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ORIGINAL RESEARCH

Geographical Distribution of Newly Accredited Anesthesiology Training Programs in Relation to Health Professional Shortage Areas and Medically Underserved Populations

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INTRODUCTION

The demand for physicians continues to outpace supply, thus posing significant challenges, particularly in specialized fields such as anesthesiology.¹ This magnifies the shortfalls associated with the overall need for healthcare services and further exacerbates persistent gaps in healthcare access and disparities in underserved communities.² Addressing these challenges necessitates a multifaceted approach that includes the establishment and expansion of residency training programs, particularly in underserved areas.^{3,4}

Anesthesiology plays a pivotal role in ensuring patient comfort and safety during surgical procedures and improving perioperative outcomes. However, despite its importance, there have been concerns for a growing shortage of anesthesiologists for over 2 decades.^{5,6} Factors contributing to this shortage include an increase in surgical treatments and expansion of ambulatory surgery centers.⁶ Consequently, hospitals and healthcare facilities must find ways to manage the scarcity of qualified providers, ranging from overworking existing staff to limiting services, both of which have substantial financial consequences.^{7,8}

To address the healthcare inequities that result from this physician shortage, there is an urgent need for the expansion of graduate medical education programs.⁹ One example is the Teaching Health

Center Graduate Medical Education program, which is sponsored by the Health Resources and Services Administration (HRSA) and aims to enhance the care provided in underserved and rural areas throughout the United States by bolstering the pipeline of qualified professionals through the establishment of residency training programs.¹⁰ However, the Teaching Health Center Graduate Medical Education program does not currently include anesthesiology in their list of programs that require expansion to assist underserved communities.¹⁰ We propose that the shortage of anesthesiologists should be considered in programs designed to address healthcare disparities. Inadequate numbers of anesthesiologists in underserved areas impose barriers on patients to receive safe procedures.⁸ Without sufficient anesthesiologists in nearby areas, patients may need to drive substantial distances to receive the standard of care related to preoperative optimization as well as the actual surgery. Travel distance is one of the key components to defining health professional shortage areas (HPSAs) and will be discussed in greater detail in the Methods section of this manuscript. Expanding the physician workforce in disadvantaged communities is imperative for addressing healthcare disparities and promoting health equity. Workforce diversity may lead to improved health outcomes, and patient-physician

racial concordance may lead to greater perceived quality of care.^{11,12} By attracting and retaining healthcare professionals in these regions beginning in residency, underserved populations may gain access to healthcare services, regardless of their postal addresses.⁴

This study's primary aim was to characterize the geographical distribution of new anesthesiology training programs throughout the United States that were accredited between 2014 and 2024 and determine if these new programs are in HPSAs. Our secondary aim was to compare the geographical distribution of new anesthesiology training programs with that of new surgery, family medicine, and obstetrical training programs that were accredited over the same time, particularly with respect to areas and patient populations identified as underserved. We chose to analyze surgery training programs because of their concordant clinical needs. We chose to analyze family medicine and obstetrical training programs because the current scores that define HPSAs are most closely linked to these specialties.

METHODS

Study Design and Setting

This study used a cross-sectional, observational design.

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Study Population

All newly Accreditation Council for Graduate Medical Education (ACGME)-accredited anesthesiology, surgery, family practice, and obstetrical training programs made up the study population.

Inclusion Criteria

The study population included all anesthesiology, surgery, family medicine, and obstetrical training programs that were accredited between 2014 and 2024 in the United States as identified on the ACGME website.

Exclusion Criteria

The study population excluded training programs outside of the United States. We also did not consider the expansion of existing programs, which may or may not be in underserved areas.

Definitions

A medically underserved area (MUA) was defined as an area with an insufficient number of primary care services.¹³ A medically underserved population (MUP) was defined as insufficient primary care services for a population made up of elderly residents or one that demonstrates high infant mortality, high level of poverty, or lack of primary care providers.¹³

Each HPSA designation was scored from 1 to 25, with higher scores indicating higher need or priority. These scores are publicly available on the HRSA website (<https://bh.w.hrsa.gov/workforce-shortage-areas/shortage-designation>) and can be found after typing in a postal address.¹³ Per the HRSA website, the HPSA score for primary care was calculated using the following components: population-to-provider ratio (10 points maximum), percentage of the population below 100% of the federal poverty level (5 points maximum), Infant Health Index (5 points maximum), and travel time to nearest source of care outside the HPSA area (5 points maximum).¹³ An HPSA score for a maternity care target area (MCTA) was calculated for every primary care HPSA using the following components: population-to-full-time-equivalent maternity care health professional ratio, percentage of the population with income at

or below 200% of the federal poverty level, and travel distance/time to nearest source of care outside the area of the MCTA.¹³

The American Medical Association region classifications (Regions 1 to 7) were not used to describe the locations of newly accredited programs in an attempt to apply more meaningful names to the regions.¹⁴ Each region in this study was associated with multiple states as indicated by the following distribution: Mideast (Delaware, Kentucky, Maryland, North Carolina, Tennessee, Virginia, and West Virginia), Midwest (Illinois, Indiana, Iowa, Michigan, Minnesota, Missouri, Ohio, and Wisconsin), Mountain-Prairie (Colorado, Kansas, Montana, Nebraska, North Dakota, South Dakota, Utah, and Wyoming), Northeast (Connecticut, Maine, Massachusetts, New Hampshire, New Jersey, New York, Pennsylvania, Rhode Island, Washington DC, and Vermont), Northwest (Alaska, Idaho, Oregon, and Washington), Southeast (Alabama, Arkansas, Florida, Georgia, Louisiana, Mississippi, Oklahoma, South Carolina, and Texas), and West (Arizona, California, Hawaii, Nevada, and New Mexico). This regional classification of states was chosen because of the descriptive region names. This classification system has been used previously in an unrelated publication.¹⁵

Data Collection

The number of newly accredited anesthesiology residency training programs were obtained from the ACGME, which supplied the name of the program and the accreditation date.¹⁶ The Fellowship and Residency Electronic Interactive Database Access System was then queried to determine the postal address for each newly accredited program.¹⁷ This sequence of tasks for the identification and geographic distribution of anesthesiology training programs was then repeated for general surgery, family medicine, and obstetric training programs.

The HRSA website was queried in April 2024 for HPSA scores for the postal addresses of the newly accredited anesthesiology, surgery, family medicine, and obstetrics programs. An HPSA score, if applicable, was recorded for primary care and maternal care. Although also available

on the HRSA website, scores indicating poor access to mental health care were not included in the dataset because of the less relevant association with anesthesiology. Whether the postal address of the training program corresponded to an MUA or MUP was recorded as a binary variable (“yes” indicating designation and “no” indicating no designation).

We did not collect demographic data such as race or ethnicity to further characterize the locations of newly accredited programs. Our aims were only related to the geographical distribution of newly accredited programs and not the demographic makeup of the surrounding areas. Further analysis of the demographic components of underserved areas may serve as an appropriate additional study for future investigation.

Aims

By using these methods, this study aimed to provide a comprehensive understanding of the geographical distribution of newly accredited anesthesiology residency programs, compare their locations with newly accredited surgical, family medicine, and obstetrical programs, and identify whether these programs are in areas shared by underserved designations.

Statistical Analysis Plan

The geographical distribution of newly accredited anesthesiology programs was compared, qualitatively, with those of newly accredited surgery, family medicine, and obstetrics training programs. Bivariate maps with different colors indicating the relationship between mean HPSA scores and number of newly accredited programs by state also assisted in qualitative description of the programs' geographical distributions. RStudio was used for all graphs.¹⁸ STATA was used for statistical tests comparing HPSA scores among training programs and frequency distribution of training programs among regions.¹⁹ Analysis of variance was used to compare HPSA scores across all training programs studied. Individual *t* tests were used to compare HPSA scores between 2 programs. Pearson's χ^2 tests were used to compare frequency distributions of training programs by US region and MUAs or MUPs. These statistical tests were all

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chosen given their interpretability in comparing multiple programs to each other and the ease with which the results could be communicated.

Ethical Considerations

This study involved the analysis of publicly available data. In describing the geographic locations of new training programs, we characterized populations based on data from HRSA. Otherwise, human participants were not involved. Institutional review board approval was not necessary.

RESULTS

A total of 603 training programs became accredited between 2014 and 2024 (anesthesiology [$N = 48$], surgery [$N = 127$], family medicine [$N = 360$], and obstetrics [$N = 68$]). The following results pertain to these newly accredited programs.

Geographical Distribution of Newly Accredited Training Programs

The greatest percentage (33%) of all newly accredited anesthesiology programs was located in the Southeast. However, this result is skewed due to the disproportionate number (11) of programs that were established in Florida. The state with the second greatest number of anesthesiology programs was California at 7. No new anesthesiology programs were established in the Northwest. The most frequent number of new anesthesiology programs per state was 1.

By contrast, the greatest percentage (30%) of all newly accredited surgery programs was located in the Northeast, whereas the lowest percentage (2%) was in the Northwest. Overall, the distributions of anesthesiology and surgery programs across the United States were comparable ($P = .75$).

Like anesthesiology, the greatest percentages of newly accredited family medicine (26%) and obstetrical (32%) programs were located in the Southeast. The Mountain-Prairie region had the fewest percentages of new family medicine (4%) and obstetrical (1%) programs. Figure 1 graphically displays the distribution and number of newly accredited programs from all included specialties that were established in each state between 2014 and 2024.

HPSAs

Roughly half of all newly established anesthesiology (48%), surgery (50%), family medicine (55%), and obstetrical (53%) programs accredited between 2014 and 2024 were in a designated shortage area for health professionals, defined as having an HPSA score of greater than 0. Overall, the distributions of programs in these shortage areas were statistically similar ($P = .68$). The mean HPSA score for anesthesiology programs was similar to that for family medicine programs (mean [standard deviation]): 14.2 [3.4] versus 14.3 [3.3], $P = .90$. Figure 2A and B are bivariate US maps that display the mean primary care HPSA score and number of programs for anesthesiology and family medicine in each state, respectively. States with the lowest density of new anesthesiology or family medicine residency programs have relatively higher HPSA scores. Florida and, to a lesser extent, California and Michigan had a relatively high density of anesthesiology programs with higher HPSA scores. For family medicine programs, Florida, New York, Michigan, Texas, Washington, and Ohio demonstrated a relatively higher density of programs with higher HPSA scores.

To focus on maternal care, the mean MCTA score for newly accredited anesthesiology programs was similar to that for obstetrical programs (mean [standard deviation]: 12.6 [3.4] versus 11.4 [4.1], $P = .26$). Figure 3A and B are bivariate US maps that display the mean MCTA score and number of programs for anesthesiology and obstetrical training programs in each state, respectively. Figure 3A indicates that most states have relatively higher MCTA scores and fewer anesthesiology programs (Nevada, Texas, Tennessee, Missouri, Illinois, and Ohio). Conversely, Figure 3B demonstrates that states with a greater number of obstetrical programs typically have higher MCTA scores (Nevada, Tennessee, Kentucky, Indiana, Illinois, and Ohio).

MUAs or MUPs

As per the definitions established by the HRSA website, MUAs and MUPs are not interchangeable. Twenty-nine percent of all newly established anesthesiology programs accredited between 2014 and 2024 are in an area designated as medically underserved,

whereas 8% of the programs share their locations with patient populations that are medically underserved. This is similar to the percentage of family medicine programs in MUAs and MUPs: 34% and 8%, respectively ($P = .85$). Additionally, 1% of family medicine programs were in an area defined as both a MUA and MUP. The percentages of new surgery and obstetrical training programs in MUAs are 29% and 32%, respectively. The percentages of surgery and obstetrical training programs in an area shared by a MUP are 6% and 9%, respectively. Overall, there was no statistically significant difference noted among the distributions of anesthesia, surgery, family medicine, or obstetrical training programs in MUAs ($P > .5$).

DISCUSSION

Overall, the geographical distributions of new anesthesiology and surgery training programs are similar. There is, however, a noted discrepancy in the number of programs accredited, with general surgery having 127 compared with 48 for anesthesiology. The reasons for this discrepancy are likely multifactorial and should be the focus of additional research investigating barriers to anesthesiology program development that are distinct from those of general surgery. Underserved areas, and particularly those in rural areas, may not sufficiently meet all ACGME requirements for anesthesiology training exposure. For example, intrathoracic, cardiac, and pediatric anesthesiology case numbers may be difficult to meet in isolated, rural settings. Additionally, facilities with intensive care units and pain clinics may present additional obstacles. Therefore, residents may need to travel to distant sites, perhaps outside of MUAs, to complement the training offered at their home institutions.

Traditionally, anesthesiology has not been considered in prior publications assessing the impact of physician shortages on health disparities.^{3,10} However, in addition to supporting surgical services, anesthesiology impacts care provided by both family medicine and obstetrics. Although the designations assigned by the HRSA are, perhaps, more immediately applicable to family medicine, internal medicine, and pediatrics,^{10,13} we contest

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that anesthesiology may be inappropriately overlooked when assigning HPSA scores. In MUAs, preoperative consultations with anesthesiologists are crucial to evaluate patient risk for serious pulmonary and cardiovascular diseases that may not have been diagnosed earlier due to poor healthcare access. Preoperative evaluation by an anesthesiologist has been associated with reduced postoperative mortality.^{20,21} Pain medicine components of anesthesia training further enhance opportunities for more comprehensive perioperative care.²² Anesthesiologists also play a pivotal role in the care of pregnant women. Areas defined as having limited access to maternity care (as measured by the MCTA score) should be of interest to anesthesiologists. The results of this study demonstrated that newly accredited anesthesiology and obstetrical training programs are in similar MCTAs. If anesthesiology training programs continue to be established in these areas, then preoperative consultation with an anesthesiologist before labor or cesarean section may prove vital in recognizing diseases that need higher levels of care.

Overall, anesthesiologists can have a profound impact and improve the quality of care and range of services provided for MUPs. However, the establishment of new anesthesiology training programs in these areas has not received the attention that other programs (internal medicine, family medicine, and pediatrics) have received. The impact of anesthesiology programs in shortage areas should be the focus of future efforts to decrease healthcare disparities and enhance the diversity of trainees.³

Limitations

Data from the HRSA may not be entirely up to date. Many areas queried in this study had not received an updated service area designation in over 10 years. Therefore, the scores reported in this manuscript may not accurately reflect current conditions. Although it is possible that the number of underserved areas and HPSA scores have decreased since their last evaluation, we suspect that this is unlikely.

Because the standard deviations for HPSA scores were low in this study, the color bars on the maps presented in this manuscript may be exaggerated. For example, states

with areas that have relatively higher HPSA scores may appear substantially different from states that have relatively lower HPSA scores on bivariate color maps, despite the difference being only 3 points, for example.

Additionally, we did not investigate the number of positions offered by each training program and did not include programs in MUAs that have expanded the number of positions offered. Those data are available but are more difficult to confidently analyze. For example, did the program start out with the full resident allotment for all years? What if the program did not match all the allotted positions? Did all trainees complete the program? Did the program maintain their accreditation?

Future Research

Future research should focus on assessing the impact of newly accredited anesthesiology programs on HPSA scores, whether trainees remain to practice in underserved areas upon graduation, and what factors impact a physician continuing practice in the area in which they trained upon graduation. In addition, information regarding the racial diversity of the trainees in programs in underserved areas compared with other programs, correlations between diversity of the trainees and the populations served by the training programs, and the impact of these correlations to the practice location of the graduates would all provide useful guidance for programs designed to address healthcare disparities.

CONCLUSIONS

States with higher HPSA scores in our dataset, or those with a greater need for health professional services, tend to have a relatively lower number of newly accredited anesthesiology and surgery programs (corresponding to the color at the bottom right corner of the legends for the bivariate maps) than states in our dataset with lower HPSA scores. Overall, the locations of newly accredited anesthesiology training programs are similar to those of newly accredited family medicine and obstetrical training programs as evidenced by similar HPSA and MCTA scores, respectively. Expansion of anesthesia services to MUAs and populations may assist in decreasing health disparities in surgical offerings and preoperative optimization, but this statement requires additional investigation.

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Abstract

Background: Expanding the physician workforce in underserved areas is imperative for addressing healthcare disparities. The creation of new residency training programs has assisted in these efforts. However, anesthesiology training programs are infrequently studied in this regard. Our objective was to compare the geographical distribution of newly accredited anesthesiology training programs with new surgery, obstetrics, and family practice programs with respect to health professional shortage areas (HPSAs) and medically underserved populations.

Methods: The locations of residency training programs accredited between 2014 and 2024 were identified by querying the Accreditation Council for Graduate Medical Education and Fellowship and Residency Electronic Interactive Database Access System. Whether the postal address of the training program corresponded to a medically underserved area or population was then recorded. HPSA and maternal

care target area (MCTA) scores were also collected as an indicator of poor access to primary care or maternal care for the postal addresses of each program. Bivariate US maps qualitatively compared the geographical distributions of newly accredited training programs, analysis of variance and *t* tests were used to compare HPSA and MCTA scores, and χ^2 tests were used to compare the percentage of programs in medically underserved areas.

Results: Forty-eight anesthesiology programs became accredited between 2014 and 2024, as well as 127 surgical, 360 family medicine, and 68 obstetrical programs (total = 603). States with higher HPSA scores tended to have a relatively lower numbers of newly accredited anesthesiology and surgery programs. The mean HPSA and MCTA scores for anesthesiology programs were comparable to those for family medicine and obstetrical programs, respectively ($P > .5$). There was no statistically significant difference noted among the distribution of anesthesia, surgery, family medicine, or obstetrical training programs in medically underserved areas ($P > .5$).

Discussion: The geographical distributions of new anesthesiology and surgery training programs are qualitatively similar. Like family medicine and obstetrical training programs, newly accredited anesthesiology training programs are in HPSAs with comparable need priorities as evidenced by statistically similar HPSA and MCTA scores. However, with only roughly one-third of all newly accredited family medicine, obstetrical, surgery, and anesthesiology training programs in medically underserved areas, substantial work is still needed.

Conclusion: States with higher HPSA scores tend to have a relatively lower number of newly accredited anesthesiology and surgery programs. The locations of newly accredited anesthesiology training programs are similar to those of newly accredited family medicine and obstetrical training programs as evidenced by similar HPSA and MCTA scores, respectively.

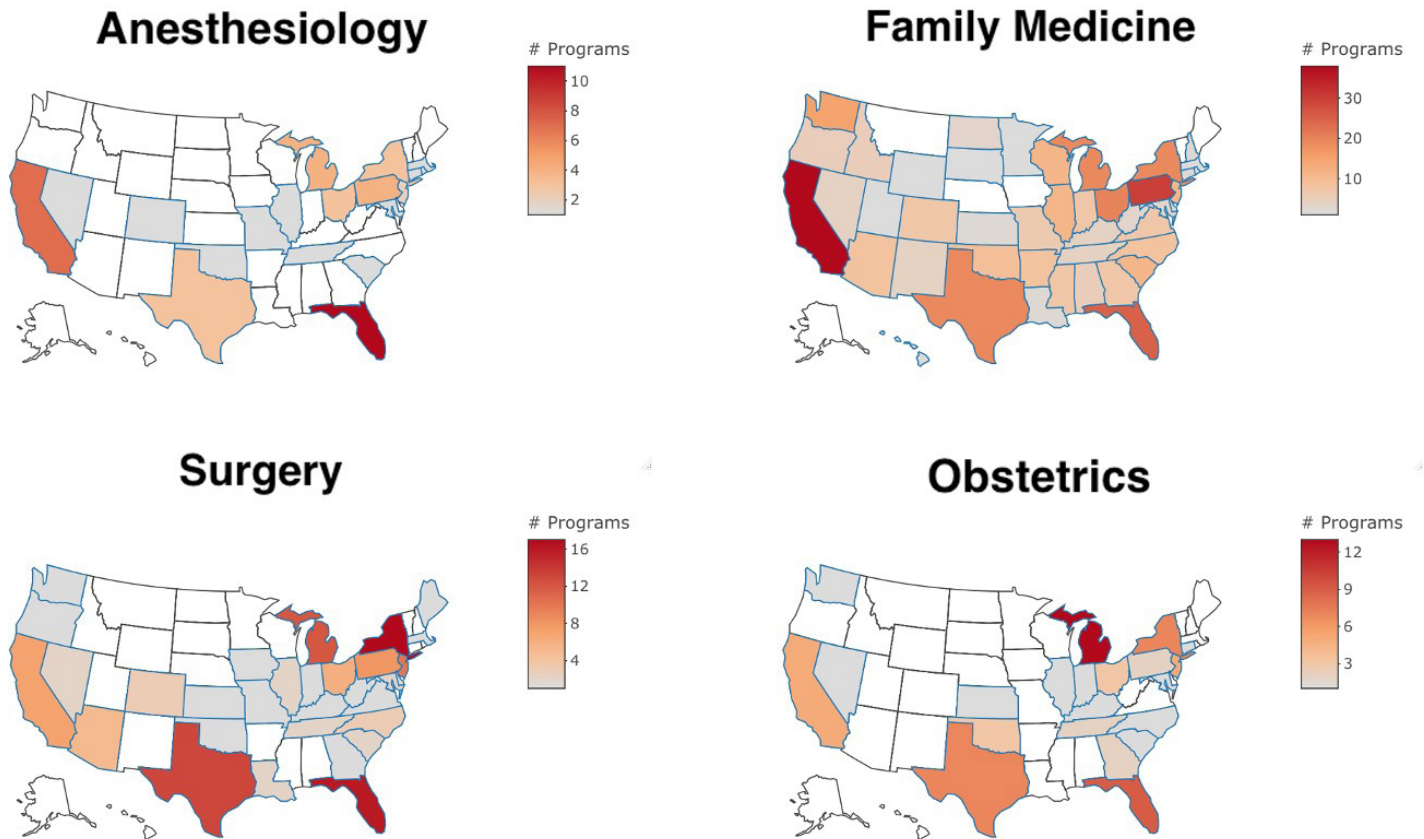
Keywords: Health disparities, graduate medical education, medically underserved area, medically underserved population

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Figures

Figure 1. Distribution of newly accredited anesthesiology, surgery, family medicine, and obstetrics programs.



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Figure 2. Mean primary care health professional shortage area (HPSA) score and number of newly accredited programs for each state.

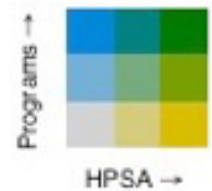
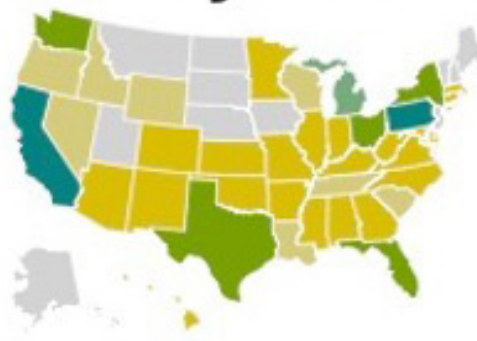
A

Anesthesiology



B

Family Medicine



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Figures continued

Figure 3. Mean maternal care target area (MCTA) score and number of newly accredited programs for each state.

