

Current Status of Diversity by Race, Hispanic Ethnicity, and Sex in Diagnostic Radiology¹

Christina H. Chapman, MD
Wei-Ting Hwang, PhD
Stefan Both, PhD
Charles R. Thomas, Jr, MD
Curtiland Deville, MD

Purpose: To assess the diversity of the U.S. diagnostic radiology physician workforce by race, Hispanic ethnicity, and sex in the context of the available pipeline of medical students.

Materials and Methods: Institutional review board evaluation and exemption were granted for the study, as primary data were obtained from publicly available registry sources, with no identifiable private or protected information. Publicly available American Medical Association, American Association of Medical Colleges, and U.S. census registries were used to assess differences for 2010 among diagnostic radiology practicing physicians, academic faculty, residents, subspecialty trainees, residency applicants, medical school graduates, and U.S. population by using binomial tests; with adjustment for multiple comparisons among different groups, differences with $P < .001$ were considered significant. Significant differences in diagnostic radiology resident representation were evaluated for academic years 2003–2004 to 2010–2011 and for 2010, compared among the 20 largest residency training programs.

Results: Females and traditionally underrepresented minorities in medicine (URM)—blacks, Hispanics, American Indians, Alaskan Natives, Native Hawaiians, and Pacific Islanders (AI/AN/NH/PI)—are underrepresented as practicing physicians (23.5% and 6.5%, respectively), faculty (26.1%, 5.9%), and diagnostic radiology residents (27.8%, 8.3%), compared with the U.S. population (50.8%, 30.0%) (all $P < .001$). Although they are increased in percentage as residents compared with practicing physicians, females and URMs remain underrepresented at the resident trainee level, compared with their proportions as medical school graduates (48.3%, 15.3%, respectively). During the past 8 years, there was no significant increase in female or URM resident (all $P > .01$) representation, suggesting no dramatic change in future representation as practicing physicians. Moreover, diagnostic radiology ranks 17th in female and 20th in URM representation among the 20 largest residency training specialties.

Conclusion: Females and URM remain underrepresented in the diagnostic radiology physician workforce despite an available medical student pipeline. Given prevalent health care disparities and an increasingly diverse society, future research and training efforts should address increasing resident diversity with program directors and department chairs.

¹From the Department of Radiation Oncology (C.H.C., S.B., C.D.) and Department of Biostatistics and Epidemiology (W.T.H.), University of Pennsylvania, Perelman School of Medicine, 3400 Civic Center Blvd, TRC 2W, Philadelphia, PA 19104; and Department of Radiation Medicine, Knight Cancer Institute, Oregon Health and Science University, Portland, Ore (C.R.T.). Received January 22, 2013; revision requested March 18; final revision received April 20; accepted May 15; final version accepted May 23. **Address correspondence to C.D.** (e-mail: deville@uphs.upenn.edu).

Diversification of the physician workforce has been identified as a strategy to address health disparities and enrich the cultural competence of all physicians. Academic medical centers ought to be at the forefront of this effort (1). Racial and ethnic minority providers are more likely to practice in underserved communities (2,3). Women are more likely to pursue careers in women's health with respect to clinical practice and research focus (4). Students from medical schools with more diverse student bodies report feeling more confident managing patients from different cultural backgrounds (5). Patients managed by a physician from the same culture report more satisfaction with their treatment and their ability to effectively communicate with their provider (6).

With women constituting 50.8% of Americans and minority groups, including blacks, Hispanics and Latinos, Asians, and American Indians, Alaskan Natives, Native Hawaiians, and Pacific Islanders

(AI/AN/NH/PI), accounting for nearly 35% of the U.S. population in 2010, a number of pressing issues highlight the need for a diverse diagnostic radiology workforce (7,8). Examples include inadequate numbers of radiologists to perform breast imaging in all areas of the country (9), a critical shortage of pediatric radiologists (10), and racial and ethnic disparities in cancer screening, which include imaging tests as a major component (11). Given that women are more likely to enter breast imaging and pediatric radiology (12) subspecialties and that racial and ethnic minorities are more likely to practice in areas with higher minority and underserved populations, increasing female and racial and ethnic minority representation in diagnostic radiology may aid in addressing these disparities and other health care needs of the overall population.

The distribution of women in diagnostic radiology has received increasing attention during the past few decades (13), acknowledging an underrepresentation as practicing radiologists and residents (14) and showing that women are more concentrated in academia than men (15). It remains unclear whether this acknowledgment has led to interest, programs, and/or efforts affecting female representation over the past several years. Researchers in a single review, on the other hand, have discussed the racial and ethnic composition of diagnostic radiology (16). The purpose of this study was to assess the diversity of the U.S. diagnostic radiology physician workforce by race, Hispanic ethnicity, and sex in the context of the available pipeline of medical students.

groups were defined as consistent with the U.S. Census Bureau (7,8). Racial groups assessed were: (a) white, (b) black or African American, referred to as *black*, (c) Asian or Asian American, referred to as *Asian*, (d) AI/AN/NH/PI, grouped as one category, and (e) other, defined in this study as any person with unknown racial information and/or not classifiable in one of the previous categories. Ethnic groups included Hispanic and non-Hispanic. The underrepresented minority in medicine (URM) grouping was used as defined by the American Association of Medical Colleges (AAMC) (17). The URM concept was first addressed by the AAMC in 1970 and was modified in 2004 to describe minorities that are underrepresented relative to their numbers in the general population, which currently includes blacks, Hispanics, and AI/AN/NH/PI. Certain Asian subgroups (Vietnamese, Hmong, and Cambodian) have historically been included in the URM designation but were not included in the URM group for the purpose of our analysis.

Advances in Knowledge

- Increased proportions of females (27.8% vs 23.5%) and underrepresented minority groups in medicine (8.3% vs 6.5%)—blacks, Hispanics, Native Americans, Alaskan Natives, Native Hawaiians, and Pacific Islanders—as diagnostic radiology residents compared with practicing physicians, respectively, suggest historical improvements in representation.
- There is no recent increase in representation for females or individual underrepresented minority groups over the past 8 academic years, with a less than 1% change per year (range, 0.01%–0.17%), suggesting that representation is not dramatically changing.
- Although ninth largest, diagnostic radiology ranks 17th for female and 20th for underrepresented minority representation among the 20 largest training programs, which include primary care, surgical, and nonsurgical specialties.

Materials and Methods

Measures

The variables evaluated were race, ethnicity, and sex. Racial, ethnic, and sex

Implication for Patient Care

- The relative lack of diversity of the diagnostic radiology physician workforce does not mirror the increasingly diverse U.S. patient population.

Data Sources

An institutional review board evaluation exemption was granted for the study, as primary data were obtained from publicly available registry sources, with no identifiable private or protected

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Abbreviations:

AAMC = American Association of Medical Colleges
AI/AN/NH/PI = American Indians, Alaskan Natives, Native Hawaiians, and Pacific Islanders
CI = confidence interval
URM = underrepresented minority in medicine

Author contributions:

Guarantors of integrity of entire study, C.H.C., W.T.H., C.D.; study concepts/study design or data acquisition or data analysis/interpretation, all authors; manuscript drafting or manuscript revision for important intellectual content, all authors; approval of final version of submitted manuscript, all authors; literature research, C.H.C., S.B., C.R.T., C.D.; clinical studies, C.D.; experimental studies, C.D.; statistical analysis, C.H.C., W.T.H., C.D.; and manuscript editing, all authors

Conflicts of interest are listed at the end of this article.

information. U.S. population data were obtained from the U.S. Census Bureau, 2010 (12,13). Practicing physician data were obtained from the American Medical Association (18). Medical school graduate numbers reflect AAMC class of 2010 data (19). Data on diagnostic radiology and other residency training programs were obtained from the *Journal of the American Medical Association* supplements (20–27). Five of the eight Accreditation Council for Graduate Medical Education diagnostic radiology subspecialty training programs have more than 20 trainees and were included in this analysis, as follows: abdominal radiology (36 trainees), musculoskeletal radiology (24 trainees), neuroradiology (234 trainees), pediatric radiology (67 trainees), and vascular and interventional radiology (180 trainees); and cardiothoracic radiology (one trainee), endovascular surgical neuroradiology (five trainees), and nuclear radiology (14 trainees) were not included. For race and ethnicity measures, unduplicated totals were provided for U.S. census, medical school graduates, and residents and fellows for race and ethnicity separately. For other data sources, Hispanics were included in the “other” racial category because no breakdown by race was provided. Mean applications submitted to diagnostic radiology residency programs reflect 2010 applicants from the AAMC Electronic Residency Application Service (standard deviations were not provided) (28,29). All data sources represent the entire population in question.

Statistical Analysis

Binomial tests were used to investigate significant differences in racial, ethnic, and sex distribution in diagnostic radiology practicing physicians and diagnostic radiology faculty, separately, compared with the U.S. population, and then, with each other. Diagnostic radiology residents were compared by individual racial groupings, ethnicity, and sex with the following: (a) diagnostic radiology practicing physicians, (b) diagnostic radiology faculty, (c) medical school graduates, (d) diagnostic radiology

subspecialty trainees, and (e) diagnostic radiology applicants. The one-sample binomial test was used for comparison with the U.S. population statistics, while two-sample tests were used for two distinct samples. Adjusting for multiple comparisons among different groups, differences with $P < .001$ were considered to be significant. To assess changes in percentages by race, ethnicity, and sex in diagnostic radiology residents during 8 academic years, the slope and the associated 95% confidence intervals (CIs) for each group were estimated by using a simple linear regression model, where year was used as an independent variable. Years 2003–2004 to 2010–2011 were selected to include the eight most recent publicly available academic years. With 8 years of data, the minimum detectable slope was 4%, 11%, or 18%, with 80% power and a two-sided .01 significance level for the percentages to be in the range of 1%, 10%, and 50%,

respectively. Finally, with the use of descriptive statistics, diagnostic radiology residency was ranked among the 20 largest residency training programs in terms of overall size and the percentages of females, URMs, and individual URM groups as diagnostic radiology residents in 2010 (27). These 20 residency training programs, ranked in order from 1 to 20 with a rank of 1 as the specialty with the largest percentage of the group in question and one with a rank of 20 as the specialty with the smallest percentage of the group in question, were as follows: rank 1, internal medicine; rank 2, family medicine; rank 3, pediatrics; and rank 4, surgery (general); rank 5, anesthesiology; rank 6, emergency medicine; rank 7, obstetrics and gynecology; rank 8, psychiatry; rank 9, diagnostic radiology; rank 10, orthopedic surgery; rank 11, pathology (anatomic and clinical); rank 12, neurology; rank 13, otolaryngology; rank 14, combined internal

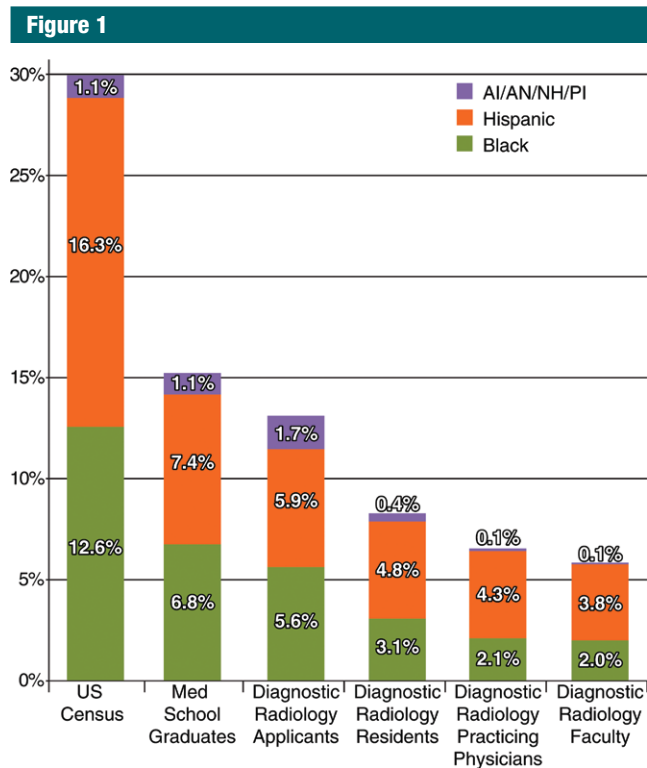


Figure 1: Distributions of URM groups in medicine for 2010 in order of descending representation of the U.S. population, U.S. medical school graduates, and diagnostic radiology residency applicants, residents, practicing physicians, and faculty. Non-URM category is not shown.

medicine and pediatrics; rank 15, ophthalmology; rank 16, physical medicine and rehabilitation; rank 17, dermatology; rank 18, neurologic surgery; rank 19, transitional year (postgraduate year 1); and rank 20, urology. The National Residency Matching Program Applicant Survey (30) was used to assess diagnostic radiology residency applicant importance of cultural, racial-ethnic, and sex diversity of institutional staff and cultural and racial-ethnic geographic diversity among the 18 reported residency training programs.

Results

Comparative Cohort Analysis

Figures 1–3 show the distribution for URM, racial groups, Hispanic ethnicity, and female sex, respectively, compared among the U.S. population, diagnostic radiology practicing physicians,

faculty, residents, and residency applicants. Table 1 shows the raw data for all groups evaluated.

Diagnostic Radiology Practicing Physicians and Faculty Compared with the U.S. Population

Individually, blacks, AI/AN/NH/PI, and Hispanics were significantly underrepresented among practicing physicians and faculty members, as compared with the overall U.S. population ($P < .001$ for each comparison), confirming their URM status in diagnostic radiology. Collectively, URMs comprised 30% of the U.S. census for 2010 (race [7] and sex [8]), 5.8% of practicing physicians, and 6.6% of faculty. Representation, respectively, for practicing physicians, faculty, and U.S. census was 2.1%, 2.0%, and 12.6% for blacks; 0.1%, 0.1%, and 1.1% for AI/AN/NH/PI; and 3.8%, 4.3%, and 16.3% for Hispanics. Females were similarly significantly underrepresented as

practicing physicians (23.5%) and faculty members (26.1%), as compared with the overall U.S. population (50.8%) ($P < .001$ for each comparison). When we compared practicing physicians with faculty members, for all individual URM groups—blacks, AI/AN/NH/PI, and Hispanics—and females, there were no significant differences ($P = .799, .503, .296,$ and $.026,$ respectively).

Diagnostic Radiology Practicing Physicians and Faculty Compared with Diagnostic Radiology Residents

URMs comprised 8.3% of residents. For all individual URM groups and females, representation was significantly increased for residents, compared with practicing physicians ($P < .001$ for each comparison). Representation for residents, compared with faculty, was not significantly different for blacks (3.1% vs 2.0%, $P = .032$), AI/AN/NH/PI (0.4% vs 0.1%, $P = .006$), Hispanics

Figure 2

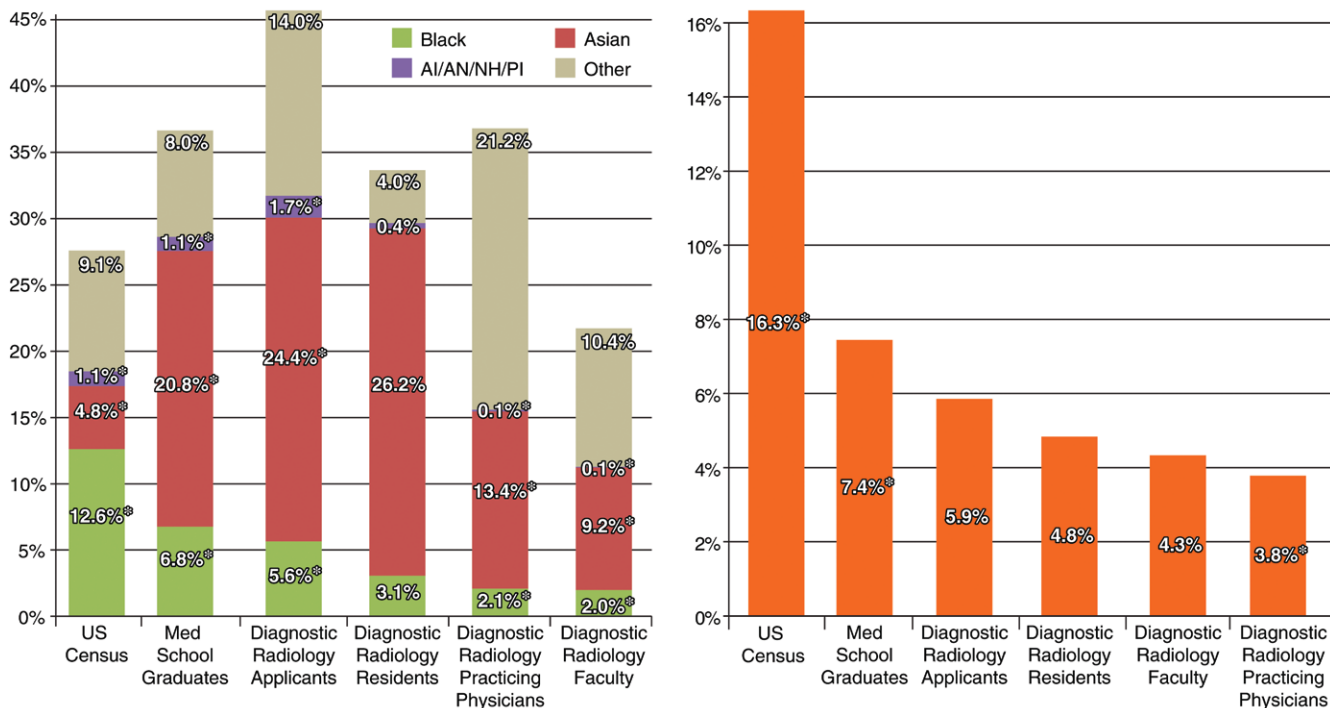


Figure 2: Distribution by (a) race and (b) Hispanic ethnicity for 2010 of the U.S. population, U.S. medical school graduates, and diagnostic radiology residency applicants, residents, practicing physicians, and faculty. * = significantly different proportion ($P < .001$) in comparison with diagnostic radiology residents; analyses were not performed for the “other” category. In a, “white” category is not shown. In b, non-Hispanic ethnicity category is not shown.

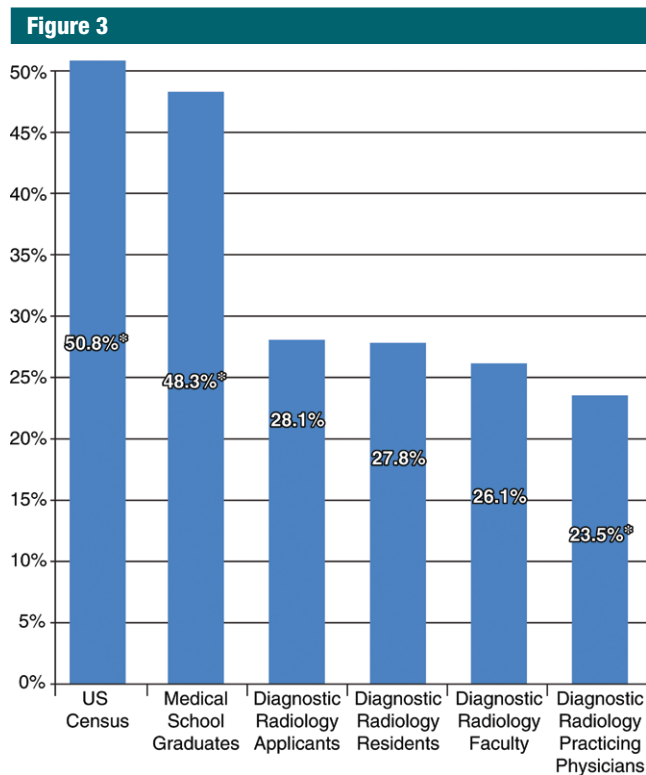


Figure 3: Distributions of female sex for 2010 in order of descending representation of the U.S. population, U.S. medical school graduates, and diagnostic radiology residency applicants, residents, faculty, and practicing physicians. * = indicates a significantly different proportion ($P < .001$) in comparison with diagnostic radiology residents; analyses were not performed for the "other" category. Data about race, ethnicity, and sex were from 2003–2004 through 2010–2011. Non-Hispanic and "other" categories were not shown.

(4.8% vs 4.3%, $P = .439$), or females (27.8% vs 26.1%, $P = .219$).

Diagnostic Radiology Residents Compared with Medical School Graduates

URMs comprised 15.3% of medical school graduates in 2010. When we compared diagnostic radiology residents with medical school graduates by individual groups, respectively, blacks (3.1% vs 6.8%), AI/AN/NH/PI (0.4% vs 1.1%), Hispanics (4.8% vs 7.4%), and females (27.8% vs 48.3%) were all significantly underrepresented ($P < .001$ for each comparison).

Diagnostic Radiology Residents Compared with Diagnostic Radiology Subspecialty Trainees

Few significant differences were noted when we compared female diagnostic

radiology residents with diagnostic radiology subspecialty trainees, and no significant differences were noted when we compared URM groups ($P = .005$ –.6386). Females showed significantly increased representation as trainees in pediatric radiology (50.7%) and underrepresentation as trainees in vascular and interventional radiology (12.2%), compared with representation as diagnostic radiology residents (27.8%) ($P < .001$ for each comparison).

Diagnostic Radiology Residents Compared with the Other Residency Training Specialties

With 4531 residents in 2010, diagnostic radiology ranked ninth in size compared with the 19 other largest training programs, ranging from a minimum of 1069 residents (urology) to 22415

residents (internal medicine). As noted in Table 2, of these 20 training programs, diagnostic radiology ranks as follows: last (20th) in representation of URMs combined at 8.3% (range for top 20, 8.3%–20.0%); 19th in representation of Hispanics at 4.8% (range for top 20, 4.7%–9.6%), above only orthopedic surgery; 18th in representation of blacks at 3.1% (range for top 20, 2.7%–10.7%), above otolaryngology and transitional year; 17th in representation of females at 27.8% (range for top 20, 13.2%–81.4%), the lowest nonsurgical specialty and also below surgery (general) and otolaryngology; and 16th in representation of AI/AL/NH/PI at 0.4% (range for top 20, 0.1%–1.3%).

Diagnostic Radiology Residents over Time by Race, Ethnicity, and Sex

Figure 4 shows the distribution of diagnostic radiology residents by race, ethnicity, and sex for the 2003–2004 through 2010–2011 academic years. The ranges were as follows: males, 71.9%–73.2%; whites, 61.8%–66.3%; Asians, 23.9%–26.2%; females, 26.8%–28.1%; URMs overall, 7.4%–8.5%; Hispanics, 4.6%–5.3%; blacks, 2.2%–3.1%; and AI/AN/NH/PI, 0.4%–0.5%. When we analyzed differences over time, representation was found to be unchanged for all groups, as follows: AI/AN/NH/PI, 0.01 (95% CI: -0.012 , 0.040 ; $P = .227$); Asians, 0.17 (95% CI: -0.108 , 0.439 ; $P = .189$); blacks, 0.06 (95% CI: -0.055 , 0.172 ; $P = .255$); Hispanics, -0.02 (95% CI: -0.104 , 0.066 ; $P = .609$); and females, 0.13 (95% CI: 0.016 , 0.245 ; $P = .032$).

Diagnostic Radiology Residency Applicant Characteristics and Comparisons with Residents and Medical School Graduates

When we compared diagnostic radiology applicants with diagnostic radiology residents, there were more black (5.6% vs 3.1%, $P < .001$) and AI/AL/NH/PI (1.7% vs 0.4%, $P < .001$) applicants, and there was no difference for Hispanic (5.9% vs 4.8%, $P = .129$), and female (28.1% vs 27.8%, $P = .835$) applicants. When we compared diagnostic radiology applicants with medical school graduates, the proportions of females

Table 1

2010 Demographic Distribution by Sex, Hispanic Ethnicity, and Race of the U.S. Population, U.S. Medical School Graduates, and Diagnostic Radiology Residency Applicants, Residents, Practicing Physicians, and Faculty

Group	Sex		Ethnicity				Race				Total, Unduplicated
	Male	Female	Hispanic	Non-Hispanic	White	Asian	Black	AI/AN/NH/PI	Other		
U.S. census*	151 781 326 (49.2)	156 964 212 (50.8)	50 477 594 (16.3)	258 267 944 (83.7)	223 553 265 (72.4)	14 674 252 (4.8)	38 929 319 (12.6)	3 472 261 (1.1)	28 116 441 (9.1)	308 745 538	
U.S. medical school graduates	8706 (51.7)	8129 (48.3)	1254 (7.4)	15 580 (92.5)	10 665 (63.4)	3503 (20.8)	1138 (6.8)	180 (1.1)	1349 (8.0)	16 835	
Diagnostic radiology applicants	993 (71.8)	388 (28.1)	81 (5.9)	1302 (94.1)	751 (54.3)	338 (24.4)	78 (5.6)	23 (1.7)	193 (14.0)	1383	
Diagnostic radiology residents	3271 (72.2)	1260 (27.8)	219 (4.8)	4312 (95.1)	3006 (66.3)	1187 (26.2)	139 (3.1)	18 (0.4)	181 (4.0)	4531	
Diagnostic radiology practicing physicians	19 919 (76.5)	6135 (23.5)	986 (3.8)	25 068 (96.2)	16 459 (63.2)	3480 (13.4)	544 (2.1)	36 (0.1)	5535 (21.2)	26 054	
Diagnostic radiology faculty	1040 (73.9)	368 (26.1)	61 (4.3)	1347 (95.7)	1102 (78.3)	130 (9.2)	28 (2.0)	1 (0.1)	147 (10.4)	1408	

Note.—Data are numbers of individuals. Numbers in parentheses are percentages unless otherwise indicated. Percentages were calculated with total, unduplicated, for the category as the denominator. Percentages were rounded.

(28.1% vs 48.3%) and whites (54.3% vs 63.4%) were significantly smaller as applicants, and for Asians the proportions were significantly larger as applicants (24.4% vs 20.8%) ($P < .001$ for each comparison); there was no difference for blacks (5.6% vs 6.8%, $P = .109$), Hispanics (5.9% vs 7.4%, $P = .029$), and AI/AL/NH/PI (1.7% vs 1.1%, $P = .043$). The reported mean number of applications per applicant for all diagnostic radiology residency applicants was 44.1 (standard deviations were not provided). The mean number of applications per group in descending order was as follows: Asian, 53.8; Hispanic, 50.1; female, 44.8; male, 42.4; white, 40.7; and black, 37.2. Reported separately, the mean number of applications per group for American Indians and Alaskan Natives combined was 31.9 and for Native Hawaiians and Pacific Islanders combined was 16.9. According to the National Residency Matching Program Applicant Survey (30), of 18 assessed specialties, diagnostic radiology tied for 14th rank for cultural, racial-ethnic, and sex diversity of institutional staff and 15th rank for cultural and racial-ethnic geographic diversity for the percentage of applicants ranking the above categories either one or two among eight total factors of importance when they were selecting where to interview and how to compile their rank lists.

Discussion

In this analysis of diversity on the basis of race, Hispanic ethnicity, and sex in the U.S. diagnostic radiology physician workforce, we found that URM groups and females are significantly underrepresented as residents, academic faculty, and practicing physicians compared with the overall U.S. population and medical school graduates. While increased URM and female proportions as residents compared with practicing physicians suggest historical improvements, there is no significant increase in representation for individual URM groups or females during the past 8 academic years, indicating that representation will not dramatically change

Table 2

Diagnostic Radiology Specialty Residency Trainee Demographic Characteristics Compared with the 20 Largest Specialties for 2010

Characteristic	Diagnostic Radiology	Range for Largest 20 Specialties	Diagnostic Radiology Ranking among 20 Largest Specialties
Overall size*	4531	1069–22415	9 th
AI/AL/NH/PI	0.4% [†]	0.1%–1.3% [‡]	16 th
Female	27.8% [†]	13.2%–81.4% [‡]	17 th
Black	3.1% [†]	2.7%–10.7% [‡]	18 th
Hispanic	4.8% [†]	4.7%–9.6% [‡]	19 th
URMs combined	8.3% [†]	8.3%–20.0% [‡]	20 th

Note.—Residency training programs in descending order of size were as follows: internal medicine; family medicine; pediatrics; surgery, general; anesthesiology; emergency medicine; obstetrics and gynecology; psychiatry; diagnostic radiology; orthopedic surgery; pathology, anatomic and clinical; neurology; otolaryngology; internal medicine and pediatrics; ophthalmology; physical medicine and rehabilitation; dermatology; neurologic surgery; transitional year; and urology.

* Overall size refers to numbers of individuals in each category.

[†] Percentages were calculated with number of individuals in each subgroup (Table 1) as the numerator and overall size of 4531 for diagnostic radiology as the denominator. Percentages were rounded.

[‡] Numerators and denominators for percentage ranges are in reference 27.

Figure 4

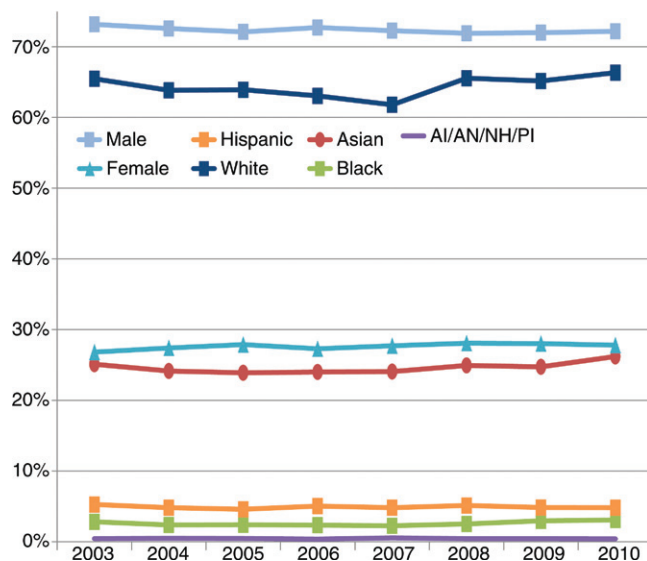


Figure 4: Diagnostic radiology residents by race, ethnicity, and sex from 2003–2004 through 2010–2011. Non-Hispanic and “other” categories are not shown.

in the near future. Efforts have been made to increase the available pipeline of medical school URM graduates (31). Nonetheless, our findings indicate that these groups decrease in representation when moving from medical school graduates to diagnostic radiology residency. Although ninth largest, diagnostic radiology ranks 17th in female and

20th in URM representation among the 20 largest residency training specialties, which include primary care, surgical, and nonsurgical specialties. In comparison with radiation oncology, its related specialty also receiving board certification by the American Board of Radiology, we have previously reported that radiation oncology had a significantly

greater proportion of females (33.3% vs 27.8%, $P = .005$) and Asians (32.8% vs 26.2%, $P < .001$), it had a smaller proportion of AI/AN/NH/PI (0.3% vs 0.4%, $P = .039$), and it showed no difference in proportions of blacks (3.3% vs 3.1%, $P = .707$) or Hispanics (3.3% vs 4.8%, $P = .097$) (32).

Researchers in previous literature (13) examined diagnostic radiology sex disparities related to interest, exposure, and mentorship. Specific influences included work attitudes and hours, job satisfaction, technology, training length, patient contact, and exposure to radiology mentors during medical school basic science and clerkship years. In a survey of women physicians, radiologists, despite having higher incomes, reported less job satisfaction and work control, they reported working more hours, they were more likely to believe they were overworked, and they noted sexual harassment (33). Although interest was unchanged after a 7-week introductory diagnostic radiology course to 1st-year medical students, the exposure revealed variable sex trends, with women rating more patient contact as a positive influence on residency selection and technological work as a negative influence (34). Without URM-specific data in diagnostic radiology, one may extrapolate from the top five reasons reported by URMs for selecting medicine as a career. Blacks and Hispanics versus other groups (including whites and Asians) rated the following as highest: patient contact (56.5% and 58.7%, respectively, vs $\leq 52.9\%$), exercise of social responsibility (66.4% and 66.0%, respectively, vs $\leq 62.8\%$), educating patients about health (85.4% and 76.6%, respectively, vs $\leq 69.9\%$), and the opportunity to make a difference (92.6% and 92.4%, respectively, vs $\leq 89.5\%$) (35). These data demonstrate that emphasizing opportunities for patient contact and education in diagnostic radiology may attract both URMs and women.

Investigation of unconscious bias (36–38) may also be warranted. A recent study showed that female laboratory manager position candidates were rated less competent and hireable

than males with equal qualifications and were offered less career mentoring (39). If throughout their educational training, equally qualified women and minorities are perceived to have less aptitude and are selected less frequently for training positions, this factor may ultimately limit educational and career opportunities. Investigators who are involved in future research should evaluate the ways in which both women and URMs are exposed to career opportunities and mentored throughout medical school and residency, particularly as it relates to less diverse fields such as diagnostic radiology, to determine whether unconscious bias has an effect on their residency selection and acceptance.

Potential strategies for addressing these disparities include the following: (a) initiating programs to expose pre-clinical students (students who have not yet begun rotating on the medical wards) to diagnostic radiology and subspecialties (eg, student interest group programming), highlighting patient contact and health education opportunities; (b) advocating for 3rd-year medical student diagnostic radiology rotations where currently not present; (c) creating opportunities for mentorship and exposure early in the pipeline in science, technology, engineering, and mathematics fields that are inclusive of women and minorities; (d) evaluating program effectiveness by race, ethnicity, and sex to determine additional insights and interventions; and most important, (e) increasing accountability. Holding health care leaders accountable for clinical operations is accepted as a necessary, industry-wide management tool. Commitment to increasing the diversity profile of highly competitive subspecialty programs by such authorities can yield positive results, as was the case with the Johns Hopkins Orthopedic Surgery training program, despite the lack of specialty-wide diversity (40,41). In business, education, and other environments where cultural diversity is valued, cultural metacognition is often at work as a positive force (42). Unless medical school deans hold diagnostic radiology leaders accountable, the current

situation with respect to diversification of the workforce will probably be left to just a few progressive training program directors to solve. Future investigation should seek to identify whether such exemplary programs currently exist in the field.

This analysis is limited in that groups were compared across 1 year, with the most recent publicly available data, acknowledging that medical school graduates and applicants in 2010 would become residents in 2012. Analysis of resident diversity annually since 2003 was performed to attempt to assess such trends in delayed diversity. Finally, in this analysis, we did not seek to establish “correct” or “sufficient” levels of racial, ethnic, and sex diversity; we simply sought to assess current diagnostic radiology representation and trends.

In conclusion, females and URM remain underrepresented in the diagnostic radiology physician workforce despite an available pipeline of medical students. Given prevalent health care disparities and an increasingly diverse society, future research and training efforts should address increasing resident diversity.

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