

Geographic Disparities in County-Level Prevalence of Allopathic, Osteopathic, Surgical, and Non-Surgical Residency Programs in the United States

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INTRODUCTION

- Allopathic (MD) and osteopathic (DO) medical residency programs transitioned to a single accrediting body in July of 2020, leading to the closure of certain long-standing DO surgical and non-surgical residency programs¹.
- DO surgical specialties have been disproportionately impacted, specifically neurological surgery.
- Physician shortage is a well-documented contributor to inequitable medical care access in rural and underserved communities^{2,3,4}.
- A reduction in DO residency prevalence may contribute to this shortage, but the literature lacks a detailed characterization of residency distribution at the county-level.

METHODS

- This study is a cross-sectional epidemiological analysis of US counties with and without residencies in 2018.
- 11,881 medical residency programs and fellowships were compiled from two national residency databases^{5,6}.
- Transitional programs and fellowships were excluded, leaving 4,882 residency programs to be classified by type (MD/DO), surgical status, and county.
- 19 county-level variables from the US Census Bureau American Community Survey (ACS) 5-Year Estimates (2013-2018)⁷ were compiled for each county.
 - The Rural-Urban Continuum Code (RUCC) was used as a measure of rurality.
- Socioeconomic profiles of US counties were analyzed by residency type using descriptive statistics, inferential statistics, and generalized linear models.

FIGURES & TABLES

Figure 1: Geographic Distribution of US Medical Residencies

Figure 1A: All US Medical Residencies

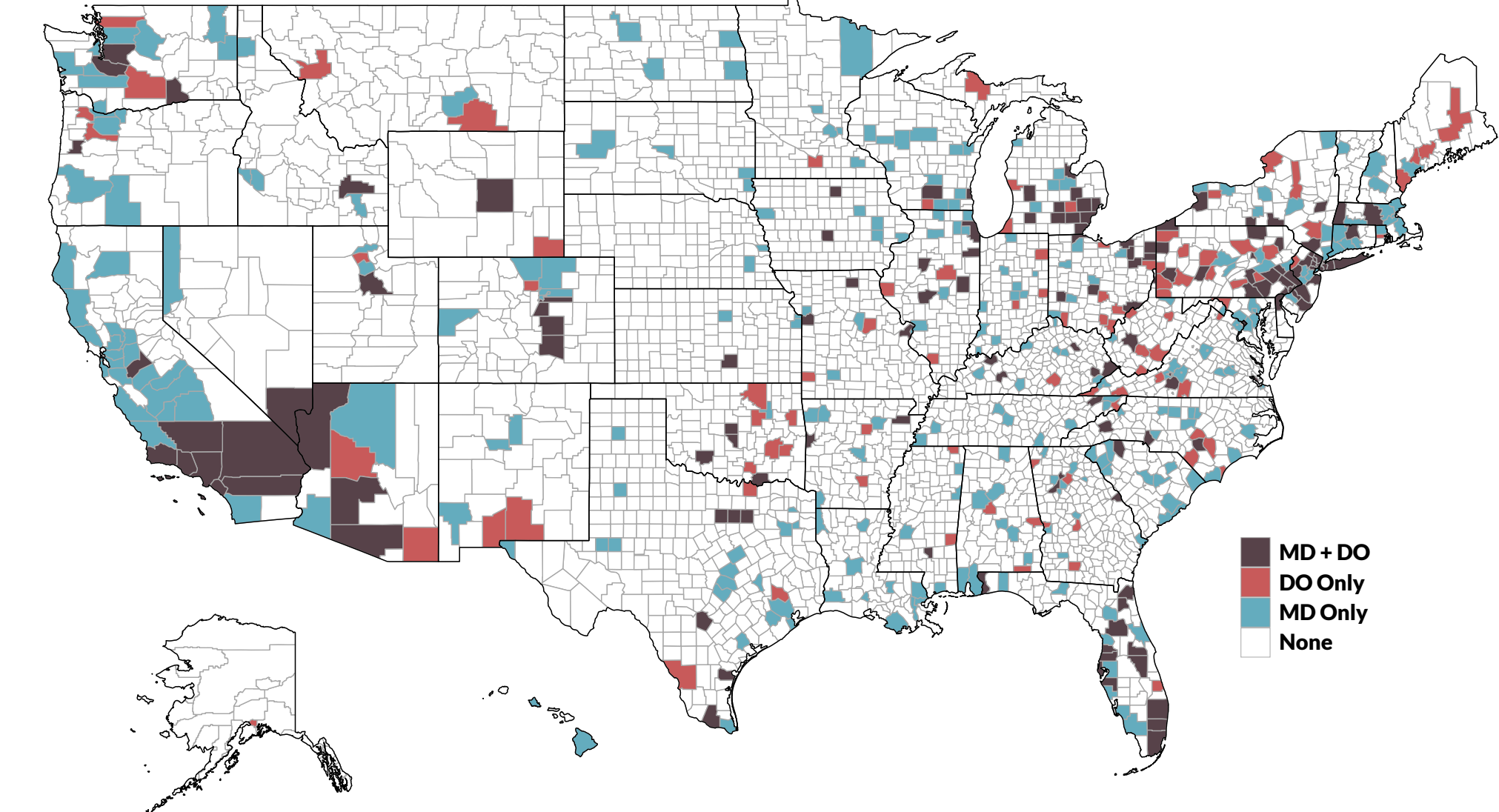


Figure 1B: Non-Surgical US Medical Residencies

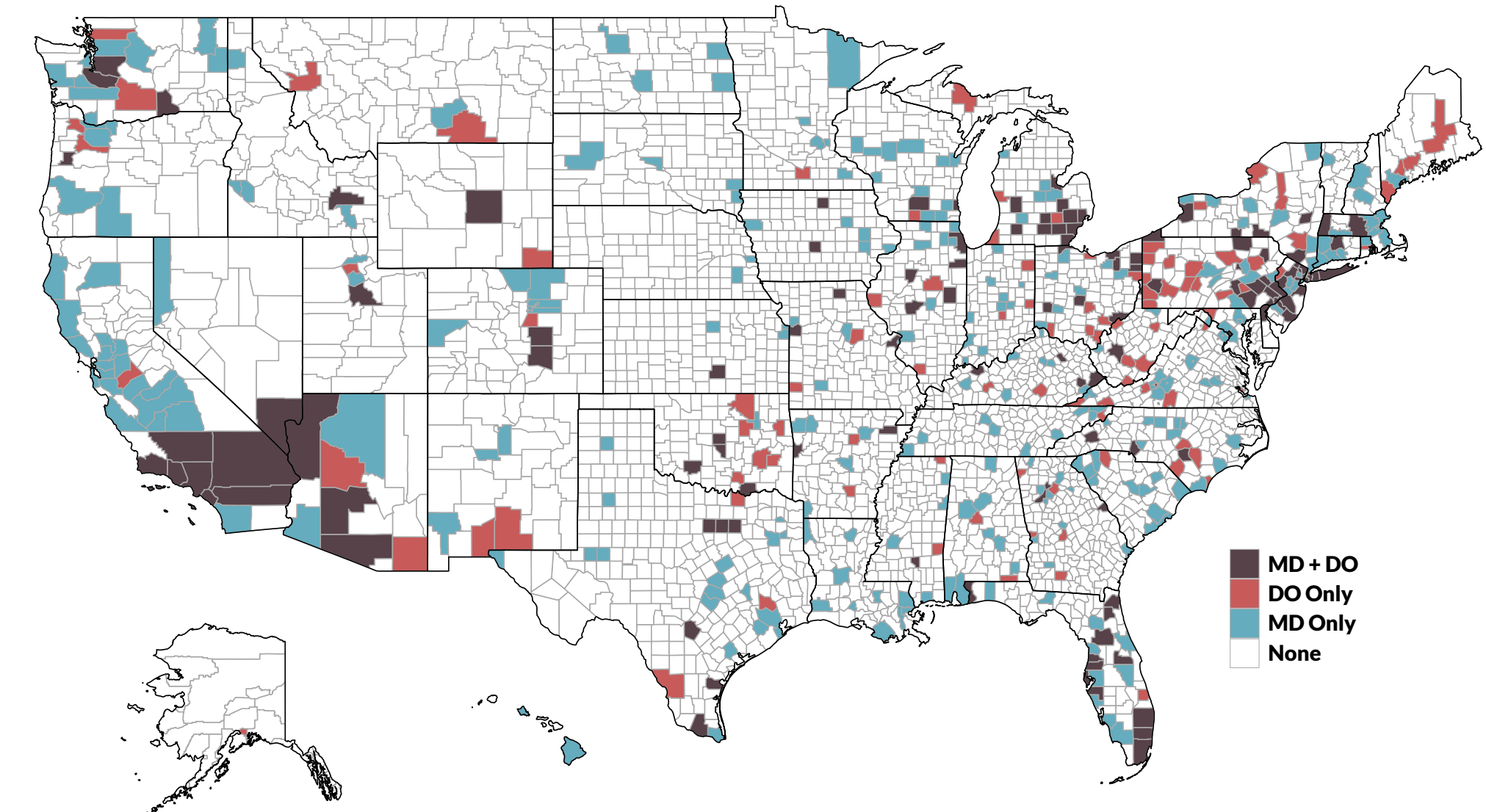


Figure 1C: Surgical US Medical Residencies

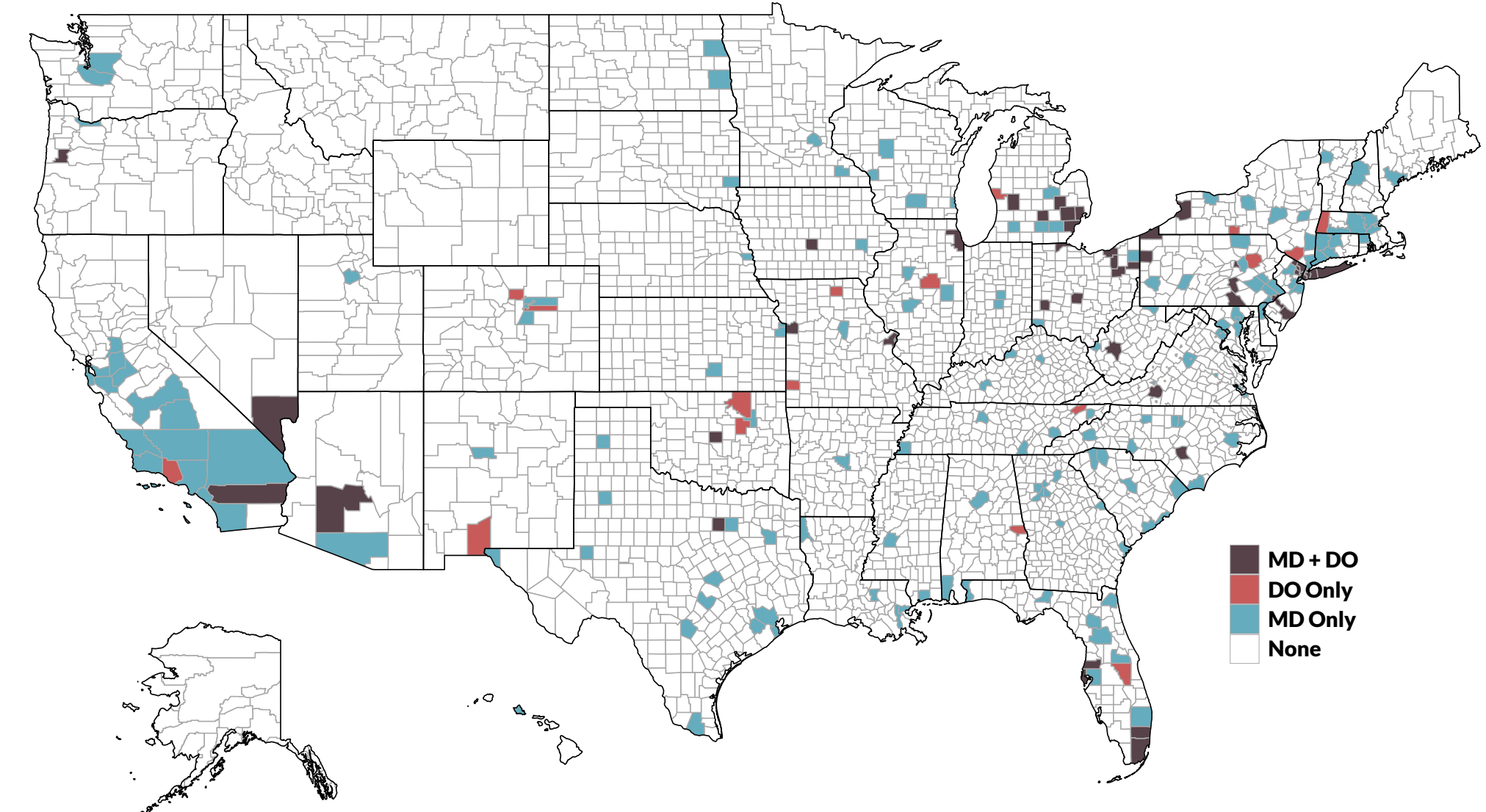


Table 1: ACS 5-Year Data for All Counties by Residency Classification

Census Variables	All United States Counties (n = 3,220)	All United States Counties containing the following residency types:					
		Non-Surgical Residencies		Surgical Residencies			
		Any Allopathic Residencies (n = 422)	Any Osteopathic Residencies (n = 238)	Only Allopathic (n = 413)	Only Osteopathic (n = 229)	Only Allopathic (n = 209)	Only Osteopathic (n = 65)
Population							
RUCC	4.9 (2.7)	2.2 (1.6)	2.6 (1.8)	2.3 (1.6)	2.6 (1.8)	1.7 (0.98)	1.7 (0.99)
Average Population	101,332 (326,096)	488,457 (778,387)	515,231 (933,846)	493,146 (785,748)	521,597 (950,384)	779,207 (1,009,551)	863,966 (986,391)
Median Age	41.3 (5.4)	38.3 (4.6)	39.1 (4.7)	38.2 (4.6)	39.1 (4.7)	37.5 (4)	38.5 (4.1)
Old-Age Dependency Ratio	31.4 (9.6)	25.6 (7.7)	26.9 (7.1)	25.6 (7.7)	26.9 (7.1)	23.9 (6.2)	25.5 (5.7)
Child Dependency Ratio	37.9 (6.8)	36.4 (5.5)	36.4 (5.8)	36.4 (5.6)	36.5 (5.9)	35.6 (5.7)	35.8 (4)
Race & Veteran Status							
Caucasian	82.6 (17.1)	75.6 (16.5)	78.9 (15.1)	75.5 (16.6)	78.9 (15.1)	70.1 (15.9)	73.1 (15.1)
Non-Caucasian	17.4 (17.1)	24.4 (16.5)	21.1 (15.1)	24.5 (16.6)	21.1 (15.1)	29.9 (15.9)	26.9 (15.1)
Disability	16 (4.5)	13.5 (3.7)	14.5 (4.1)	13.5 (3.7)	14.5 (4.1)	12.4 (2.7)	13.1 (2.8)
Veteran	8.8 (2.8)	6 (3.1)	8.3 (3)	8 (3.1)	8.4 (3)	7.3 (2.8)	7.2 (2.7)
Economic							
Median Household Income	\$50,792 (\$14,456)	\$59,106 (\$16,558)	\$56,545 (\$14,805)	\$58,995 (\$16,329)	\$56,501 (\$14,909)	\$61,511 (\$17,391)	\$57,909 (\$13,811)
Families Below Poverty Level	12.0 (7.7)	10.8 (6)	11.0 (4.4)	10.8 (6.1)	11 (4.5)	10.8 (5.2)	11.2 (4)
Unemployment Rate	6.1 (3.6)	6.1 (2.6)	6.2 (1.8)	6.1 (2.6)	6.2 (1.8)	6.1 (1.9)	6.2 (1.7)
Education							
Less Than 9 th Grade	5.3 (4.1)	4.8 (3.5)	4.6 (3.1)	4.8 (3.5)	4.6 (3.2)	4.9 (3.3)	4.5 (2.7)
High School Graduate	34.2 (7.2)	28 (6.8)	30.7 (7.5)	27.9 (6.6)	30.7 (7.5)	26 (6.7)	29.3 (6.7)
Bachelor's Degree or Higher	21.6 (9.4)	30.7 (10.6)	28 (10.4)	30.8 (10.6)	27.9 (10.2)	34.3 (10.8)	30.7 (9)
Health Insurance							
No Health Insurance	10.0 (5.1)	8.7 (4.1)	9.0 (4.8)	8.8 (4.1)	9.0 (4.8)	8.9 (4.3)	8.5 (3.5)
With Health Insurance	90.0 (5.1)	91.3 (4.1)	91.0 (4.8)	92.2 (4.1)	91.0 (4.8)	91.1 (4.3)	91.5 (3.5)
Public Insurance	39.5 (9.8)	35.7 (8.6)	37.3 (7.9)	35.7 (8.6)	37.4 (7.9)	34.4 (7.5)	36.6 (6.7)
Private Insurance	64.8 (11.6)	68.1 (9.6)	66.9 (9.3)	68.1 (9.6)	66.9 (9.4)	68.3 (9.1)	67.1 (7.8)

Table 2: ACS 5-Year Data Comparisons by Exclusive Residency Types

Census Variables	Only Allopathic Residencies (n = 239)	Only Osteopathic Residencies (n = 96)	p (ns)	Non-Surgical Residencies		p (ns)	Surgical Residencies		p (ns)
				Only Allopathic (n = 235)	Only Osteopathic (n = 101)		Only Allopathic (n = 161)	Only Osteopathic (n = 17)	
Population									
RUCC	2.5 (1.6)	3.4 (1.9)	0.001 (0.81)	2.5 (1.6)	3.3 (1.9)	0.001 (0.46)	1.8 (1.0)	2.5 (1.4)	0.011 (0.57)
Average Population	345,075 (448,447)	136,636 (135,912)	0.001 (0.63)	345,511 (446,103)	141,060 (140,092)	0.001 (0.62)	688,139 (979,888)	240,820 (220,960)	0.001 (0.63)
Median Age	38.1 (4.6)	39.8 (4.8)	0.002 (0.36)	38.1 (4.6)	39.9 (4.8)	0.001 (0.38)	37.1 (4.0)	37.7 (5.0)	0.547 (0.13)
Old-Age Dependency Ratio	28.6 (8)	24.8 (6.9)	0.002 (0.37)	28.6 (8)	28.1 (6.9)	0.001 (0.39)	23.4 (6.3)	25.2 (6.9)	0.054 (0.29)
Child Dependency Ratio	36.4 (5.7)	36.5 (6.4)	0.897 (0.02)	36.5 (5.6)	36.8 (6.3)	0.673 (0.05)	35.6 (6.2)	36.0 (5.0)	0.823 (0.07)
Race, Disability, Veteran Status									
Caucasian	75.7 (17.3)	84.0 (13.9)	0.001 (0.53)	75.7 (17.4)	83.9 (14.2)	0.001 (0.52)	70.2 (16.0)	82.3 (9.8)	0.001 (0.93)
Non-Caucasian	24.3 (17.3)	16 (13.9)	0.001 (0.53)	24.3 (17.4)	16.1 (14.2)	0.001 (0.52)	29.8 (16.0)	17.7 (9.8)	0.001 (0.93)
Disability	13.4 (13.7)	15.8 (4.1)	0.001 (0.61)	13.5 (13.7)	15.9 (4.1)	0.001 (0.61)	12.3 (2.8)	13.8 (3.5)	0.644 (0.47)
Veteran	8.2 (3.1)	9.3 (2.8)	0.002 (0.39)	8.1 (3.1)	9.3 (2.8)	0.001 (0.43)	7.4 (2.8)	7.9 (1.2)	0.412 (0.23)
Economic									
Median Household Income	\$58,899 (\$16,963)	\$52,152 (\$12,022)	0.001 (0.46)	\$58,651 (\$16,171)	\$52,369 (\$13,123)	0.001 (0.42)	\$62,378 (\$18,297)	\$55,942 (\$14,367)	0.162 (0.39)
Families Below Poverty Level	10.9 (8.7)	11.4 (4.6)	0.518 (0.08)	10.9 (8.7)	11.3 (4.6)	0.547 (0.07)	10.7 (9.5)	11.1 (4.1)	0.763 (0.08)
Unemployment Rate	6 (2.8)	6.1 (1.8)	0.832 (0.04)	6.1 (2.8)	6.1 (1.8)	0.790 (0.00)	6.0 (1.9)	5.7 (1.3)	0.555 (0.16)
Education									
Less Than 9 th Grade	4.9 (3.6)	4.4 (2.9)	0.236 (0.15)	4.9 (3.6)	4.5 (3.0)	0.326 (0.12)	4.9 (3.4)	4.2 (2.7)	0.416 (0.23)
High School Graduate	27.5 (6.6)	33.5 (4.7)	0.001 (0.86)	27.7 (6.6)	33.8 (4.7)	0.001 (0.87)	25.2 (6.6)	30.4 (6.6)	0.003 (0.68)
Bachelor's Degree or Higher	30.8 (10.7)	24.1 (9.1)	0.001 (0.67)	30.6 (10.7)	23.8 (8.8)	0.001 (0.69)	35.3 (11.5)	29.0 (11.9)	0.054 (0.54)
Health Insurance									
No Health Insurance	8.8 (4.0)	8.6 (5.5)	0.187 (0.17)	8.8 (4.0)	9.5 (5.5)	0.250 (0.15)	9.0 (4.6)	8.3 (3.7)	0.521 (0.17)
With Health Insurance	91.2 (4.0)	90.4 (5.5)	0.187 (0.17)	91.2 (4.0)	90.5 (5.5)	0.250 (0.15)	91.0 (4.6)	91.7 (3.7)	0.521 (0.17)
Public Insurance	35.4 (9.8)	38.8 (7.9)	0.003 (0.38)	35.5 (9.8)	38.7 (7.9)	0.001 (0.38)	33.7 (7.7)	36.3 (8.0)	0.187 (0.33)
Private Insurance	68.4 (9.9)	66.0 (10.0)	0.043 (0.24)	68.3 (9.9)	65.9 (9.9)	0.043 (0.24)	68.8 (9.4)	67.9 (8.1)	0.717 (0.10)

Table 3: Frequencies of US County RUCC by Residency Type

Rural-Urban Continuum Code (RUCC)		Allopathic Residencies (n = 422)		Osteopathic Residencies (n = 238)		Non-Surgical		Surgical	
		Allopathic Residencies (n = 422)	Osteopathic Residencies (n = 238)	Allopathic Residencies (n = 422)	Osteopathic Residencies (n = 238)	Allopathic Residencies (n = 422)	Osteopathic Residencies (n = 238)	Allopathic Residencies (n = 422)	Osteopathic Residencies (n = 238)
Countries in metro areas of 1 million population or more	1	34.6%	32.4%	29.3%	13.5%	29.5%	14.9%	45.3%	17.6%
Countries in metro areas of 250,000 to 1 million population	2	32.7%	28.2%	32.1%	19.8%	32.6%	20.8%	37.3%	35.3%
Countries in metro areas of fewer than 250,000 population	3	29.4%	21%	23.6%	31.3%	23.2%	30.7%	13.7%	41.2%
Urban population of 20,000 or more, not adjacent to a metro area	4	3.1%	5.9%	3.9%	12.5%	3.9%	11.9%	0.6%	0%
Urban population of 20,000 or more, not adjacent to a metro area	5	2.6%	2.5%	3.6%	5.2%	3.5%	5%	0.6%	0%
Urban population of 2,500 to 19,999, not adjacent to a metro area	6	3.1%	5.5%	3.9%	11.5%	3.9%	10.9%	1.9%	0%
Urban population of 2,500 to 19,999, not adjacent to a metro area	7	1.9%	2.1%	2.1%	3.1%	2.1%	3%	0.6%	5.9%
Completely rural or less than 2,500 urban population, adjacent to a metro area	8	0.7%	1.3%	0.4%	1%	0.4%	1%	0%	0%
Completely rural or less than 2,500 urban population, not adjacent to a metro area	9	0.9%	1.3%	1.1%	2.1%	1.1%	2%	0%	0%

Table 4: Odds Ratios (OR) and 95% Confidence Intervals for RUCC Score

Comparison	Unadjusted OR (95% CI)	p-value	Adjusted OR ¹ (95% CI)	p-value
MD Only vs. No Residency	0.50 (0.26, 0.85)	<0.0001	0.63 (0.39, 0.88)	<0.0001
DO Only vs. No Residency	0.74 (0.69, 0.81)	<0.0001	0.74 (0.67, 0.82)	<0.0001
Both MD and DO vs. No Residency	0.50 (0.45, 0.57)	<0.0001	0.52 (0.46, 0.59)	<0.0001

¹Estimated using multinomial logistic regression. Significance determined at $\alpha=0.05$.

²Adjusted for median age of the county, percent of the county with White race, median household income, and old-age dependency ratio.

RESULTS

- Allopathic and osteopathic programs differed significantly in frequency and geographic distribution (Figures 1A,1B,1C) yet were independently consistent with most census variable mean values of the general U.S. population (Table 1).
- Comparisons between counties with exclusively allopathic and osteopathic programs revealed osteopathic residencies served (Table 2):
 - less populous and educated counties with [mean(SD)]:
 - lower incomes [\$52,152(\$12,022)]
 - older age [39.8(4.8)]
 - higher percentage of disabled persons [15.8%(4.1%)]
 - higher percentage of veterans [9.3%(2.5%)]
- Osteopathic residency programs are located in more rural areas (Table 3).
- For every 1-unit RUCC increase (rurality), there was (Table 4):
 - 50% decreased odds of finding a residency program
 - 40% decreased odds of finding an allopathic program
 - 25% decreased odds of finding an osteopathic program
- Post-accreditation unification directly reduced the prevalence of surgical and non-surgical residencies in 26 counties.
- Fifty percent of neurological surgery residencies were eliminated despite having an average existence of 26.9 years.

CONCLUSION

- Osteopathic residencies are distributed in more rural and underserved counties.
- Post-accreditation unification may reduce future access to surgical and non-surgical care.
- Future accreditation efforts toward improving access to care through residency distribution should incorporate osteopathic placement strategies.

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