Distribution of General Surgery Residencies in the United States and Gender Inequality: Are We There Yet?

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OBJECTIVE: Surgeons are unevenly distributed across the United States (U.S.), possibly as a result of disproportionately distributed General Surgery (GS) residencies. This study primarily aimed to examine the relationship between the distribution of GS residency positions and population by U.S. region and states. Differences in the distribution by race and gender were also examined.

DESIGN: A review of the Accreditation Council for Graduate Medical Education (ACGME) and the American Osteopathic Association (AOA) National Residency Matching Program (NRMP) data over 5 years. Categorical Surgery Residency PGY1 positions (SurgPGY1) were categorized into Northeast, Midwest, South, and West regions. SurgPGY1 to population ratios were compared by region. The distribution of SurgPGY1s by race/gender was also compared.

PARTICIPANTS: Medical students who match into SurgPGY1 positions through the NRMP.

RESULTS: The mean SurgPGY1s per 10^6 population was 4.18 ± 0.52 for 2018. Most commonly, SurgPGY1s are concentrated in the Northeast (5.79 ± 0.64) then the South (5.12 ± 1.41), then the Midwest (4.22 ± 0.37), and lastly the West (1.91 ± 0.39). NY, MA, and DC had significantly higher SurgPGY1s ratios, with DC topping at 27.05. Four States had no SurgPGY1s (AK, ID, MT, WY), while AR, MS, and UT were under 2 SurgPGY1s/10^6. From 2014 to 2018, the percent of ACGME positions given to females increased 2.93%, while the AOA positions increased 11.84%. When adjusted for the population the race with the most residencies for their population was Asian (482.42% ACGME, 324.52% AOA).

CONCLUSION: There is a significant disproportion in the distribution of GS residencies and not proportional to population, race or gender. (J Surg Ed 76:1460−1468. © 2019 Published by Elsevier Inc. on behalf of Association of Program Directors in Surgery.)

KEY WORDS: Residency distribution, Gender inequality, Gender equity, General surgery residency

COMPETENCIES: Patient Care, Professionalism, Systems-Based Practice

INTRODUCTION

In the current era of physician shortages, there is a need to analyze the characteristics that shape the physician distribution in the United States (U.S.). Particularly, practicing surgeons are unevenly distributed across the U.S., especially in rural areas. The surgeon maldistribution may be caused by disproportionately distributed General Surgery (GS) residencies. According to data from the 2012 National Resident Matching Program (NRMP), there were 17 states above the average for Categorical Surgical Residents in Post Graduate Year 1 (SurgPGY1) positions per 10^6 population. This demonstrates maldistribution of surgery residents by showing that most states fell below the average resident to population ratio.

After Surgery Residents finish their training, they become surgeons and there are currently no benchmarks for the ideal surgeon to population ratio, however, the 1980 Graduate Medical Education National Accreditation Council recommended 4.7 practicing general surgeons per 100,000 population as a minimally acceptable ratio.[1] However, many states, especially those with rural areas, fall below this ratio. The Southwestern Surgical Congress comprises 19 states, one-third of the U.S. population, and half of the total square miles of the country but only represents one-fourth of GS residencies.[2] This is further demonstrated

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by evidence that in 2006, 30% of U.S. counties, of where 9.5 million Americans lived, lacked a single surgeon.[2]

There has been recognition of the problem in response to the maldistribution of GS residencies. The American College of Surgeons (ACS) has made it a priority to increase opportunity and incentive for rural general surgery training and practice.[3-5] New rural GS tracks have shown to increase the proportion of residents that practice in rural areas after residency compared to other general surgery programs.[6,7] Recently, the ACS Rural Surgery Advisory Council has identified 12 programs with rural surgery tracks or rural surgery focus.[8] Therefore, there have been attempts to correct the maldistribution of general surgeons.

In analyzing the distribution of surgeons, it is important to address the effect residency has on the issue. The Merrit-Hawkins 2017 Final-Year Medical Resident Survey reported only 1% of final-year medical residents surveyed would prefer to practice in a community of 10,000 people or less, and only 3% would prefer to practice in a community of 25,000 or fewer.[9] Concerns cited by surgical residents considering rural surgery include a lack of exposure to general and rural surgery in training, lack of exposure during residency to a wide breadth of services and skills that rural general surgeons are expected to deliver, perceived challenges of on-call requirements, and limited opportunities to engage in lifelong learning.[4,10,11] Consequently, it is of increasing importance to evaluate the distribution of residencies within the U.S. as this is shown to directly affect the distribution of surgeons.

Further, there is also a demonstrated maldistribution of residencies by gender and race. The proportions of men and women graduating from medical school are almost equal. Despite this, the proportion of women in GS residency programs has remained significantly lower. One study found that females currently make up 60% of undergraduate students and 50% of medical students, but only 36% of surgical residents.[12] Many studies reason that pregnancy and parenthood are the most important factors causing this disparity.[13,14] Nevertheless, there is agreement that female contribution to the surgical workforce is important and steps need to be taken to resolve this gender inequality. As with gender inequality, there is demonstrated a racial maldistribution in GS residency positions. One study revealed the field of medicine – particularly surgery – has historically had a racial distribution that misrepresents the patient population.[15] The racial distribution of surgeons is particularly important as this might affect minority specific healthcare needs. This study primarily aimed to examine the relationship between the distribution of General Surgery residency positions by U.S. region and state. The distribution by race and gender were also examined.

METHODS

A retrospective longitudinal review of the Accreditation Council for Graduate Medical Education (ACGME) and the American Osteopathic Association (AOA) NRMP data over a 5-year period (2014-2018) was performed. The NRMP's data reporting is administered by its Data Release and Research Committee. All reports produced by the NRMP preserve the confidentiality of applicants, medical schools, residency programs, and teaching hospitals. The time period of 2014-2018 is the most current period of which all data were available at the inception of this study and comprised an acceptable range of time for analyses. SurgPGY1 positions were used because the number of PGY1 level surgery positions is the most current representation of the general surgery residency distribution.

The number of SurgPGY1 positions offered by each state, the District of Columbia (DC), and Puerto Rico (PR) were obtained from the NRMP data and benchmarked by 10^6 population. The number of active general surgeons (as opposed to residents) was obtained from the Association of American Medical Colleges (AAMC) 2017 State Physician Workforce Data Report and benchmarked by 10^5 population.[16] The population for each of the 50 states, DC, and PR was obtained from the 2010 U.S. Census, which is the latest survey available.[17] Residency positions were categorized into Northeast, Midwest, South, and West geographical census regions.

SurgPGY1 to population ratios were calculated and compared for each state and region. Means $\pm$ standard error means (SEM) were calculated for each geographical region. The distribution of SurgPGY1 positions by race and gender were compared over the 5-year period by calculating percent male vs female and percent of each race of the filled residency positions. Percent race was adjusted by the population of each race within the U.S. by dividing percent race of filled positions by percent race in the U.S. This adjusted percent shows the percent of each race per the population of that race. *t* test analyses were used with a statistical significance defined as p value$\leq$ 0.05.

RESULTS

The mean SurgPGY1s per 10^6 population in the entire U.S. was 4.18 $\pm$ 0.52 for 2018. Most commonly, SurgPGY1s are concentrated in the Northeast at 5.79 $\pm$ 0.64, followed by the South at 5.12 $\pm$ 1.41, the Midwest at 4.22 $\pm$ 0.37, and lastly the West with the fewest at 1.91 $\pm$ 0.39. There was a significant difference between the Northeast vs West ($p = 0.0001$), South vs West ($p = 0.04$), and Midwest vs West ($p = 0.0003$) SurgPGY1/10^6 population ratios. There were no significant differences between the Northeast vs Midwest ($p = 0.051$), Northeast vs South

($p = 0.67$), and Midwest vs South ($p = 0.55$) SurgPGY1/10^6 population ratios. The states of New York, Massachusetts, and Washington DC have the highest SurgPGY1 to population ratios, with DC topping the list at 27.05 SurgPGY1/10^6. States with low SurgPGY1s included Arkansas, Mississippi, and Utah, which were all under 2 SurgPGY1s/10^6. While the 4 states with no SurgPGY1s were Alaska, Idaho, Montana, and Wyoming. The SurgPGY1 positions in the 50 states, DC, and PR categorized into the 4 census regions are represented in Table 1.

The proportion of GS residency positions filled by women has been relatively stagnant in ACGME residencies but has significantly increased in AOA residencies. From 2014 to 2018, the percent of ACGME residency positions given to females has increased by 2.9%, while the percent of AOA positions given to females has increased by 11.8%. The percent of all GS residency positions filled by women reached a high of 37% in 2018 and only increased by 3.5% in 5 years. The distribution of residencies by gender for 2014-2018 is represented in Table 2.

The race with the highest raw percent of residency positions filled in 2018 was White (46.51% ACGME and 65.58 AOA) followed by Asian (23.16% ACGME and 15.58% AOA). The lowest raw percent of residency positions was given to American Indian/Alaska Native (0.83% ACGME and 0.19% AOA) and Native Hawaiian/Pacific Islander (0.29% ACGME and 0.19% AOA) in 2018. When adjusted by the population of each race within the U.S., the races with the highest positions filled in 2018 for their population was Asian (482.42% ACGME and 324.52% AOA) and Native Hawaiian/Pacific Islander (145.68% ACGME and 96.15% AOA). The races with the lowest positions filled in 2018 for their population was Hispanic (59.08%) and White (64.24%) for the ACGME and Black (18.32%) and American Indian/Alaska Native (21.37%) for the AOA. Further, the races with the largest increase in positions filled over the 5-year period was White (+1.69%) and Hispanic (+0.91%) for the ACGME and Native Hawaiian/Pacific Islander (+0.19%) and Hispanic (0.41%) for the AOA, while the race with the largest decrease in positions filled was Asian (−1.52% ACGME and −2.31% AOA). The distribution of residencies by race for 2014-2018 is represented in Table 3 and the distribution of residencies by race adjusted by race population is represented in Table 4.

TABLE 1. Distribution of General Surgery Residencies

Region:	**Northeast**	**Midwest**	**South**	**West**	**N/A**
Region population	56,111,079	68,308,744	124,753,948	77,993,663	3,195,153
Residency programs	79	67	89	42	2
SurgPGY1 positions	373	295	437	205	8
*Regional PGY1/10^6	6.65	4.32	3.50	2.63	2.50
	CT 6.72	IL 4.32	DE 6.20	AZ 4.04	PR 2.50
	ME 2.99	IN 1.94	DC 27.05	CO 3.16	
	MA 7.68	MI 5.80	FL 3.33	ID 0.00	
	NH 2.95	OH 5.39	GA 2.76	MT 0.00	
	RI 6.62	WI 3.61	MD 3.97	NV 2.31	
	VT 6.39	IA 3.17	NC 3.56	NM 2.86	
	NJ 4.15	KS 3.78	SC 3.93	UT 1.90	
	NY 7.83	MN 3.56	VA 2.94	WY 0.00	
	PA 6.79	MO 4.41	WV 6.65	AK 0.00	
		NE 4.67	AL 3.68	CA 2.68	
		ND 6.58	KY 3.58	WA 2.26	
		SD 3.40	MS 1.67	HI 2.82	
			TN 5.32	OR 2.86	
			AR 1.66		
			LA 5.37		
			OK 2.54		
			TX 2.75		
*Average PGY1/10^6	5.79	4.21	5.12	1.91	N/A
Standard deviation	1.91	1.27	5.83	1.42	N/A
Standard Error	0.64	0.37	1.41	0.39	N/A

*Regional PGY1/10^6 = total PGY1 per the total population of that census region.

*Average PGY1/10^6 = average of each State's PGY1 in that region.

Note: Distribution of General Surgery Residencies shows the regional populations, residency programs, SurgPGY1 positions, and SurgPGY1 to population ratios. The SurgPGY1 per population ratios for each individual state, DC, and PR are represented. PR is not included in any census region. There was a significant difference between Northeast vs West ($p = 0.0001$), Midwest vs West ($p = 0.0003$), and South vs West ($p = 0.04$) ratios. There was not a significant difference between the Northeast vs Midwest ($p = 0.051$), Northeast vs South ($p = 0.67$), and Midwest vs South ($p = 0.55$) PGY1/10^6 population ratios.

TABLE 2. Distribution of General Surgery Residencies by Gender

ACGME	2014	2015	2016	2017	2018	% change	p value
Male							<0.0002
count	5308	5066	4871	4922	4739	−2.9%	
Percent	66.0%	64.6%	65.1%	63.4%	63.1%		
Female							
count	2729	2772	2606	2840	2769	+2.9%	
Percent	34.0%	35.4%	34.9%	36.6%	36.9%		
AOA							
Male							0.0004
count	260	309	299	334	277	-11.8%	
Percent	68.6%	65.6%	61.8%	63.0%	56.8%		
Female							
count	119	162	185	196	211	+11.8%	
Percent	31.4%	34.4%	38.2%	37.0%	43.2%		
All Positions							
Male							<0.0001
count	5568	5375	5170	5256	5016	−3.5%	
Percent	66.2%	64.7%	64.9%	63.4%	62.7%		
Female							
count	2848	2934	2791	3036	2980	+3.5%	
Percent	33.8%	35.3%	35.1%	36.6%	37.3%		

Note: Distribution of General Surgery Residencies by Gender shows the number of male and female GS residents and the percent male and female for each year from 2014-2018. A percent change over the 5-year period of male and female is represented. The p-values comparing the percent male and female over the 5-year period are represented.

DISCUSSION

There is currently widespread discussion of the looming physician shortage, which has been evidenced by numerous leading medical establishments. Specifically, the AAMC recently released a report that shows the United States could see a shortage of between 42,600 and 121,300 physicians by the end of the next decade.[18] This report highlights surgery as a category of significant shortage. This shortage demonstrates the importance of GS residency distribution in the U.S., as residency distribution often mirrors physician distribution.

In our study, we found the ratios of SurgPGY1 positions to 1,000,000 population demonstrated a maldistribution of residency positions based on population. It is expected that higher population states would have

TABLE 3. Distribution of General Surgery Residencies by Race

ACGME%	2014	2015	2016	2017	2018	% change
American Indian/Alaska Native	0.65	0.81	0.58	0.79	0.83	+0.18%
Asian	24.67	24.80	24.04	24.18	23.16	−1.51%
Black/AA	9.03	9.03	8.83	8.44	8.69	−0.34%
Hispanic, Latino, or Spanish Origin	8.72	8.43	8.88	8.93	9.63	+0.91%
Native Hawaiian/Pacific Islander	0.12	0.18	0.19	0.19	0.29	+0.17%
White	44.82	46.56	45.76	46.21	46.51	+1.69%
Other	4.52	5.11	4.21	4.26	4.14	−0.37%
Unknown	7.48	5.08	7.51	7.00	6.75	−0.73%
AOA%						
American Indian/Alaska Native	0.25	0.80	0.99	0.54	0.19	−0.06%
Asian	17.88	15.17	16.90	15.25	15.58	−2.31%
Black/AA	2.77	3.19	2.78	3.99	2.31	−0.46%
Hispanic, Latino, or Spanish Origin	4.79	5.19	5.57	3.81	5.19	+0.41%
Native Hawaiian/Pacific Islander	0.00	0.00	0.00	0.18	0.19	+0.19%
White	67.00	66.67	64.81	67.70	65.58	−1.43%
Other	2.52	4.39	2.98	2.72	3.65	+1.13%
Unknown	4.79	4.59	5.96	5.81	7.31	+2.52%

Note: Distribution of General Surgery Residencies by Race shows the percent of GS residency positions filled by each race for each year from 2014-2018. Both the ACGME and AOA distributions are represented. A percent change over the 5-year period of each race is represented.

TABLE 4. Distribution by Race Adjusted by Race Populations

ACGME%	2014	2015	2016	2017	2018	% change
American Indian/Alaska Native	71.67	89.78	64.17	87.93	92.01	+20.34%
Asian	514.04	516.63	500.75	503.65	482.42	−31.62%
Black/AA	71.67	71.70	70.11	66.96	69.01	−2.67%
Hispanic, Latino, or Spanish Origin	53.52	51.73	54.48	54.78	59.08	+5.57%
Native Hawaiian/Pacific Islander	58.64	88.14	93.65	97.06	145.68	+87.04%
White	61.90	64.30	63.21	63.83	64.24	+2.34%
AOA%						
American Indian/Alaska Native	27.99	88.71	110.45	60.50	21.37	−6.62%
Asian	372.59	316.03	352.05	317.60	324.52	−48.07%
Black/AA	21.99	25.35	22.09	31.69	18.32	−3.68%
Hispanic, Latino, or Spanish Origin	29.36	31.84	34.15	23.38	31.85	+2.49%
Native Hawaiian/Pacific Islander	0.00	0.00	0.00	90.74	96.15	+96.15%
White	92.54	92.08	89.52	93.50	90.58	-1.97%

Note: Distribution by Race adjusted by Race Populations shows the distribution of residencies by race adjusted by the population of the race within the U.S. Adjusted percentages were found by dividing percent race of filled positions by percent race in the U.S. The percentages represent the percent of residency positions per race per the population of that race.

more GS residencies to ensure there are enough physicians to appropriately care for the population; however, we did not find this. The states with the most SurgPGY1 residency positions per 10^6 population were New York, Massachusetts, and Washington DC. The census region with the most SurgPGY1 residency positions per 10^6 was the Northeast, which is the region with the lowest population. The 4 states with zero SurgPGY1 positions per 10^6 population were Idaho, Montana, Wyoming, and Alaska. The census region with the least SurgPGY1 positions per 10^6 was the West, which had the second lowest population.

The maldistribution found in this study is supported by evidence from previous studies. Sirinek and colleagues evaluated the geographic distribution of general surgery PGY1 positions per capita and found a similar result; that there is a maldistribution of PGY1 positions compared with state and regional populations, particularly in rural areas.[19] They also found the maldistribution reflects the maldistribution of practicing general surgeons across the U.S.[19] Charles and colleagues assessed the trends in the surgical workforce in southern states of the U.S. and also found a geographic maldistribution of surgeons.[20] Likewise, Lynge and colleagues conducted an analysis of the workforce issues in rural surgery and determined that there is significant maldistribution of general surgeons across regions and different types of rural areas.[21] These studies evidence the maldistribution of GS residency positions and the resulting maldistribution of active general surgeons across the U.S. by population.

Maldistribution of active general surgeons is followed by maldistribution of GS residency positions. Previous studies have shown that choosing a residency program committed to rural general surgery preparation is strongly correlated to rural practice.[22] Students that choose to complete a residency in a rural residency program are more likely to practice in a rural area. Additionally, the number of current PGY1 level surgery positions is an estimate of the current general surgery residency distribution. Given that the ACS has made it a priority to increase the opportunity for rural general surgery training, it is important to determine whether new positions are created in areas where there is physician shortage.

Our study also determined that U.S. residencies are maldistributed based on gender and are not significantly improving. The percent of all GS residency positions filled by women reached a high of 37% in 2018 and only increased by 3.5% in 5 years. When broken down by program, the 5-year period saw the percent of ACGME residency positions given to females increase only 2.9%, while the female-filled percent of AOA positions increased by 11.8%. This is unpredicted by the gender distribution in medical students. Not only is there gender inequality in the GS residency position filling, but this inequality is relatively stagnant, especially in ACGME positions.

The maldistribution of residency positions by gender was also found in previous studies. Cruz and colleagues found the number of women accepted to a Puerto Rican general surgery residency program has increased in recent years; however, they also found gender inequality remains.[12] While Cruz' study addressed the gender inequality in one GS residency program, the same results were found in our study which assessed nationwide GS programs. Similarly, Andriole and colleagues evaluated the extent to which recent increases in levels of gender diversity in the overall resident-physician workforce were evident among core-surgical specialty resident workforces and determined that proportions of women in every board-certified specialty workforce, except

obstetrics/gynecology, remained lower than in the overall board-certified workforce.[23] While none of these studies looked exactly at the disparities of gender in GS residency positions across the country like our study, they support the notion that there is a maldistribution of residency positions by gender.

Furthermore, our study found maldistribution of residency positions by race and ethnicity. The race with the highest percent of residency positions filled was White followed by Asian and the lowest percent of residency positions was given to Native Hawaiian/Pacific Islander races. When adjusted by the population of each race within the U.S., the race with the highest positions filled for their population was Asian. The races with the lowest positions filled for their population was Hispanic for the ACGME and Black for the AOA. Further, the races with the largest increase in positions filled over the 5-year period were White for the ACGME and Hispanic for the AOA, while the race with the largest decrease in positions filled was Asian. These results demonstrate that residency positions are not distributed evenly based on race nor population of that race within the U.S.

Our results on the racial distribution of SurgPGY1 positions are supported by evidence in the literature. Recently, Stain and colleagues examined the modern attributes of top-ranked applicants to GS residency programs and found a significant predictor of competitive program ranking was Asian race.[24] Beyond this, Butler and colleagues analyzed the exact demographics of U.S. surgical residents and uncovered that academic surgery is exceedingly deficient of minority residents, with Whites comprising 64.4% of U.S. surgical residents.[15] This study demonstrates that there is a maldistribution in residency positions by race, which supports our findings here.

It is possible that the maldistribution of gender and race in general surgery residency positions is an issue of geographic region and may be more heavily present in certain areas of the country. Supporting minority surgeons in practice should be a priority in order to encourage a better representation of the diversity seen in graduating medical school classes in general surgery residency positions. For instance, in the past few years women were the majority of matriculants to U.S. medical schools yet represented fewer and fewer surgical positions as position level increased.[25] Further, the retention and promotion of underrepresented minority academic surgeons is poor, with most unlikely to remain in academia.[26] This underrepresentation extends beyond positions to even representation at surgical conferences. Recently it was reported that women continue to be underrepresented at surgical conferences, only representing on average 28.4% of speakers in 2017.[27] This underrepresentation is similar to the underrepresentation of women in general surgery residency positions.

There are some limitations to this study. This study relied on data available from the NRMP, which may have

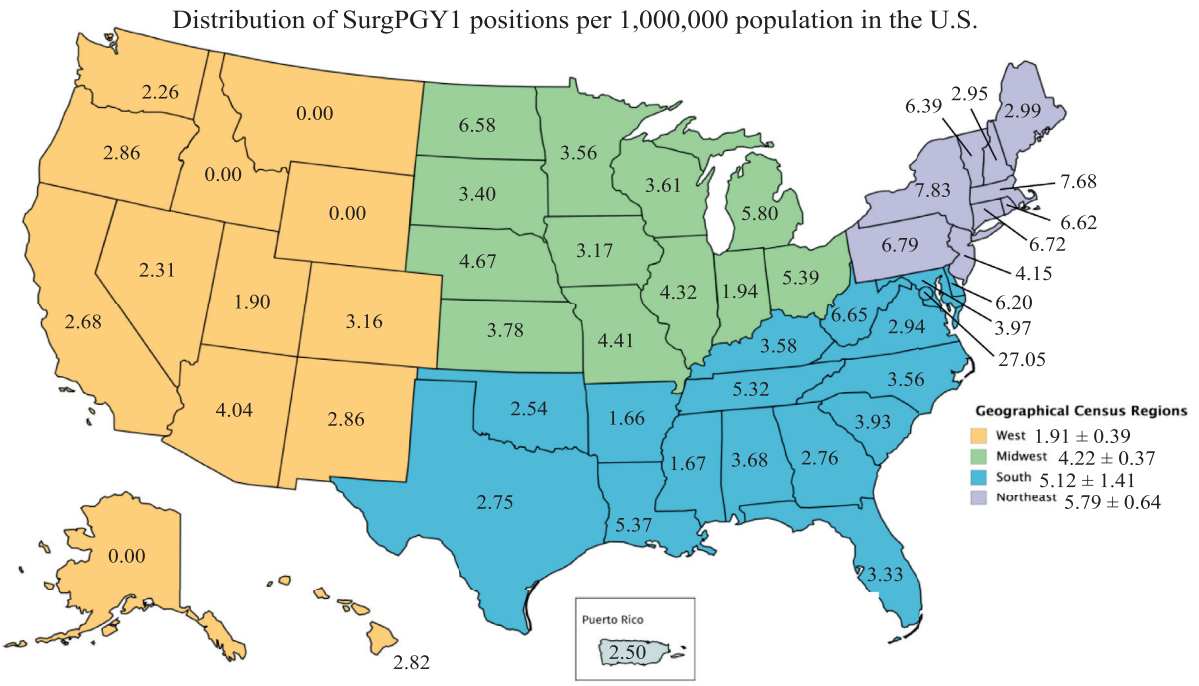

FIGURE 1. Distribution of General Surgery Residencies in the U.S. 2018 shows the SurgPGY1 positions to 1,000,000 population ratios for each state for the year 2018. The mean ± standard error mean (SEM) is represented for each geographical region.

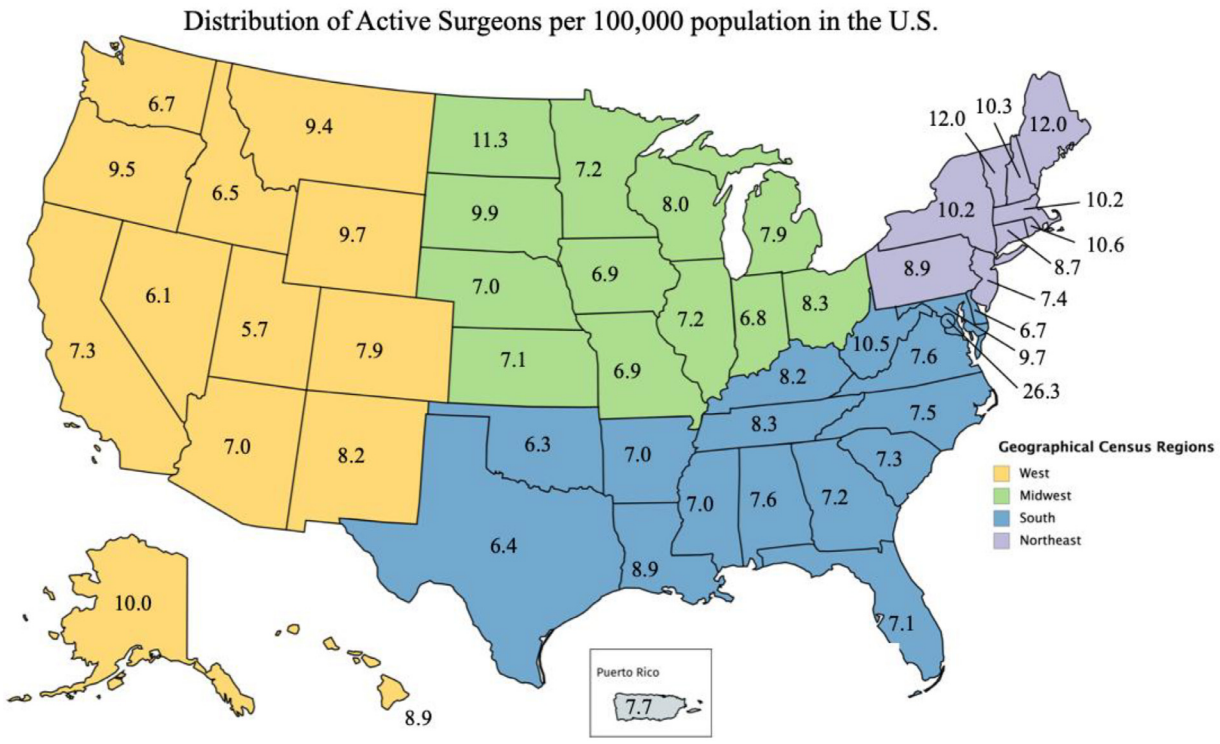

FIGURE 2. Distribution of Active General Surgeons in the U.S. 2016 shows the ratio of active general surgeons per 100,000 population for each state for the year 2016. This data was provided by the AAMC 2017 Workforce Data Report.[16]

errors in gender and race reporting or misclassification. Additionally, the NRMP dataset does not track if preliminary positions turned into categorical positions. The NRMP only lists the number of preliminary spots and does not follow what eventually happens to those positions. We did not include preliminary positions in our study due to this limitation. Some students that matched into General Surgery may have had attrition or switched specialties, which is a limitation of our study. Also, some individuals may not classify themselves either male or female, which affects the distribution of gender amongst surgical residencies. Further, the evaluation of race distribution is limited in that many people in the U.S. self-report as multiple races, making it difficult to accurately document racial distributions. Future studies should account for unique racial combinations and other gender possibilities to determine the modern distribution of surgical residents.

Addressing the misdistribution of residency positions requires a multifaceted approach. On a national level, more funding for the creation of general surgery residency programs will be needed to address the shortage of general surgeons in rural areas. Recent changes in health care policy have focused on expanding primary care specialties, under which general surgery has historically not been included. General surgery advocates must emphasize the breadth of general surgery and argue for its inclusion amongst the primary care specialties. This will have the further benefit of opening the door to medical students receiving loan forgiveness when choosing a general surgery residency. Several studies have examined factors that may influence students to choose a rural residency and residents to practice in rural areas, and many innovative tracks and programs have been created in the last 5 years to further this goal.[22,28] In each of these studies, the factor most often linked to choosing a practice in a rural area was exposure to rural practice. Therefore, the ACS must encourage both medical schools and residencies to offer rural rotations as part of their regular program. Increasing opportunity and increasing interest must go hand-in-hand in order to begin to address this multifactorial problem. Addressing the underrepresentation of minorities and women in General Surgery residency necessitates both open discussions and task forces on surgical equity, equality, and inclusivity. This would initiate the recognition of implicit and systematic biases towards minorities and gender in surgical programs which would lead to increased awareness and eventually action on this issue (Figures 1 and 2).

CONCLUSION

There is a significant disproportion in the distribution of General Surgery residencies. The distribution of General

Surgery residency positions is not proportional to population, gender, or race/ethnicity.

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SUPPLEMENTARY INFORMATION

Supplementary material associated with this article can be found in the online version at doi:10.1016/j.jsurg.2019.05.008.