

Preparing Physicians for Rural Practice: Availability of Rural Training in Rural-Centric Residency Programs

Davis G. Patterson, PhD
C. Holly A. Andrilla, MS
Lisa A. Garberson, PhD

ABSTRACT

Background Exposing residents to rural training encourages future rural practice, but unified accreditation of allopathic and osteopathic graduate medical education under one system by 2020 has uncertain implications for rural residency programs.

Objective We describe training locations and rural-specific content of rural-centric residency programs (requiring at least 8 weeks of rurally located training) before this transition.

Methods In 2015, we surveyed residency programs that were rurally located or had rural tracks in 7 specialties and classified training locations as rural or urban using Rural-Urban Commuting Area (RUCA) codes.

Results Of 1849 residencies in anesthesiology, emergency medicine, general surgery, internal medicine, obstetrics and gynecology, pediatrics, and psychiatry, 119 (6%) were rurally located or offered a rural track. Ninety-seven programs (82%) responded to the survey. Thirty-six programs required at least 8 weeks of rural training for some or all residents, and 69% of these rural-centric residencies were urban-based and 53% were osteopathic. Locations were rural for 26% of hospital rotations and 28% of continuity clinics. Many rural-centric programs (35%) reported only urban ZIP codes for required rural block rotations; 54% reported only urban ZIP codes for required rural clinic sessions, and 31% listed only urban ZIP codes in reporting rural full-time training locations. Programs varied widely in coverage of rural-specific training in 6 core competencies.

Conclusions In multiple specialties important for rural health care systems, little rurally located residency training and rural-specific content was available. Substantial proportions of training locations reported to be rural were actually urban according to a common rural definition.

Introduction

Although 19% of the US population was estimated to be rural in 2014, rural physicians comprised only 11% of all physicians.¹ Urban-rural maldistribution in generalist specialties (family medicine, general internal medicine, and general pediatrics) and subspecialties, including anesthesiology, emergency medicine, general surgery, obstetrics and gynecology, and psychiatry, are widespread and well documented.²⁻⁴ Past research assessing provider characteristics, aspects of training, financial incentives, and characteristics of practice settings indicates that along with a rural background (eg, being born in a rural area), rural training, especially during residency, is one of the strongest predictors of rural practice,⁵⁻¹⁴ particularly for physicians from an urban background.¹⁵ A small amount of graduate medical education (GME), however, occurs in rural settings in high-need specialties such as family

medicine,¹⁶ internal medicine,⁹ general surgery,^{17,18} and psychiatry.¹⁹

Osteopathic residency programs contributed more growth to rural GME over 10 years (2005–2015) than allopathic programs,²⁰ but the transition by 2020 to a single allopathic and osteopathic GME accreditation system operated by the Accreditation Council for Graduate Medical Education (ACGME) has uncertain implications for small and rurally focused residency programs, particularly osteopathic programs. Osteopathic programs outside of generalist specialties could be vulnerable because these programs tend to have fewer residents than allopathic programs, and rural programs are more often smaller.²¹ Though maintaining a minimum number of residents is not a core requirement for ACGME accreditation, the ACGME does specify minimums in detailed specialty requirements. Thus, a residency with fewer than the minimum required number of residents could receive a citation, increasing its vulnerability to losing accreditation.

Though several studies examining rurally focused GME in family medicine have found that rural

DOI: <http://dx.doi.org/10.4300/JGME-D-18-01079.1>

Editor's Note: The online version of this article contains the survey used in the study.

training is associated with future rural practice,⁵ but that rural training opportunities are relatively scarce,¹⁶ little is known about the availability of rural training and the rural content of programs in other specialties. Past studies found 12 surgery residency programs with a rural training track and 5 programs in rural areas¹⁰ as well as 6 programs in emergency medicine with required rural rotations.¹⁴ This study seeks to quantify the availability of rurally located training and rural content in residency programs aiming to produce rural physicians in the rurally relevant specialties of anesthesiology, emergency medicine, general surgery, internal medicine, obstetrics and gynecology, pediatrics, and psychiatry.

Methods

We used FREIDA Online and the American Osteopathic Association Opportunities database to identify all 1849 US allopathic, osteopathic, and dual-accredited residency programs in 2015 in the specialties of anesthesiology, emergency medicine, general surgery, internal medicine, obstetrics and gynecology, pediatrics, and psychiatry. We included programs meeting any of 3 criteria: (1) rural location, for programs in a non-metropolitan county according to

What was known and gap

Several studies have examined family medicine graduate medical education programs that focus on rural practice and have found that rural training is associated with future rural practice, although training opportunities are scarce. However, little is known about the availability of rural training and the rural content of programs in other specialties.

What is new

A survey of residency programs that are rurally located or have rural tracks in 7 specialties, using Rural-Urban Commuting Area codes to classify training locations as rural or urban.

Limitations

The definition used for rural may not have captured all programs providing relevant training that prepares physicians for rural practice.

Bottom line

In multiple specialties important for rural health care systems, there was little rurally located residency training and rural-specific content available. Many training locations reported to be rural were actually urban according to a common rural definition.

Urban Influence Codes (UICs)²² or rural ZIP code according to Rural-Urban Commuting Area Codes (RUCAs; 2014 version 3.1 ZIP approximation; codes 4.0–10.6 excluding 4.1, 5.1, 7.1, 8.1, and 10.1)²³; (2) urban allopathic programs offering a self-reported “rural track” in FREIDA Online; and (3) lacking

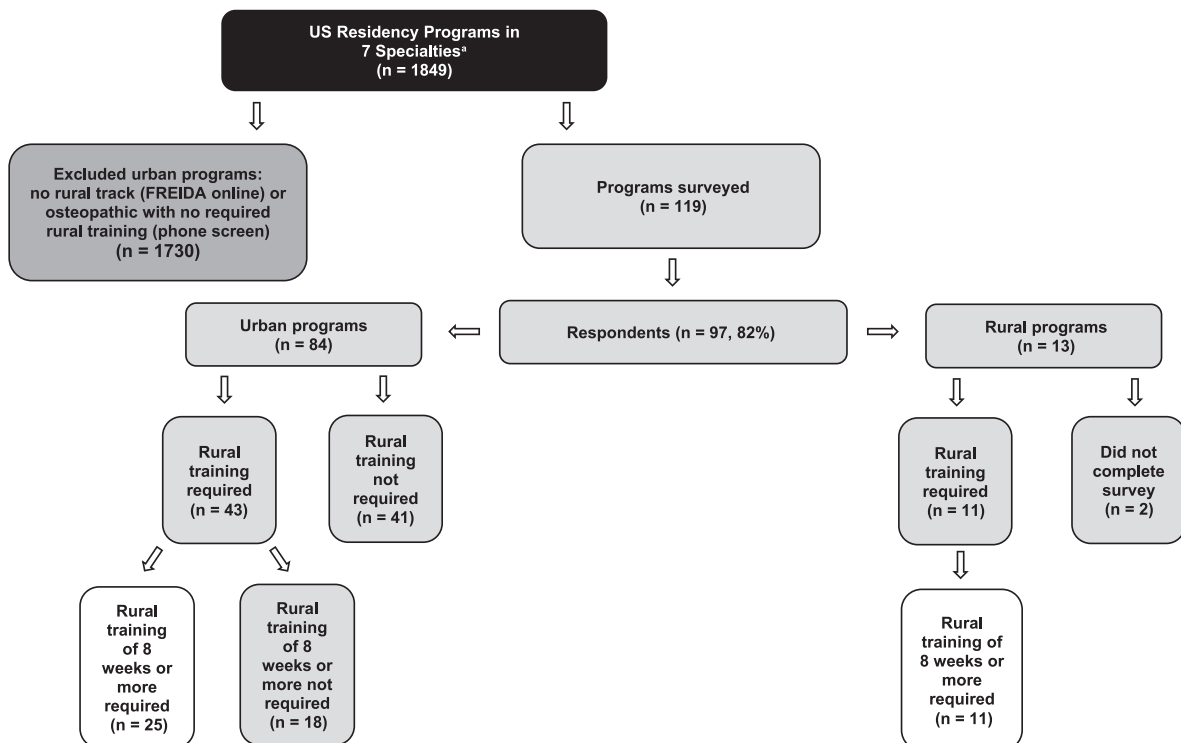


FIGURE 1
Rural-Centric Residency Program Sample Selection Process

^a Specialties are anesthesiology, emergency medicine, internal medicine, obstetrics and gynecology, pediatrics, psychiatry, and general surgery.

information on osteopathic programs with a rural track, we included urban osteopathic programs where personnel responded “yes” to a screening question by telephone or e-mail: “Does your program require rural training for some or all of your graduates?” (FIGURE 1). We used either UICs or RUCAs to classify rurally located programs to more inclusively identify programs likely to have a rural mission.

We modeled the 55-question survey instrument (provided as online supplemental material) after a similar survey of family medicine residency programs that was developed with the input of experts in allopathic, osteopathic, and rural GME,¹⁶ as well as items from previous studies.^{24–26} Programs responding that they did not require at least 8 total weeks of rural training across all program years for any residents were not asked further questions. This 8-week minimum is based on a study of family medicine residency programs in 1998, suggesting that fewer than 2 months of rural training resulted in lower yields of graduates to rural practice.²⁷ We are not aware of more recent work identifying an appropriate threshold for the amount of rural training. We refer to programs meeting the 8-week threshold as “rural-centric.” Subsequent items included basic program information and questions about residency training locations and content. Training location information included up to 5 ZIP codes each for required rural continuity clinic sessions, block rotations, and full-time training in a rural location, as well as ZIP codes of the hospital where most inpatient rotations occurred and the base program continuity clinic. The questionnaire also asked the following question about 6 core competencies defined by the American Board of Medical Specialties (ABMS)²⁸ and the ACGME: “In which of the following core competencies does your program provide training that is specific to practice in a rural setting?” If a respondent indicated rural-specific content, the questionnaire asked an open-ended question about rural-specific skills covered.

We made up to 8 attempts from April through November 2015 by e-mail or telephone to contact programs meeting inclusion criteria to respond to the Qualtrics online survey. Contacts included program coordinators, program directors, and directors of medical education.

We geocoded training location ZIP codes using RUCA codes, which offer a more precise classification of urban and rural geography than county-based methods such as metropolitan/non-metropolitan or UIC categories. We tested for statistically significant differences between rural-centric and non-rural-centric programs in terms of specialties, type of sponsoring institution, type of accreditation, and US

Census region using chi-square or Fisher’s exact tests as appropriate. We used *t* tests, chi-square, or Fisher’s exact tests as appropriate to compare allopathic with osteopathic programs and rurally located programs with urban programs that required rural training on items measuring the number of weeks of required rural block rotations, urban block rotations, required rural clinic sessions, training locations, and rural-specific content in ABMS/ACGME core competencies. We used SPSS 22.0 (IBM Corp, Armonk, NY) for all analyses. Significant findings are reported at $P < .05$.

The University of Washington Human Subjects Division determined that this study was not human subjects research.

Results

Of 119 programs meeting study inclusion criteria, 97 responded to the survey (82%). Response rates by specialty were as follows: anesthesiology 50% (1 of 2), emergency medicine 72% (13 of 18), general surgery 86% (24 of 28), internal medicine 77% (27 of 35), obstetrics and gynecology 78% (7 of 9), pediatrics 100% (11 of 11), and psychiatry 88% (14 of 16). Results reported exclude missing responses.

Overall, 58% (54 of 93) of responding programs reported actively recruiting applicants with an interest in rural practice. Of the 56% (54 of 97) that reported rural training was required of some or all residents, 67% (36 of 54) indicated that the required rural training (block rotations, continuity clinic sessions, or full-time rural training) was at least 8 weeks, programs we refer to as “rural-centric.” The TABLE shows characteristics of responding rural-centric and non-rural-centric programs. Over a third of rural-centric programs were in internal medicine (36%, 13 of 36), followed by general surgery (25%, 9 of 36). We identified only 2 rural-centric programs each in obstetrics and gynecology and pediatrics, and no rural-centric programs in anesthesiology. Rural-centric and non-rural-centric programs did not differ by type of sponsoring institution (community-based, non-affiliated; community-based, medical school affiliated; community-based, medical school administered; medical school-based; military; or other) or US Census region. Among respondents, 53% (19 of 36) of rural-centric residencies had osteopathic accreditation only, a greater proportion than among all 1849 residencies in the 7 specialties, of which just 14% (268 of 1849) were osteopathic only and 3% (52 of 1849) were dually accredited (not shown). Rural-centric programs are the subject of all subsequent analyses.

TABLE

Characteristics of US Rural-Centric and Non-Rural-Centric Residency Programs Responding to the Survey (2015)^a

Characteristic	Rural-Centric Programs ^b (n = 36)	Non-Rural-Centric Programs ^b (n = 61)	Total ^b (n = 97)
Specialty			<i>P</i> = .74 ^c
Anesthesiology	0 (0%)	1 (2%)	1 (1%)
Emergency medicine	5 (14%)	8 (13%)	13 (13%)
General surgery	9 (25%)	15 (25%)	24 (25%)
Internal medicine	13 (36%)	14 (23%)	27 (28%)
Obstetrics and gynecology	2 (6%)	5 (8%)	7 (7%)
Pediatrics	2 (6%)	9 (15%)	11 (11%)
Psychiatry	5 (14%)	9 (15%)	14 (14%)
Total	36 (37%)	61 (63%)	97
Type of sponsoring institution			<i>P</i> = .38 ^c
Community-based, non-affiliated	5 (14%)	7 (12%)	12 (13%)
Community-based, medical school affiliated	17 (47%)	20 (35%)	37 (40%)
Community-based, medical school administered	1 (3%)	5 (9%)	6 (6%)
Medical school-based	12 (33%)	25 (44%)	37 (40%)
Military	0 (0%)	0 (0%)	0 (0%)
Other	1 (3%)	0 (0%)	1 (1%)
Total	36 (39%)	57 (61%)	93 ^d
Accreditation			<i>P</i> = .01 ^{c,e}
Allopathic only	17 (47%)	14 (23%)	31 (32%)
Osteopathic only	19 (53%)	38 (62%)	57 (59%)
Dually accredited	0 (0%)	9 (15%)	9 (9%)
Total	36 (37%)	61 (63%)	97
Census region			<i>P</i> = .40 ^c
Northeast	3 (8%)	10 (16%)	13 (13%)
Midwest	11 (31%)	20 (33%)	31 (32%)
South	15 (42%)	16 (26%)	31 (32%)
West	7 (19%)	15 (25%)	22 (23%)
Total	36 (37%)	61 (63%)	97

^a Rurally located programs and urban programs with a rural track or requiring rural training were surveyed. "Rural-centric" programs are those requiring at least 8 weeks of rural training.

^b Column total percentages may not equal 100 due to rounding.

^c Row comparisons, Fisher's exact test.

^d Four programs did not respond to this question.

^e With Bonferroni correction.

Rural and Urban Training Configurations

Of 36 rural-centric programs, 69% (25 of 36) were urban with a rural track; the remainder were rurally located. Of rural-centric programs, 83% (29 of 35) reported requiring rural block rotations, and 47% (16 of 34) had training based full-time in a rural location. Of programs in internal medicine, obstetrics and gynecology, pediatrics, and psychiatry, 65% (13 of 20) reported requiring rural clinic sessions (programs in other specialties were not queried). The mean reported total number of weeks of required rural block rotations, across all years of training, was 21.9

(FIGURE 2); rurally located rural-centric programs reported more than rural-centric programs in urban areas with a rural track (49.1 versus 11.3 weeks, not shown; *P* < .001). Mean weekly hours reported in required rural clinic sessions, across all years of training, was 28.3.

Across all years of training, 26% (32 of 123) of hospital inpatient rotation locations and 28% (21 of 74) of base program continuity clinic locations were rural according to RUCA codes. Substantial proportions of rural block rotations, required rural clinic sessions, and rural full-time training sites reported as rural were in RUCA-defined urban areas (FIGURE 3).

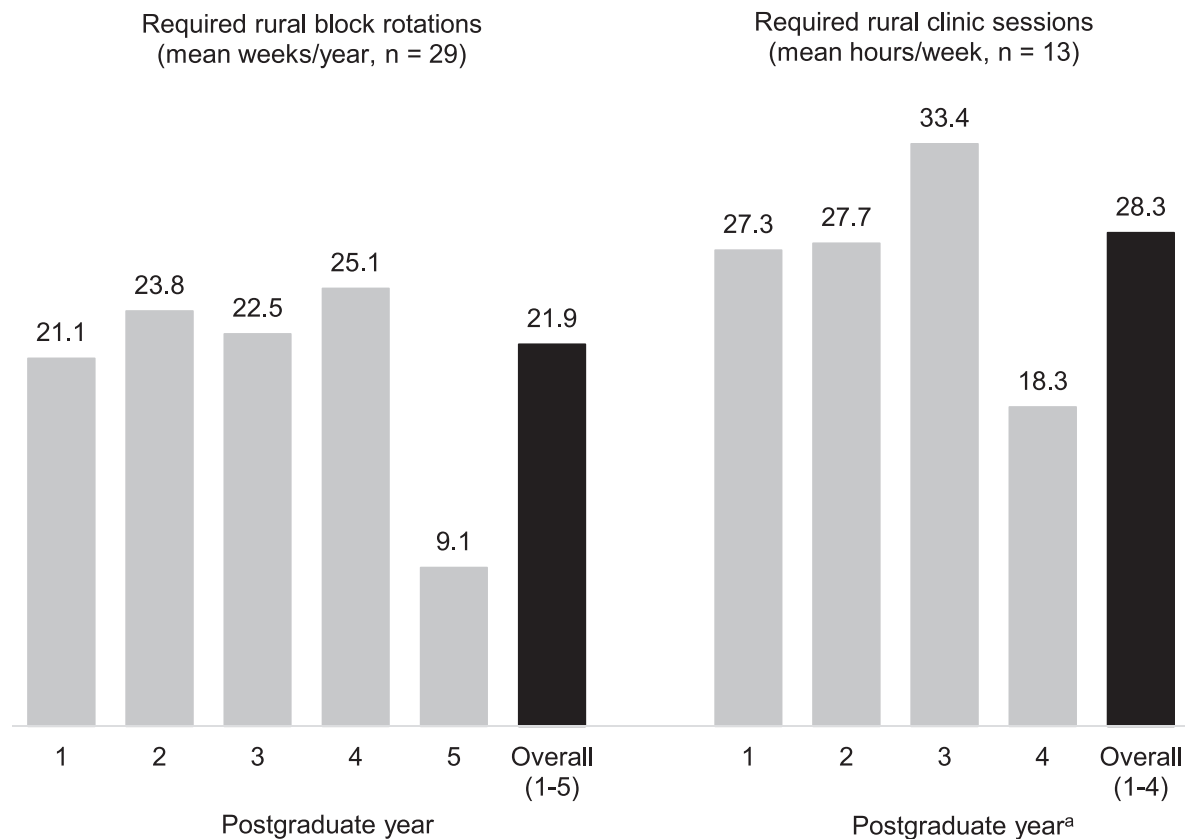


FIGURE 2
Time in Required Rural Block Rotations and Required Rural Continuity Clinic Sessions in Rural-Centric US Residencies (2015)

^a This question was only asked for internal medicine, obstetrics and gynecology, pediatrics, and psychiatry, all of which are 4 or fewer years in duration.

For required rural block rotations, 34% (10 of 29) of rural-centric programs reported only urban ZIP codes; 28% (8 of 29) reported a mix of urban and rural ZIP codes. Overall, 44% (47 of 106) of required rural block rotation locations listed, across all years of training, were in rural areas. Over half (54%, 7 of 13) of programs reported only urban ZIP codes for required rural clinic sessions; others (46%, 6 of 13) reported all rural ZIP codes. Half (50%, 26 of 52) of ZIP codes listed for rural clinic sessions were rural. For rural full-time training locations, 31% (5 of 16) of programs reported urban ZIP codes only; 69% (11 of 16) reported all rural ZIP codes. Of ZIP codes listed for rural full-time training, 75% (42 of 56) were rural. There were no significant differences by type of accreditation (allopathic or osteopathic) in any of the analyses of rural and urban training locations.

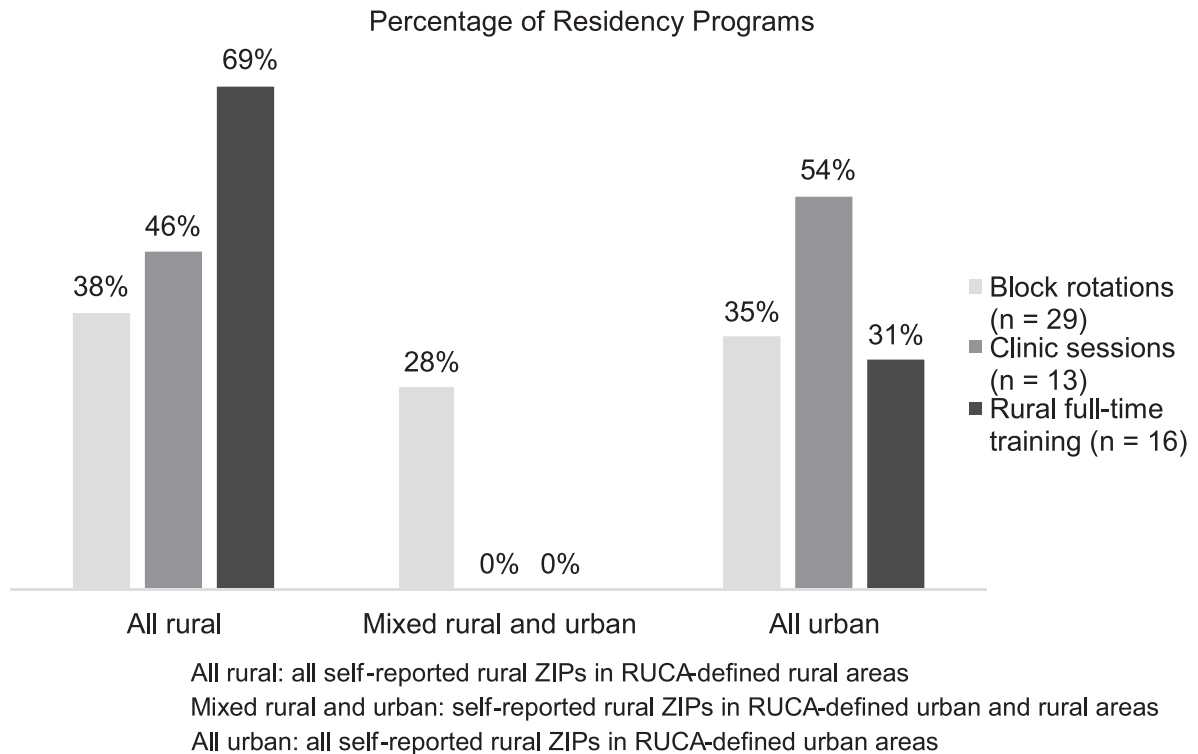
Rural-Specific Training Content

Overall, 55% (12 of 22) of rural-centric programs reported providing rural-specific training in the ABMS/ACGME core competencies of patient care/

procedural skills and systems-based practice, compared with 45% (10 of 22) in medical knowledge, 41% (9 of 22) in interpersonal and communication skills, 41% (9 of 22) in professionalism, and 32% (7 of 22) in practice-based learning. Rurally located programs did not differ from urban programs that required at least 8 weeks of rural training in providing rural-specific training in each of the core competencies. Programs also did not differ significantly on these items by type of accreditation (allopathic versus osteopathic). Most programs did not respond to the follow-up question asking for rural-specific skills covered, but responses included the need for an exceptional knowledge base and clinical judgment in a low-resource context, for example, to manage critical care and care transitions independently.

Discussion

This study provides evidence that rurally located training available in critical, relevant specialties is limited, particularly in anesthesiology, obstetrics and gynecology, and pediatrics. Some programs reported

**FIGURE 3**

Distribution of Programs' Reported Rural Training Experiences in Rural-Centric US Residencies by Rural-Urban Commuting Area (RUCA) Codes (2015)

rural training locations that were not rural according to RUCA codes, consistent with findings from a similar study of family medicine programs.¹⁶ Reported rural-specific content addressing the ABMS/ACGME core competencies varied widely across rural-centric programs.

The overrepresentation of osteopathic programs among the small numbers of rural-centric programs identified in this study indicates that a successful transition to ACGME accreditation will be important to maintaining rural training in the 7 specialties studied. Multiple calls have been issued for GME reform based on rational planning to address physician workforce maldistribution and meet the needs of all US residents, particularly given the influence of residency training on choice of practice location and development of community-relevant competencies.^{1,20,29,30}

Study limitations include the use of a rural definition that may not have captured all programs providing relevant training for preparing rural physicians, for example, urban programs serving high numbers of rural patients. Two emergency medicine programs did not report continuity clinic ZIP codes. As with all surveys, the reliability of self-reported data is subject to possible bias or misinterpretation.

Responding programs may not represent the total population of interest, but this limitation is mitigated by the high response rate. Finally, small numbers may have prevented detection of real differences between programs by location or type of accreditation.

More research is needed to understand how programs with a rural mission define "rural" and designate training sites as providing rural clinical experiences. More evaluation of training models is also needed to identify programs in varying rural contexts that are successful at producing high-quality rural physicians.

Conclusions

Of 119 residency programs in anesthesiology, emergency medicine, general surgery, internal medicine, obstetrics and gynecology, pediatrics, and psychiatry that were either rurally located or urban with a rural track or required rural training, our survey identified 36 that reported requiring at least 8 weeks total of rural training. What program personnel counted as "rural" did not always meet a commonly used definition of rural location. Just over half of the 36 programs reported providing rural-specific training in 6 ABMS/ACGME core competencies. These findings provide a baseline for monitoring changes in rural

training after unification of allopathic and osteopathic accreditation.

References

1. Institute of Medicine. *Graduate Medical Education That Meets the Nation's Health Needs*. Washington, DC: The National Academies Press; 2014.
2. Fordyce MA, Chen FM, Doescher MP, Hart LG. 2005 Physician Supply and Distribution in Rural Areas of the United States. Final Report #116. <https://depts.washington.edu/uwrhrc/uploads/RHRC%20FR116%20Fordyce.pdf>. Accessed August 27, 2019.
3. MacDowell M, Glasser M, Fitts M, Nielsen K, Hunsaker M. A national view of rural health workforce issues in the USA. *Rural Remote Health*. 2010;10(3):1531.
4. American College of Obstetricians and Gynecologists. ACOG committee opinion No. 586: health disparities in rural women. *Obstet Gynecol*. 2014;123(2, pt 1):384–388. doi:10.1097/01.AOG.0000443278.06393.d6.
5. Hempel S, Maggard Gibbons M, Ulloa JG, Macqueen I, Mlake-Lye I, Beroes J, et al. Rural Healthcare Workforce: A Systematic Review. VA Evidence-based Synthesis Program Reports. Washington, DC: Department of Veterans Affairs; 2015.
6. Jarman BT, Cogbill TH, Mathiason MA, O'Heron CT, Foley EF, Martin RF, et al. Factors correlated with surgery resident choice to practice general surgery in a rural area. *J Surg Educ*. 2009;66(6):319–314. doi:10.1016/j.jsurg.2009.06.003.
7. Chen F, Fordyce M, Andes S, Hart LG. Which medical schools produce rural physicians? A 15-year update. *Acad Med*. 2010;85(4):594–598. doi:10.1097/ACM.0b013e3181d280e9.
8. Deveney K, Deatherage M, Oehling D, Hunter J. Association between dedicated rural training year and the likelihood of becoming a general surgeon in a small town. *JAMA Surg*. 2013;148(9):817–821. doi:10.1001/jamasurg.2013.2681.
9. Dick JF 3rd, Wilper AP, Smith S, Wipf J. The effect of rural training experiences during residency on the selection of primary care careers: a retrospective cohort study from a single large internal medicine residency program. *Teach Learn Med*. 2011;23(1):53–57. doi:10.1080/10401334.2011.536893.
10. Doty B, Zuckerman R, Borgstrom D. Are general surgery residency programs likely to prepare future rural surgeons? *J Surg Educ*. 2009;66(2):74–79. doi:10.1016/j.jsurg.2008.11.005.
11. Myhre DL, Bajaj S, Jackson W. Determinants of an urban origin student choosing rural practice: a scoping review. *Rural Remote Health*. 2015;12(3):3483.
12. Goodfellow A, Ulloa JG, Dowling PT, Talamantes E, Chheda S, Bone C, et al. Predictors of primary care physician practice location in underserved urban or rural areas in the United States: a systematic literature review. *Acad Med*. 2016;91(9):1313–1321. doi:10.1097/ACM.0000000000001203.
13. MacQueen IT, Maggard-Gibbons M, Capra G, Raaen L, Ulloa JG, Shekelle PG, et al. Recruiting rural healthcare providers today: a systematic review of training program success and determinants of geographic choices. *J Gen Intern Med*. 2018;33(2):191–199. doi:10.1007/s11606-017-4210-z.
14. Talley BE, Moore SA, Camargo CA Jr, Rogers J, Ginde AA. Availability and potential effect of rural rotations in emergency medicine residency programs. *Acad Emerg Med*. 2011;18(3):297–300. doi:10.1111/j.1553-2712.2010.00987.x.
15. Chan BT, Degani N, Crichton T, Pong RW, Rourke JT, Goertzen J, 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.
16. Evans D, Patterson DG, Andrilla CHA, Schmitz D, Longenecker R. Do residencies that aim to produce rural family physicians offer relevant training? *Fam Med*. 2016;48(8):596–602.
17. Blanchard J, Petterson S, Bazemore A, Watkins K, Mullan F. Characteristics and distribution of graduate medical education training sites: are we missing opportunities to meet US health workforce needs? *Acad Med*. 2016;91(10):1416–1422. doi:10.1097/ACM.0000000000001184.
18. Sirinek KR, Willis R, Stewart RM. Geographic maldistribution of general surgery PGYI residents: another US surgical desert. *Am J Surg*. 2014;208(6):1023–1028. doi:10.1016/j.amjsurg.2014.06.033.
19. Bonham C, Salvador M, Altschul D, Silverblatt H. Training psychiatrists for rural practice: a 20-year follow-up. *Acad Psychiatry*. 2014;38(5):623–626. doi:10.1007/s40596-014-0080-4.
20. US Government Accountability Office. Physician workforce: locations and types of graduate training were largely unchanged, and federal efforts may not be sufficient to meet needs. May 2017. <https://www.gao.gov/assets/690/684946.pdf>. Accessed August 27, 2019.
21. Cummings M. Osteopathic students' graduate medical education aspirations versus realities: the relationship of osteopathic medicine and primary care. *Acad Med*. 2016;91(1):36–41. doi:10.1097/ACM.0000000000000892.
22. US Department of Agriculture. Economic Research Service. Urban Influence Codes. <http://www.ers.usda.gov/data-products/urban-influence-codes.aspx>. Accessed August 27, 2019.

23. US Department of Agriculture. Economic Research Service. Rural Urban Commuting Area (RUCA) Codes 3.1. August 4, 2014. <https://ruralhealth.und.edu/ruca>. Accessed August 27, 2019.
24. Chen FM, Andrilla CH, Doescher MP, Morris C. WWAMI Rural Health Research Center. Family medicine residency training in rural locations. Final Report #126. depts.washington.edu/uwrhrc/uploads/RHRC_FR126_Chen.pdf. Accessed August 27, 2019.
25. Rosenblatt RA, Schneeweiss R, Hart LG, Casey S, Andrilla CH, Chen FM. Family medicine training in rural areas. *JAMA*. 2002;288(9):1063–1064. doi:10.1001/jama.288.9.1063.
26. Rural Training Track Technical Assistance Program. Policy Brief: Rural Residency Training for Family Medicine Physicians: Graduate Early-Career Outcomes, 2008–2012. depts.washington.edu/uwrhrc/uploads/RTT_Grad_Outcomes_PB_2013.pdf. Accessed August 27, 2019.
27. Bowman RC, Penrod JD. Family practice residency programs and the graduation of rural family physicians. *Fam Med*. 1998;30(4):288–292.
28. American Board of Medical Specialties. Based on Core Competencies. <http://www.abms.org/board-certification/a-trusted-credential/based-on-core-competencies/>. Accessed August 7, 2019.
29. Council on Graduate Medical Education. Towards the Development of a National Strategic Plan for Graduate Medical Education: 23rd Report. <https://www.hrsa.gov/advisorycommittees/bhpradvisory/cogme/Reports/twentythirdreport.pdf>. Accessed August 27, 2019.
30. United States Government Accountability Office. HHS Needs Better Information to Comprehensively Evaluate Graduate Medical Education Funding. <https://www.gao.gov/assets/700/690581.pdf>. Accessed August 27, 2019.

[gao.gov/assets/700/690581.pdf](https://www.gao.gov/assets/700/690581.pdf). Accessed August 27, 2019.



All authors are with University of Washington School of Medicine. **Davis G. Patterson, PhD**, is Research Assistant Professor, Department of Family Medicine, and Deputy Director, WWAMI Rural Health Research Center; **C. Holly A. Andrilla, MS**, is Biostatistician and Research Scientist, Department of Family Medicine; and **Lisa A. Garberson, PhD**, is Research Scientist, Department of Family Medicine.

Funding: This study was supported by the Federal Office of Rural Health Policy (FORHP), Health Resources and Services Administration (HRSA), US Department of Health and Human Services (HHS) under cooperative agreement #U1CRH03712. The information, conclusions, and opinions expressed in this article are those of the authors and no endorsement by FORHP, HRSA, or HHS is intended or should be inferred.

Conflict of interest: The authors declare they have no competing interests.

This work was previously presented at the Association of American Medical Colleges Health Workforce Research Conference, Chicago, Illinois, May 5, 2016; the National Rural Health Association Annual Conference, Minneapolis, Minnesota, May 12, 2016; the AcademyHealth Annual Research Meeting, Boston, Massachusetts, June 25–27, 2016; the North American Primary Care Research Group Annual Meeting, Colorado Springs, Colorado, November 12–16, 2016; and the RTT Collaborative Annual Meeting, Anderson, South Carolina, April 20, 2017.

The authors would like to thank Randall Longenecker, MD, and David Schmitz, MD, for their contributions to study design, and Cynthia Coulthard, MPH, for study implementation and analysis assistance.

Corresponding author: Davis G. Patterson, PhD, WWAMI Rural Health Research Center, 4311 11th Avenue NE, Suite 210, Seattle, WA 98105, 206.543.1892, davis@uw.edu

Received December 17, 2018; revisions received May 15, 2019, and August 3, 2019; accepted August 5, 2019.