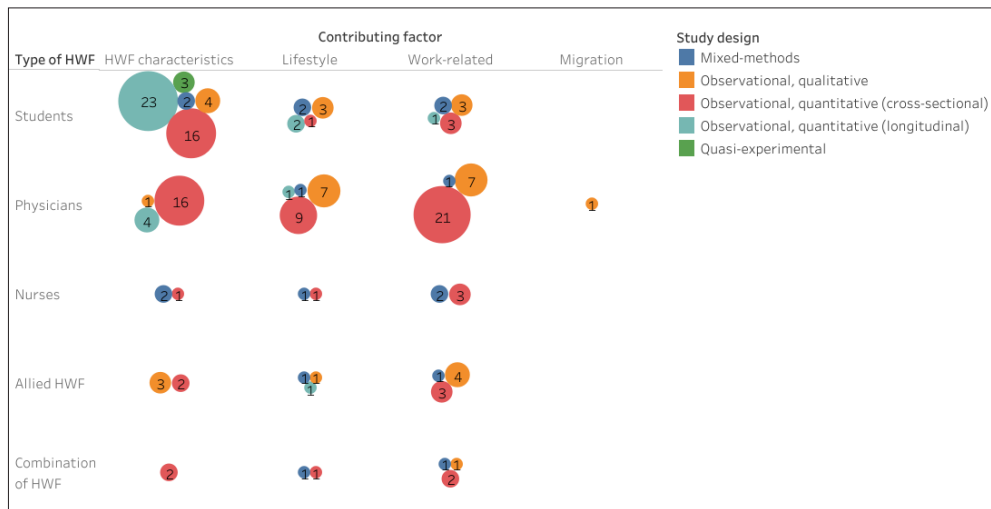


Figure 3. Types of Contributing Factors by Type of Health Work Force and Study Design. Abbreviation: HWF, health workforce.

placement on the attitudes towards rural health workplaces persisted in postgraduate years; but also found that the undergraduate training itself is unlikely to result in a significant effect. Furthermore, Orpin and Gabriel⁴⁹ identified that the ‘rural exposure’ had actually influenced two-thirds of health science students away from a rural career. Two studies^{75,208} evaluated specific rural clinical-rotation programs: the so-called John Flynn Placement Program and the fifth-year rural health curriculum at Dunedin School of Medicine. Both appeared to have a positive influence on students’ intentions to enter and work in rural areas.

- Twenty studies^{16,43,56,63,78,121,125,136, 156,193,199,202,205,207,210-215} assessed the recruitment and retention rates of graduates in rural areas after undergoing rural clinical rotations. Nineteen studies^{16,43,56,63,78,121,136,156, 193,199,202,205,207,210-215} showed an increase in the number of graduates choosing rural placements associated with undergraduate rural clinical rotations. However, Butler and Sheppard¹²⁵ reported that the undergraduate program was only adequate to prepare physiotherapy students for their professional roles but did not necessarily encourage students to accept rural positions.
- Four studies^{96,115,214,216} evaluated the effectiveness of *rural student recruitment* programs to increase the low number of rural students enrolled into medical faculties. They concluded that a program that enrolls students interested in rural healthcare areas, and provides training in rural communities, were successful to stimulate graduates to practice in rural areas.
- Ten studies assessed the effect of school programs *supporting early-entry rural and generalist pathways*^{57,82,122,190,193,217-221} on rural recruitment and retention. Wood¹²² showed that nursing students who attended a nursing program focusing on ‘rural nursing’ were twice as likely to practice in rural areas. Two studies^{193,217} presented that early career practice locations and movements of medical graduates from different rural clinical training programs positively influenced the likelihood to choose rural career paths.

Six studies^{57,190,218-221} evaluated the Physician Shortage Area Program as an educational approach focusing on recruitment and retention of rural GPs demonstrating its success. Longenecker et al²²² showed that medical school characteristics and activities may result in more graduates choosing rural general practice. Finally, Bennett et al⁸² described a structured and comprehensive educational clinical placement experience on undergraduate nurses. The authors showed that this enhanced the level of confidence of these nurses in the area of primary care.

2. Postgraduate Training and Continuing Medical Education Adapted to the Scope of Rural Practice

For this category the following approaches were found in the studies:

- Postgraduate training as a *family or GP* has been associated with an increase in the likelihood of working in urban underserved and rural areas, in contrast with other specialists working in primary care.^{116,223} Another study showed that training in community health centers not only meets the HWF needs in rural areas, but also enhances the recruitment of GPs in underserved settings.⁴⁵ Furthermore, exposing family practice residents to rural family practice training has shown to increase the number of GPs working in these rural areas.^{17,61,115,142,214}
- Six studies^{58,114,178,224-226} assessed the need of *continuing education* strategies with the aim of developing procedural and non-procedural skills specific to rural practice. Hajat et al²²⁴ and Rourke et al⁶¹ identified job-specific continuing education as the most important training needs of rural local public health agencies and GPs, respectively. Two studies^{32,60} evaluated the development of an interdisciplinary palliative care education program. Both showed that the program increased the capacity to deliver palliative care as reported by rural and remote communities as well as the job satisfaction of the healthcare workers.
- *Online courses* were identified as the preferred means for receiving continuing education by nurses in rural schools.⁵⁸ In Newman et al⁴⁷ survey findings showed that

videoconferencing was an overall success with general positive feedback of nurses working in rural areas. Ray et al²²⁷ evaluated the educational impact of videoconferencing to increase the confidence of healthcare workers to deliver quality palliative care in rural and remote areas. Results showed that the confidence level indeed increased significantly for all the types of HWFs.

- In three studies, *rural mentoring* was considered central to recruitment and retention of allied HWFs in rural areas.^{65,114,169}
- Furthermore, *scholarships* to follow management of education programs in rural settings showed to have significantly increased rural nurses' intention to stay in their current rural positions.⁷⁷

3. Professional Support and Infrastructure

This category of approaches was found in eight studies^{39,61,73,99,141,225,228,229} describing or assessing approaches to support rural HWF and provide them with improved infrastructure.

- Jones et al²²⁵ examined the effectiveness of a set of recruitment and retention *incentives* from the perspective of rural GPs. The GPs were asked to rate the importance of such approaches in terms of their impact. The two strategies that were rated most important were (1) better remuneration and (2) better after hours and on-call arrangements. Better locum availability and funding to improve practice infrastructure were rated as medium importance. Better education and professional support activity were rated as the least important. In Rourke et al,⁶¹ a different outcome of a similar study was presented. GPs working in rural areas rated funding for learner-driven continuing medical education as one of the most important solutions, along with reducing the number of on-call duty nights. Pathman et al¹⁴¹ compared the retention rates of a rural national scholarship program with other rural programs, showing that the effect of the scholarship program on retention rate of physicians was poor.
- In Kuhn et al,²²⁹ almost three quarters of local politicians agreed that one of the strategies that might improve primary care is the availability of allied health professional services. Lin and Goodale³⁹ also showed that allied health professional services increased satisfaction among the HWF in rural areas.
- Humphreys et al²²⁸ defined *six sentinel indicators* as the best way to support recruitment and retention of GPs in rural areas (ie, total hours, public hospital, on-call, time-off, partner employment and schooling). Their study was based on a data collected in four population size groups and comparing five levels of rural areas.
- Hanson et al reported that having relatively perceived *autonomy* within their professional work settings⁹⁹ has been a satisfactory approach for retaining nurses in rural areas.
- White et al⁷³ developed and implemented a *stress management* and reduction program among healthcare workers in rural areas. Participants that used such

intervention reported between 25% to 72% reduced stress levels.

4. Planning and Monitoring the HWF Distribution

Three studies^{86,158,226} focused on strategies to better plan and monitor the HWF maldistribution in rural and underserved areas. The approach proposed by Bowman⁸⁶ and McGrail et al¹⁵⁸ is to *align general practice training distribution* to meet the needs of rural and underserved communities. Russell et al²²⁶ identified *benchmarks* to analyze the length of stay of primary care HWF in rural and remote areas, by using survival analysis of longitudinal data on healthcare workers to inform rural HWF planning and retention strategies.

5. Innovative Models of Care

This final category consists of nine studies^{25,28,36,62,87,123,138,229,230} that described and/or evaluated innovative models of care as a solution to mitigate HWF issues in medical deserts. These approaches can be distinguished as follows:

- Four studies^{25,28,62,230} evaluated approaches that substituted in-person consultations of specialized HWF by using *telemedicine* in underserved rural areas. Such approaches comprised a ward-based geriatric consultation service delivered via a mobile videoconferencing system which showed to be highly accepted by patients and cost-effective.²⁵ Also, a pediatric critical care telemedicine consultation was found to improve patient care²⁸ and a program which placed telemonitors in rural satellite clinics to increase access to a pediatric obesity clinic which improved weight status compared with conventional treatment.²³⁰ A similar study was on a tele-oncology model of care which allowed cancer patients to receive specialist consultations and chemotherapy treatments closer to home.⁶²
- Wood et al¹²³ evaluated in a quasi-experimental study the implementation of a *satellite specialized HIV clinic* program which showed improved patient-related outcomes and increased access to best practice HIV care.
- Two studies^{36,87} assessed *interprofessional student-run clinics* providing care to vulnerable and underserved populations. Bradley et al⁸⁷ demonstrated, through a three-year evaluation, substantial improvement of health-related outcomes as well as reduction of use of health resources such as number of emergency department visits and hospital admissions. Lawrence et al³⁶ reported in a quasi-experimental study high levels of patients satisfaction.
- Ceronisky et al¹³⁸ described the framework of a *rural palliative care* initiative consisting of individualized action plans tailored to the community's needs and resources and verified its feasibility. They formulated five recommendations and conditions to support rural palliative care development: (1) external resources and support, (2) networking, (3) defining community-based metrics, (4) reimbursement for palliative care services, and (5) alignment of the palliative care program with

other efforts to redesign care delivery.

- Kuhn et al²²⁹ analyzed different innovative models of care which can improve local primary care by discussing these with respondents from a local government point of view. Half of the respondents supported the implementation of patient buses as model (where patients come to the physician's office), while less than one-third voted for mobile physician's offices (where physicians or allied health workers go near the patient's home). Telemedicine, which allows both the patient and the HWF to stay at home or office, respectively, appeared to be a model that was seen less suitable by the local politicians.

The above list and categories of approaches to mitigate HWF issues in medical deserts (in most cases being defined as rural areas), is summarized in Figure 4. Here the size of the circles shows the number of studies, broken down by type of approach (columns), type of HWF (rows), and study design (by color). The figure makes clear that most studies described approaches with regard to undergraduate and postgraduate training, either directed to medical or nurse students, or physicians working in rural areas.

Discussion

This paper provides a systematic overview of primary research published in scientific journals on the definitions and characteristics of medical deserts, and the contributing factors and approaches to mitigate the HWF issues in medical deserts with a focus on Western countries.

Summary of Results and Comparison With Literature

This scoping review included a significant body of 240 empirical studies relevant to the subject of medical deserts in the context of their HWF issues. Most of the peer-reviewed articles found were from Australia, New Zealand and North America (92%). On the one hand this reflects the bias of Anglo-Saxon publications often seen in literature reviews.^{9,231}

On the other, it also reflects the size and maturity of the challenge related to medical deserts in such large countries and geographical settings. We also found a number of studies on medical deserts in European countries such as Germany and Greece, among others. Most of the studies found used an observational study design (98%), a few used an observational longitudinal design (22%) and just a small percentage used a quasi-experimental design (2%), as it has as well been reported in other reviews.^{9,232,233}

Most medical deserts were defined in the studies by population-based characteristics, ie, population density which is mostly referred to as rural areas.^{43,94-106,108,110-116,118-129,228,234} However, a relevant number of studies referred to rural areas without a proper definition and furthermore without a consistent definition of what an area was considered defaulting the comparison among them or the generalizability of the results.

The contributing factors that enhance or sustain HWF issues in medical deserts seem to mainly depend on the background and previous job characteristics of the HWF, followed by work-related and lifestyle related factors but to a lesser extent. Without claiming this as the ultimate study, we refer to Godwin et al²³⁵ as an example. Their systematic review with a focus on dental practitioners working in rural areas showed that the most mentioned motivational factor for recruitment and retention was the effect of prior 'rural exposure' for dental practitioners. The study showed that having a rural background (39%) and having received rural training were the most frequently (42%) and positively associated factors with working in a rural setting. These findings have been corroborated in a review of reviews performed by Asghari et al²³¹ about the most influential factors for recruitment and retention of GPs.

Finally, the studies included in our review show that approaches and strategies to mitigate HWF issues in medical deserts mostly focused on training; and thereby the early recruitment and exposure of students and HWF to rural areas.



Figure 4. Types of Approaches by Type of Health Work Force and Study Design. Abbreviation: HWF, health workforce.

Next improving the scope of rural practice was also frequently found as an effective approach as also shown in one recently published review of the literature.²³⁶ Verma et al²³³ confirmed in their systematic review that although the evidence base for recruitment strategies was weak, they found evidence to support undergraduate and postgraduate placements in medical deserts. Buykx et al²³⁷ found that as multiple factors influence recruitment and retention of the HWF, a flexible and multifaceted response is needed. According to Dolea et al²³² there is frequently a lack of coherence between the proposed strategy for recruitment and retention of the HWF and the factors that matter most to health workers in their choice of practice location. Therefore, a situation analysis should be mandatory before selecting the most appropriate approach or approaches to encourage the HWF to choose and stay in a medical desert.

Strengths and Limitations

To the best of our knowledge, our study provides the first scoping review of empirical studies on (1) the definitions and characteristics of medical deserts, and (2) the contributing factors and approaches to mitigate HWF issues in medical deserts in Western countries. Our study has also contributed to a categorization of studies on medical deserts, enabling further analyses of the relationship between different types of medical deserts, types of HWF groups and issues, and the related contributing factors and potential solutions. Our review also provides a base and an agenda for further research in this field. We found that observational studies were the most common type of design of the studies included, which shows the scarcity of longitudinal studies that actually investigate the impact of factors contributing to HWF issues in medical deserts. Also, we identified the absence of interventional studies to evaluate the effectiveness of approaches to mitigate medical deserts. Therefore, longitudinal studies as well as controlled experimental studies should be increasingly encouraged and funded. We also identified that the majority of the studies focused on medical students or physicians (mostly GPs) and more efforts should be made to determine the factors and evaluate programs targeted at other types of health workers.

A limitation of this study is that we did not include 'grey literature' that might have been published in non-scientific journals, national, regional or sector-specific sources. We explored this type literature but it has been found not to identify additional studies in a way that justifies the effort involved in this type of search.²³⁸ We also excluded studies from lower-middle income countries and therefore, results can only be generalized to high income countries from Australia and Zealand, North America and (to a lesser extent) Europe. Additionally, we did not use specific related terms in our search to identify studies performed in European countries and thus to increase the sensitivity of the search to the detriment of specificity, which may have caused a loss of studies focused on Europe. Contributing factors to medical deserts and approaches to mitigate them may not be comparable across continents, as may not be across countries, and therefore not generalizable.

Conclusions

This scoping review has collected, classified, extracted and synthesized the available empirical studies related to medical deserts and their HWF issues, published until June 2021 in Western countries. Whilst most studies originate from Australia, New Zealand and North America, studies from European countries were also included. Next to descriptive results we identified several gaps in the set of 240 studies included. One is the omission of longitudinal studies that measure the actual impact of factors contributing to HWF issues in medical deserts. Related is the lack of interventional studies that evaluate the effectiveness of approaches to mitigate HWF issues in medical deserts. We therefore advocate that more and next studies should invest in larger scaled and more rigor research, to fulfill the need for more evidence and research-based policy in medical deserts. This review shows that this research can be well based on the current studies, as new studies are now required to enable best practice outcomes for HWF policies in medical deserts.

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Ethical issues

Not applicable.

Competing interests

Authors declare that they have no competing interests.

Authors' contributions

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Disclaimer

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Supplementary files

- Supplementary file 1. PRISMA-ScR Checklist.
 Supplementary file 2. Search Strategies by Electronic Databases.
 Supplementary file 3. Excluded Studies and Reasons for Exclusion.
 Supplementary file 4. Key Characteristics of the Included Studies.
 Supplementary file 5. Definitions of Medical Deserts.

References

- World Health Organization (WHO). *Increasing Access to Health Workers in Remote and Rural Areas Through Improved Retention: Global Policy Recommendations*. Geneva: WHO; 2010.
- Bärnighausen T, Bloom DE. Designing financial-incentive programmes for return of medical service in underserved areas: seven management functions. *Hum Resour Health*. 2009;7:52. doi:10.1186/1478-4491-7-52
- Lucas-Gabrielli V, Chevillard G. ["Medical deserts" and accessibility to care: what are we talking about?]. *Med Sci (Paris)*. 2018;34(6-7):599-603. doi:10.1051/medsci/20183406022
- Chow AF, Morgan D, Bayly M, Kosteniuk J, Elliot V. Collaborative approaches to team-based primary health care for individuals with dementia in rural/remote settings. *Can J Aging*. 2019;38(3):367-383. doi:10.1017/s0714980818000727
- Wong C. Indicators in use: challenges to urban and environmental planning in Britain. *Town Plan Rev*. 2000;71(2):213-239.
- Ono T, Schoenstein M, Buchan J. *Geographic Imbalances in Doctor Supply and Policy Responses*. Paris: OECD; 2014.
- WHO Regional Office for Europe. *United Action for Better Health in Europe, Draft European Programme of Work, 2020-2025*. Copenhagen: WHO Regional Office for Europe; 2020.
- Kelly C, Hulme C, Farragher T, Clarke G. Are differences in travel time or distance to healthcare for adults in global north countries associated with an impact on health outcomes? A systematic review. *BMJ Open*. 2016;6(11):e013059. doi:10.1136/bmjopen-2016-013059
- Kroezen M, Dussault G, Craveiro I, et al. Recruitment and retention of health professionals across Europe: a literature review and multiple case study research. *Health Policy*. 2015;119(12):1517-1528. doi:10.1016/j.healthpol.2015.08.003
- Tricco AC, Lillie E, Zarin W, et al. PRISMA extension for scoping reviews (PRISMA-ScR): checklist and explanation. *Ann Intern Med*. 2018; 169(7):467-473. doi:10.7326/m18-0850
- Arksey H, O'Malley L. Scoping studies: towards a methodological framework. *Int J Soc Res Methodol*. 2005;8(1):19-32. doi:10.1080/1364557032000119616
- McGowan J, Sampson M, Salzwedel DM, Cogo E, Foerster V, Lefebvre C. PRESS peer review of electronic search strategies: 2015 guideline statement. *J Clin Epidemiol*. 2016;75:40-46. doi:10.1016/j.jclinepi.2016.01.021
- Browne RH. On the use of a pilot sample for sample size determination. *Stat Med*. 1995;14(17):1933-1940. doi:10.1002/sim.4780141709
- Ricketts TC, Tropman SE, Sliifkin RT, Konrad TR. Migration of obstetrician-gynecologists into and out of rural areas, 1985-1990. *Med Care*. 1996; 34(5):428-438. doi:10.1097/00005650-199605000-00005
- Theodorakis PN, Mantzavinis GD. Inequalities in the distribution of rural primary care physicians in two remote neighboring prefectures of Greece and Albania. *Rural Remote Health*. 2005;5(3):457.
- Booza JC, Bridge PD, Neale AV, Schenk M. Incorporating Geographic Information Systems (GIS) into program evaluation: lessons from a rural medicine initiative. *J Am Board Fam Med*. 2010;23(1):59-66. doi:10.3122/jabfm.2010.01.090167
- 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):254-259. doi:10.1111/jrh.12156
- Daniels ZM, Vanleit BJ, Skipper BJ, Sanders ML, Rhyne RL. Factors in recruiting and retaining health professionals for rural practice. *J Rural Health*. 2007;23(1):62-71. doi:10.1111/j.1748-0361.2006.00069.x
- Denz-Penhey H, Shannon S, Murdoch CJ, Newbury JW. Do benefits accrue from longer rotations for students in Rural Clinical Schools? *Rural Remote Health*. 2005;5(2):414.
- Eley D, Baker P. Does recruitment lead to retention? Rural Clinical School training experiences and subsequent intern choices. *Rural Remote Health*. 2006;6(1):511.
- Eley D, Young L, Przybeck TR. Exploring temperament and character traits in medical students; a new approach to increase the rural workforce. *Med Teach*. 2009;31(3):e79-84. doi:10.1080/01421590802335892
- Elliott-Schmidt R, Strong J. Rural occupational therapy practice: a survey of rural practice and clinical supervision in rural Queensland and Northern New South Wales. *Aust J Rural Health*. 1995;3(3):122-131. doi:10.1111/j.1440-1584.1995.tb00164.x
- Gillham S, Risteovski E. Where do I go from here: we've got enough seniors? *Aust J Rural Health*. 2007;15(5):313-320. doi:10.1111/j.1440-1584.2007.00900.x
- Goetz K, Musselmann B, Szecsenyi J, Joos S. The influence of workload and health behavior on job satisfaction of general practitioners. *Fam Med*. 2013;45(2):95-101.
- Gray LC, Wright OR, Cutler AJ, Scuffham PA, Wootton R. Geriatric ward rounds by video conference: a solution for rural hospitals. *Med J Aust*. 2009;191(11-12):605-608. doi:10.5694/j.1326-5377.2009.tb03345.x
- Whitson HE, Steinhauer K, Ammarell N, et al. Categorizing the effect of comorbidity: a qualitative study of individuals' experiences in a low-vision rehabilitation program. *J Am Geriatr Soc*. 2011;59(10):1802-1809. doi:10.1111/j.1532-5415.2011.03602.x
- Hays R, Wynd S, Veitch C, Crossland L. Getting the balance right? GPs who chose to stay in rural practice. *Aust J Rural Health*. 2003;11(4):193-198.
- Heath B, Salerno R, Hopkins A, Hertzog J, Caputo M. Pediatric critical care telemedicine in rural underserved emergency departments. *Pediatr Crit Care Med*. 2009;10(5):588-591. doi:10.1097/PCC.0b013e3181a63eac
- Isaac V, Watts L, Forster L, McLachlan CS. The influence of rural clinical school experiences on medical students' levels of interest in rural careers. *Hum Resour Health*. 2014;12:48. doi:10.1186/1478-4491-12-48
- Jones M, Humphreys J, Prideaux D. Predicting medical students' intentions to take up rural practice after graduation. *Med Educ*. 2009;43(10):1001-1009. doi:10.1111/j.1365-2923.2009.03506.x
- Kamien M. Staying in or leaving rural practice: 1996 outcomes of rural doctors' 1986 intentions. *Med J Aust*. 1998;169(6):318-321. doi:10.5694/j.1326-5377.1998.tb140285.x
- Kelley ML, Habjan S, Aegard J. Building capacity to provide palliative care in rural and remote communities: does education make a difference? *J Palliat Care*. 2004;20(4):308-315.
- 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):1121-1129. doi:10.1111/j.1365-2923.2011.04055.x
- Lasala K. Nursing workforce issues in rural and urban settings: looking at the difference in recruitment, retention and distribution. *Online J Rural Nurs Health Care*. 2000;1(1):8-24. doi:10.14574/ojrh.v1i1.499
- Lavanchy M, Connelly I, Grzybowski S, Michalos AC, Berkowitz J, Thommasen HV. Determinants of rural physicians' life and job satisfaction. *Soc Indic Res*. 2004;69(1):93-101. doi:10.1023/B:SOCI.0000032662.79752.e8
- Lawrence D, Bryant TK, Nobel TB, Dolansky MA, Singh MK. A comparative evaluation of patient satisfaction outcomes in an interprofessional student-run free clinic. *J Interprof Care*. 2015;29(5):445-450. doi:10.3109/13561820.2015.1010718
- Steinhaeuser J, Joos S, Szecsenyi J, Miksch A. A comparison of the workload of rural and urban primary care physicians in Germany: analysis of a questionnaire survey. *BMC Fam Pract*. 2011;12:112. doi:10.1186/1471-2296-12-112
- 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.
- Lin IB, Goodale BJ. Improving the supervision of therapy assistants in Western Australia: the Therapy Assistant Project (TAP). *Rural Remote Health*. 2006;6(1):479.
- Lindeke L, Jukkala A, Tanner M. Perceived barriers to nurse practitioner practice in rural settings. *J Rural Health*. 2005;21(2):178-181. doi:10.1111/j.1748-0361.2005.tb00079.x
- Maclsaac P, Snowdon T, Thompson R, Crossland L, Veitch C. General practitioners leaving rural practice in Western Victoria. *Aust J Rural Health*. 2000;8(2):68-72. doi:10.1046/j.1440-1584.2000.00232.x
- Magnus JH, Tolan A. Rural doctor recruitment: does medical education in rural districts recruit doctors to rural areas? *Med Educ*. 1993;27(3):250-253. doi:10.1111/j.1365-2923.1993.tb00264.x

43. Matthews C, Bagg W, Yelder J, Mogol V, Poole P. Does Pukawakawa (the regional-rural programme at the University of Auckland) influence workforce choice? *N Z Med J*. 2015;128(1409):35-43.
44. Mills A, Millsteed J. Retention: an unresolved workforce issue affecting rural occupational therapy services. *Aust Occup Ther J*. 2002;49(4):170-81. doi:10.1046/j.1440-1630.2002.00293.x
45. Morris CG, Johnson B, Kim S, Chen F. Training family physicians in community health centers: a health workforce solution. *Fam Med*. 2008;40(4):271-276.
46. Natanzon I, Szecsenyi J, Ose D, Joos S. Future potential country doctor: the perspectives of German GPs. *Rural Remote Health*. 2010;10(2):1347.
47. Newman C, Martin E, McGarry DE, Cashin A. Survey of a videoconference community of professional development for rural and urban nurses. *Rural Remote Health*. 2009;9(2):1134.
48. Tsiouli K, Karamesinis K, Antonarakis GS, Christou P. Prediction model of regional orthodontic workforce needs, using Greece as an example. *Eur J Paediatr Dent*. 2016;17(1):29-33.
49. Orpin P, Gabriel M. Recruiting undergraduates to rural practice: what the students can tell us. *Rural Remote Health*. 2005;5(4):412.
50. O'Toole K, Schoo A, Hernan A. Why did they leave and what can they tell us? Allied health professionals leaving rural settings. *Aust Health Rev*. 2010;34(1):66-72. doi:10.1071/ah09711
51. O'Toole K, Schoo A, Stagnitti K, Cuss K. Rethinking policies for the retention of allied health professionals in rural areas: a social relations approach. *Health Policy*. 2008;87(3):326-332. doi:10.1016/j.healthpol.2008.01.012
52. Pepper CM, Sandefer RH, Gray MJ. Recruiting and retaining physicians in very rural areas. *J Rural Health*. 2010;26(2):196-200. doi:10.1111/j.1748-0361.2010.00282.x
53. Perkins D, Larsen K, Lyle D, Burns P. Securing and retaining a mental health workforce in Far Western New South Wales. *Aust J Rural Health*. 2007;15(2):94-98. doi:10.1111/j.1440-1584.2007.00860.x
54. Playford D, Larson A, Wheatland B. Going country: rural student placement factors associated with future rural employment in nursing and allied health. *Aust J Rural Health*. 2006;14(1):14-19. doi:10.1111/j.1440-1584.2006.00745.x
55. Playford D, Wheatland B, Larson A. Does teaching an entire nursing degree rurally have more workforce impact than rural placements? *Contemp Nurse*. 2010;35(1):68-76. doi:10.5172/conu.2010.35.1.068
56. Playford DE, Cheong E. Rural Undergraduate Support and Coordination, Rural Clinical School, and Rural Australian Medical Undergraduate Scholarship: rural undergraduate initiatives and subsequent rural medical workforce. *Aust Health Rev*. 2012;36(3):301-307. doi:10.1071/ah11072
57. 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):728-732. doi:10.1097/00001888-200508000-00004
58. Ramos MM, Fullerton L, Sapien R, Greenberg C, Bauer-Creegan J. Rural-urban disparities in school nursing: implications for continuing education and rural school health. *J Rural Health*. 2014;30(3):265-274. doi:10.1111/jrh.12058
59. Ulmer B, Harris M. Australian GPs are satisfied with their job: even more so in rural areas. *Fam Pract*. 2002;19(3):300-303. doi:10.1093/fampra/19.3.300
60. Raymond L, Charles M, Israel F, Read T, Treston P. A strategy to increase the palliative care capacity of rural primary health care providers. *Aust J Rural Health*. 2005;13(3):156-161. doi:10.1111/j.1440-1854.2005.00687.x
61. Rourke JT, Incitti F, Rourke LL, Kennard M. Keeping family physicians in rural practice. Solutions favoured by rural physicians and family medicine residents. *Can Fam Physician*. 2003;49:1142-1149.
62. Sabesan S, Larkins S, Evans R, et al. Telemedicine for rural cancer care in North Queensland: bringing cancer care home. *Aust J Rural Health*. 2012;20(5):259-264. doi:10.1111/j.1440-1584.2012.01299.x
63. McDonnell Smedts A, Lowe MP. Efficiency of clinical training at the Northern Territory Clinical School: placement length and rate of return for internship. *Med J Aust*. 2008;189(3):166-168. doi:10.5694/j.1326-5377.2008.tb01953.x
64. Spencer RJ, Cardin AJ, Ranmuthugala G, Somers GT, Solarsh B. Influences on medical students' decisions to study at a rural clinical school. *Aust J Rural Health*. 2008;16(5):262-268. doi:10.1111/j.1440-1584.2008.00978.x
65. Steenbergen K, Mackenzie L. Professional support in rural New South Wales: perceptions of new graduate occupational therapists. *Aust J Rural Health*. 2004;12(4):160-165. doi:10.1111/j.1440-1854.2004.00590.x
66. Stratton TD, Dunkin JW, Szigeti E, Muus KJ. Recruitment barriers in rural community hospitals: a comparison of nursing and nonnursing factors. *Appl Nurs Res*. 1998;11(4):183-189. doi:10.1016/s0897-1897(98)80307-8
67. Thackrah RD, Hall M, Fitzgerald K, Thompson SC. Up close and real: living and learning in a remote community builds students' cultural capabilities and understanding of health disparities. *Int J Equity Health*. 2017;16(1):119. doi:10.1186/s12939-017-0615-x
68. Tolhurst HM, Adams J, Stewart SM. An exploration of when urban background medical students become interested in rural practice. *Rural Remote Health*. 2006;6(1):452.
69. Walker JH, Dewitt DE, Pallant JF, Cunningham CE. Rural origin plus a rural clinical school placement is a significant predictor of medical students' intentions to practice rurally: a multi-university study. *Rural Remote Health*. 2012;12:1908.
70. Alexander C. Why doctors would stay in rural practice in the New England health area of New South Wales. *Aust J Rural Health*. 1998;6(3):136-139. doi:10.1111/j.1440-1584.1998.tb00299.x
71. Ward AM, Kamien M, Lopez DG. Medical career choice and practice location: early factors predicting course completion, career choice and practice location. *Med Educ*. 2004;38(3):239-248. doi:10.1046/j.1365-2923.2004.01762.x
72. Wayne SJ, Kalishman S, Jerabek RN, Timm C, Cosgrove E. Early predictors of physicians' practice in medically underserved communities: a 12-year follow-up study of University of New Mexico School of Medicine graduates. *Acad Med*. 2010;85(10 Suppl):S13-16. doi:10.1097/ACM.0b013e3181ed1bee
73. White CH, Meier N, Swint C. The implementation of a stress management program for health care workers through a rural occupational health clinic. *Workplace Health Saf*. 2021;69(4):161-167. doi:10.1177/2165079920982406
74. Williams E, D'Amore W, McMeeken J. Physiotherapy in rural and regional Australia. *Aust J Rural Health*. 2007;15(6):380-386. doi:10.1111/j.1440-1584.2007.00931.x
75. Williamson M, Gormley A, Bills J, Farry P. The new rural health curriculum at Dunedin School of Medicine: how has it influenced the attitudes of medical students to a career in rural general practice? *N Z Med J*. 2003;116(1179):U537.
76. Williamson MI, Wilson R, McKechnie R, Ross J. Does the positive influence of an undergraduate rural placement persist into postgraduate years? *Rural Remote Health*. 2012;12:2011.
77. Wilson AA. Impact of management development on nurse retention. *Nurs Adm Q*. 2005;29(2):137-145. doi:10.1097/00006216-200504000-00008
78. Worley P, Martin A, Prideaux D, Woodman R, Worley E, Lowe M. Vocational career paths of graduate entry medical students at Flinders University: a comparison of rural, remote and tertiary tracks. *Med J Aust*. 2008;188(3):177-178. doi:10.5694/j.1326-5377.2008.tb01567.x
79. Sullivan Havens D, Warszawsky NE, Vasey J. RN work engagement in generational cohorts: the view from rural US hospitals. *J Nurs Manag*. 2013;21(7):927-940. doi:10.1111/jonm.12171
80. Wilkinson D. Selected demographic, social and work characteristics of the Australian general medical practitioner workforce: comparing capital cities with regional areas. *Aust J Rural Health*. 2000;8(6):327-334. doi:10.1046/j.1440-1584.2000.00316.x
81. Allan J, Crockett J, Ball P, Alston M, Whittenbury K. 'It's all part of the package' in rural allied health work: a pilot study of rewards and barriers in rural pharmacy and social work. *Internet J Allied Health Sci Pract*. 2007;5(3):1-11. doi:10.46743/1540-580x/2007.1161
82. Bennett P, Jones D, Brown J, Barlow V. Supporting rural/remote primary health care placement experiences increases undergraduate nurse confidence. *Nurse Educ Today*. 2013;33(2):166-172. doi:10.1016/j.nedt.2012.02.015
83. Bent A. Allied health in Central Australia: challenges and rewards in remote area practice. *Aust J Physiother*. 1999;45(3):203-212. doi:10.1016/s0004-9514(14)60351-2
84. Abbiati M, Savoldelli GL, Baroffio A, Bajwa NM. Motivational factors influencing student intentions to practise in underserved areas. *Med Educ*. 2020;54(4):356-363. doi:10.1111/medu.14063
85. Berk ML, Bernstein AB, Taylor AK. The use and availability of medical care in health manpower shortage areas. *Inquiry*. 1983;20(4):369-380.
86. Bowman RC. Measuring primary care: the standard primary care year. *Rural Remote Health*. 2008;8(3):1009.

87. Bradley KJ, Wros P, Bookman N, et al. The Interprofessional Care Access Network (I-CAN): achieving client health outcomes by addressing social determinants in the community. *J Interprof Care*. 2018;1-8. doi:10.1080/13561820.2018.1560246
88. Feng X, Sambamoorthi U, Wiener RC. Dental workforce availability and dental services utilization in Appalachia: a geospatial analysis. *Community Dent Oral Epidemiol*. 2017;45(2):145-152. doi:10.1111/cdoe.12270
89. Fryer GE Jr, Drisko J, Krugman RD, et al. Multi-method assessment of access to primary medical care in rural Colorado. *J Rural Health*. 1999; 15(1):113-121. doi:10.1111/j.1748-0361.1999.tb00605.x
90. Kaye HS, Chapman S, Newcomer RJ, Harrington C. The personal assistance workforce: trends in supply and demand. *Health Aff (Millwood)*. 2006;25(4):1113-1120. doi:10.1377/hlthaff.25.4.1113
91. Lyng DC, Larson EH, Thompson MJ, Rosenblatt RA, Hart LG. A longitudinal analysis of the general surgery workforce in the United States, 1981-2005. *Arch Surg*. 2008;143(4):345-350. doi:10.1001/archsurg.143.4.345
92. Simou E, Karamagioli E, Roumeliotou A. Reinventing primary health care in the Greece of austerity: the role of health-care workers. *Prim Health Care Res Dev*. 2015;16(1):5-13. doi:10.1017/s1463423613000431
93. Toomey P, Lovato CY, Hanlon N, Poole G, Bates J. Impact of a regional distributed medical education program on an underserved community: perceptions of community leaders. *Acad Med*. 2013;88(6):811-818. doi:10.1097/ACM.0b013e318290f9c7
94. Ariste R. Availability of health workforce in urban and rural areas in relation to Canadian seniors. *Int J Health Plann Manage*. 2019;34(2):510-520. doi:10.1002/hpm.2712
95. Easterbrook M, Godwin M, Wilson R, et al. Rural background and clinical rural rotations during medical training: effect on practice location. *CMAJ*. 1999;160(8):1159-1163.
96. Florence JA, Goodrow B, Wachs J, Grover S, Olive KE. Rural health professions education at East Tennessee State University: survey of graduates from the first decade of the community partnership program. *J Rural Health*. 2007;23(1):77-83. doi:10.1111/j.1748-0361.2006.00071.x
97. Frisch L, Kellerman R, Ast T. A cohort study of family practice residency graduates in a predominantly rural state: initial practice site selection and trajectories of practice movement. *J Rural Health*. 2003;19(1):47-54. doi:10.1111/j.1748-0361.2003.tb00541.x
98. Hancock C, Steinbach A, Nesbitt TS, Adler SR, Auerswald CL. Why doctors choose small towns: a developmental model of rural physician recruitment and retention. *Soc Sci Med*. 2009;69(9):1368-1376. doi:10.1016/j.socscimed.2009.08.002
99. Hanson CM, Jenkins S, Ryan R. Factors related to job satisfaction and autonomy as correlates of potential job retention for rural nurses. *J Rural Health*. 1990;6(3):302-316. doi:10.1111/j.1748-0361.1990.tb00669.x
100. Henderson Betkus M, MacLeod ML. Retaining public health nurses in rural British Columbia: the influence of job and community satisfaction. *Can J Public Health*. 2004;95(1):54-58. doi:10.1007/bf03403635
101. Henning-Smith C, Kozhimannil KB. Availability of child care in rural communities: implications for workforce recruitment and retention. *J Community Health*. 2016;41(3):488-493. doi:10.1007/s10900-015-0120-3
102. Hogue A, Huntington MK. Family physician burnout rates in rural versus metropolitan areas: a pilot study. *S D Med*. 2019;72(7):306-308.
103. Jones MP, Bushnell JA, Humphreys JS. Are rural placements positively associated with rural intentions in medical graduates? *Med Educ*. 2014; 48(4):405-416. doi:10.1111/medu.12399
104. Kent M, Verstappen AC, Wilkinson T, Poole P. Keeping them interested: a national study of factors that change medical student interest in working rurally. *Rural Remote Health*. 2018;18(4):4872. doi:10.22605/rrh4872
105. Bath B, Gabrush J, Fritzier R, et al. Mapping the physiotherapy profession in Saskatchewan: examining rural versus urban practice patterns. *Physiother Can*. 2015;67(3):221-231. doi:10.3138/ptc.2014-53
106. Mathews M, Rourke JT, Park A. The contribution of Memorial University's medical school to rural physician supply. *Can J Rural Med*. 2008;13(1):15-21.
107. Mathews M, Seguin M, Chowdhury N, Card RT. Generational differences in factors influencing physicians to choose a work location. *Rural Remote Health*. 2012;12:1864.
108. McGrail MR, Humphreys JS, Joyce CM. Nature of association between rural background and practice location: a comparison of general practitioners and specialists. *BMC Health Serv Res*. 2011;11:63. doi:10.1186/1472-6963-11-63
109. McGrail MR, Humphreys JS, Joyce CM, Scott A, Kalb G. How do rural GPs' workloads and work activities differ with community size compared with metropolitan practice? *Aust J Prim Health*. 2012;18(3):228-233. doi:10.1071/py11063
110. O'Connor M, Lee-Steere R. General practitioners' attitudes to palliative care: a Western Australian rural perspective. *J Palliat Med*. 2006; 9(6):1271-1281. doi:10.1089/jpm.2006.9.1271
111. Orzanco MG, 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.
112. Pathman DE, Konrad TR, King TS, Taylor DH Jr, Koch GG. Outcomes of states' scholarship, loan repayment, and related programs for physicians. *Med Care*. 2004;42(6):560-568. doi:10.1097/01.mlr.0000128003.81622.ef
113. Puddey IB, Mercer A, Playford DE, Riley GJ. Medical student selection criteria and socio-demographic factors as predictors of ultimately working rurally after graduation. *BMC Med Educ*. 2015;15:74. doi:10.1186/s12909-015-0359-5
114. Roots RK, Brown H, Bainbridge L, Li LC. Rural rehabilitation practice: perspectives of occupational therapists and physical therapists in British Columbia, Canada. *Rural Remote Health*. 2014;14:2506.
115. Rourke J, O'Keefe D, Ravalia M, et al. Pathways to rural family practice at Memorial University of Newfoundland. *Can Fam Physician*. 2018;64(3):e115-e125.
116. Burnett WH, Mark DH, Midtling JE, Zellner BB. Primary care physicians in underserved areas. Family physicians dominate. *West J Med*. 1995;163(6):532-536.
117. Royston P, Parmar MK, Sylvester R. Construction and validation of a prognostic model across several studies, with an application in superficial bladder cancer. *Stat Med*. 2004;23(6):907-926. doi:10.1002/sim.1691
118. Szafran O, Crutcher RA, Chaytors RG. Location of family medicine graduates' practices. What factors influence Albertans' choices? *Can Fam Physician*. 2001;47:2279-2285.
119. Thomas CR, Holzer CE 3rd. The continuing shortage of child and adolescent psychiatrists. *J Am Acad Child Adolesc Psychiatry*. 2006; 45(9):1023-1031. doi:10.1097/01.chi.0000225353.16831.5d
120. van Hassel D, Verheij R, Batenburg R. Assessing the variation in workload among general practitioners in urban and rural areas: an analysis based on SMS time sampling data. *Int J Health Plann Manage*. 2019; 34(1):e474-e486. doi:10.1002/hpm.2663
121. 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):241-247. doi:10.1046/j.1365-2923.2002.01143.x
122. Wood D. Effects of educational focus on a graduate nurse's initial choice of practice area. *J Prof Nurs*. 1998;14(4):214-219. doi:10.1016/s8755-7223(98)80061-6
123. Wood BR, Bell C, Carr J, et al. Washington state satellite HIV clinic program: a model for delivering highly effective decentralized care in under-resourced communities. *AIDS Care*. 2018;30(9):1120-1127. doi:10.1080/09540121.2018.1481194
124. Bushy A, Leipter BD. Factors that influence students in choosing rural nursing practice: a pilot study. *Rural Remote Health*. 2005;5(2):387.
125. Butler C, Sheppard L. The impact of undergraduate rural education on recently graduated physiotherapists. *Aust J Physiother*. 1999;45(1):23-31. doi:10.1016/s0004-9514(14)60339-1
126. Carter RG. The relation between personal characteristics of physicians and practice location in Manitoba. *CMAJ*. 1987;136(4):366-368.
127. Chan BT, Degani N, Crichton T, et al. Factors influencing family physicians to enter rural practice: does rural or urban background make a difference? *Can Fam Physician*. 2005;51(9):1246-1247.
128. Chen C, Petterson S, Phillips RL, Mullan F, Bazemore A, O'Donnell SD. Toward graduate medical education (GME) accountability: measuring the outcomes of GME institutions. *Acad Med*. 2013;88(9):1267-1280. doi:10.1097/ACM.0b013e31829a3ce9
129. Cramer M, Nienaber J, Helget P, Agrawal S. Comparative analysis of urban and rural nursing workforce shortages in Nebraska hospitals. *Policy Polit Nurs Pract*. 2006;7(4):248-260. doi:10.1177/1527154406296481
130. Bamford EJ, Dunne L, Taylor DS, Symon BG, Hugo GJ, Wilkinson D. Accessibility to general practitioners in rural South Australia. A case study using geographic information system technology. *Med J Aust*. 1999;171(11-12):614-616.
131. Doogan NJ, Roberts ME, Wewers ME, Tanenbaum ER, Mumford EA,

- Stillman FA. Validation of a new continuous geographic isolation scale: a tool for rural health disparities research. *Soc Sci Med*. 2018;215:123-132. doi:10.1016/j.socscimed.2018.09.005
132. Gilliland JA, Shah TI, Clark A, Sibbald S, Seabrook JA. A geospatial approach to understanding inequalities in accessibility to primary care among vulnerable populations. *PLoS One*. 2019;14(1):e0210113. doi:10.1371/journal.pone.0210113
133. Jo O, Kruger E, Tennant M. Geospatial analysis of the urban and rural/remote distribution of dental services in Scotland, Wales and Northern Ireland. *Int Dent J*. 2020;70(6):444-454. doi:10.1111/idj.12590
134. Lavergne MR. Identifying distinct geographic health service environments in British Columbia, Canada: cluster analysis of population-based administrative data. *Healthc Policy*. 2016;12(1):43-51.
135. Pearce J, Witten K, Bartie P. Neighbourhoods and health: a GIS approach to measuring community resource accessibility. *J Epidemiol Community Health*. 2006;60(5):389-395. doi:10.1136/jech.2005.043281
136. Playford DE, Mercer A, Carr SE, Puddey IB. Likelihood of rural practice in medical school entrants with prior tertiary experience. *Med Teach*. 2019;41(7):765-772. doi:10.1080/0142159x.2019.1570099
137. Iversen L, Farmer JC, Hannaford PC. Workload pressures in rural general practice: a qualitative investigation. *Scand J Prim Health Care*. 2002;20(3):139-144. doi:10.1080/028134302760234573
138. Ceronisky L, Shearer J, Weng K, Hopkins M, McKinley D. Minnesota Rural Palliative Care Initiative: building palliative care capacity in rural Minnesota. *J Palliat Med*. 2013;16(3):310-313. doi:10.1089/jpm.2012.0324
139. Griffin B, Porfeli E, Hu W. Who do you think you are? Medical student socioeconomic status and intention to work in underserved areas. *Adv Health Sci Educ Theory Pract*. 2017;22(2):491-504. doi:10.1007/s10459-016-9726-1
140. Abid Y, Connell CJW, Sijnja B, Verstappen AC, Poole P. National study of the impact of rural immersion programs on intended location of medical practice in New Zealand. *Rural Remote Health*. 2020;20(4):5785. doi:10.22605/rrh5785
141. Pathman DE, Konrad TR, Ricketts TC 3rd. The comparative retention of National Health Service Corps and other rural physicians. Results of a 9-year follow-up study. *JAMA*. 1992;268(12):1552-1558.
142. Pathman DE, Steiner BD, Jones BD, Konrad TR. Preparing and retaining rural physicians through medical education. *Acad Med*. 1999;74(7):810-820. doi:10.1097/00001888-199907000-00016
143. Pegram RW, Humphreys JS, Calcino G. Primary medical care workforce enumeration in rural and remote areas of Australia: time for a new approach? *Aust J Rural Health*. 2006;14(1):24-28. doi:10.1111/j.1440-1584.2006.00751.x
144. Rohova M. Regional imbalances in distribution of Bulgarian health professionals. *J IMAB*. 2017;23(1):1427-1431. doi:10.5272/jimab.2017231.1427
145. Smith JL. Examination of the relative importance of hospital employment in non-metropolitan counties using location quotients. *Rural Remote Health*. 2013;13(3):2497.
146. Zhu X, Mueller KJ, Vaughn T, Ullrich F. A rural taxonomy of population and health-resource characteristics. *Rural Policy Brief*. 2015;(2015 4):1-6.
147. Boscardin CK, Grbic D, Grumbach K, O'Sullivan P. Educational and individual factors associated with positive change in and reaffirmation of medical students' intention to practice in underserved areas. *Acad Med*. 2014;89(11):1490-1496. doi:10.1097/acm.0000000000000474
148. Duma O, Anton D, Tarțău L, Mocanu V. [Medical-social aspects of medical staff migration]. *Rev Med Chir Soc Med Nat Iasi*. 2011;115(2):507-511. [Romanian].
149. Garcia AN, Kuo T, Arangua L, Pérez-Stable EJ. Factors associated with medical school graduates' intention to work with underserved populations: policy implications for advancing workforce diversity. *Acad Med*. 2018;93(1):82-89. doi:10.1097/acm.0000000000001917
150. O'Connell TF, Ham SA, Hart TG, Curlin FA, Yoon JD. A national longitudinal survey of medical students' intentions to practice among the underserved. *Acad Med*. 2018;93(1):90-97. doi:10.1097/acm.0000000000001816
151. Bigbee J, Mixon D. Recruitment and retention of rural nursing students: a retrospective study. *Rural Remote Health*. 2013;13(4):2486.
152. Butler DC, Petterson S, Bazemore A, Douglas KA. Use of measures of socioeconomic deprivation in planning primary health care workforce and defining health care need in Australia. *Aust J Rural Health*. 2010;18(5):199-204. doi:10.1111/j.1440-1584.2010.01154.x
153. Horner RD, Samsa GP, Ricketts TC 3rd. Preliminary evidence on retention rates of primary care physicians in rural and urban areas. *Med Care*. 1993;31(7):640-648. doi:10.1097/00005650-199307000-00006
154. Humphreys JS. Delimiting 'rural': implications of an agreed 'rurality' index for healthcare planning and resource allocation. *Aust J Rural Health*. 1998;6(4):212-216. doi:10.1111/j.1440-1584.1998.tb00315.x
155. Kulig JC, Andrews ME, Stewart NJ, et al. How do registered nurses define rurality? *Aust J Rural Health*. 2008;16(1):28-32. doi:10.1111/j.1440-1584.2007.00947.x
156. McGirr J, Seal A, Barnard A, et al. The Australian Rural Clinical School (RCS) program supports rural medical workforce: evidence from a cross-sectional study of 12 RCSs. *Rural Remote Health*. 2019;19(1):4971. doi:10.22605/rrh4971
157. McGrail MR, Wingrove PM, Petterson SM, Humphreys JS, Russell DJ, Bazemore AW. Measuring the attractiveness of rural communities in accounting for differences of rural primary care workforce supply. *Rural Remote Health*. 2017;17(2):3925. doi:10.22605/rrh3925
158. McGrail MR, Russell DJ, O'Sullivan BG, Reeve C, Gasser L, Campbell D. Demonstrating a new approach to planning and monitoring rural medical training distribution to meet population need in North West Queensland. *BMC Health Serv Res*. 2018;18(1):993. doi:10.1186/s12913-018-3788-0
159. Steinhäuser J, Otto P, Goetz K, Szecsenyi J, Joos S. Rural area in a European country from a health care point of view: an adoption of the Rural Ranking Scale. *BMC Health Serv Res*. 2014;14:147. doi:10.1186/1472-6963-14-147
160. Hills D, Joyce C, Humphreys J. Validation of a job satisfaction scale in the Australian clinical medical workforce. *Eval Health Prof*. 2012;35(1):47-76. doi:10.1177/0163278710397339
161. 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):512-517. doi:10.1111/j.1445-5994.1995.tb01497.x
162. Hays RB, Veitch PC, Cheers B, Crossland L. Why doctors leave rural practice. *Aust J Rural Health*. 1997;5(4):198-203. doi:10.1111/j.1440-1584.1997.tb00267.x
163. Humphreys JS, Jones MP, Jones JA, Mara PR. Workforce retention in rural and remote Australia: determining the factors that influence length of practice. *Med J Aust*. 2002;176(10):472-476. doi:10.5694/j.1326-5377.2002.tb04518.x
164. Laurence CO, Williamson V, Sumner KE, Fleming J. "Latte rural": the tangible and intangible factors important in the choice of a rural practice by recent GP graduates. *Rural Remote Health*. 2010;10(2):1316.
165. Hoffmann K, Wojcowski S, George A, Schäfer WL, Maier M. Stressed and overworked? A cross-sectional study of the working situation of urban and rural general practitioners in Austria in the framework of the QUALICOPC project. *Croat Med J*. 2015;56(4):366-374. doi:10.3325/cmj.2015.56.366
166. Janes R, Elley R, Dowell A. New Zealand Rural General Practitioners 1999 Survey--Part 2: gender issues. *N Z Med J*. 2004;117(1191):U814.
167. Chisholm M, Russell D, Humphreys J. Measuring rural allied health workforce turnover and retention: what are the patterns, determinants and costs? *Aust J Rural Health*. 2011;19(2):81-88. doi:10.1111/j.1440-1584.2011.01188.x
168. Lee S, Mackenzie L. Starting out in rural New South Wales: the experiences of new graduate occupational therapists. *Aust J Rural Health*. 2003;11(1):36-43. doi:10.1046/j.1440-1584.2003.00476.x
169. Wainer J. Work of female rural doctors. *Aust J Rural Health*. 2004;12(2):49-53. doi:10.1111/j.1038-5282.2004.00557.x
170. Smith T, Cross M, Waller S, et al. Ruralization of students' horizons: insights into Australian health professional students' rural and remote placements. *J Multidiscip Healthc*. 2018;11:85-97. doi:10.2147/jmdh.s150623
171. Humphreys JS, Jones JA, Jones MP, et al. The influence of geographical location on the complexity of rural general practice activities. *Med J Aust*. 2003;179(8):416-420. doi:10.5694/j.1326-5377.2003.tb05619.x
172. Cameron PJ, Este DC, Worthington CA. Physician retention in rural Alberta: key community factors. *Can J Public Health*. 2010;101(1):79-82. doi:10.1007/bf03405568
173. Rabinowitz HK, Diamond JJ, Hojat M, Hazelwood CE. Demographic, educational and economic factors related to recruitment and retention of physicians in rural Pennsylvania. *J Rural Health*. 1999;15(2):212-218. doi:10.1111/j.1748-0361.1999.tb00742.x
174. Keane S, Smith T, Lincoln M, Fisher K. Survey of the rural allied health

- workforce in New South Wales to inform recruitment and retention. *Aust J Rural Health*. 2011;19(1):38-44. doi:10.1111/j.1440-1584.2010.01175.x
175. Eley DS, Synnott R, Baker PG, Chater AB. A decade of Australian Rural Clinical School graduates--where are they and why? *Rural Remote Health*. 2012;12:1937.
 176. Stagg P, Greenhill J, Worley PS. A new model to understand the career choice and practice location decisions of medical graduates. *Rural Remote Health*. 2009;9(4):1245.
 177. King KR, Purcell RA, Quinn SJ, Schoo AM, Walters LK. Supports for medical students during rural clinical placements: factors associated with intention to practise in rural locations. *Rural Remote Health*. 2016;16(2):3791.
 178. Brockwell D, Wielandt T, Clark M. Four years after graduation: occupational therapists' work destinations and perceptions of preparedness for practice. *Aust J Rural Health*. 2009;17(2):71-76. doi:10.1111/j.1440-1584.2008.01020.x
 179. Puddey IB, Mercer A, Playford DE, Riley GJ. Medical student selection criteria and socio-demographic factors as predictors of ultimately working rurally after graduation. *BMC Med Educ*. 2015;15:74. doi:10.1186/s12909-015-0359-5
 180. McGrail MR, Humphreys JS. Spatial access disparities to primary health care in rural and remote Australia. *Geospat Health*. 2015;10(2):358. doi:10.4081/gh.2015.358
 181. Puddey IB, Mercer A, Playford DE, Pognault S, Riley GJ. Medical student selection criteria as predictors of intended rural practice following graduation. *BMC Med Educ*. 2014;14:218. doi:10.1186/1472-6920-14-218
 182. Australian Medical Workforce Advisory Committee (AMWAC). Doctors in vocational training: rural background and rural practice intentions. *Aust J Rural Health*. 2005;13(1):14-20. doi:10.1111/j.1440-1854.2004.00640.x
 183. Beauchamp J, Bélanger M, Schofield A, Bordage R, Donovan D, Landry M. Recruiting doctors from and for underserved groups: does New Brunswick's initiative to recruit doctors for its linguistic minority help rural communities? *Can J Public Health*. 2013;104(6 Suppl 1):S44-48. doi:10.17269/cjph.104.3478
 184. Kondalsamy-Chennakesavan S, Eley DS, Ranmuthugala G, et al. Determinants of rural practice: positive interaction between rural background and rural undergraduate training. *Med J Aust*. 2015;202(1):41-45. doi:10.5694/mja14.00236
 185. Herd MS, Bulsara MK, Jones MP, Mak DB. Preferred practice location at medical school commencement strongly determines graduates' rural preferences and work locations. *Aust J Rural Health*. 2017;25(1):15-21. doi:10.1111/ajr.12301
 186. Hogenbirk JC, McGrail MR, Strasser R, Lacarte SA, Kevat A, Lewenberg M. Urban washout: how strong is the rural-background effect? *Aust J Rural Health*. 2015;23(3):161-168. doi:10.1111/ajr.12183
 187. Kwan MMS, 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. doi:10.1371/journal.pone.0180394
 188. Playford D, Ngo H, Gupta S, Puddey IB. Opting for rural practice: the influence of medical student origin, intention and immersion experience. *Med J Aust*. 2017;207(4):154-158. doi:10.5694/mja16.01322
 189. 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):493-497. doi:10.1097/ACM.0b013e3182488c06
 190. 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):1041-1048. doi:10.1001/jama.286.9.1041
 191. 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):1225-1228. doi:10.2105/ajph.90.8.1225
 192. Runge CE, MacKenzie A, Loos C, et al. Characteristics of Queensland physicians and the influence of rural exposure on practice location. *Intern Med J*. 2016;46(8):981-985. doi:10.1111/imj.13156
 193. Sen Gupta T, Woolley T, Murray R, Hays R, McCloskey T. Positive impacts on rural and regional workforce from the first seven cohorts of James Cook University medical graduates. *Rural Remote Health*. 2014;14:2657.
 194. Smith T, Sutton K, Beauchamp A, et al. Profile and rural exposure for nursing and allied health students at two Australian universities: a retrospective cohort study. *Aust J Rural Health*. 2021;29(1):21-33. doi:10.1111/ajr.12689
 195. Strasser R, Hogenbirk JC, Lewenberg M, Story M, Kevat A. Starting rural, staying rural: how can we strengthen the pathway from rural upbringing to rural practice? *Aust J Rural Health*. 2010;18(6):242-248. doi:10.1111/j.1440-1584.2010.01167.x
 196. 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):165-171. doi:10.1111/ajr.12106
 197. Drovandi A, Woolley T. Workforce supply of pharmacists in Queensland communities from James Cook University Pharmacy Graduates. *Aust J Rural Health*. 2020;28(5):462-468. doi:10.1111/ajr.12662
 198. O'Sullivan B, McGrail M, Major L, Woodfield M, Holmes C. Rural work outcomes of medical students participating in a contracted Extended Rural Cohort (ERC) program by course-entry preference. *Med Teach*. 2019;41(6):703-710. doi:10.1080/0142159x.2019.1569755
 199. Playford DE, Ng WQ, Burkitt T. Creation of a mobile rural workforce following undergraduate longitudinal rural immersion. *Med Teach*. 2016;38(5):498-503. doi:10.3109/0142159x.2015.1060304
 200. Rosenblatt RA, Whitcomb ME, Cullen TJ, Lishner DM, Hart LG. Which medical schools produce rural physicians? *JAMA*. 1992;268(12):1559-1565.
 201. 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(2):2313.
 202. Somers GT, Spencer RJ. Nature or nurture: the effect of undergraduate rural clinical rotations on pre-existent rural career choice likelihood as measured by the SOMERS Index. *Aust J Rural Health*. 2012;20(2):80-87. doi:10.1111/j.1440-1584.2012.01258.x
 203. Bailey BE, Wharton RG, Holman CD. Glass half full: survival analysis of new rural doctor retention in Western Australia. *Aust J Rural Health*. 2016;24(4):258-264. doi:10.1111/ajr.12260
 204. Shires L, Allen P, Cheek C, Deb W. Regional universities and rural clinical schools contribute to rural medical workforce, a cohort study of 2002 to 2013 graduates. *Rural Remote Health*. 2015;15(3):3219.
 205. Gupta S, Ngo H, Burkitt T, Puddey I, Playford D. Survival analysis of Rural Clinical School of Western Australia graduates: the long-term work of building a long-term rural medical workforce. *BMC Health Serv Res*. 2019;19(1):998. doi:10.1186/s12913-019-4816-4
 206. Clark TR, Freedman SB, Croft AJ, et al. Medical graduates becoming rural doctors: rural background versus extended rural placement. *Med J Aust*. 2013;199(11):779-782. doi:10.5694/mja13.10036
 207. Zink T, Center B, Finstad D, et al. 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. doi:10.1097/ACM.0b013e3181d2b537
 208. Young L, Kent L, Walters L. The John Flynn Placement Program: evidence for repeated rural exposure for medical students. *Aust J Rural Health*. 2011;19(3):147-153. doi:10.1111/j.1440-1584.2011.01201.x
 209. Eley D, Baker P, Chater B. The Rural Clinical School Tracking Project: more IS better--confirming factors that influence early career entry into the rural medical workforce. *Med Teach*. 2009;31(10):e454-459. doi:10.3109/01421590902850857
 210. May J, Brown L, Burrows J. In-place training: optimizing rural health workforce outcomes through rural-based education in Australia. *Educ Sci*. 2018;8(1):20. doi:10.3390/educsci8010020
 211. Playford DE, Evans SF, Atkinson DN, Auret KA, Riley GJ. Impact of the Rural Clinical School of Western Australia on work location of medical graduates. *Med J Aust*. 2014;200(2):104-107. doi:10.5694/mja13.11082
 212. 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):113-119. doi:10.1097/acm.0000000000000885
 213. Kane KY, Quinn KJ, Stevermer JJ, et al. Summer in the country: changes in medical students' perceptions following an innovative rural community experience. *Acad Med*. 2013;88(8):1157-1163. doi:10.1097/ACM.0b013e318299fb5d
 214. 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):809-814. doi:10.1046/j.1365-2923.2003.01596.x
215. Brockwell D, Wielandt T, Clark M. Four years after graduation: occupational therapists' work destinations and perceptions of preparedness for practice. *Aust J Rural Health.* 2009;17(2):71-76. doi:10.1111/j.1440-1584.2008.01020.x
216. Emery A, Hurley S, Williams J, Pougnauld S, Mercer A, Tennant M. A seven-year retrospective analysis of students entering medicine via a rural student recruitment program in Western Australia. *Aust J Rural Health.* 2009;17(6):316-320. doi:10.1111/j.1440-1584.2009.01105.x
217. Jamar E, Newbury J, Mills D. Early career location of University of Adelaide rural cohort medical students. *Rural Remote Health.* 2014;14:2592.
218. 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):480-486. doi:10.1056/nejm198808253190805
219. 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):934-939. doi:10.1056/nejm199304013281307
220. Rabinowitz HK, Diamond JJ, Markham FW, Santana AJ. Retention of rural family physicians after 20-25 years: outcomes of a comprehensive medical school rural program. *J Am Board Fam Med.* 2013;26(1):24-27. doi:10.3122/jabfm.2013.01.120122
221. 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):255-260. doi:10.1001/jama.281.3.255
222. Longenecker RL, Andrilla CHA, Jopson AD, et al. Pipelines to pathways: medical school commitment to producing a rural workforce. *J Rural Health.* 2021;37(4):723-733. doi:10.1111/jrh.12542
223. 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):216-221. doi:10.5694/mja16.00063
224. Hajat A, Stewart K, Hayes KL. The local public health workforce in rural communities. *J Public Health Manag Pract.* 2003;9(6):481-488. doi:10.1097/00124784-200311000-00007
225. Jones JA, Humphreys JS, Adena MA. Rural GPs' ratings of initiatives designed to improve rural medical workforce recruitment and retention. *Rural Remote Health.* 2004;4(3):314.
226. Russell DJ, Humphreys JS, McGrail MR, Cameron WI, Williams PJ. The value of survival analyses for evidence-based rural medical workforce planning. *Hum Resour Health.* 2013;11:65. doi:10.1186/1478-4491-11-65
227. Ray RA, Fried O, Lindsay D. Palliative care professional education via video conference builds confidence to deliver palliative care in rural and remote locations. *BMC Health Serv Res.* 2014;14:272. doi:10.1186/1472-6963-14-272
228. Humphreys JS, McGrail MR, Joyce CM, Scott A, Kalb G. Who should receive recruitment and retention incentives? Improved targeting of rural doctors using medical workforce data. *Aust J Rural Health.* 2012;20(1):3-10. doi:10.1111/j.1440-1584.2011.01252.x
229. Kuhn B, Kleij KS, Liersch S, Steinhäuser J, Amelung V. Which strategies might improve local primary healthcare in Germany? An explorative study from a local government point of view. *BMC Fam Pract.* 2017;18(1):105. doi:10.1186/s12875-017-0696-z
230. Irby MB, Boles KA, Jordan C, Skelton JA. TeleFIT: adapting a multidisciplinary, tertiary-care pediatric obesity clinic to rural populations. *Telemed J E Health.* 2012;18(3):247-249. doi:10.1089/tmj.2011.0117
231. Asghari S, Kirkland MC, Blackmore J, et al. A systematic review of reviews: recruitment and retention of rural family physicians. *Can J Rural Med.* 2020;25(1):20-30. doi:10.4103/cjrm.cjrm_4_19
232. Dolea C, Stormont L, Braichet JM. Evaluated strategies to increase attraction and retention of health workers in remote and rural areas. *Bull World Health Organ.* 2010;88(5):379-385. doi:10.2471/blt.09.070607
233. Verma P, Ford JA, Stuart A, Howe A, Everington S, Steel N. A systematic review of strategies to recruit and retain primary care doctors. *BMC Health Serv Res.* 2016;16:126. doi:10.1186/s12913-016-1370-1
234. Royston PJ, Mathieson K, Leafman J, Ojan-Sheehan O. Medical student characteristics predictive of intent for rural practice. *Rural Remote Health.* 2012;12:2107.
235. Godwin DM, Hoang H, Crocombe LA, Bell E. Dental practitioner rural work movements: a systematic review. *Rural Remote Health.* 2014;14(3):2825.
236. Noya F, Carr S, Freeman K, Thompson S, Clifford R, Playford D. Strategies to facilitate improved recruitment, development, and retention of the rural and remote medical workforce: a scoping review. *Int J Health Policy Manag.* 2021;11(10):2022-2037. doi:10.34172/ijhpm.2021.160
237. Buykx P, Humphreys J, Wakerman J, Pashen D. Systematic review of effective retention incentives for health workers in rural and remote areas: towards evidence-based policy. *Aust J Rural Health.* 2010;18(3):102-109. doi:10.1111/j.1440-1584.2010.01139.x
238. Benzie KM, Premji S, Hayden KA, Serrett K. State-of-the-evidence reviews: advantages and challenges of including grey literature. *Worldviews Evid Based Nurs.* 2006;3(2):55-61. doi:10.1111/j.1741-6787.2006.00051.x