



Trends in Racial and Ethnic Representation Among Neurosurgery Applicants and Residents: A Comparative Analysis of Procedural Specialties

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■ **BACKGROUND:** Diversity, equity, and inclusion within the healthcare workforce are conducive to providing culturally competent care. However, few existing studies have assessed the level of racial and ethnic diversity among resident physicians and residency applicants. Our objective was to provide a comparative analysis of the trends in racial and ethnic representation within different subspecialties in medicine.

■ **METHODS:** Using data from the American Association of Medical Colleges and the Journal of the American Medical Association, we evaluated the racial and ethnic identification of residency applicants and current residents in 9 procedural-focused specialties from 2005 to 2019 and performed a descriptive analysis to compare the different levels of racial and ethnic diversity in these specialties.

■ **RESULTS:** Among the specialties analyzed during the study period, neurosurgery had the greatest magnitude of differences between Black/African-American residency applicants and current residents. The percentage of Black/African-American applicants was 92% greater than that of Black/African-American residents (10% of applicants vs. 5.2% of residents). In contrast, the percentage of White neurosurgery residents was 17.6% greater than that of White neurosurgery applicants (53.9% of applicants vs.

63.4% of residents). Similar trends were noted in all the specialties evaluated. Obstetrics and gynecology demonstrated the least disparity between Black/African-American applicants and residents (13.7% of applicants vs. 10.2% of residents; 35.4% difference). Hispanic and Asian representation varied widely between specialties.

■ **CONCLUSIONS:** Among the surveyed specialties, neurosurgery demonstrated the greatest disparity between the percentage of Black/African-American residency applicants and current residents. To further drive progress in this domain, we advocate for a series of initiatives designed to increase underrepresented minority participation in neurosurgery practice and scholarship.

INTRODUCTION

As of July 2019, ~40% of the U.S. population identified as a non-White racial or ethnic group.¹ By 2060, the U.S. Census Bureau estimates suggest that <50% of the U.S. population will identify as non-Hispanic White.² Likewise, those who identify as Hispanic and Black/African American will increase to 27.5% and 15.0%, respectively.² These trends underscore the need for physician education to include cultural

Key words

- Diversity
- Ethnic
- Neurosurgery
- Racial
- Residency
- Socioeconomic
- Workforce

Abbreviations and Acronyms

AAMC: American Association of Medical Colleges
JAMA: Journal of the American Medical Association
OBGYN: Obstetrics and gynecology
URM: Underrepresented minority
WINS: Women in Neurosurgery

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competency and social determinants of health and increased racial and ethnic diversity within the healthcare workforce.³ Multiple studies have postulated that racial and ethnic diversity among healthcare workers can positively influence patient health and compliance with treatment.³⁻⁵ Similarly, the lack of racial and ethnic diversity can exacerbate disparities between socioeconomic strata in the quality of care.³⁻⁵ However, despite these potential benefits, racial and ethnic diversity in the physician workforce has lagged behind that of the general population. In 2018, Black/African-American and Hispanic physicians constituted ~5% and ~5.8% of the workforce, respectively, and >56% of practicing physicians identified as non-Hispanic White.⁶

The field of neurosurgery is not immune to this trend. In 2018, 64% of the practicing neurosurgeons had identified as White, and only 5% and 3.8% had identified as Hispanic and Black/African American, respectively.^{7,8} Other medical and surgical specialties have demonstrated similar trends, and this lack of racial and ethnic diversity is not limited to practicing physicians.⁹ In 2018, only 17.5% of medical student applicants and 14.3% of matriculants to surgical specialty residencies had identified as an underrepresented minority (URM), defined as “those racial and ethnic populations that are underrepresented in the medical profession relative to their numbers in the general population.” In neurological surgery, the percentages of URM applicants and matriculants decrease to 13.2% and 12.1%, respectively, and these percentages are similar in the fields of anesthesiology and otolaryngology.^{10,11} Existing analyses have assessed racial and ethnic representation among neurosurgery trainees and changes in neurosurgery resident recruitment over time.^{12,13} Specifically, a significant increase has occurred in female residents in neurosurgery during the past decade; however, no statistically significant changes have occurred in ethnicity during the same period.¹² Additionally, minimal attention has been devoted to how neurosurgery compares with other procedural-focused specialties. Therefore, we performed a retrospective analysis to compare racial and ethnic identification of medical student applicants to residency programs in multiple specialties certified by the Accreditation Council for Graduate Medical Education. Through this comparative analysis, we have provided a novel juxtaposition of the racial and ethnic composition of neurosurgery residency applicants and that of other disciplines.

METHODS

We acquired data from U.S. allopathic medical schools regarding residency applicants to the following procedural-focused specialties: neurosurgery, thoracic surgery, urology, orthopedic surgery, plastic surgery, general surgery, dermatology, ophthalmology, and obstetrics and gynecology (OBGYN). OBGYN was included because its practice encompasses both procedural and primary care responsibilities, which will aid in potential comparisons with surgical subspecialties. The data queried included the total number of residency applicants to these specialties, number of residency programs, total number of residency spots, and the race or ethnicity of the applicants and residents in 2005, 2009, 2014, and 2019, according to when data were available for query. The number of residency applicants in each specialty was acquired by a direct query to the American Association of

Medical Colleges (AAMC). The number of residency programs, total residency spots, and resident racial and ethnic identification were acquired from the Journal of the American Medical Association (JAMA) Annual Reports on Graduate Medical Education for each year. Our analysis focused on applicants and residents who had identified with the following racial/ethnic categories: Asian, Black/African American, Hispanic/Latino/Spanish origin, and non-Hispanic White (hereafter referred to as White). Our descriptive analysis was unable to capture applicants who had identified as multiracial or multiethnic, “other,” or had not specify a race or ethnicity, because these categories carry inherent ambiguity and were not consistently included in the source data during the queried periods. Additionally, we elected to exclude the categories of Native American/Alaskan Native and Native Hawaiian/Pacific Islander from the analysis, because they were present in substantially lower numbers in the queried specialties. The race and ethnicity data in the present study were based on applicant and resident self-identification, which can be driven by a variety of sociological influences and carries a degree of subjectivity. A descriptive analysis was performed to stratify and trend the racial and ethnic composition of residency applicants and current residents in neurosurgery over time and to assess how these trends compared to those in other medical specialties. Institutional review board approval was not required for the present study, because the applicant data were de-identified, publicly available, and unrelated to direct patient care.

RESULTS

Our analysis evaluated the residency applicant data and current resident racial and ethnic identification data for the queried subspecialties (Table 1; Supplementary Figures 1–4). Despite the increase in the number of neurosurgery programs and residency positions, the proportion of Black/African-American neurosurgery residents remained unchanged (4.92% of residents in 2005 vs. 4.91% of residents in 2019). Between 2009 and 2019, 10% of the total residency applicants had identified as Black/African American; however, only 5.2% of neurosurgery residents had identified as such. In contrast, 53.9% of neurosurgery residency applicants from 2009 to 2019 had identified as White; however, 63.4% of neurosurgery residents had identified as White. A similar trend was noted for each of the 8 medical specialties we examined. The percentage of Black/African-American applicants was greater than the percentage of Black/African-American residents; however, the percentage of White residents was greater than the percentage of White applicants. Additionally, among the specialties we analyzed, neurosurgery had the greatest magnitude of difference between resident and applicant racial and ethnic demographics (10% of applicants vs. 5.2% of residents; 92% difference). Although neurosurgery had the greatest discrepancy between Black/African American residents and applicants (92% difference) during the study period, every specialty we studied demonstrated this disparity to various degrees (Table 1). OBGYN, which was the only primary care specialty we analyzed, demonstrated the least disparity between Black/African-American applicants and residents (13.7% of applicants vs. 10.2% of residents; 35.4% difference).

In contrast to Black/African American residents and applicants, the percentage of Hispanic neurosurgery residents (6.6%) was

Table 1. Differences Between Average Races and Ethnicities of Applicants and Residents*

Race or Ethnicity	Neurosurgery	Thoracic Surgery	Urology	General Surgery	Orthopedic Surgery	Dermatology	Plastic Surgery	OBGYN
Black residents	5.2†	5.0†	4†	5.9†	4.0†	4.4†	3.6†	10.2†
Black applicants	10†	9.3†	6.4†	10.1†	7.2†	7.8†	5.9†	13.7†
Hispanic residents	6.6‡	7.5‡	5.6‡	8.1	4.7†	5.9†	7.3‡	8.8‡
Hispanic applicants	4.9‡	5.2‡	6.1†	8.1	5.2†	6.6†	6.5‡	8.0‡
Asian residents	21.8†	24.9‡	19.9‡	19.7‡	12.4†	19.1†	19.8†	15.0‡
Asian applicants	22.3†	19.6‡	19.4‡	18.8‡	14.7†	20.4†	21.8†	14.1‡
White residents	63.4‡	63.6‡	68.2‡	60.1‡	73.3‡	68.0‡	68.0‡	61.5‡
White applicants	53.9‡	51.4‡	64.2‡	57.5‡	67.5‡	57.5‡	60.0‡	59.3‡

OB/GYN, obstetrics and gynecology.

Data presented as percentages.

*Resident population averages based on Journal of the American Medical Association data available from 2005 (earliest year available) to 2019; applicant population averages based on American Association of Medical Colleges data available from 2009 (earliest year available) to 2019.

†Greater proportion of applicants compared with residents.

‡Greater proportion of residents compared with applicants.

34.5% greater than the percentage of Hispanic applicants (4.9%). Although this trend is encouraging, the raw percentages of Black/African-American and Hispanic applicants and residents in neurosurgery represent <10% of the overall population. Although these percentages are not dissimilar to the representation of Hispanic and Black/African-American medical students (5.3% and 6.2%, respectively),⁶ they trail these groups' representation within the overall U.S. population (18.7% and 12.1%, respectively).¹⁴ This suggests that even with the positive trends in representation changes, more work is needed to increase the representation of these groups. We also observed wide variations in Asian representation among the specialties. In neurosurgery, 22.3% of applicants had identified as Asian, which was only 2.4% greater than the percentage of Asian residents (21.8%; **Supplementary Figures 1A** and **3A**). Finally, we observed a decline in the percentage of White applicants from 2009 to 2019 in multiple specialties, paralleling a decline in the overall response rate. This might reflect a combination of survey fatigue and an increased percentage of respondents choosing to refrain from answering questions related to racial and ethnic identity.

DISCUSSION

Multiple studies have established the relationship between race, ethnicity, and inequalities in clinical outcomes and access to care.^{15–17} However, many of these studies did not provide a temporal analysis of racial and ethnic representation in multiple specialties. To address this need, our study has provided an evaluation of racial and ethnic diversity among neurosurgery residents and residency applicants, how that diversity has changed during the preceding 10–15 years, and how this change compares with that in other procedural specialties. We observed that, although the percentage of Black/African-American and Hispanic applicants increased from 2005 to 2019, a stark disparity remains in neurosurgery between the percentage of applicants who identify

as Black/African American and Hispanic compared with the percentage of residents who identify as Black/African American and Hispanic. This result is consistent with the differences between resident and applicant populations in other specialties and with prior studies of the evolving racial and ethnic diversity of the neurosurgery residency landscape.¹³ Our analysis revealed a bottleneck in racial and ethnic equity at the transition from medical school to residency. However, we could not quantify how this bottleneck is reflected in the traditional measures of successful applicants, including enrollment in highly ranked medical schools, high U.S. Medical Licensing Examination scores and number of peer-reviewed publications, access to home institution neurosurgery mentors, and availability of protected research time, because many of these items, stratified by race/ethnicity and specialty, are not directly available. However, attention to these parameters is paramount, and we plan future survey analyses to provide quantitative detail regarding how these factors are related to demographic and socioeconomic data. This work will inform extramural and institutional initiatives, targeted to this juncture in training, to support racial and ethnic diversity in neurosurgery practice.

Our analysis has provided an impetus to focus the neurosurgical community's attention on how to improve URM recruitment and engagement at critical transition points in training, namely the undergraduate-to-medical school and medical school-to-residency transitions. Among the potential strategies for alleviating disparities in URM representation at these time points include a detailed examination and reform of the interview and selection process¹⁸ and the development of programs to alleviate the financial burdens on applicants at these stages.¹⁹ We also encourage the popularization of integrated mentorship networks tailored to URM students at various stages of training, beginning in high school and continuing through college, medical school, and residency training. This program would allow URM students to identify mentors, develop professional networks with lasting

continuity, and tailor their focus toward achieving many of the established benchmarks for success in the neurosurgery match. These benchmarks include enrollment at a highly ranked medical school, high U.S. Medical Licensing Examination scores, research experience and peer-reviewed publications, and academic honor society membership.^{12,20-23}

Our data also can be used to support the development of new methods of improving racial and ethnic diversity and cultural sensitivity in neurosurgery training. One such opportunity is the creation of a Black neurosurgical organization, as discussed by Detchou et al.²⁴ This organization would encompass recruitment efforts, mentorship arrangements, and collaboration with existing neurosurgical societies to build a greater coalition of Black neurosurgical trainees and practicing neurosurgeons.²⁴ Similar strategies have been used to encourage recruitment and retention of women in neurosurgery. The Women in Neurosurgery (WINS) organization has demonstrated a commitment to mentorship and collaboration with national neurosurgical societies to promote a diverse workforce and advocate for the career development of female neurosurgeons. The 2008 WINS white paper published in the *Journal of Neurosurgery* highlighted the presence of gender inequity in neurosurgery training and practice²⁵ and spurred the creation of mentorship programs that are thought to be partially responsible for the increased retention of female neurosurgery residents in recent years.²⁶ Organizations such as WINS and a Black neurosurgical organization could serve as models for future collaborative efforts to recruit and retain URMs into neurosurgical residency positions. Furthermore, the field of neurosurgery can look to specialties with comparatively favorable representation of URMs, such as OBGYN, for further insight. A survey of OBGYN program directors revealed a number of key methods for encouraging URM recruitment. Specifically, although brochures and program websites highlighting diversity were thought to be less effective, more intensive and personal approaches (including travel subsidies, hosting second visits, and individual telephone calls with URM applicants) were thought to more meaningfully communicate a program's commitment to inclusion.²⁷ Additionally, detailed interviews with OBGYN program directors emphasized the benefits of a holistic review process, with special attention to candidates who have persevered through adverse life experiences, and the importance of selecting residents who can identify with, and best represent, the patient population they serve.²⁸

Additionally, because improvements in patient care are often driven by clinical and laboratory research, our analysis results could spur further efforts to encourage URM contributions in the scientific community. Evidence has suggested that diverse research teams tend to publish more frequently and in more impactful journals compared with less diverse research teams.²⁹ However, URMs still account for <15% of U.S. M.D. and Ph.D. candidates, which is a lower than these groups' overall share of the U.S. population.³⁰ New opportunities to support URM students performing clinical and laboratory research will bolster their preparation for neurosurgery residency and ongoing career accomplishments. This objective could be accomplished through the development of neurosurgery research fellowships, sponsored by academic institutions or national neurosurgical

societies, which are tailored to URMs students or students investigating socioeconomic questions. Special attention from leading neurosurgical journals to socioeconomic topics would also provide a forum to highlight work that analyzes the influence of demographic factors on neurosurgical care. This emphasis could come in the form of theme issues, such as those popularized by *Neurosurgical Focus*, or dedicated space in each issue for articles focused on the influence of race, ethnicity, and the importance of diversity in neurosurgery practice.

Despite these insights, our analysis had some limitations. First, because we acquired survey data from multiple institutions, selection bias and a lack of standardized response rates could have influenced our results. Thus, we were unable to perform an inferential analysis to assess whether differences in racial/ethnic populations between specialties were statistically significant, and our analysis was limited to a select set of medical specialties. Additionally, our study defined diversity according to varying proportions of Black/African-American, Hispanic, White, and Asian trainees. These designations were pre-determined from the data available from the AAMC and JAMA. However, we would argue that these classifications are inappropriately broad, do not account for subgroup differences, and could obscure significant trends. Furthermore, this definition excluded a host of other racial and ethnic categories, notably Native American/Alaskan Native and Native Hawaiian/Pacific Islander. As of 2018, <1% of practicing male neurosurgeons and no practicing female neurosurgeons had identified as members of these groups.^{7,8} The sparse representation of Native American/Alaskan Native and Native Hawaiian/Pacific Islanders in neurosurgery should not be ignored; however, our analysis of this population was limited by the small sample sizes in the AAMC and JAMA data. We also omitted from our analysis responses from applicants and trainees who had identified as multiracial or "other," because these categories reflect a variety of racial/ethnic experiences that have been reported less consistently. Furthermore, we were unable to stratify changes in applicant and resident populations across specialties by gender, because survey respondent gender was not specified. Multiple analyses have suggested that women are underrepresented in neurosurgery, especially when considering that >50% of medical school graduates are women.^{25,26,31,32} Abosch and Rutka²⁶ provided a comprehensive discussion of potential methods to encourage women to pursue careers in neurosurgery. These include equitable compensation packages, gender parity on local and national neurosurgical society committees, prioritization of women speakers at conferences, and zero-tolerance policies designed to eliminate harassment.²⁶ All these strategies could also be effectively used to bolster the presence of underrepresented racial and ethnic groups in neurosurgery. As Gabriel et al.¹³ proposed, future analyses could also benefit from an intersectional approach that accounts for the interdependence of race, ethnicity, socioeconomic status, and gender in neurosurgical career development and practice. An intersectional approach will also facilitate additional studies of other facets of diversity in neurosurgery, including marital status, number of dependents, socioeconomic status, sexual orientation, and gender identity. This advance will require modified survey designs that reflect respondents' backgrounds and personal experiences in detail, rather than requiring the selection of specific racial, ethnic, and gender categories. Future analyses that address these limitations will

generate greater insight regarding the existing trends in diversity in neurosurgery.

CONCLUSIONS

We have provided a retrospective analysis comparing the racial and ethnic diversity of residency applicants and current residents across 9 procedural-focused specialties, including neurosurgery. Our results suggest that although many specialties have relatively few Black/African American and Hispanic applicants and trainees, neurosurgery residencies demonstrate greater disparity between the percentage of applicants and percentage of current residents than that of any other specialty. Although these insights are sobering, they can motivate our field to catalyze long-term progress, both in fostering diversity in neurosurgery training and in providing quality care for all patients.

CRediT AUTHORSHIP CONTRIBUTION STATEMENT

James P. Caruso: Conceptualization, Formal analysis, Writing — original draft, Writing — review & editing. **Ravinderjit Singh:** Conceptualization, Formal analysis, Data curation, Writing — original draft, Writing — review & editing. **Catherine Mazzola:** Writing — review & editing, Supervision. **Cody M. Eldridge:** Formal analysis, Data curation. **Sai Chilakapati:** Formal analysis, Data curation. **Palvasha Deme:** Formal analysis, Data curation. **Karin Swartz:** Writing — review & editing, Supervision. **Clemens M. Schirmer:** Writing — review & editing, Supervision. **Kristin Huntoon:** Writing — review & editing, Supervision. **Joseph Cheng:** Writing — review & editing, Supervision. **Michael Steinmetz:** Writing — review & editing, Supervision. **Owoicho Adogwa:** Conceptualization, Formal analysis, Writing — review & editing, Supervision, Resources.

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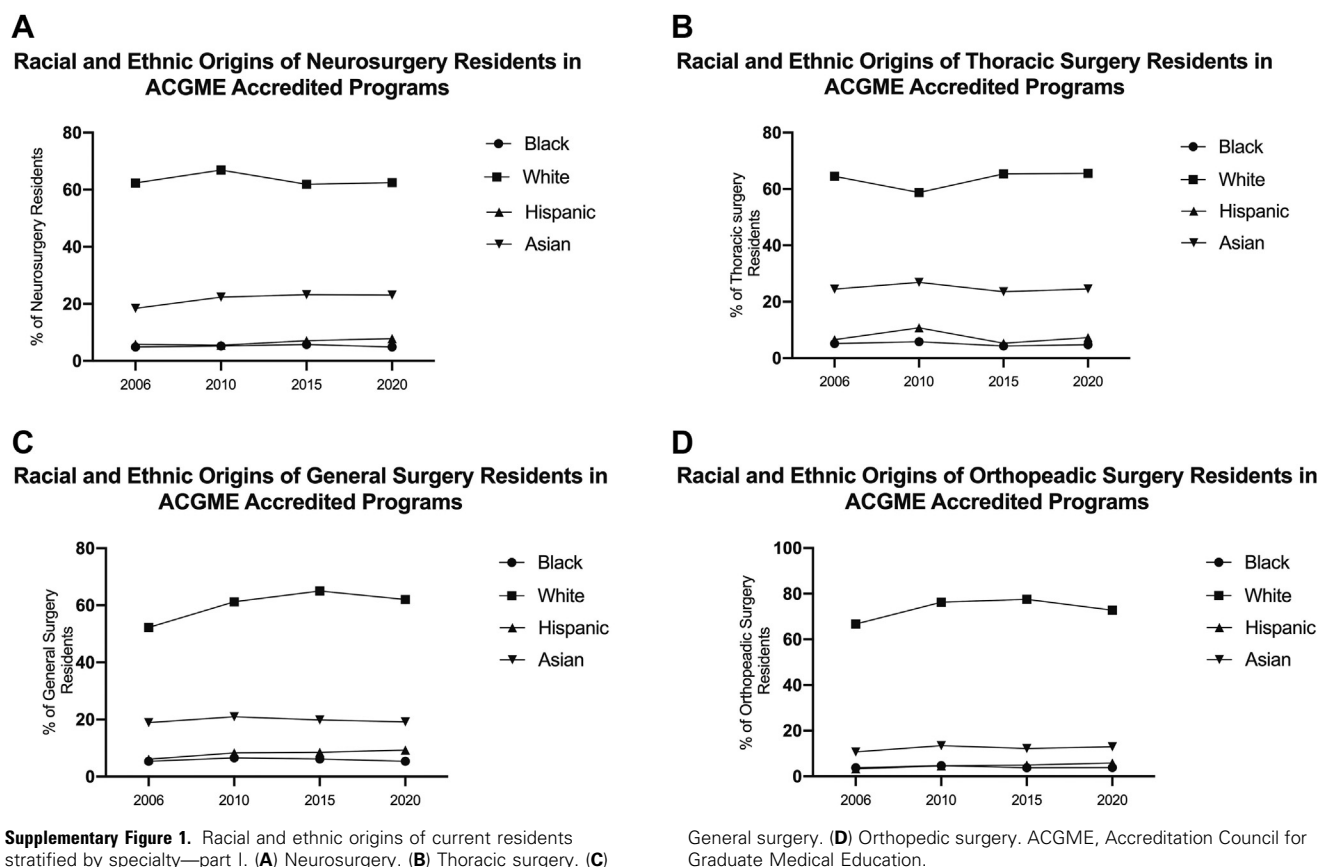
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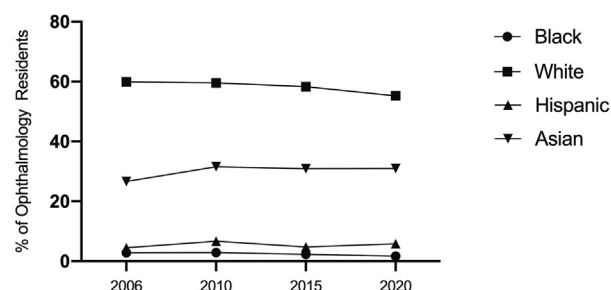
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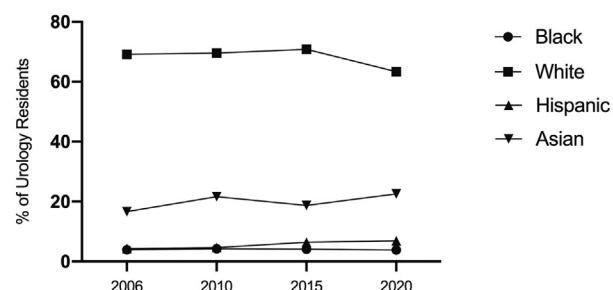
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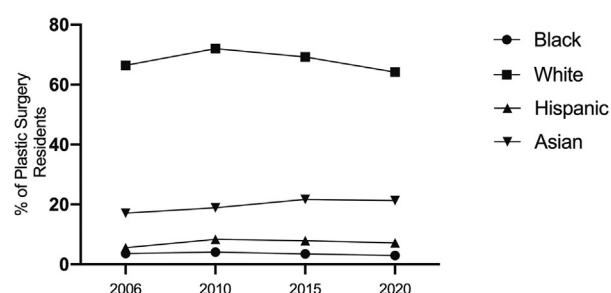
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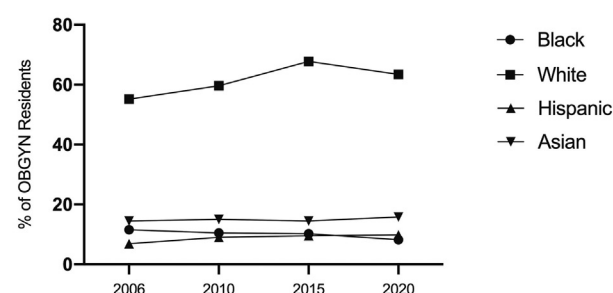
B
Racial and Ethnic Origins of Urology Residents in ACGME Accredited Programs



C
Racial and Ethnic Origins of Plastic Surgery Residents in ACGME Accredited Programs



D
Racial and Ethnic Origins of OB/GYN Residents in ACGME Accredited Programs



Supplementary Figure 2. Racial and ethnic origins of current residents stratified by specialty—part II. (A) Ophthalmology. (B) Urology. (C) Plastic

surgery. (D) Obstetrics/gynecology. ACGME, Accreditation Council for Graduate Medical Education.

