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CLINICAL RESEARCH

Longitudinal Urban-Rural Discrepancies in the US Orthopaedic Surgeon Workforce

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Abstract

Background It is unclear whether the supply of orthopaedic surgeons can meet the needs of a growing and aging population. This may be especially concerning in rural areas where there are known disparities in overall healthcare provision.

Questions/purposes We therefore (1) determined urban-rural trends in the US physician and orthopaedic workforce (including the age of that workforce) from 1995 to 2010; (2) geographically mapped the physician and orthopaedic distribution; and (3) examined urban-rural changes in select nonorthopaedic musculoskeletal provider (chiropractor and podiatrist) workforces from 2000 to 2010.

Methods County-level provider data from 1995 to 2010 were obtained from the Department of Health and Human Services. This was aggregated to Hospital Referral Regions and ranked by Rural-Urban Continuum Code. Hospital Referral Region-level data were mapped to identify geographic trends. Total physician and orthopaedic surgeon workforce data were averaged across the most urban and rural regions for the study period.

Results There were urban-rural discrepancies in the physician and orthopaedic workforce from 1995 to 2010 with fewer orthopaedic surgeons in rural areas than urban areas (6.52 versus 8.73 per 100,000 in 2010; $p = 0.001$). Furthermore, orthopaedic surgeons in rural areas were older than their urban counterparts, with a workforce age ratio (age > 55: age < 55 years) of 0.92 versus 0.65 in 2010 ($p = 0.024$). From 2000 to 2010, the rural chiropractor and podiatrist workforces showed tremendous growth of 229.6% and 279.9%, respectively.

Conclusions There were significant urban-rural orthopaedic surgeon workforce discrepancies from 1995 to 2010. Concurrent growth in chiropractor and podiatrist numbers shows significant trends in the musculoskeletal provider workforce that warrant continuing observation and analysis.

Level of Evidence Level IV, economic and decision analyses. See Guidelines for Authors for a complete description of levels of evidence.

One of the authors certifies that he (JNG), or a member of his immediate family, has or may receive payments or benefits, during the study period, an amount less than USD 10,000 from Affinergy (Morrisville, NC, USA), less than USD 10,000 from Alphatec (Carlsbad, CA, USA), USD 10,000–USD 100,000 from DePuy (Raynham, MA, USA), USD 10,000–USD 100,000 from Harvard Clinical Research Institute (Boston, MA, USA), less than USD 10,000 from Medtronic (Minneapolis, MN, USA), less than USD 10,000 from Powered Research (Research Triangle Park, NC, USA), and USD 10,000–USD 100,000 from Stryker (Kalamazoo, MI, USA). All ICMJE Conflict of Interest Forms for authors and *Clinical Orthopaedics and Related Research* editors and board members are on file with the publication and can be viewed on request.
Each author certifies that his or her institution approved or waived approval for the reporting of this case and that all investigations were conducted in conformity with ethical principles of research.

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Introduction

With the continued growth and aging of the population, demand for healthcare services, and for musculoskeletal care in particular, is expected to substantially increase in the United States. The number of Americans older than 65 years will increase 104% from 2000 to 2030 [4, 10]. As the general population increases in size, the elderly

population will grow faster than the population of younger Americans [10]. Furthermore, the elderly, who already have a higher utilization of physician services than the rest of the population [3], are increasing their utilization rate. Between 1980 and 2000, the number of physician visits per capita in people 74 to 84 years old increased 80% from 3.5 to 6.3 visits per year [4].

It is unclear whether the current and future supply of orthopaedic surgeons is sufficient to meet this need. It has been reported that between 2000 and 2020, the demand for orthopaedic services is expected to increase by 23% in this country [14]. The main drivers of this demand include increasing age and prevalence of osteoarthritis of the hip and knee, as well as obesity [6, 10]. Current estimates indicate that the supply of orthopaedic surgeons to provide this care will increase by only 2% [14]. The surgeon supply projections are complicated by the fact that among active and future physicians, the effective physician supply may be further influenced by generational differences in gender, lifestyle choices, and practice patterns [4]. As a result, this unmet demand has the potential to result in care previously performed by orthopaedic surgeons instead to be offered by midlevel and other musculoskeletal providers including chiropractors and podiatrists.

There are also well-documented concerns regarding disparities in the provision of healthcare services between rural and urban populations [5, 9, 19]. Numerous studies have shown that rural areas of the country tend to have fewer and older physicians, particularly general surgeons [5, 7, 13, 15, 16, 20]. There is reason to propose that similar urban-rural disparities exist in the orthopaedic surgery workforce, and if so, nonorthopaedic providers of musculoskeletal care may play a role in addressing potential shortages.

To examine the question of urban-rural disparities in the orthopaedic surgery workforce, we (1) determined longitudinal urban-rural trends in the US total physician and orthopaedic surgeon workforce (including the age of that workforce) from 1995 to 2010; (2) geographically mapped the US total physician and orthopaedic surgeon distribution in 2010; and (3) examined changes in the workforce of select nonorthopaedic musculoskeletal providers (chiropractors and podiatrists) between 2000 and 2010 in urban and rural areas.

Materials and Methods

Data Sources

Total population, demographic, and physician distribution data for each year from 1995 to 2010 (except 1996, 2006, and 2009) and chiropractor and podiatrist workforce data for 2000 and 2010 were obtained from the Area Resource File published by the Health Resources and Services Administration of the Department of Health and Human Services [17]. The information was reported on a per-county basis with data about healthcare provider resources, including the number of physicians by specialty and age bracket.

Hospital Referral Regions and Data Aggregation

Hospital Referral Regions are widely used geographic units as a means of measuring variability in healthcare access in this country. There are 306 Hospital Referral Regions in the United States, and each represents a substantial population that receives care based on historical geographic referral patterns for major surgical procedures. To aggregate the data from the Area Resource File to Hospital Referral Regions, the county data were first deaggregated to a Zip Code Tabulation Area level weighted by population data from that year. A Zip Code Tabulation Area-to-county crosswalk provided by the Department of Housing and Urban Development was used [18]. For Zip Code Tabulation Areas that overlapped multiple counties, a correction factor based on the percentage of residential addresses of the area in each particular county was used. The Zip Code Tabulation Area-level data were then reaggregated up to the Hospital Referral Region level. Repeated testing of data aggregation errors using total population as a marker consistently resulted in differences less than 0.5% between the sum of county populations in the Area Resource File and the processed Hospital Referral Region population data.

Urban and Rural Classification

Among the demographic data for each county in the Area Resource File is a Rural-Urban Continuum Code, a classification scheme developed by the Economic Research Service of the Department of Agriculture. It distinguishes "metropolitan" counties by size and "nonmetropolitan" counties by the degree of urbanization and proximity to metropolitan areas. The code is on a nine-point scale and was aggregated in our data processing to the Hospital Referral Region level. The most recent Rural-Urban Continuum Code classifications from 2003 were used. For further analysis and comparison of the physician workforce between urban and rural areas, the 30 most urban or rural Hospital Referral Regions based on Rural-Urban Continuum Code were used and their variables averaged as a group, respectively.

Statistical Analysis

Means for the 30 most urban or rural Hospital Referral Regions and overall national means were calculated for total physician density (number of physicians per 100,000 people), total orthopaedic surgeon density (total number of orthopaedic surgeons per 100,000 people), total chiropractor density (number of chiropractors per 100,000 people), total podiatrist density (number of podiatrists per 100,000 people), and the ratio of orthopaedic surgeons older than 55 years to those younger than 55 years. This age ratio was used as a variable given the availability of the physician age data in the Area Resource File in the form of age brackets. The 306 Hospital Referral Regions were mapped and chromatically scaled based on total physician density, orthopaedic surgeon density, and orthopaedic surgeon age ratio for 2010. Standard error of the mean and 95% CIs were calculated. Two-tailed t-tests were used to compare the urban and rural variables. Statistical significance was determined to be $p < 0.05$.

Results

From 1995 to 2010, the national average for total physician density increased 16.1% from 205 to 238 per 100,000. In urban areas, the total physician density increased 14.3% from 294 to 336 per 100,000. In rural areas, the density increased 11.9% from 160 to 179 per 100,000 (Fig. 1). There was a steady upward trend in total physician density in urban areas and in the nation overall, whereas in rural areas, a peak of 185 per 100,000 was reached in 2003 followed by a consistent decline since then. The urban-rural discrepancy in total physician density was statistically significant in 2010, with $p < 0.001$.

In the same time period, the total orthopaedic surgeon density increased 1.1% from 7.26 to 7.34 per 100,000. In urban areas, this decreased 3.5% from 9.05 to 8.73 per 100,000. In rural areas, this number increased by 4.8% from 6.22 to 6.52 per 100,000 (Fig. 2). The urban-rural difference in the number of orthopaedic surgeons was at its lowest in 2002, at 1.42 surgeons per 100,000, but has since steadily increased to 2.21 surgeons per 100,000 in 2010, which was also significant with $p < 0.001$.

Between 1995 and 2010, the total orthopaedic workforce age ratio increased 94.9% from 0.39 to 0.76. In urban areas, the age ratio increased 54.8% from 0.42 to 0.65. In rural areas, the ratio increased by 73.6% from 0.53 to 0.92 (Fig. 3). Although urban and rural areas have seen significant increases in the orthopaedic surgeon age ratio, it has especially accelerated in the rural workforce since 2005. The urban-rural age ratio difference in 2010 was statistically significant to $p = 0.024$.

With geographic representation of the data, the mapped and scaled Hospital Referral Regions show the heterogeneity in provider density distribution, for total physicians (Fig. 4) and orthopaedic surgeons (Fig. 5), and the orthopaedic surgeon age ratio (Fig. 6). They also show that areas with fewer orthopaedic surgeons (Fig. 4) often coincide with areas where the workforce is older (Fig. 6).

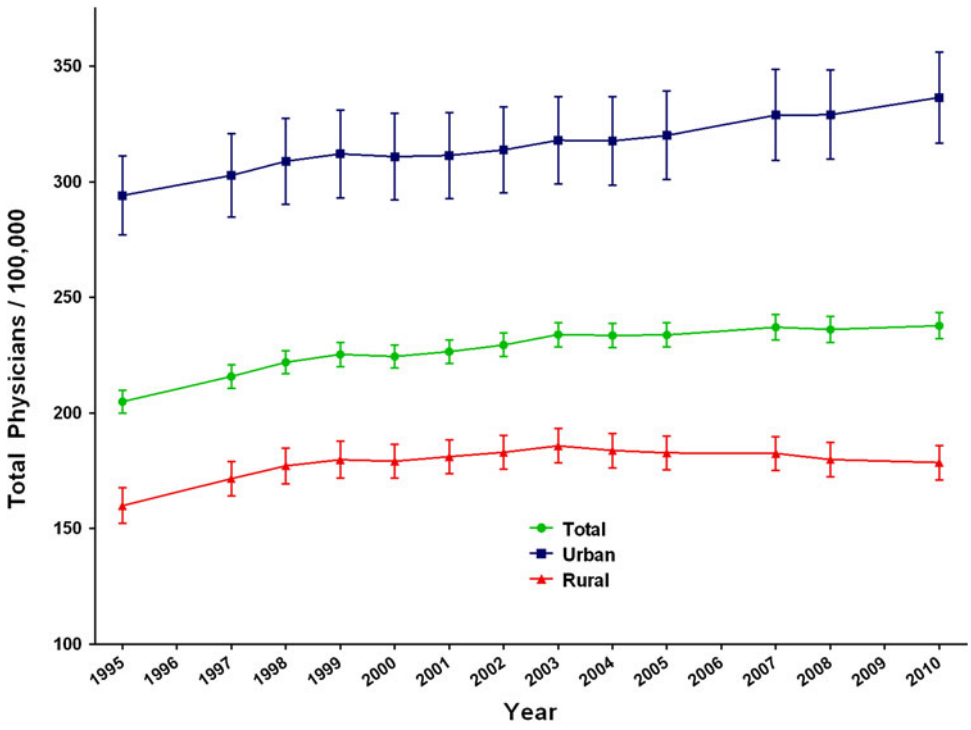

Fig. 1 Total physician density from 1995 to 2010 shows significant longitudinal urban-rural discrepancies, with fewer physicians in rural areas.

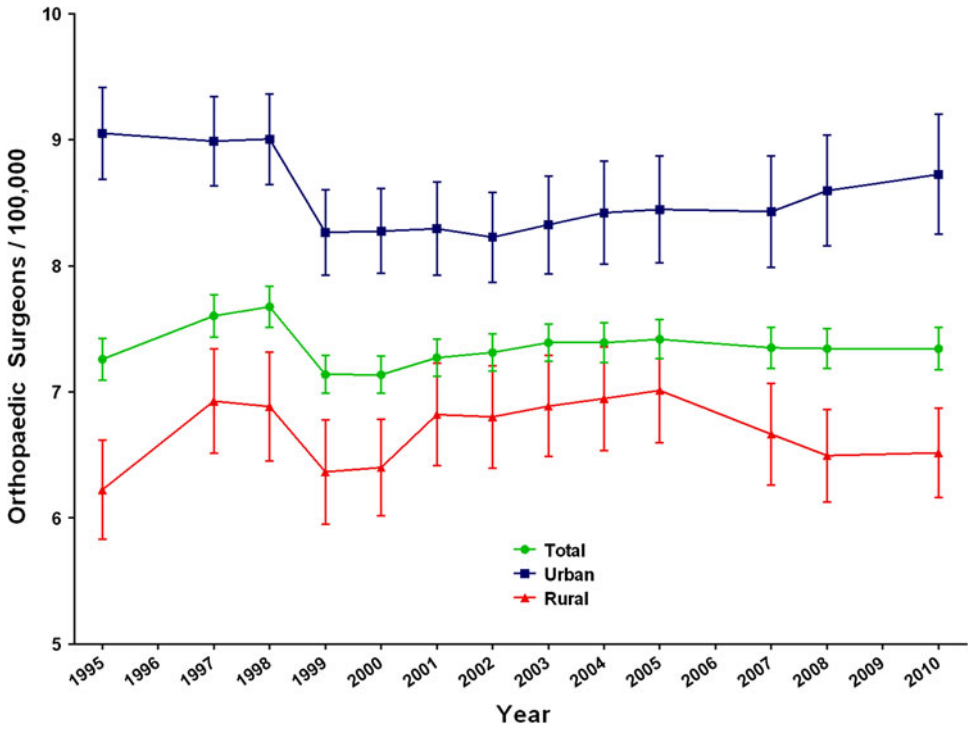

Fig. 2 Orthopaedic surgeon density from 1995 to 2010 shows significant longitudinal urban-rural discrepancies, with fewer orthopaedic surgeons in rural areas.

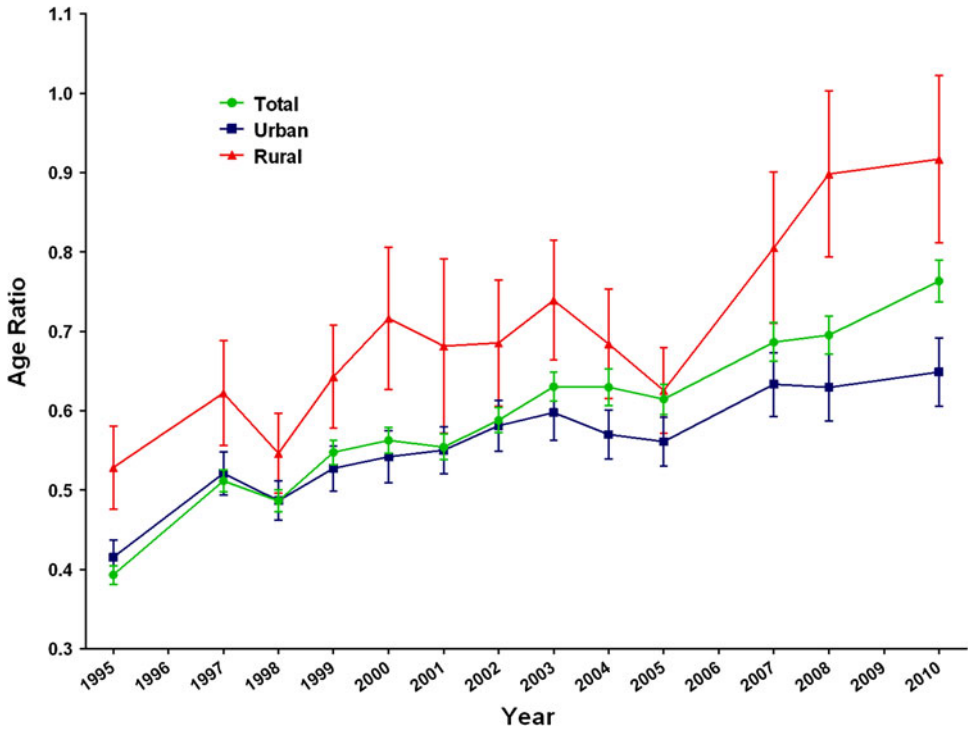

Fig. 3 Orthopaedic surgeon age ratio (age > 55 years: age < 55 years) from 1995 to 2010 shows aging of the overall orthopaedic surgeon workforce, and that rural orthopaedic surgeons tend to be older than their urban counterparts.

From 2000 to 2010, the density of chiropractors increased 90.3% from 12.38 to 23.56 per 100,000 (Table 1). In urban areas, this increased 31.0% from 20.34 to 26.64, whereas in rural areas, this increased by 229.6% from 6.42 to 21.18 per 100,000. During the same period, the total density of podiatrists increased 80.5% from 2.71 to 4.89 per 100,000. In urban areas, this number increased 45.1% from 5.59 to 8.11 per 100,000. In rural areas, this increased by 279.9% from 0.80 to 3.03 per 100,000.

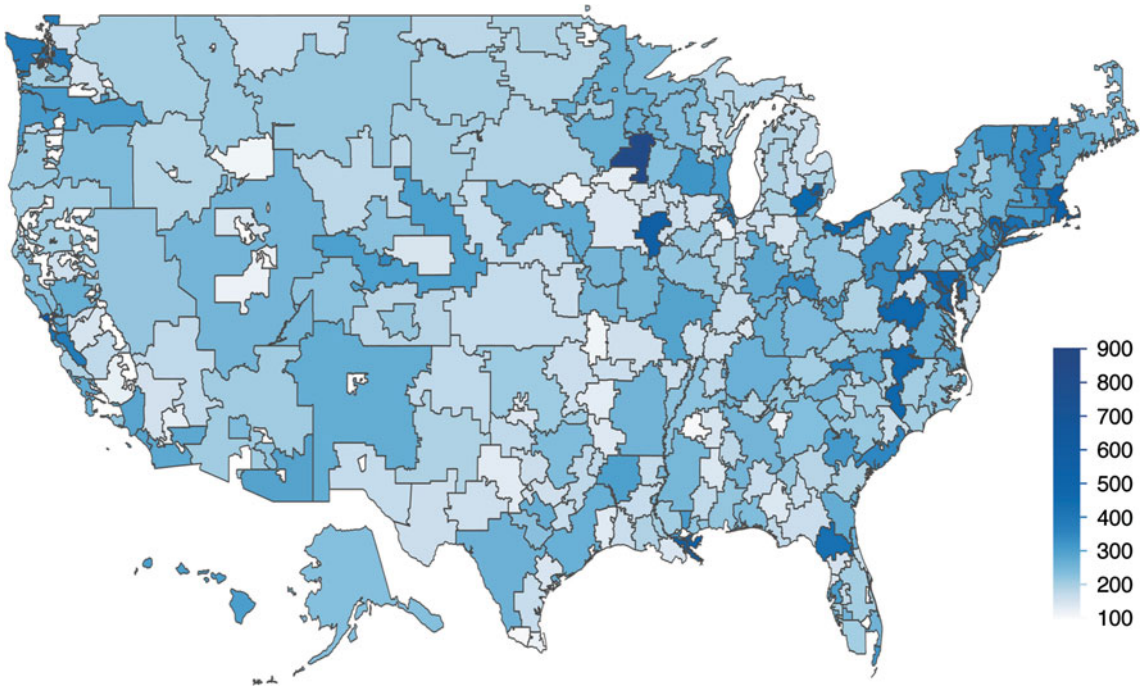

Fig. 4 Geographic mapping of Hospital Referral Regions scaled by total physicians per 100,000 population in 2010 shows the heterogeneity in provider distribution.

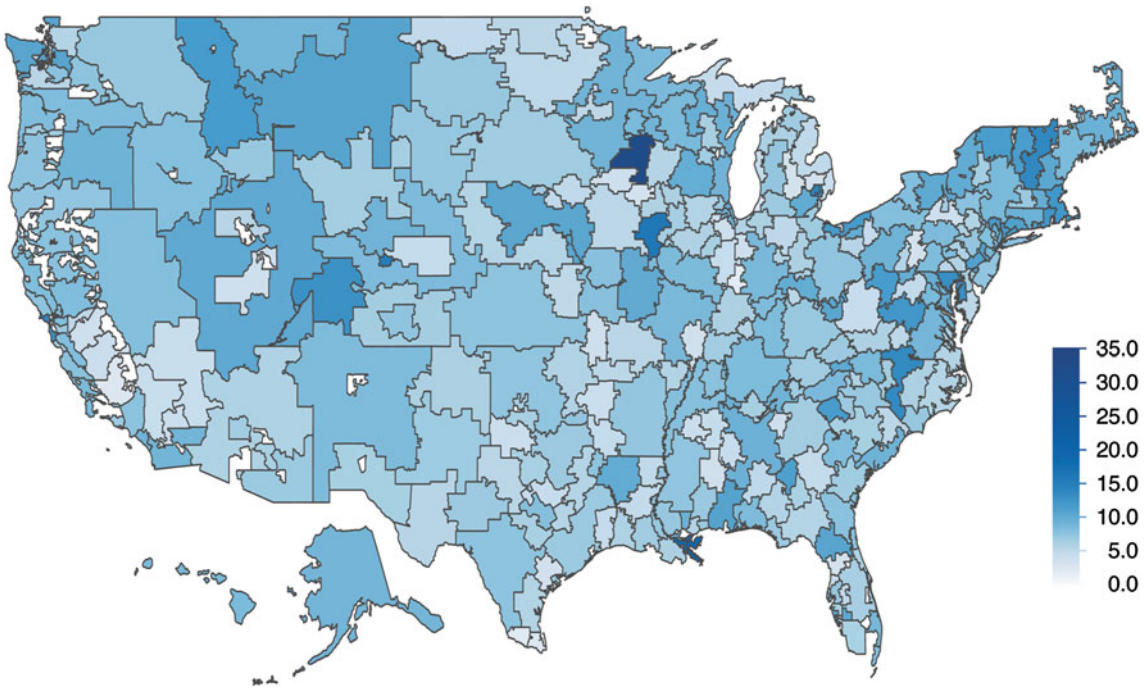

Fig. 5 Geographic mapping of Hospital Referral Regions scaled by orthopaedic surgeons per 100,000 population in 2010 shows the heterogeneity in provider distribution.

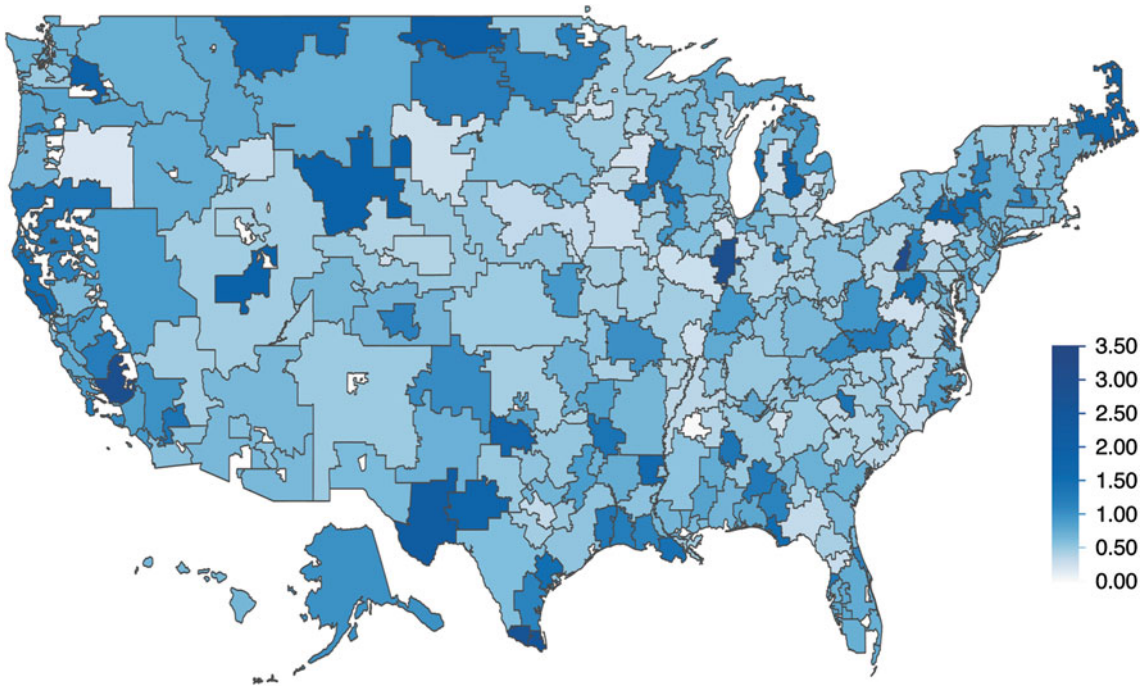

Fig. 6 Geographic mapping of Hospital Referral Regions scaled by orthopaedic surgeon age ratio (age > 55 years: age < 55 years) in 2010, highlights regions with older orthopaedic surgeons.

Table 1. Total, urban, and rural chiropractors and podiatrists per 100,000 population*

Practitioner	Total			Urban			Rural		
	2000	2010	Percent increase	2000	2010	Percent increase	2000	2010	Percent increase
Chiropractor	12.38 (9.54)	23.56 (10.53)	90.3	20.34 (8.28)	26.64 (7.41)	31.0	6.42 (6.64)	21.18 (13.31)	229.6
Podiatrist	2.71 (3.15)	4.89 (2.64)	80.5	5.59 (4.21)	8.11 (3.67)	45.1	0.80 (1.41)	3.03 (1.28)	279.9

* Mean with SD in parentheses.

Discussion

In this era of rapidly evolving healthcare demands based on our changing population, it is important to understand the demographics of the physician and orthopaedic surgeon workforce.

This study attempts to elucidate the present and future state of the orthopaedic surgeon supply in this country by processing and aggregating publicly available data in a way that we believe describes the current workforce in a meaningful way. We found significant urban-rural discrepancies in the orthopaedic surgeon workforce from 1995 to 2010, in that there were fewer orthopaedic surgeons in rural areas of the country and they were older. Concurrently, there have been tremendous increases in the numbers of other nonorthopaedic musculoskeletal providers, such as chiropractors and podiatrists, most notably in rural areas.

Our study is subject to several limitations. To facilitate longitudinal workforce comparisons in consistent urban and rural areas, a single county-based measure of "urbanness," the Rural-Urban Continuum Code from 2003, was applied across the study period. Given the population growth and migration during this time, defining urban and rural areas over a 15-year period is a challenge, and we attempted to minimize this limitation by using the 2003 definition, which is the halfway point in our study period. The numbers of physicians and orthopaedic surgeons were simple aggregates and not necessarily indicative of actual practice patterns or workload. Haralson and Zuckerman suggested that approximately 11% of orthopaedic surgeons work part time [6]. Moreover, the effects of "itinerant surgeons" such as urban-based surgeons who travel to and serve rural areas a few days per month [13] were not taken into consideration. These variables in surgeon practice patterns are difficult to estimate, however, we believe their

effects on our study outcomes are likely to be small relative to the discrepancies found in our analysis. The inclusion of chiropractor and podiatrist workforce data is an attempt at examining trends in nonorthopaedic musculoskeletal provider workforces that are concurrent with the orthopaedic workforce data presented. Our results do not discern whether the growth of other musculoskeletal providers in rural areas actually represents a response to an access void, or rather a migration out of urban areas owing to competitive stresses from orthopaedic providers. Furthermore, the overlap in services among the musculoskeletal providers studied consists only of foot/ankle and spinal manipulation. Therefore, our data are limited to identifying the ongoing trends in these related workforces, but cannot definitively conclude that other musculoskeletal providers are replacing orthopaedic surgeons owing to workforce discrepancies and unmet clinical demand. Finally, this is a study of the availability of providers on a geographic level and not of utilization. The traveling of patients for surgical services that are locally unavailable is not directly captured in our analysis, most notably, the potential preference among rural patients to seek musculoskeletal care in urban areas. The use of Hospital Referral Regions in our study does somewhat address this limitation, however, because it is a geographic unit designed to measure access to care and referral patterns for major procedures at large tertiary centers, often over long distances.

The first aim of our study was to characterize the trends in the orthopaedic surgeon workforce from 1995 to 2010, in terms of provider density relative to the population and provider age. Despite increasing demands for musculoskeletal care in our aging population, the number of orthopaedic surgeons in this country is expected to increase by just 2% between 2000 and 2020 [14], a figure consistent with and a slight improvement on the 1.1% increase that we found from 1995 to 2010. However, making accurate workforce predictions is difficult and requires consideration of numerous factors. As reported by Farley et al., in 1998, the RAND Corporation projected that in 2010, the United States would have a surplus of 4122 orthopaedic surgeons [4]. Lee et al. subsequently called for a reduction in the number of residency training spots [11]. By contrast, more recent studies have indicated potential physician shortages in the near future [1, 14]. Although the number of physicians is expected to increase by 24% between 2000 and 2020, once population growth is taken into account, physicians per capita will peak in 2015 and then begin to decrease [1]. These models are complicated by the uncertain retirement patterns of aging baby boomers and younger physicians trending toward different lifestyle choices. Accounting for these factors alters the model such that the physician full-time equivalent per capita actually peaks earlier, perhaps as early as 2005 [4]. In the face of this projected shortage of physicians and orthopaedic surgeons, our study showed longitudinal urban-rural workforce discrepancies in the United States from 1995 to 2010. There were significantly less physicians and orthopaedic surgeons per capita in rural areas of the country, and the rural orthopaedic surgeons also tended to be older. These trends do not appear to be abating, and the age discrepancy in particular appears to be widening. The magnitude of this age difference is noteworthy, especially the 73.6% increase in the ratio of orthopaedic surgeons older than 55 years to those younger than 55 years in rural areas from 1995 to 2010.

Based on our mapping of the variables under examination, which was the second aim of this study, it was evident that areas with fewer orthopaedic surgeons per capita frequently coincided with areas with higher age ratios. This is consistent with the reported demographics of the rural provider workforce in general surgery [13, 16]. Although rural areas overall might have anticipated shortages in the provision of orthopaedic surgery services compared with urban areas, there may be pockets of even greater impending need, areas with fewer and older orthopaedic surgeons as identified in our geographic analysis.

The disparity in the orthopaedic surgeon workforce, especially in rural areas, is a concern that we believe should be addressed. If these significant discrepancies in the supply of orthopaedic surgeons continue unabated, potential shortages of orthopaedic surgeons may arise in many areas of the country. As a result, other nonorthopaedic musculoskeletal providers may move forward to provide care to address the excess clinical demand. In our urban-rural analysis of the chiropractor and podiatrist workforce from 2000 to 2010 as examples of nonorthopaedic providers in the areas of foot/ankle and spine, we observed tremendous growth, especially in rural areas, with increases of 229.6% and 279.9% respectively, in the rural workforce density of chiropractors and podiatrists. After taking into account the concurrent urban-rural trends and discrepancies in the orthopaedic surgery workforce shown in this study, it appears that nonorthopaedic providers already may have begun to help meet the rural need for access to musculoskeletal specialty services. This shift in the provision of musculoskeletal services from orthopaedic surgeons to other musculoskeletal providers has important potential effects on patient outcomes, safety, and healthcare costs. The use of complementary and alternative medicine in this country has been increasing [2], with an especially important role in the provision of rural healthcare [8]. In the musculoskeletal realm, Lind et al. reported that a significant portion of patients with back pain use complementary and alternative medicine exclusively [12], and further studies on outcomes and cost-effectiveness are warranted.

Our longitudinal geographic analysis of the orthopaedic surgery workforce reveals important urban-rural discrepancies, with fewer and older orthopaedic surgeons in rural areas of the country. This may potentially affect access to orthopaedic care in these areas and the number and types of services that other nonorthopaedic musculoskeletal care providers may offer in rural practice settings. Coupled with the tremendous growth in the number of chiropractors and podiatrists, especially in rural areas, it appears that there are significant ongoing workforce shifts that warrant continuing observation and analysis.

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