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Examining Racial and Gender Diversity in the Plastic Surgery Pipeline: Where is the Leak?

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Background: There is limited information about minority representation throughout the plastic and reconstructive surgery (PRS) pipeline. The aim of this study was to examine trends in representation among minorities at different stages of the PRS training pathway, starting with potential candidates in high school through practicing physicians.

Methods: The PRS pipeline was defined as high school; college; medical school applicants, matriculants, and graduates; PRS residency applicants, matriculants, and active residents; and PRS practicing physicians. Racial data for each stage were obtained from the US Census and Association of American Medical Colleges. The proportion of races at each stage were divided by their US population counterpart proportions to produce representation quotients (RQs). Medians and interquartile ranges (IQRs) are reported. Mann–Whitney *U* tests compared RQ values within identities between successive stages.

Results: Black students had high representation in high school (RQ = 1.26 [IQR: 1.21–1.29]) but had significant, stepwise decreases in representation in subsequent stages. A similar trend was observed for Hispanic individuals, who had their highest representation in high school (1.43 [1.37–1.50]), followed by significant decreases in RQ at nearly every subsequent stage up to and including practicing physicians (0.30 [0.28–0.31). Asian individuals were overrepresented at every stage (high school RQ: 1.01 [1.00–1.03]; practicing physician RQ: 2.30 [2.27–2.32]). White individuals were underrepresented before residency but had an RQ that approximated 1 in subsequent stages.

Conclusions: Racial minorities experienced decreases in representation at each successive stage in the PRS pipeline following high school. Ongoing diversity efforts should focus on premedical recruitment and professional support for minority students. *(Plast Reconstr Surg Glob Open 2024; 12:e5552; doi: 10.1097/GOX.0000000000005552; Published online 25 January 2024.)*

INTRODUCTION

There have been substantial increases in the representation of historically marginalized racial/ethnic and gender groups in US medical schools in the last 20 years.[1] This has been motivated in part due to a growing body of evidence suggesting that physician–patient identity concordance leads to higher patient satisfaction, greater medication adherence, and improved clinical outcomes among historically underserved populations when compared with racially discordant pairs.[2–4] Surgical fields are not exempt from the benefits of workforce diversity. Hassan et al found that breast cancer patients who had a shared racial identity with their operating plastic surgeon reported greater improvements in their physical quality of life than patients who did not.[5] Although the benefits of increased racial and gender diversity have been established in medicine,[6–11] the rapidly changing demographics in medical schools have not consistently been mirrored in physician populations.[1] This is especially true for surgical subspecialties such as plastic surgery, for which racial and ethnic diversity lags behind that of nonsurgical residency training programs.[12]

Several investigators have documented the percentage representation of minority trainees at each stage of

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the plastic and reconstructive surgery (PRS) pipeline beginning at medical school and terminating at faculty tenure.[13–15] Their studies suggest that the underrepresentation of minorities permeates the pipeline, and that diversity recruitment efforts should occur early and at different stages of training to exert maximal effect. These studies fail to consider, however, the demographics of to-be medical students before their entry into medical school, a juncture that is commonly described as the "bottleneck" to becoming a physician.[16] Furthermore, the evaluation of minority representation using only percentages and absolute counts insufficiently captures the degree to which various groups are over- or underrepresented within PRS. Without a baseline comparison, it becomes difficult to contextualize the percentage representation of different groups as they progress through the plastic surgery pipeline that is marked by an increasingly diminishing population size.

An acceptable measure of inequity must be independent of population size and the unit of measurement.[17] The representation quotient (RQ) perfectly satisfies these requirements. RQs summarize the degree of equity by dividing the proportion of a race or gender group in the population of interest by the proportion of that same group in a larger reference population. The purpose of this study was, therefore, to compute RQs for racial and gender identities throughout the PRS training pathway (beginning with high school students and ending with active plastic surgeons) compared with their greater US population counterparts. The authors hypothesize that the use of RQs will better convey the extent of minority underrepresentation in plastic surgery.

METHODS

Data Acquisition

The PRS pipeline was defined by the following cohorts: the US population (all age groups); public high school students (grades 9–12); undergraduate students; college graduates; medical school applicants, matriculants, and graduates; integrated PRS residency applicants, matriculants, and active residents; and active US plastic surgeons. US population data were obtained from the United States Census Bureau American Community Survey.[18] High school and undergraduate population demographics were obtained from the National Center for Education Statistics.[19] Demographic reports for private school students were available for K–12 only; private high school–specific data was unavailable at the time of data collection, hence the population's exclusion. Medical school data were obtained from the Association of American Medical Colleges (AAMC) by request and through their publicly accessible Data & Reports page.[20] PRS residency applicant and matriculant demographics were obtained from the AAMC. Active plastic surgery resident data were obtained from the American Medical Association and AAMC.[21] Active physician data were obtained from the AAMC. All data were deidentified, and populations with fewer than 10 individuals within a given racial/ethnic identity were omitted from the reports to preserve anonymity.

Takeaways

Question: At each stage in the plastic surgery pipeline, what is the representation of each racial/ethnic and gender group relative to their representation in the greater US population?

Findings: Black and Hispanic individuals were significantly underrepresented at each post–high school stage in the plastic surgery pipeline. Asian and White individuals were over- and equitably represented at nearly every stage, respectively.

Meaning: Racial minorities have been underrepresented at most premedical and all medical stages of training in the plastic surgery pipeline from 2010 to 2021.

The self-reported racial/ethnic identities were American Indian/Alaskan Native (AI/AN), Asian, Black or African American (herein "Black"), Hispanic, Latino, or of Spanish origin (herein "Hispanic"), Native Hawaiian/other Pacific Islander (NHoPI), and White. At the residency applicant and matriculant stages, individuals who selected more than one race were counted into each category that they self-identified; these individuals may therefore be counted more than once because they are indistinguishable from those who only selected one race. For all other stages of the training pathway, individuals are only counted once and were grouped into the multiple race category (not represented in the present study) if they selected more than one race. At the stage of college graduates, Asian is combined with Pacific Islander as one identity (Asian/Pacific Islander [API]) in the original report, and these data were not disaggregated. Therefore, no data are presented for NHoPI at this stage. Given that the total count of Asian individuals in the dataset was considerably greater than that of NHoPI, the authors chose to use API college graduate totals as an estimate for that of Asian individuals at this stage. The population counts for male and female individuals were included for each stage after high school because gender data were not available at this stage.

Statistical Analyses

RQs for each race/ethnicity and gender were calculated by dividing the percentage of individuals at a given stage by their percentage representation among the US population. An RQ less than or greater than 1 indicates under- or overrepresentation relative to an identity's greater US population counterparts, respectively; an RQ that approximates 1 suggests an equal rate of representation compared with the greater US population. The median RQs and interquartile ranges (IQRs) were calculated for each racial/ethnic and gender identity at each stage for which data was available between 2010 and 2021. Individuals considered underrepresented in medicine (URM) in accordance with the AAMC definition[22] were combined to evaluate changes in general URM representation. Self-identified Asian or White individuals were combined into the non-URM group. Median RQs in successive stages were compared using Mann–Whitney *U* tests to assess for statistical changes in representation within each identity throughout the pipeline.

Each *P* value reported after an RQ value indicates the statistical difference in representation from that of the prior stage. Linear regressions were performed on yearly RQ values for URM and non-URM individuals to assess for changes in representation at select stages in the plastic surgery training pathway. Statistical tests were two-tailed. A *P* value less than 0.05 was deemed significant. Analyses were conducted, and graphs were produced using GraphPad Prism (version 10.0.0 for Mac, GraphPad Software, San Diego, Calif., www.graphpad.com). This study was reviewed by the local IRB and was designated as "research—not human subjects research" (board reference #2011381).

RESULTS

High School and College Representation

The RQ for each race/ethnicity at each stage is summarized in Table 1. Asian public high school students were proportionally represented compared with their US population counterparts (RQ = 1.01 [IQR 1.01–1.03]) and experienced gains in representation among college enrollees (1.23 [1.22–1.25], $P < 0.001$) and graduation (1.45 [1.43–1.49], $P < 0.001$; Fig. 1A). Public high school students who self-identified as Black (1.26 [1.21–1.29]) or Hispanic (1.43 [1.37–1.50]) were overrepresented at this stage relative to their US population proportions (Table 1). This representation statistically decreased in a stepwise fashion thereafter, with Black college enrollees (1.08 [1.03–1.17], $P < 0.001$) and Black college graduates (0.82 [0.80–0.84], $P < 0.001$) being considerably underrepresented compared with the previous stage (Fig. 1B). Hispanic college enrollees were similarly underrepresented compared with their US counterparts (0.72 [0.62–0.80], $P < 0.001$; Fig. 1C). Self-identified White individuals were underrepresented in public high schools (0.81 [0.79–0.83]) but gained representation in college enrollment (0.88 [0.86–0.91], $P < 0.001$) and graduation (1.00 [0.97–1.04], $P < 0.001$; Fig. 1D). Male (college enrollment RQ = 0.88 [0.87–0.88]) and female individuals (1.12 [1.11–1.13]) had similar representation when transitioning from college enrollment to college graduation ($P = 0.028$ for both; Table 1).

Medical School Applicant, Matriculant, and Graduate Representation

Asian individuals had a significant increase in RQ at the start of the medical school pipeline: their representation was approximately 300% higher among medical school applicants (3.83 [3.79–4.26], $P < 0.001$), matriculants (4.01 [3.89–4.25], $P = 0.16$), and graduates (4.08 [4.01–4.23], $P = 0.22$) than what would be predicted by their US population proportions (Fig. 1A). There was a continued statistically significant sequential decrease in RQ for self-identified Black individuals at the medical school applicant (0.65 [0.60–0.68], $P < 0.001$), matriculant (0.55 [0.50–0.60], $P = 0.003$), and graduate (0.49 [0.46–0.55], $P = 0.02$; Fig. 1B) levels. A similar trend was observed among Hispanic students: there were significant declines in RQ among medical school applicants (0.52 [0.47–0.55], $P < 0.001$) and medical school graduates

Table 1. Median RQ (Interquartile Range) of Different Racial/Ethnic and Gender Identities at Different Stages from 2010 to 2021

	High School*	College Enrollee	College Graduate†‡	Medical School Applicant	Medical School Matriculant	Medical School Graduate	Residency Applicant§	Residency Matriculant§	Active Resident	Active PRS Physician¶
AI/AN	1.56 (1.49–1.61)	1.11 (1.03–1.25)	0.77 (0.71–0.94)	0.34 (0.29–0.36)	0.32 (0.30–0.40)	0.23 (0.20–0.28)	1.17 (0.99–2.07)	1.30 (0.00–1.94)	0.36 (0.16–0.61)	0.44 (0.43–0.47)
Asian	1.01 (1.00–1.03)	1.23 (1.22–1.25)	1.45 (1.43–1.49)	3.83 (3.79–4.26)	4.01 (3.89–4.25)	4.08 (4.01–4.23)	3.35 (3.06–3.69)	4.29 (3.76–4.63)	3.97 (3.86–4.08)	2.30 (2.27–2.32)
Black	1.26 (1.21–1.29)	1.08 (1.03–1.17)	0.82 (0.80–0.84)	0.65 (0.60–0.68)	0.55 (0.50–0.60)	0.49 (0.46–0.55)	0.48 (0.33–0.56)	0.26 (0.18–0.35)	0.23 (0.20–0.31)	0.24 (0.22–0.25)
Hispanic	1.43 (1.37–1.50)	0.98 (0.89–1.06)	0.72 (0.62–0.80)	0.52 (0.47–0.55)	0.54 (0.51–0.57)	0.31 (0.29–0.34)	0.47 (0.43–0.56)	0.38 (0.28–0.43)	0.40 (0.36–0.41)	0.30 (0.28–0.31)
NHoPI	2.24 (2.20–2.28)	1.72 (1.56–1.96)	N/A	0.61 (0.46–1.16)	0.59 (0.38–0.84)	0.31 (0.21–0.53)	1.06 (0.00–1.91)	0.00 (0.00–2.34)	0.00 (0.00–1.20)	0.52 (0.52–0.52)
White	0.81 (0.79–0.83)	0.88 (0.86–0.91)	1.00 (0.97–1.04)	0.77 (0.73–0.83)	0.82 (0.78–0.88)	0.92 (0.88–0.94)	0.82 (0.78–0.88)	1.08 (1.04–1.12)	1.11 (1.08–1.13)	1.06 (0.96–1.09)
URM	1.37 (1.35–1.38)	1.03 (1.02–1.05)	0.76 (0.72–0.79)	0.57 (0.52–0.59)	0.54 (0.51–0.57)	0.38 (0.36–0.43)	0.48 (0.41–0.56)	0.35 (0.27–0.42)	0.32 (0.31–0.36)	0.28 (0.26–0.29)
Non-URM	0.83 (0.81–0.85)	0.90 (0.89–0.93)	1.03 (1.01–1.07)	1.00 (0.98–1.07)	1.06 (1.03–1.11)	1.16 (1.14–1.17)	1.01 (0.98–1.06)	1.34 (1.27–1.36)	1.32 (1.31–1.34)	1.16 (1.06–1.20)
Male	N/A	0.88 (0.87–0.88)	0.87 (0.87–0.87)	1.06 (0.98–1.09)	1.04 (0.97–1.08)	1.06 (1.03–1.07)	1.37 (1.21–1.38)	1.18 (1.07–1.27)	1.20 (1.17–1.28)	1.71 (1.68–1.74)
Female	N/A	1.12 (1.11–1.13)	1.13 (1.13–1.13)	0.94 (0.92–1.02)	0.96 (0.93–1.03)	0.95 (0.93–0.97)	0.65 (0.63–0.79)	0.83 (0.74–0.93)	0.81 (0.73–0.84)	0.31 (0.28–0.34)

*Sex data were not available at this stage.
†Data for the academic year 2021–2022 was not available at the time of data acquisition.
‡Data source combined individuals who self-identified as Asian or Pacific Islander into one group.
§Category totals may not add up to the unduplicated total counts because a person could designate multiple categories.
¶Race/ethnicity data were only provided for academic years 2013–2014, 2018–2019, and 2021–2022.
AI/AN, American Indian/American Native; NHoPI, Native Hawaiian/other Pacific Islander.

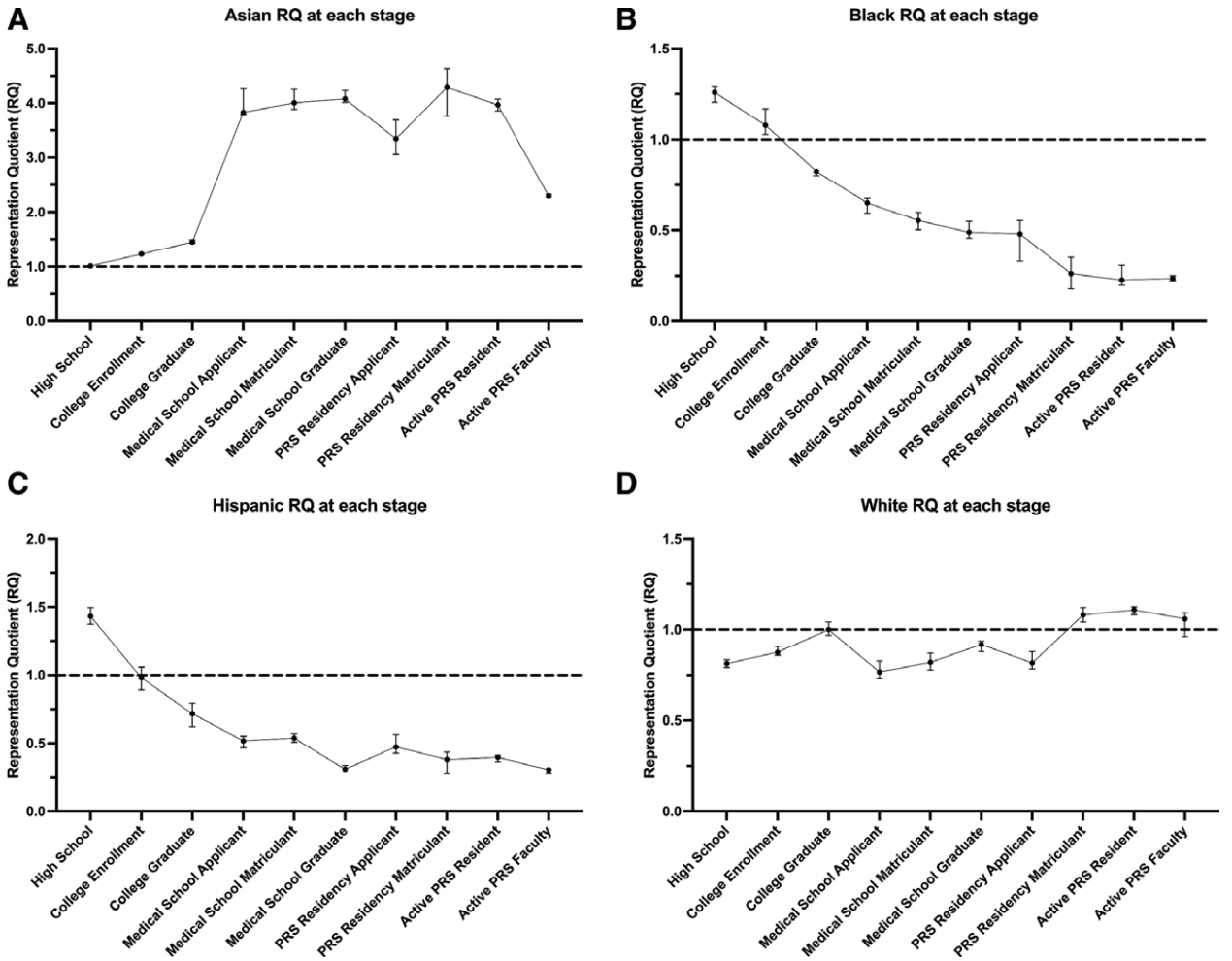

Fig. 1. Representation of each racial/ethnic group throughout the plastic surgery pipeline. A, Median RQs of self-identified Asian individuals at each stage in the plastic surgery training pathway between 2010 and 2021. Error bars represent 25th and 75th percentiles. B, Median RQs of self-identified Black individuals at each stage in the plastic surgery training pathway between 2010 and 2021. C, Median RQs of self-identified Hispanic individuals at each stage in the plastic surgery training pathway between 2010 and 2021. D, Median RQs of self-identified White individuals at each stage in the plastic surgery training pathway between 2010 and 2021.

(0.31 [0.29–0.34], $P < 0.001$) when compared with their respective prior stages (Fig. 1C). White individuals consistently had RQs lower than 1 throughout medical school but experienced consistent increases in representation at each medical school stage (Fig. 1D). Male and female individuals both had RQs that approximated 1 at each of the three medical school stages examined, and these values did not statistically differ.

Plastic Surgery Applicants, Matriculants, Residents, and Active Physicians

Plastic surgery applicants who self-identified as either Asian (3.35 [3.06–3.69], $P < 0.001$) or White (0.82 [0.78–0.88], $P = 0.004$) had significantly lower representation compared with their medical school graduate counterparts, but experienced gains in representation as plastic surgery matriculants and active residents (Table 1). Among active plastic surgeons, only White (1.06 [0.96–1.09], $P = 0.05$) and Asian (2.30 [2.27–2.32], $P = 0.004$) physicians had an RQ greater than 1. Hispanic plastic surgery applicants continued to experience statistically significant, stepwise declines in representation among plastic surgery applicants (0.47 [0.43–0.56], $P < 0.001$), matriculants (0.38 [0.28–0.43], $P = 0.009$), and as active plastic surgeons (0.30 [0.28–0.31], $P = 0.004$). Black individuals had a statistically significant drop in RQ only among plastic surgery matriculants (0.26 [0.18–0.35], $P < 0.001$). When considering only gender, male individuals had lower representation among plastic surgery matriculants compared with applicants but were overrepresented as residents (1.20 [1.17–1.28], $P = 0.27$) and as active plastic surgeons (1.71 [1.68–1.74], $P < 0.001$). Female individuals were underrepresented through the remainder of the pipeline after application to plastic surgery, with significant declines occurring at nearly each stage. Female individual representation among active residents (0.81 [0.73–0.84], $P = 0.27$) was significantly less than that of active plastic surgeons (0.31 [0.28–0.34], $P < 0.001$).

Table 2. Linear Regression Results for URM and Non-URM Individuals at Select Stages in the Plastic Surgery Pipeline from 2010 to 2021

	High School	College Enrollee	Medical School Matriculant	Active Resident	Active PRS Physician
URM	**+0.0048 (+0.0034 to +0.0062)**	**+0.0041 (+0.0031 to +0.0051)**	**+0.014 (+0.0089 to +0.018)**	–0.0052 (–0.011 to +0.00023)	+0.0035 (–0.0026 to +0.0096)
Non-URM	**–0.0058 (–0.0066 to –0.0051)**	**–0.0062 (–0.0081 to –0.0043)**	**–0.0096 (–0.0015 to –0.0042)**	–0.0013 (–0.0056 to +0.0031)	+0.018 (–0.014 to +0.051)

RQ slopes and 95% Confidence Intervals (95% CIs) are reported. Boldface indicates statistical significance at $P < 0.05$.

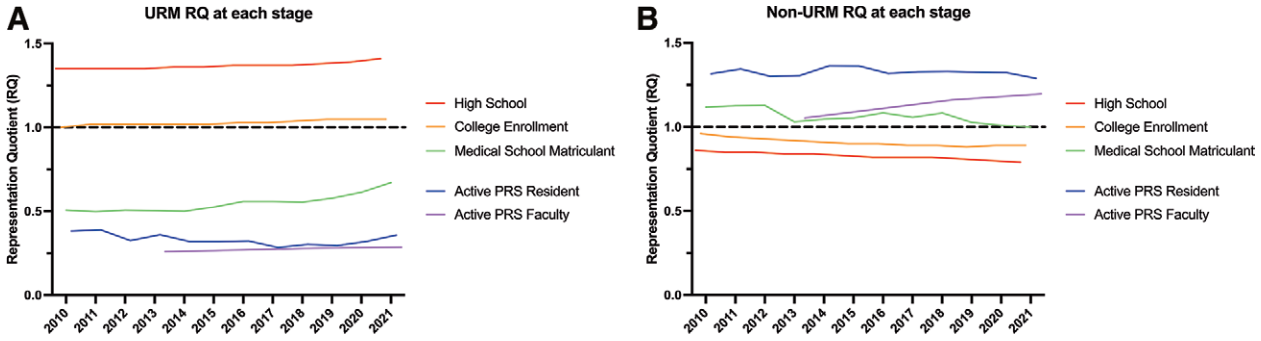

Fig. 2. Trends in representation at selected pipeline stages between 2010 and 2021. A, Yearly trends in RQs of URM individuals at select stages in the plastic surgery training pathway between 2010 and 2021. B, Yearly trends in RQs of non-URM individuals at select stages in the plastic surgery training pathway between 2010 and 2021.

Trends in URM and Non-URM Representation throughout the Pipeline

The changes in URM and non-URM representation over time are shown in Table 2 and Figure 2. URM individuals were overrepresented in high school (1.37 [1.35–1.38]) and among college enrollees (1.03 [1.02–1.05]) and had statistical increases in representation at these stages during the study period. Non-URM students were underrepresented in both high school (0.83 [0.81–0.85]) and college (0.90 [0.89–0.93]) but trended toward decreased representation over time (Table 2). Among medical school matriculants, URM students were underrepresented (0.54 [0.51–0.57]) despite having a statistical increase in RQ (+0.014 per year [95% CI: +0.0089 to +0.018]). Non-URM students were nearly equivalently represented compared with their US population counterparts (1.06 [1.03–1.11)] and experienced statistical declines in RQ. URM plastic surgery residents and active plastic surgeons were considerably underrepresented, whereas non-URM individuals were overrepresented at these stages; both groups had statistically stagnant representation between 2010 and 2021.

DISCUSSION

The purpose of this study was to use RQs to quantify and contextualize the trends in representation of different racial and gender identities throughout the PRS pipeline. We ultimately found self-identified Black or Hispanic individuals experienced statistically significant, stepwise decreases in representation in their application to medical school through practicing plastic surgeons. Self-identified Asian or White individuals gained representation at nearly every successive stage from medical school onward, despite being underrepresented compared with their US counterparts in high school and college. These findings are especially concerning given that the annual trends in RQ were declining or unchanged for URM individuals in plastic surgery. In addition, self-identified female individuals remain underrepresented compared with their male counterparts at every stage examined following college graduation.

Several studies have highlighted the dearth of minorities in plastic surgery. In 2009, Butler et al found that the racial demographics of academic plastic surgeons did not adequately mirror that of the US population, medical school graduates, and plastic surgery faculty over a 40-year period.[13] A follow-up study in 2021 additionally noted both percentage drop-offs in representation throughout the plastic surgery pipeline and a lack of minorities in PRS leadership positions.[14] In their analyses of plastic surgery residents, Silvestre et al and Parmeshwar et al separately concluded that Black individuals were underrepresented and Asian individual were overrepresented in plastic surgery, and that female individual representation increased while Black representation decreased among plastic surgery residents, respectively.[23,24] The results from our study are consistent with these investigators' findings. Our results further add to the discussion through our use of RQs, which simultaneously summarize the extent of over- and underrepresentation of different groups as a single value and contextualize representation relative to a reference population. Furthermore, our inclusion of data before medical school shows that URM students are nearly proportionally represented in high school and colleges relative to what would be predicted by US population demographics. This finding may suggest that there are significant barriers that prevent the equitable entry of URM students into medicine in general, let alone into plastic surgery (Fig. 3). These results are critical to further uncovering and addressing the representational gaps that have long plagued plastic surgery.

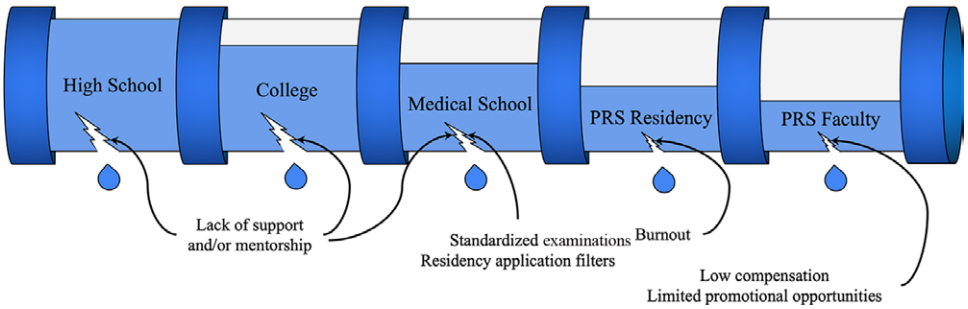

Fig. 3. Illustrative depiction of the pipeline to becoming a plastic surgeon. The arrows represent systemic insults or barriers that disrupt pipeline integrity. The droplets are the qualitative "loss" of underrepresented minorities.

Faculty racial diversity plays a pivotal role in improving diversity throughout the PRS pipeline, as academic plastic surgeons can establish mentorship opportunities and cultivate an inclusive learning environment for medical students and residents alike. Such professional relationships have been shown to provide URM students with greater exposure to plastic surgery and to aid them in overcoming minority-specific barriers, both of which may be more pronounced among racial- and/or gender-concordant mentor-mentee pairs.[25] However, barely one-quarter of North American PRS faculty are non-White or nonmale individuals. This lack of representation—perpetuated by limited academic and professional promotion opportunities—is likely to further impede the equitable entry of URMs into PRS.[25]

In June 2023, the US Supreme Court ended race-conscious admission programs at colleges and universities across the nation, a ruling that may be reasonably considered to forecast a worsening of racial diversity in the plastic surgery workforce to the detriment of our colleagues and patients.[26] Institutions may consider "an applicant's discussion of how race affected the applicant's life, so long as that discussion is concretely tied to a quality or character or unique ability that the particular applicant can contribute to the university." Although this ruling does not seem to directly impact racial diversity among resident physicians, reduced URM medical school enrollment will undoubtedly limit the number of PRS residency candidates in future application cycles. Despite this, leaders in plastic surgery can implement several recruitment strategies to ensure a continued influx of URM and women plastic surgery trainees.

Plugging the Leak

The Liaison Committee on Medical Education guidelines require that accredited medical schools[27]:

1. Develop pipeline programs that support the preparation and counseling of individuals from targeted diversity groups for entry into medicine." The Pathways to Medicine Pipeline at Brown and the Mayo Clinic Career Advancement, Research, and Education Summer (CARES) Program are two examples of student mentorship and exposure programs that connect high school students with student mentors and physicians to expose students to medicine before college.[28,29] Providing plastic surgery mentorship to high school students in these programs might help diversify the cohort of PRS applicants, but the immediate impacts may not be evident for several years.
2. Create policies and implement practices that focus on recruitment, admission, retention, and support for students from targeted diversity groups." An example of such a program that satisfies this requirement is the Minority Association of Pre-medical Students (MAPS)—the premedical counterpart to the Student National Medical Association—whose goal is to provide academic and professional support to URM students.[30] Plastic surgeons can volunteer with any one of the more than 200 MAPS chapters nationwide to provide early guidance to students interested in the field.[31]
3. Recruit, hire, and support faculty and administrators from the targeted diversity groups to support the ability to attract and retain a diverse student body." All physician educators with faculty appointments in undergraduate medical schools have a role in investing in medical students and supporting the pipeline, regardless of specialty. Within plastic surgery specifically, divisions and departments that invest in programs aimed at diversifying medical school populations are directly addressing one of the most prominent barriers to improving PRS workforce diversity.

LIMITATIONS

This study has important limitations. First, racial and ethnic data are all self-reported and are grouped into broad, heterogenous categories that neither reflect the true racial diversity of populations nor indicate the ways in which individuals may be perceived throughout their premedical and medical training. Second, there were no demographic data for private high school students, which may over- or underestimate the representation of different racial/ethnic groups at the high school level. Despite this limitation, the use of public high school data nonetheless provides important context about premedical minority representation.[32] Third, we did not have access to faculty-level racial and ethnic data for all years between 2010 and 2021. The faculty reports were obtained from publicly accessible pages on the AAMC website, which routinely archives older data. Lastly, the diversity data described are presented in aggregate and are therefore

not indicative of representation trends at individual institutions. The availability of more granular data may further uncover representational differences across US regions.

CONCLUSIONS

The underrepresentation of racial minorities is a significant concern in plastic surgery, especially given the importance minority representation in addressing the needs of racially diverse patient populations. Our findings indicate that racial minorities such as Black and Hispanic individuals experienced precipitous declines in representation as they progressed through the premedical and plastic surgery training aspects of the PRS pipeline. Continued diversity outreach efforts targeted at premedical racial minorities should be enacted to ensure both the equitable recruitment of these individuals and to ensure that the plastic surgery workforce more adequately reflects the patient population that they wish to serve.

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DISCLOSURE

The authors have no financial interest to declare in relation to the content of this article.

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