RESEARCH ARTICLE

Differences in referral patterns for rural primary care physicians from 2005 to 2016

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Abstract

Objective: To examine differences in referral patterns in a nationally representative sample between primary care physicians (PCP) practicing in rural vs nonrural areas and changes over time.

Study Design: Using the 2005-2016 National Ambulatory Medical Care Survey and multivariate logit regression models, I compare referral patterns of PCPs in rural vs nonrural areas.

Data Collection: Multiple years of data were combined.

Principal Findings: A PCP visit was 1.9 percentage points (95% confidence interval: 0.1 pp, 3.8 pp) more likely to result in a referral in nonrural areas than rural areas, controlling for physician and patient characteristics, a 17 percent increase. This difference is driven by a widening gap in referral rates between nonrural and rural areas over time, with large differences in later periods. The regression-adjusted predicted probability of a PCP visit resulting in a referral was 71 percent higher in nonrural than rural areas in 2013-2014 and 92 percent higher in 2015-2016.

Conclusions: Recognizing that the optimal PCP referral rate is unknown, referrals are less common in rural areas with a widening gap in recent years. This difference may reflect specialist availability, distance to care, or patient preferences. As changes occur to health care financing and delivery, continuing to monitor practice patterns is important to ensure patients are receiving appropriate levels of care across geographic regions.

KEYWORDS

ambulatory care, physician practice patterns, referrals, rural

1 | INTRODUCTION

Referrals from primary care physicians (PCP) to specialists and among different specialists and subspecialists are important contributors to medical care costs and quality.^{1,2} Referrals have increased over time, potentially due to the increased complexity of medical care¹; research shows PCP referral rates are stable within physician over time, but have significant variation across physicians.⁴⁻⁶ Referrals contribute to appropriate medical care^{1,4}; better understanding current determinants of referrals and appropriate use is important for

improving care delivery, particularly in medically underserved rural areas.^{7,8} Access to care and availability of specialists are concerns in rural areas due to distance to providers and the nonrural location of many specialists.⁷⁻¹⁰ This results in decreased specialist visits and an increased reliance on PCPs in rural areas.¹¹

The ideal PCP referral rate within and across conditions to optimize patient care to provide the highest quality at the lowest cost is unknown. Referrals may be both over- and under-used by PCPs¹²; referrals may generate excess spending and increase care fragmentation, but specialists have been shown to be more likely to

provide evidence-based care in their area of expertise.² PCPs vary substantially in their knowledge across and within specialties and in the comprehensiveness of conditions they treat.^{13,14} If PCPs in rural areas are able to adequately diagnose and treat conditions rather than referring to a specialist, lower referral rates may improve patient access and decrease care coordination problems. However, if PCP diagnosis and treatment of a condition are suboptimal, then patients would benefit from additional referrals in rural areas.

Previous research using data from the 1992 to 2002 period shows referrals are less common in rural areas,¹⁵⁻¹⁷ with patients in rural areas less likely to see specialists.¹⁸ Referrals for conditions generally managed by PCPs, which may be of lower value, are more common in areas with higher concentrations of specialists.⁴ Given this lower propensity to refer when there are fewer specialists combined with low levels of specialists in rural areas, including OB/GYNs and other specialties such as neurology and psychiatry,⁷ rural areas may have lower rates of both higher- and lower-value referrals.

Changes in the US financing and delivery system due to the Affordable Care Act (ACA) insurance expansion¹⁹⁻²¹ and delivery system changes and innovations²²⁻²⁴ have differentially impacted rural areas. Understanding differences in referral patterns between rural and urban areas over time is important. Referrals have significant downstream implications for cost and quality, and optimizing referrals may be a key contribution in delivery system reform efforts.¹² The differences in impacts of the ACA in rural and nonrural areas may extend to changes in referral patterns, which have not been examined over time or in the post-ACA era. This study quantifies differences in referral patterns in a nationally representative sample between primary care physicians practicing in rural vs nonrural areas and assesses changes in these patterns over the 2005-2016 period.

2 | METHODS

2.1 | Overview

Using the 2005-2016 National Ambulatory Medical Care Survey, I compare the referral patterns of physicians in rural vs nonrural areas, controlling for a number of factors associated with referral patterns. Using this 12-year period of data, changes over time in referral rates between rural and nonrural areas are examined.

2.2 | Data and sample

The data used are ambulatory visits to office-based physicians from the National Ambulatory Medical Care Survey (NAMCS) for 2005-2016, conducted by the National Center for Health Statistics (NCHS).²⁵ The NAMCS is a survey of physicians that includes detailed information about 50 patient visits in a 1-week period. The average unweighted response rate of the NAMCS over the period is 49.7 percent, although response rates declined over the period

What This Study Adds

- Referrals from primary care physicians (PCP) to specialists and among different specialists are important contributors to medical care costs and quality, although the optimal referral rate is unknown.
- Changes in the US financing and delivery system over the last decade have differentially impacted rural areas, and this may extend to changes in referral patterns between rural and nonrural areas.
- This study quantifies differences in referral patterns in a nationally representative sample between PCPs practicing in rural vs nonrural areas and assesses changes in these patterns over the 2005-2016 period.
- PCP referrals are significantly less common in rural areas, with a widening gap in recent years.

(Table S1).²⁵ NCHS constructs visit weights to account for physician selection and nonresponse²⁵; these weights make the sample representative of all office-based physician visits nationally.

The analytic sample includes visits by adults aged 18 and older to primary care office-based physicians, including physicians employed by practices owned by hospitals in 2014-2016. The sample excludes federally employed physicians, physicians practicing in community health centers, and physicians practicing primarily in hospital outpatient facilities.²⁵ Additionally, visits were excluded if they are missing data on the outcome or control variables (Figure S1 and Table S1).

2.3 | Measures

The primary outcome measure is whether the visit resulted in a referral, as determined by the visit disposition. The primary independent variable of interest is whether the physician is located in a metropolitan statistical area (MSA). Visits with physicians outside of an MSA are termed "rural" and those with physicians located in an MSA are termed "nonrural." This distinction between rural and nonrural is based on the federal definition by the Office of Management and Budget, one of two major federal classifications of rural areas²⁶; this indicator is consistently available in the NAMCS over the full period.

Included controls reflect physician, patient, and visit characteristics. First, physician and organizational characteristics include information about physician specialty (ie, general/family medicine vs internal medicine), practice ownership (ie, physician is full or part owner, office setting is private practice, physician is in solo practice, practice is owned by physician or physician group), geographic (Census) region, and whether a practice uses any electronic medical records. Patient characteristics include race/ethnicity (including data imputed by NCHS), sex, age, and payment type (ie, private insurance, Medicare, Medicaid, or "Other"). "Other" payment includes worker's compensation, self-pay/uninsured, no charge, and other.

Visit characteristics include the major reason for visit (eg, visit for a new problem) and a linear time trend for year of visit. Chronic condition controls include indicators from a visit-level question of whether, in addition to diagnoses coded during the visit, a patient currently has arthritis, asthma, chronic renal failure, coronary artery disease/ischemic heart disease, diabetes, cerebrovascular disease, congestive heart failure, chronic obstructive pulmonary disease, hyperlipidemia, hypertension, obesity, and/or osteoporosis.

2.4 | Statistical analysis

Descriptive statistics compare visits to physicians in a rural vs nonrural area using *t* tests (continuous variables) and chi-squared tests (binary variables) to determine whether statistically significant differences exist between visits in rural vs nonrural areas.

To determine whether referral patterns differ for PCP visits in rural vs nonrural areas for the full period, I first estimate a logit model with the outcome of whether the visit resulted in a referral and the independent variable of whether the visit was to a PCP physician in a rural or nonrural area ("unadjusted results"). To isolate the association between rural location and whether a visit results in a referral, I re-estimate this regression controlling for physician, organization, patient, and insurance characteristics ("adjusted results") as described above. Average marginal effects (AME) are calculated using the effect calculated for each observation in the sample and averaged over the sample; results indicate the change in predicted probability of the visit resulting in a referral associated with a one-unit change in the independent variable.

To determine whether differences in PCP referral patterns between rural and nonrural areas have changed over the period, I estimate a logit model with independent variables of rural, categorical indicators of 2-year periods (eg, 2005-2006), and interaction terms between the variables. This is repeated with controls as described above, excluding the time trend. I note whether the difference in the predicted probability of referrals between rural and nonrural areas is statistically significant for each period. As a sensitivity analysis to ensure that changes in the sample composition are not driving the results, I repeat this analysis restricted to physicians in practices that are owned by a physician or physician group.

Analyses use visit weights constructed by NCHS to make results representative of national visits. Standard errors for average marginal effects and predicted probabilities are calculated using the delta method and account for the complex survey design. An alpha of 0.05 is considered statistically significant. All analyses are conducted in Stata-MP version 15.0 (StataCorp). The University of Massachusetts Amherst Institutional Review Board considered this study exempt.

2.5 | Subgroup and sensitivity analyses

I conduct several subgroup and sensitivity analyses to further explore the findings. To ensure that changes in the sample are not

driving changes over time in referral rates, I limit the analysis to PCPs in a practice owned by physicians or a physician group. PCP referral patterns likely vary from those of specialists; I examine differences in medical and surgical specialist referrals in rural and nonrural areas as well, as well as examining changes over time. I estimate adjusted regressions examining the association of referrals and rural location when stratifying the PCP analytic sample by Census region of the physician location as these regions may vary in rurality. I additionally examine whether there are differences in rural and nonrural areas for less and more complex patients, as measured by estimating adjusted regression when stratifying the PCP analytic sample by whether the patient had three or fewer chronic conditions vs four or more chronic conditions. To conduct an exploratory analysis of referral patterns by PCPs for specific reasons for visits, PCP visits are classified using the primary reason for visit categories identified by Barnett et al.^{1,27,28} This categorizes visits into 12 mutually exclusive categories: cardiovascular, dermatologic, ear/nose/throat, general/viral, gastrointestinal, gynecologic/breast, neurologic, ocular, orthopedic, psychiatric, pulmonary, and urologic.

3 | RESULTS

Visit-weighted results included 3 272 860 219 visits to an office-based PCP over the 12-year period from 2005 to 2016 (Table 1; full results in Table S2). Of these visits, 84.7 percent were to a physician located in an MSA (nonrural). Thirteen percent of visits resulted in a referral to another doctor, with referrals significantly less common in rural areas than nonrural areas. PCPs in rural areas were significantly more likely to have a specialty of general/family practice vs internal medicine. Significant differences in patient demographics and insurance status were seen; visits in rural areas were for patients who were more likely to be non-Hispanic White, and more likely to have public insurance. Visits in rural areas were also more likely to be for patients with COPD, congestive heart failure, and arthritis, but less likely to be for patients with chronic renal failure. Other differences in chronic conditions between rural and nonrural areas were not statistically significant.

A visit to a PCP located in a nonrural area is 2.9 percentage points (pp) more likely to result in a referral to another physician than visits to physician in a rural area (unadjusted AME = 0.0287, $P < .001$; Table 2; full results in Table S3). When controlling for patient, visit, physician, and organizational characteristics, a visit to a PCP in a nonrural area was associated with a 1.9 pp increase in the probability of referral (adjusted AME = 0.0192, $P < .01$). This is a substantial increase in relative terms, representing a 17.3 percent increase from the regression-adjusted mean predicted probability of referral in rural areas.

Referral rates are increasing over time in nonrural areas for the 2005-2016 period (Figure 1). In rural areas, the predicted probability a PCP visit resulted in a referral rises over the 2005-2010 period and then begins to decline. This results in non-statistically significant differences in predicted probabilities of a PCP visit resulting in a referral

TABLE 1 Descriptive statistics for outpatient primary care physician office visits (2005-2016)

Mean (SD) or %	Overall (N = 3 272 860 219)	Physician located in a metropolitan statistical area	
		No (N = 499 428 419)	Yes (N = 2 773 431 799)
Referral to other MD	12.7	10.3	13.2*
In MSA	84.7	0	100.0*
Physician characteristics			
Physician specialty			
General/family practice	57.2	71.9	54.6*
Internal medicine	42.8	28.1	45.4
Physician is full or part owner of practice	63.2	65.4	62.8
Office setting is a private solo or group practice	90.9	90.5	91.0
Physician is in a solo practice	36.0	40.1	35.2
Practice is owned by physician or physician group	76.8	77.2	76.7
Practice uses any electronic medical records	61.3	54.6	62.5
Patient characteristics			
Patient is female	57.8	58.1	57.7
Patient age in years	55.3 (0.3)	56.8 (0.9)	55.1 (0.3)
Race/Ethnicity			
Non-Hispanic White	73.2	88.2	70.5*
Non-Hispanic Black	10.7	7.0	11.4
Hispanic	11.0	3.6	12.3
Non-Hispanic Other	5.0	1.2	5.7
Patient payment type			
Private	54.6	44.7	56.4*
Medicare	30.9	38.6	29.5
Medicaid	7.8	10.1	7.4
Other—worker's comp, self-pay, no charge, and other	6.8	6.6	6.8
Patient chronic conditions			
Arthritis	17.2	20.0	16.6*
Diabetes	18.3	17.9	18.4
Hyperlipidemia	31.5	28.6	32.0
Hypertension	42.5	43.4	42.4
Obesity	11.7	11.0	11.8

Note: Statistical significance based on *t* tests and chi-squared for categorical variables. Linearized standard errors in parentheses for continuous variables, accounting for sample design. Overall sample size is 79 702 weighted to represent 3 272 860 219 visits over the 2005-2016 period. The five most common chronic conditions are reported.

*Indicates difference significant at $P < .05$.

between rural and nonrural areas for 2005-2012, and significantly higher probabilities of referral in nonrural vs rural areas in 2013-2016. Unadjusted (Figure 1, Panel A) and regression-adjusted (Figure 1, Panel B) analyses show similar results. The gap in later years is quite large, with the regression-adjusted predicted probability of a PCP visit resulting in a referral being 71 percent higher in nonrural than rural areas in 2013-2014 and 92 percent higher in 2015-2016. Results are very similar in magnitude and direction when restricted to PCPs in a practice owned by physicians or a physician group (Figure S2, Panels

A and B), but the statistical significance of differences over time varies slightly from the main results. A similar pattern appears in the analysis of specialist referral rates over the period (Figure S3, Panels A and B).

Subgroup analyses show that there are differences in the association of PCP referrals with being in a rural area across different geographic (Census) regions (Table 3, Panel A) and patient complexity (Table 3, Panel B). The predicted probability of referral was higher in nonrural than rural areas only in the Midwest, although the magnitude was similar in the South and West. In the Northeast,

TABLE 2 Regression-adjusted estimates of change in probability of referral for primary care physician visits based on rural status

Outcome: Visit resulted in referral to other physician	(1)	(2)
Physician is located in MSA	0.029* (0.010)	0.019* (0.0095)
Controls included?	No	Yes
Number of visits (weighted)	3 272 860 219	3 272 860 219

Note: Weights are used to make sample nationally representative. Coefficients shown are average marginal effects calculated after logit regression with standard errors in parentheses calculated to account for sampling design. Controls included in column 2 for female patient, patient age, major reason for visit, patient payment type, patient race/ethnicity, year of visit, physician (Census) region, physician full or part owner, office setting is private practice, solo practice, physician ownership of practice, use of electronic medical records, and patient chronic conditions of arthritis, asthma, chronic renal failure, coronary artery disease/ischemic heart disease, diabetes, cerebrovascular disease, congestive heart failure, chronic obstructive pulmonary disease, hyperlipidemia, hypertension, obesity, and osteoporosis.

* $P < .05$.

the predicted probability of referral was slightly negatively associated with being in a nonrural area, although this difference was not statistically significant. Regression-adjusted results were similar for less and more complex patients, stratified based on the number of chronic conditions, although the difference between rural and nonrural areas was not statistically significant for more complex patients. Analysis of referrals by specialists shows that there is no statistically or practically significant difference in the predicted probability of the visit resulting in a referral between rural and nonrural areas (Table S4). Exploratory analyses of differences between rural and nonrural areas in the predicted probability a PCP visit resulted in a referral by reason for visit show that using both unadjusted and regression-adjusted analyses (Figure S4, Panels A and B), differences between rural and nonrural areas are not consistent by reason for visit. The predicted probability of a referral is lower in rural areas for some, but not all, reasons for visits; the confidence intervals on these estimates are wide for rural areas, making it difficult to draw conclusions from this analysis.

4 | DISCUSSION

In this study, I find that PCP visits in nonrural areas are more likely to result in a referral than PCP visits in rural areas, and this result is both statistically and practically significant. Increased referral rates in nonrural areas persist even after controlling for a number of patient, visit, physician, and organizational characteristics associated with referrals. The gap in referral rates between rural and nonrural areas widens over the period, with increasing differences over time and large differences in the 2013-2016 period. The differences I find in PCP referral patterns over time may contribute to persistent differences in care patterns for individuals in rural areas. PCP visits and PCP supply rates are declining nationally,^{22,29} and if there is a

differential decline in rural areas, rural patients would have fewer occasions to receive a PCP referral. Therefore, the difference in specialty referrals in a given year between rural and nonrural patients is likely even larger than what was estimated in the per-visit analyses.

These results are consistent with previous findings that physicians in nonrural areas had higher referral rates than physicians in rural areas.¹⁵⁻¹⁷ Iverson et al¹⁵ find family physician self-reported referral rates are lower in small towns than larger towns and cities; this study did not include internists or control for patient characteristics, which influence the probability of referrals and may differ among physician patient panels.¹⁵ Using Medicare data from the early 1990s and examining shared-patient relationships, Shea and colleagues (1999) find referrals are less common in rural areas, but that seeing both a usual care provider and at least one other physician was not less common in rural areas.¹⁶ Their definition of referrals is difficult to compare to this study as referrals may reflect shared-patient patterns from cross-practice coverage, long-term co-management of a condition by a specialist and a PCP, or true referrals.^{1,16,30}

In addition to the widening gap over time in referrals between rural and nonrural areas, there is variation in the size of the difference across Census regions. The probability of a visit resulting in a referral is significantly higher in the Midwest, where there is the largest difference in specialist availability between rural and nonrural locations.⁷ Patients often travel from rural to urban areas to see specialists,¹⁰ with patients and caregivers incurring substantial financial and time costs.^{11,31,32} The difference between the probability of referral in rural and nonrural areas is very small in the Northeast, where there are substantially more specialists located in rural areas than in other regions.⁷ In line with previous findings,⁴ these region-specific results suggest an increased number of specialists in rural areas may result in more PCP referrals for specialty care.

The overall findings suggest PCPs have a higher threshold for referral in rural areas. As previously discussed, this may improve care if it reduces overutilization of specialists and reduces care fragmentation, but may reflect less adequate care if PCPs are not able to properly diagnose and treat conditions they would otherwise refer to specialists. The widening gap due to increases in referrals in nonrural regions and plateaus or decreases in referrals in rural region, combined with differences in results across regions, suggests that the lower rates of referrals in rural areas may reflect limited access to specialty care. With continued increases in referral rates in nonrural areas, the optimal referral rate may in fact lie between the rural and nonrural rates.

I find suggestive but not conclusive evidence these differences in referrals are primarily concentrated among less complex patients. Differences in the probability of a referral between rural and nonrural areas are statistically significant for less complex patients and not for more complex patients; however, the magnitude of the effects being nearly identical across these groups makes interpreting this finding difficult. Similarly, there are not consistent, nor statistically significant, differences between regression-adjusted referral probabilities in rural and nonrural areas when PCP visits are categorized for reason for visit.

Panel A: Unadjusted results **Panel B: Adjusted results**

FIGURE 1 Predicted PCP visit referral rates for rural and nonrural areas over time, 2005-2016.

Note: Panel A, Unadjusted results. *Indicates difference in predicted probability of visit resulting in referral between nonrural and rural areas is statistically significant ($P < .05$). 95% confidence intervals are shown.

Panel B, Adjusted results. *Indicates difference in predicted probability of visit resulting in referral between nonrural and rural areas is statistically significant ($P < .05$). 95% confidence intervals are shown. Controls are included in the regression for female patient, patient age, major reason for visit, patient payment type, patient race/ethnicity, year of visit, physician (Census) region, physician full or part owner, office setting is private practice, solo practice, physician ownership of practice, use of electronic medical records, and patient chronic conditions of arthritis, asthma, chronic renal failure, coronary artery disease/ischemic heart disease, diabetes, cerebrovascular disease, congestive heart failure, chronic obstructive pulmonary disease, hyperlipidemia, hypertension, obesity, and osteoporosis

TABLE 3 Subgroup analyses for PCP visit sample

Outcome: Visit resulted in referral to other physician				
Panel A: Results stratified by Census region of physician location				
	(1)	(2)	(3)	(4)
	Northeast	Midwest	South	West
Physician is located in MSA	−0.012 (0.031)	0.023* (0.0081)	0.028 (0.017)	0.035 (0.018)
Controls included?	Yes	Yes	Yes	Yes
Number of visits (weighted)	589 363 357	763 618 582	1 220 489 178	699 389 102
Panel B: Results stratified by patient chronic conditions				
	(1)	(2)		
	3 or fewer chronic conditions	4 or more chronic conditions		
Physician is located in MSA	0.019* (0.0094)	0.020 (0.022)		
Controls included?	Yes	Yes		
Number of visits (weighted)	2 906 053 674	366 806 544		

Note: Weights are used to make sample nationally representative. Coefficients shown are average marginal effects calculated after logit regression with standard errors in parentheses calculated to account for sampling design. Panel A is stratified by Census region of physician office location. Panel B is stratified by whether the patient has three or fewer chronic conditions vs four or more chronic conditions from the included set. Controls included in all regressions (as applicable) for female patient, patient age, major reason for visit, patient payment type, patient race/ethnicity, year of visit, physician (Census) region, physician full or part owner, office setting is private practice, solo practice, physician ownership of practice, use of electronic medical records, and patient chronic conditions of arthritis, asthma, chronic renal failure, coronary artery disease/ischemic heart disease, diabetes, cerebrovascular disease, congestive heart failure, chronic obstructive pulmonary disease, hyperlipidemia, hypertension, obesity, and osteoporosis.

* $P < .05$.

Due to difficulties in accessing specialty care in rural areas, significant attention has focused on the use of electronic consults and telemedicine.³³ Electronic consults and related training mechanisms allow PCPs to obtain specialist advice regarding diagnosis and treatment without making a formal referral. Electronic consults have been shown to be acceptable to PCPs and specialists, although patients require ongoing management by the PCP rather than transferring care to a specialist.^{34–36} Electronic consults can increase PCP skill sets and comprehensiveness of their care, but may be difficult to sustain if PCPs are not adequately compensated for the additional workload.^{36–38} Telemedicine allows specialists to provide care, often via video consultation with a nonphysician practitioner doing the hands-on work during the physical exam and operating video equipment.³⁹ Telemedicine can increase access to specialists for patients in rural areas, substantially decreasing travel costs for either patients or specialists.^{23,34,39,40} Both of these types of changes to care delivery may allow PCPs in rural areas to make fewer referrals for in-person visits and maintain a high quality of care, but are still very uncommon.^{34,37,41} For example, in 2017, after significant growth in telemedicine over the decade prior, 0.4 percent of members of a large population of commercially insured individuals used non–primary care telemedicine in 2017.⁴¹ Thus, increases in telemedicine by specialists over the period are not likely to explain the widening gap in referrals between rural and nonrural areas.

The study has several limitations. The first is in the composition of the NAMCS physician sample; the sample excludes physicians practicing in community health centers and hospital outpatient departments and does not include nurse practitioners or other nonphysician practitioners. Physicians practicing in hospital outpatient departments generally have higher referral rates.¹ An analysis of 2011 NAMCS and NHAMCS data, the last year for which complete information for all settings is available, shows that 6.8 percent of adult PCP visits are in hospital outpatient departments, 4.6 percent are in community health centers, and 88.6 percent of visits are to the office-based PCPs examined in this study (author's calculations). Thus, although the results do not include the universe of all primary care visits nationally, they are representative of the vast majority of outpatient PCP visits. Changes over time in the composition of physician practice ownership^{42,43} and the proportion of primary care visits by advanced practice clinicians⁴⁴ may cause the proportion of visits this sample represents to change over time, which is a limitation of the available NAMCS data. Physicians employed by hospital-owned practices—distinct from hospital outpatient departments—were added to the sample in 2014–2016, which may be an additional limitation of the generalizability of the composition of the sample over time. I control for practice ownership in the regression-adjusted results to account for this and conduct an additional sensitivity analysis for changes over time, which shows broadly similar results. The

second limitation is that I use a limited definition of rurality, based on whether the PCP is located in an MSA. This definition is one of two used by the federal government and may potentially undercount rural areas as areas within MSAs may be rural. The MSA definition results in approximately 15 percent of the total US population in 2010 categorized as living in rural areas; a more careful analysis using both government definitions by the Federal Office of Rural Health Policy finds that about 18 percent of the total US population is categorized as living in rural areas. Thus, there are likely to be relatively few PCPs classified as nonrural by the definition used here that would be classified as rural under a more careful definition. The other primary limitation of the use of MSA as a rurality measure is that it does not allow for a thorough analysis of the association between referral patterns and the degree of rurality or specialist supply, which would be helpful to identify policy levers to optimize referral patterns. Third, the indicator of a visit resulting in a referral does not reflect completed referrals nor does it show the target of the referral (eg, specialty or specific physician). Previous research showed the indicator was highly specific but only moderately sensitive⁴⁵ and that not all referrals are made during office visits,⁴⁶ meaning that the referral rates I find are likely an underestimate of true referral rates in all geographic areas. Estimates of referral completion rates show that approximately half of referrals are completed, although this varies across specialties and reasons for referral⁴⁷⁻⁴⁹; it is not known whether this rate varies by rural location.¹⁶ If PCPs in rural areas have more issues in completing referrals due to common access issues in rural areas such as specialist supply, wait times, or patient travel limitations,^{11,50} this may be one explanation for lower referral rates.

My findings suggest that referrals by PCPs located in rural areas are significantly less common than in nonrural areas, and the difference has widened over time with changes in the health care financing and delivery system. Advances in telemedicine and electronic consults may improve care for patients in rural areas that are underserved by specialists, but this will require appropriate compensation of PCPs to ensure that patients receive adequate and well-coordinated care.^{34,36-38} Continued attention to changes in rural health care patterns of primary and specialty care given ongoing rural hospital closures and associated changes in availability of specialty care²⁴ is important to ensure adequate access to care and quality of care for rural populations.

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SUPPORTING INFORMATION

Additional supporting information may be found online in the Supporting Information section.

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