

General Surgery Residency Expansion Does Not Systematically Scale with Population Growth Across U.S. Regions: A National Analysis, 2013–2024

Zeran Zhang

zeran.zhang@temple.edu

Lewis Katz School of Medicine at Temple University <https://orcid.org/0009-0001-9618-4152>

Luke Phillips

Lewis Katz School of Medicine at Temple University

Elizabeth Dauer

RWJBarnabas Health

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Abstract

Purpose. General surgery residency positions are disproportionately concentrated in urban centers, potentially limiting resident case exposure and operative preparedness. As the national per capita supply of general surgeons declines, rural regions have a disproportionately older workforce with insufficient replacement. Residency programs with rural training exposure improves rural retention yet recent trends in regional allocation of the general surgery resident workforce relative to population growth remains poorly defined. Here, we perform a retrospective review to investigate whether regional differences in general surgery resident workforce allocation align with population changes across U.S. regions.

Methods. We performed a retrospective review of publicly available data from the National Resident Matching Program and the United States Census Bureau spanning 2013-2024. General surgery resident workforce is approximated by entering residency positions per capita. Regions are defined according to U.S. Census Bureau divisions. The strength and direction of a linear relationship between percentage change in entering general surgery residency positions per capita and percentage change in population from 2013-2024 was assessed by Pearson Correlation Coefficient. Differences in these percentage changes were assessed by paired t-tests.

Results. The national mean percentage change in entering residency positions per capita and population from 2013–2024 was 1.35% and 0.48%, respectively. There was no significant difference between workforce and population changes across regions ($p>0.05$). Regionally, New England demonstrated a significant decline in residency positions per capita, whereas several regions, including the Mid-Atlantic and South Atlantic, showed significant growth over time ($p<0.001$). Workforce allocation relative to population varied by region, with the strongest positive correlation observed in the East North Central region ($r=0.63$) and the most negative in the East South Central region ($r=-0.57$).

Conclusions. U.S. general surgery resident workforce allocation from 2013-2024 varies by Census Bureau regions and does not systematically scale with population growth. Heterogeneity in allocation highlights regional disparities in training environments and access to surgical care.

INTRODUCTION

The United States is facing a general surgery workforce crisis, driven by an aging surgeon population. The adequacy gap in general surgeon supply will continue to widen through 2037, with rural regions bearing the greatest burden of this shortage due to a disproportionately older workforce and inadequate replacement rates [1–2]. Residency training is the foundational mechanism by which this workforce is replenished, yet general surgery residency positions remain heavily concentrated in urban academic centers. Notably, rural training exposure during residency has been shown to increase the likelihood of rural practice after graduation, underscoring the importance of where—not just how many—residency positions are allocated [3].

Prior studies have examined urban-rural disparities in general surgery training environments. In 2018, first-year general surgery residents (SurgPGY1) were most concentrated in the Northeast, followed by the South, Midwest, and West, with four states having no SurgPGY1s and several others having fewer than 2 per 10⁶ population [4]. More recently, Khalil et al. found that over half of matched applicants trained in the same region as their medical school, reinforcing the notion that the distribution of training positions has downstream implications for where surgeons ultimately practice [6]. Despite growing recognition of these geographic disparities, the relationship between residency training capacity and regional population dynamics has not been systematically examined.

Understanding whether residency expansion mirrors or diverges from population growth across U.S. regions is critical for identifying gaps in surgical training capacity and informing policy aimed at improving access to surgical care. Such policies emphasize strengthening the rural surgical workforce through rural-focused medical education and training, expanding clinical technologies, and sustaining hospital infrastructure [7]. We aimed to identify if regional differences in general surgery resident workforce allocation align with population changes across U.S. regions in recent years.

METHODS

We performed a retrospective observational study examining trends in entering general surgery residency positions per capita across U.S. regions from 2013 to 2024. Entering SurgPGY1 positions were used as a proxy for the surgical training pipeline and future workforce supply, as they represent the primary point of entry into the general surgery workforce and reflect institutional training capacity within a given region. Normalizing by population allows for comparison of training capacity relative to regional demand. U.S. regions were defined according to the U.S. Census Bureau divisions which is consistent with the Fellowship and Residency Electronic Interactive Database Access (FREIDA) facilitated by the American Medical Association (AMA). These regions and encompassing States are New England (CT, MA, ME, NH, RI, VT), Mid Atlantic (NJ, NY, PA), East North Central (IL, IN, MI, OH, WI), West North Central (IA, KS, MN, MO, ND, NE, SD), South Atlantic (DC, DE, FL, GA, MD, NC, VA, WV), East South Central (AL, KY, MS, TN), West South Central (AR, LA, OK, TX), Mountain (AZ, CO, ID, MT, NM, NV, UT, WY), Pacific (AK, CA, HI, OR, WA), and Puerto Rico.

Annual Match Rates by Specialty and State reports were downloaded from the National Resident Matching Program (NRMP) Main Residency Match® public database for the years 2013–2024. From each annual report, the total number of filled PGY-1 general surgery positions per state was extracted. State-level totals were then aggregated into regions as defined by the nine U.S. Census Bureau divisions to yield the total number of entering general surgery residents per region for each year from 2013 to 2024.

State-level population estimates for 2013–2024 were obtained from two publicly available U.S. Census Bureau reports: the Annual Estimates of the Resident Population covering April 1, 2010 through July 1, 2019, and the corresponding estimates covering April 1, 2020 through July 1, 2024 [8, 9]. State

populations were aggregated into U.S. Census Bureau regions using the same classification applied to the residency data.

Per capita workforce was calculated for each year from 2013 to 2024. Linear regression was used to model entering residency positions per capita over time for each region. Model fit was assessed using R^2 , and statistical significance was determined from regression-derived p-values.

Year-over-year percentage change in entering residency positions per capita was calculated for each region. Mean percentage changes with standard deviations and 95% confidence intervals were computed across years 2013–2024 for each region and nationally. This was repeated for population data.

Paired t-tests were used to compare the annual percentage change in entering residency positions per capita with the corresponding percentage change in population for each region and nationally. Pearson correlation coefficients were calculated to assess the strength and direction of the linear relationship between percentage change in entering residency positions per capita and percentage change in population from 2013 to 2024, both by region and across all regions. All analyses were performed using Microsoft Excel Data Analysis ToolPak and GraphPad Prism. Statistical significance was set at $p < 0.05$.

RESULTS

Regional Trends in Entering Residency Positions Per Capita. From 2013 to 2024, regional trends in entering general surgery residency positions per capita (ERP per capita) varied substantially across the United States. Linear regression demonstrated significant increases in positions per capita in the Mid Atlantic ($R^2=0.90$, $p < 0.0001$), East North Central ($R^2=0.74$, $p = 0.0002$), South Atlantic ($R^2=0.89$, $p < 0.0001$), and Mountain ($R^2=0.73$, $p = 0.0002$) regions. In contrast, New England exhibited a significant decline ($R^2=0.75$, $p = 0.0001$). The remaining regions — West North Central, East South Central, West South Central, and Pacific — demonstrated no statistically significant linear trends.

Workforce Expansion Relative to Population Growth. Comparing the annual percentage change in entering residency positions per capita to that of population yielded no significant results for all regions individually and nationally (all $p > 0.05$). Nationally, the mean annual percentage change in entering residency positions per capita was 1.35% (SE = 0.674, 95% CI: 0.03–2.67), compared to 0.48% (SE = 0.081, 95% CI: 0.33–0.64) for population growth. Annual mean percentage changes for both measures are presented in Fig. 1. Longitudinal changes across all regions for both measures are presented in Fig. 2.

Correlation Between Workforce Allocation and Population Change. Despite similar aggregate growth rates, the relationship between workforce expansion and population change varied by region. The East North Central region demonstrated a moderate positive correlation ($r = 0.63$, $p = 0.028$), suggesting relative alignment between training capacity and population growth. In contrast, the East South Central region demonstrated a moderate negative correlation ($r = -0.57$, $p = 0.051$), indicating divergence

between workforce allocation and population trends. Most other regions exhibited weak or no meaningful correlation. At the national level, there was no significant correlation between changes in residency positions per capita and population growth ($r = 0.05$, $p = 0.884$). Regional Pearson correlation coefficients with interpretive classifications are presented in Fig. 3.

DISCUSSION

This study provides a longitudinal, population-adjusted analysis of general surgery residency position allocation across U.S. Census regions from 2013 to 2024. While national residency positions per capita grew modestly over this period, the findings reveal substantial regional heterogeneity in training capacity expansion and a lack of systematic alignment between workforce pipeline growth and population dynamics.

In our study, several regions experienced significant per capita increases in residency positions which may reflect deliberate efforts to expand graduate medical education (GME) capacity in response to projected workforce shortages. However, others saw a decline, most notably observed in New England which has historically maintained the highest concentration of GME positions and Medicare GME funding in the nation. This oversupply is a product of historical institutional concentration with GME positions remaining anchored to legacy institutional locations without redistribution in response to population shifts [10]. The federal cap on Medicare-funded residency slots enacted in the late 1990s further entrenched this maldistribution by intentionally constraining supply. While approximately 15,000 new positions have been authorized by Medicare since the initial federal cap, teaching hospitals concentrated in the Northeast continue to hold a disproportionate share of training capacity even as population growth has shifted toward the South and West [11]. Taken together, New England's per capita decline may represent a gradual correction toward equilibrium rather than a meaningful reduction in training capacity, though the implications for regional surgical access remain an important consideration.

The moderate positive correlation observed in the East North Central region suggests that some degree of alignment between training capacity and population growth is achievable. Several structural features may contribute to this relative alignment. The region encompasses Illinois, Indiana, Michigan, Ohio, and Wisconsin—states with a high density of established academic medical centers and GME capacity exceeding the national average [12]. This robust institutional infrastructure, combined with relatively stable population dynamics compared to the rapid expansion seen in the South and West, may create conditions in which incremental changes in residency positions more closely track demographic shifts. In contrast, the moderate negative correlation in the East South Central region is concerning, as it implies that residency positions may be contracting or stagnating in a region experiencing population growth.

The East South Central region encompasses Alabama, Kentucky, Mississippi, and Tennessee—states with substantial rural populations and among the lowest life expectancies [13]. Mississippi currently has one of the lowest general surgeon workforce adequacies nationally at 64.3% yet the region receives

disproportionately low Medicare GME funding relative to population need [10]. This divergence is particularly consequential from a health equity standpoint, as these states already face higher disease burden, fewer practicing surgeons, and an aging surgical workforce—with 28.1% of general surgeons in nonmetropolitan areas aged 65 and older, and 60% projected to reach retirement age within the next decade [2]. Nationally, only 2% of Medicare-funded training slots are located in rural areas, meaning federal GME investment has largely bypassed the communities most in need of surgical workforce development [11].

Policy implications of these findings are significant. Workforce planning efforts should incorporate population-adjusted metrics when evaluating the adequacy of residency expansion. Strategies such as incentivizing residency program development in underserved regions through targeted Medicare GME cap adjustments, expanding rural training tracks within existing programs, strengthening academic–rural health system partnerships, and linking graduate medical education funding to population-based workforce needs assessments may help realign the training pipeline with the geographic realities of surgical demand. For example, Maine’s Rural Graduate Medical Education (MERGE) Collaborative has established 18 rural rotation sites, providing residents with exposure to diverse populations and health care challenges. Likewise, the state-funded Wisconsin Rural Physician Residency Assistance Program supports 8-week rural rotations across multiple specialties. At the federal level, the Health Resources and Services Administration (HRSA)-funded Rural Residency Planning and Development (RRPD) Program provides startup funding and technical assistance for new residency programs in several specialties important to rural health systems, including general surgery and obstetrics/gynecology. As of 2023–2024, RRPD programs account for 21.6% of all rural residency programs nationally [14].

At the state level, Medicaid represents a largely underutilized but immediately actionable lever for expanding rural surgical training capacity. Unlike Medicare GME, which is federally capped and institutionally anchored to 1996 slot counts, Medicaid GME payments are governed by state-designed formulas and administered through State Plan Amendments (SPAs) submitted to CMS for approval, meaning states retain direct authority to restructure how training dollars flow without federal legislative action. States with high rural populations and disproportionate surgical workforce shortages, such as those in the East South Central region, could pursue several concrete Medicaid-based strategies. First, states not currently paying Medicaid GME, a category that includes some of the most underserved states in the country, could adopt a Medicaid GME SPA, immediately unlocking federal matching funds for every state dollar invested in residency training, further incentivizing creation of local training positions. Second, states with existing Medicaid GME programs could redesign their SPA payment formulas to explicitly weight reimbursement toward rural training sites, community-based rotations, or shortage specialties such as general surgery, a targeting flexibility that Medicare’s uniform national formula does not permit. Third, as states increasingly shift Medicaid enrollees into managed care, explicit GME carve-outs from capitation rates are essential to prevent training dollars from flowing to managed care organizations with no obligation to direct them toward teaching programs. Finally, Medicaid GME can serve as a durable funding mechanism to sustain rural residency programs initiated through time-limited federal grants such as HRSA’s RRPD Program, converting startup investments into

long-term training infrastructure. Taken together, a coordinated state strategy leveraging Medicaid GME alongside existing federal programs could meaningfully expand the rural surgical training pipeline without requiring new federal legislation, though realizing this potential will require improved data infrastructure to track where Medicaid GME dollars flow and whether they translate into measurable workforce outcomes in high-need regions.

This study has several limitations. First, the use of Census division–level data may obscure important intra-regional variation, particularly between urban and rural areas within the same division. Second, the analysis examines entering residency positions as a proxy for workforce pipeline capacity but does not account for attrition, fellowship sub specialization, or the ultimate practice locations of graduating residents—all of which influence the effective general surgery workforce. Third, the study period of 2013–2024, while providing meaningful longitudinal data, may not capture longer-term secular trends or the full impact of recent policy changes such as the Consolidated Appropriations Act provisions for GME expansion. It also overlaps with the COVID-19 pandemic, which may have influenced both population dynamics and residency training capacity in ways that are difficult to disentangle from secular trends [11]. Finally, correlation analyses do not establish causation, and the observed associations between residency growth and population change may be influenced by unmeasured confounders including state-level funding policies, institutional priorities, and market forces.

In conclusion, this study demonstrates that general surgery residency position growth across the United States from 2013 to 2024 has not systematically aligned with regional population changes. While national per capita training capacity has modestly expanded, the absence of correlation with population dynamics and the significant regional variability in trends suggest that current workforce pipeline expansion is not strategically calibrated to meet evolving population needs. These findings underscore the need for population-informed, geographically intentional approaches to graduate medical education planning to address the growing maldistribution of the surgical workforce and improve equitable access to surgical care.

Declarations

Conflict of Interest Statement:

On behalf of all authors, the corresponding author states that there is no conflict of interest.

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Figures

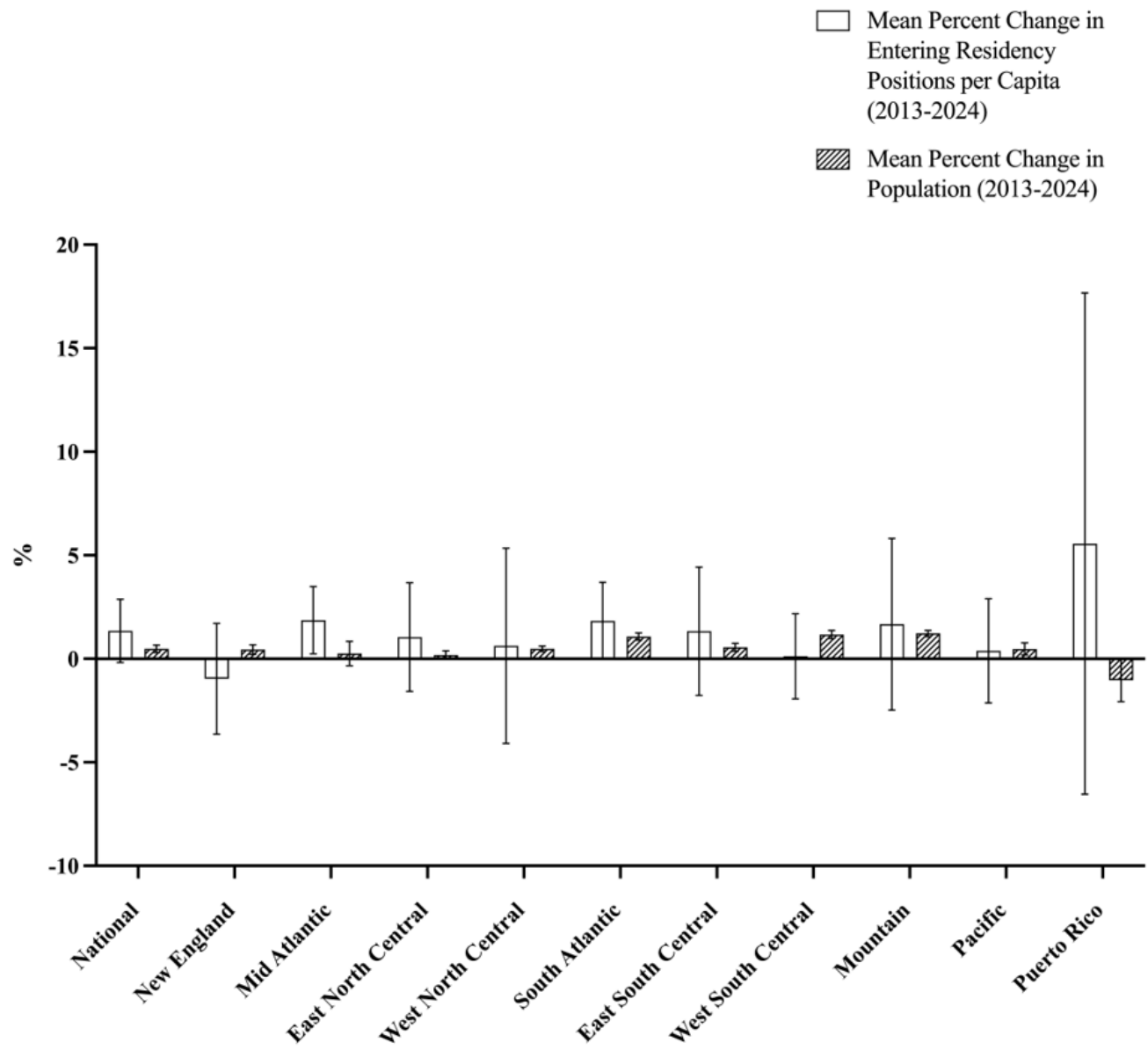


Figure 1

Annual percentage change in entering residency positions per capita and population growth, 2013–2024. Bars show means with 95% confidence intervals. No statistically significant differences were found ($p > 0.05$).

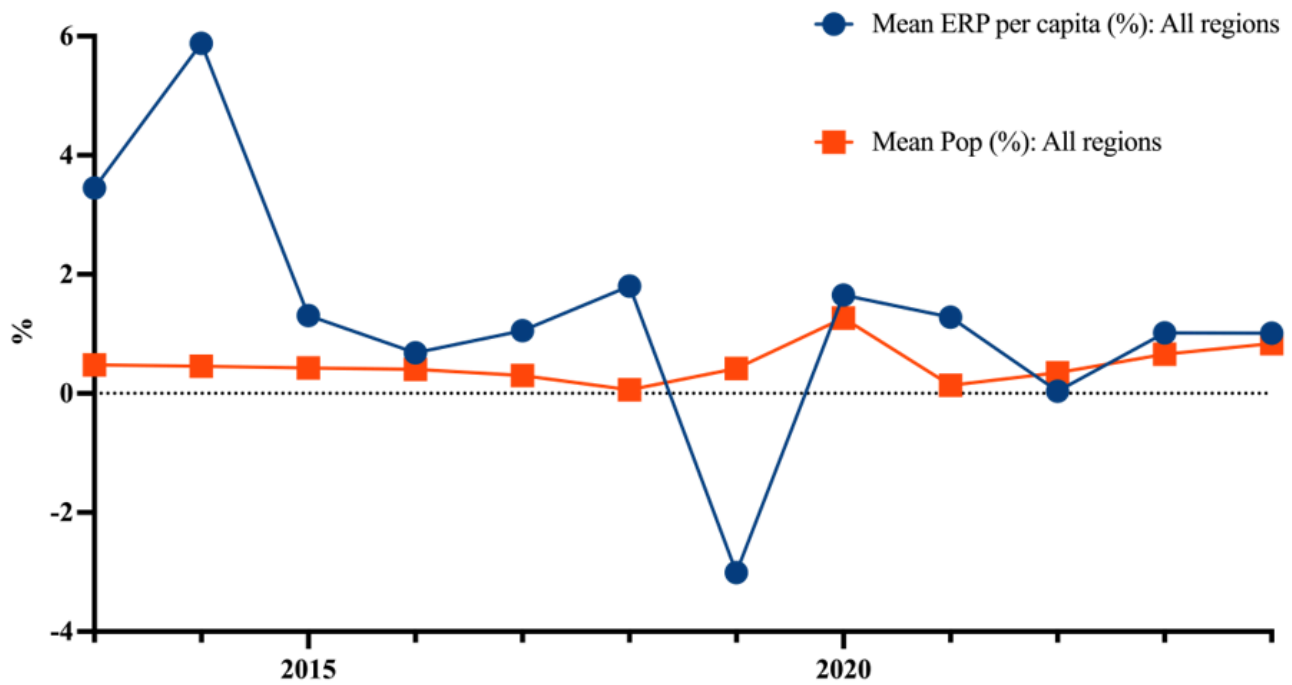


Figure 2

Annual percentage change in national ERP per capita versus population growth, 2013–2024. Blue line: ERP per capita; Orange line: general population growth.

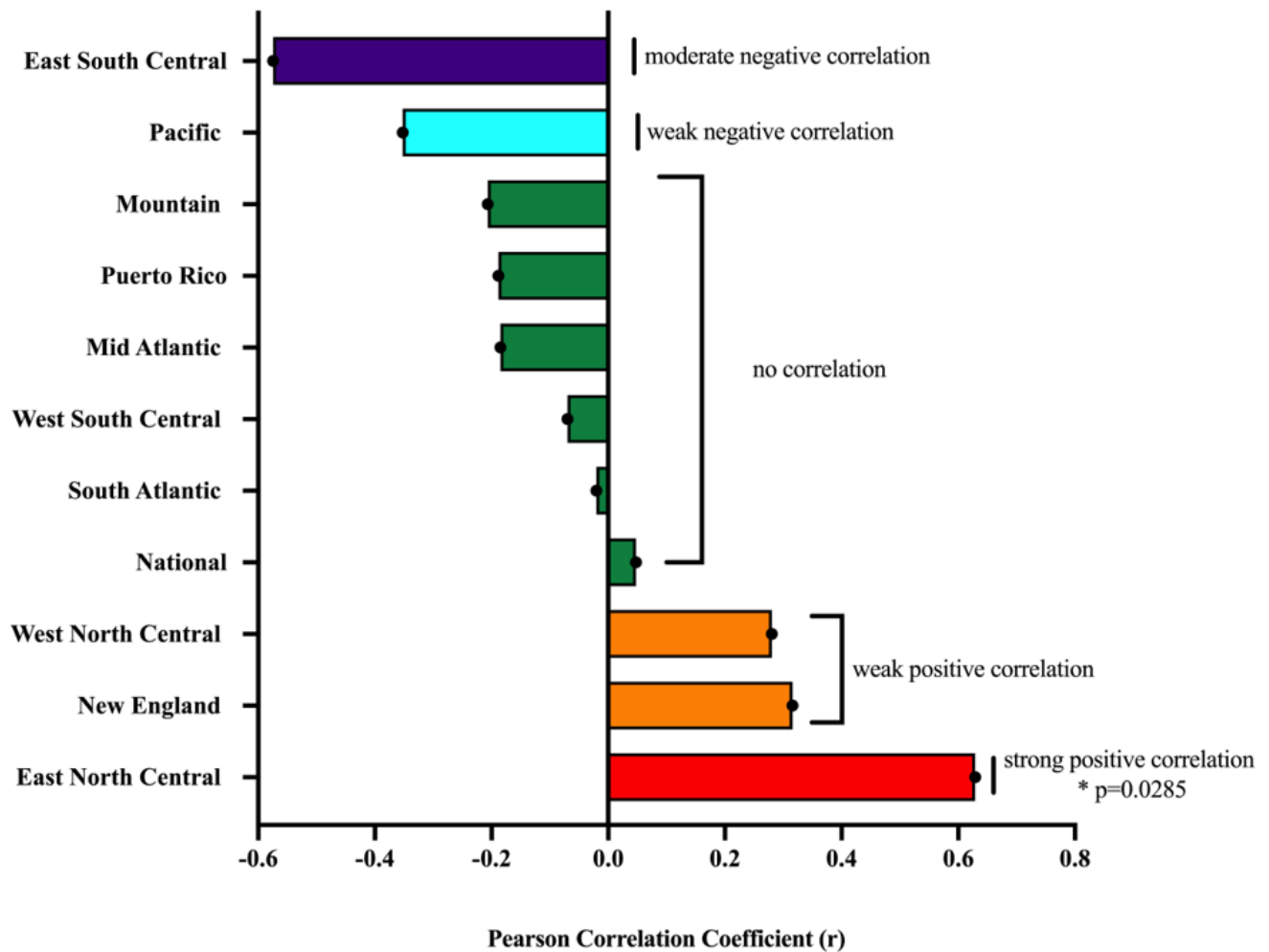


Figure 3

Pearson correlations between regional entering residency positions per capita and population growth changes (2013–2024). Regions are ordered by coefficient value. Colors signify strength and direction (purple/turquoise: negative; moss green: none; orange/red: positive). $p < 0.05$.