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# New docs on the block: A profile of applicants and subsequent PGY1 trainees of categorical general surgery programs (2013–2016)

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ABSTRACT

*Background:* The categorical general surgery (GS) applicant pool and trainees have evolved. The purpose of this study is to profile contemporary applicants and subsequent matriculates of GS residencies.
*Study design:* This study is a retrospective review of GS applicant and PGY1 trainee data which were obtained from ERAS, NRMP, and AAMC for the years 2013–2016. Univariate statistics were used to compare matched GS trainees other trainees in other specialties.
*Results:* In 2016 GS was among the top 5 most competitive residencies as measured by mean applications/applicant. In 2013, 2415 applicants applied for 1185 spots resulting in 99.6% fill.
The 2014 PGY1 class exhibited: mean **Step 1232 vs. 213 and Step 2245 vs. 226 when comparing matched to unmatched**. The mean number of abstracts/publications and %AOA were 4.4 v. 2.7, and 4.4% vs.2.7% respectively. Surgical subspecialty trainees had significantly higher Step 1 and 2 scores, publications, and %AOA ($p < .0001$).
*Conclusion:* General surgery is an increasingly competitive specialty. PGY1 trainees compare well with their CIM and Obstetrics peers, but lag behind their surgical subspecialty colleagues.


## Introduction

General surgery training has been through several paradigm shifts. The pyramidal system championed by Halsted left much to be desired, but even after its removal and replacement by a largely rectangular system, championed by Churchill,[1] issues such as attracting the best and brightest senior medical students to surgery and retaining trainees have persisted. This has been attributed to long work hours and increasing desires for work life balance by Gen X'ers and Millennials entering the workforce.[2–5] The early 2000s were a particularly challenging time for surgical education as the number of applicants to general surgery continued to fall and 68 spots went unfilled in 40 programs in 2001.[6] There was serious concern that the quality of applicants to general surgery was deteriorating and the applicant pool would not be sufficient to meet the demands of the surgical workforce.[7,8] Fortunately, after 2003 this was no longer the case as U.S. senior medical students filled 82.7% of spots and continued to fill over 90% thereafter.[4] In 2016, there were 1241 categorical general surgery spots available in 260 programs. Following the main residency match, not including SOAP, only 2 positions went unfilled in 2 programs, resulting in a 99.8% fill.[9]

The advent of the 80-h work week and continued adjustments to resident work hours has stirred much conversation regarding applicant attitudes toward applying to general surgery. Miller et al.[10] found that potential trainees viewed work hour limitations as favorable to their training and would likely spend the additional time to further their education through reading scholarly articles or surgical textbooks. While workload and resident lifestyle can still serve as deterrents to entering surgical training, one study found that students planning a surgical career were less deterred by these things than their peers who were planning other careers and cited personality fit and identification of a surgical mentor as strong influences for considering surgery.[11]

The introduction of integrated specialty programs in peripheral vascular, plastic and cardiothoracic surgery has also altered the

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pool of available applicants to general surgery programs. While this hasn't been found to alter the operative volume of general surgery in programs that coexist with integrated training programs,[12] there is concern that these programs will attract highly qualified applicants away from general surgery training.

Categorical general surgery (GS) and its applicant pool and trainees has changed. The purpose of this study is to profile contemporary applicants and subsequent matriculates of GS residencies, compare them to trainees in other medical and surgical specialties, and offer limited though valuable insight into applicant preferences.

## Methods

### *Data sources*

General surgery applicant and PGY1 trainee data were obtained from the Electronic Residency Application Service (ERAS), National Resident Matching Program (NRMP), U.S. Medical Licensing Exam (USMLE) and the Association of American Medical Colleges (AAMC)[13–17] for the years 2013–2016. Applicant data were obtained for 2013 and compared with the resultant 2014 PGY1 class. The same was true for 2014 applicants and the subsequent 2015 categorical general surgery cohort. Data included were race, gender, NIH top 40 medical school (school listed in the top 40 for NIH funding per NRMP), Alpha Omega Alpha Honor Medical Society (AOA) status, USMLE Step 1 and 2 scores, research, work, or volunteer experience as well as number of applications submitted for residency and frequency of cross specialty application. All of these data were readily available and publically accessible on each organization's respective website in the form of PDF files. Requests were made by the authors to both ERAS and NRMP to obtain more complete raw data regarding applicant demographics and match data, but neither were willing to provide that information. We felt this would have allowed for a more robust statistical analysis. Therefore, our analysis is limited to the publically available information and remains largely descriptive. This information still provides a snapshot of the applicant pools for 2013–2016.

### *Statistical analysis*

Descriptive statistics were used to evaluate most information about residency trainees including number of applications overall as well as by sex, race, and graduating medical school (international vs. US medical graduate). Differences in demographics such as race and sex were calculated using univariate statistics including chi-square test for proportions. Data from ERAS was used to calculate differences in MCAT scores, Step1 &2 scores, research, work and volunteer experiences between incoming PGY1 categorical GS and other specialties in the 2015–2016 year. Differences were calculated using Student's t-test with Welch's approximation for unequal variances. Alpha was set at $p < .05$ for all analyses. Characteristics of matched applicants versus unmatched applicants were evaluated using descriptive statistics as well. All statistical analyses were completed with Stata 14 (College Station, TX). As these data are publicly available and de-identified, the project was deemed exempt by the institutional review board at our institution.

## Results

For the first time in 2016, GS was #4 among the top 5 most competitive residencies (behind Orthopedics (Ortho), Urology, and Dermatology) as measured by average applications/applicant with a mean of 50 applications per applicant. Otolaryngology (ENT) followed behind Gen Surg in fifth place with a mean 49 applications per applicant. Table 1 shows the top 5 most competitive residencies for the last three years and their respective mean number of applications per applicant.[13] It is important to note that the number of applicants discussed here does not indicate or equal the number of trainees granted interviews, rather those that submitted applications via ERAS. The number of trainees working in categorical general surgery training programs is not insignificant. There were 8155 active (currently working in a training program) general surgery residents in the 2015–2016 year. Of these, 15.9% (1295) were international medical graduates (IMG) and 84.1% (6860) were US medical graduates (UMG). This is consistent with years past, as IMGs are less likely to participate in categorical GS programs as compared with categorical internal medicine (CIM) where the proportion of IMGs approached 40% in 2015.[14]

The number of applicants applying to categorical GS residency (per ERAS) has fluctuated over the years as seen in Fig. 1. In 2015, of the 6874 GS residency applicants, 44.3% (3047) were UMGs and 55.7% were IMGs. Students came from a variety of medical schools: US public schools (23.9%), US private schools (13.9%), and osteopathic schools (6.45%). This number differs from the number of applicants that actually participate in the match via NRMP. These estimates are much more modest with the number of GS residency applications fluctuating between 2250 applicants in 2012 to 2350 applicants in 2016.[9,15] For the duration of this paper, the term applicants will refer to those that submitted applications via ERAS and not only limited to those that participated in the Match, unless otherwise specified. Despite this fluctuation, categorical GS programs have been able to fill greater than 99% of their available spots without including those acquired during the Supplemental Offer and Acceptance Program (SOAP) from 2012 to present.

### *Demographics*

In 2013, there were 7732 applicants (33.9% female, 38.1% White, 9.9% AA, 32.6% Asian, 8.6% Hispanic, 3.2% AOA) at submission for 1185 GS spots resulting in 99.6% fill. In 2015, there were 6874 applicants (36.3% female, 44.1% White, 10.2% AA, 30.4% Asian, 9.1% Hispanic, 3.8%AOA) at submission for 1230 GS spots resulting in 99.8% fill.[14] There were less than 1% Native Americans and Pacific Islanders for both years. The racial composition of GS programs from 2013 to 2015 is depicted in Fig. 2. While the proportion of white applicants significantly increased from 2013 to 2015 (38.1% vs. 44.1%, $p < .001$), the proportion of Asians decreased slightly, and

**Table 1**
Top five most competitive residencies (2014–2016).

| Rank | 2014 | Average applications per applicant | 2015 | Average applications per applicant | 2016 | Average applications per applicant |
|---|---|---|---|---|---|---|
| 1 | Orthopedics | 60 | Orthopedics | 70 | Orthopedics | 79 |
| 2 | Otolaryngology | 60 | Dermatology | 66 | Urology | 67 |
| 3 | Dermatology | 58 | Urology | 62 | Dermatology | 59 |
| 4 | Urology | 58 | Otolaryngology | 52 | General Surgery | 50 |
| 5 | Neurological Surgery | 54 | Neurological Surgery | 44 | Otolaryngology | 49 |

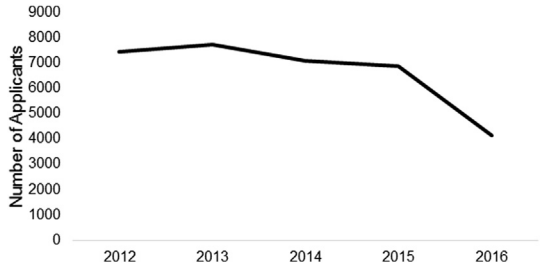


**Fig. 1.** Number of applicants to categorical general surgery residencies by year (2012–2016).

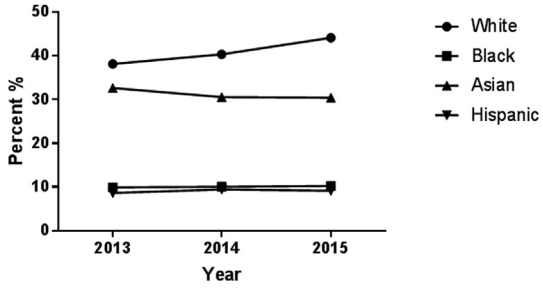


**Fig. 2.** Racial composition of categorical general surgery programs by year (2013–2015). Circle: White; Square: Black, Triangle: Asian; Inverted Triangle: Hispanic.

the number of AA and Hispanic applicants did not change significantly over time. The percentage of females significantly increased from 2013 to 2015 (33.9% vs. 36.3%, p = .0024), but decreased from 2015 to 2016 (36.3% vs. 34.9% p = .08). The proportions of IMG applicants to categorical general surgery has decreased steadily over time from 61.8% in 2012 to 46.9% in 2016 (Fig. 3.). The

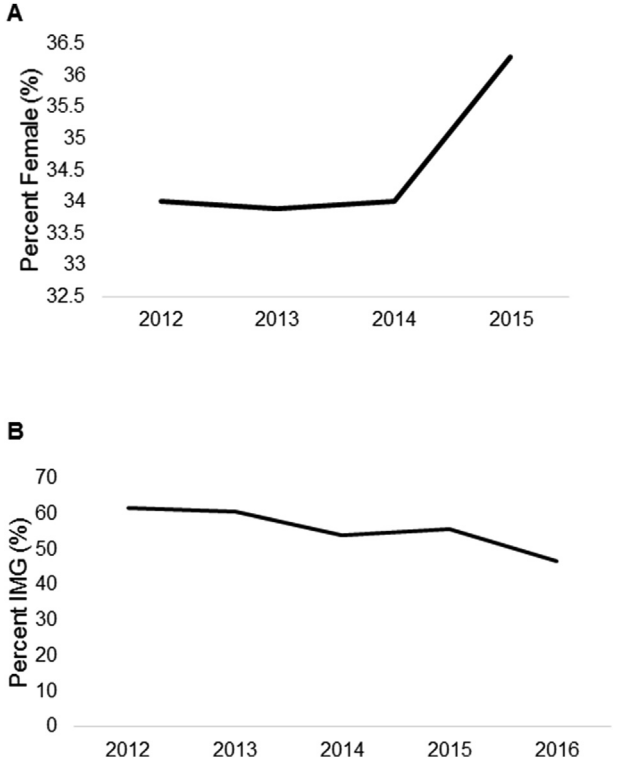


**Fig. 3.** (A) Percent female composition of categorical general surgery applicants by year (2012–2015). (B)Percent International Medical Graduate (IMG) composition of categorical general surgery applicants.

percentage of applicants with AOA distinction has steadily risen from 2012 to 2015. From 2013 to 2015 there was a statically significant increase in the percent of applicants with AOA distinction at submission (3.2% vs. 4.2% p = .0013).

### *Application Patterns*

The mean number of applications is used as a proxy for competitiveness across specialties. In general, the applicants to categorical GS programs are submitting more applications (Fig. 4). Fig. 5A compares the mean number of applications between male and female applicants from 2012 to 2015, showing an increase for both genders, with 36.3 applications and 33.5 applications for males and females respectively in 2015 compared to 30.2 and 26.5 applications respectively in 2012. Overall, male applicants tend to submit more applications than female applicants, but it remains unclear whether males match at a higher rate than females. When looking at race/ethnicity, Hispanic applicants tend to submit more applications than the other races. In 2015, Hispanics had the highest mean number of applications with 42.1 while the mean for whites was 38. Interestingly, Native Americans and Pacific Islanders sent an average of 34.3 and 37.1 applications respectively. African-Americans had the lowest mean number of applications with 27.6 (Fig. 5B). As seen with the aforementioned groups, the number of applications per applicant being submitted by IMGs has also increased over time, but they are submitting far more applications than the average UMG applicant with a mean of 49.8 applications/applicant in 2016.

We recognize the shortcomings of this metric as the sole means of determining competitiveness. As a result, we calculated a measure that normalizes for both applicants and application numbers to give a better representation of surgical specialty competitiveness. It is calculated as the number of spots available divided by the number of applicants multiplied by the number of applications per applicant. [spots/(#applicants* #applications submitted)]

After normalizing for both applicant numbers and number of applications, we see that general surgery while, less competitive overall than plastic surgery, ortho and neurosurgery has become more competitive over time (Fig. 6).

Cross specialty application in which applicants rank programs in more than one specialty is common. In 2015, GS applicants, applied across specialties to Prelim Surgery (59.9%), CIM (34.4%), Family Medicine (25.4%) and Preliminary Internal Medicine (24.2%). In surgical specialties, cross specialty applications occurred with: Obstetrics & Gynecology (9.2%), Integrated Plastic Surgery (6.4%), Integrated Vascular Surgery (5.7%), Ortho (5.3%), and ENT (3.2%). The success rate for US graduates for ranking only GS programs was 92.1% (771/837) compared to CIM (98%), Ortho (80%), Neurological Surgery (81%), and ENT (82%).

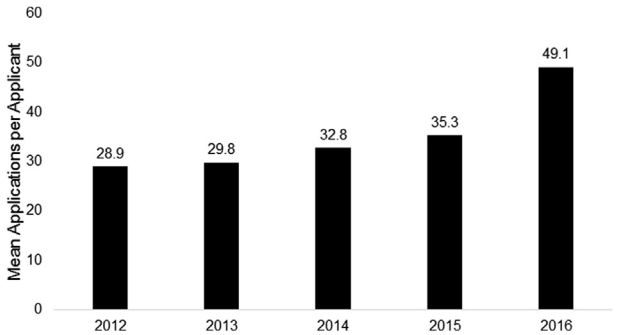


**Fig. 4.** Mean number of applications/applicant to categorical general surgery residency by year (2012–2016).

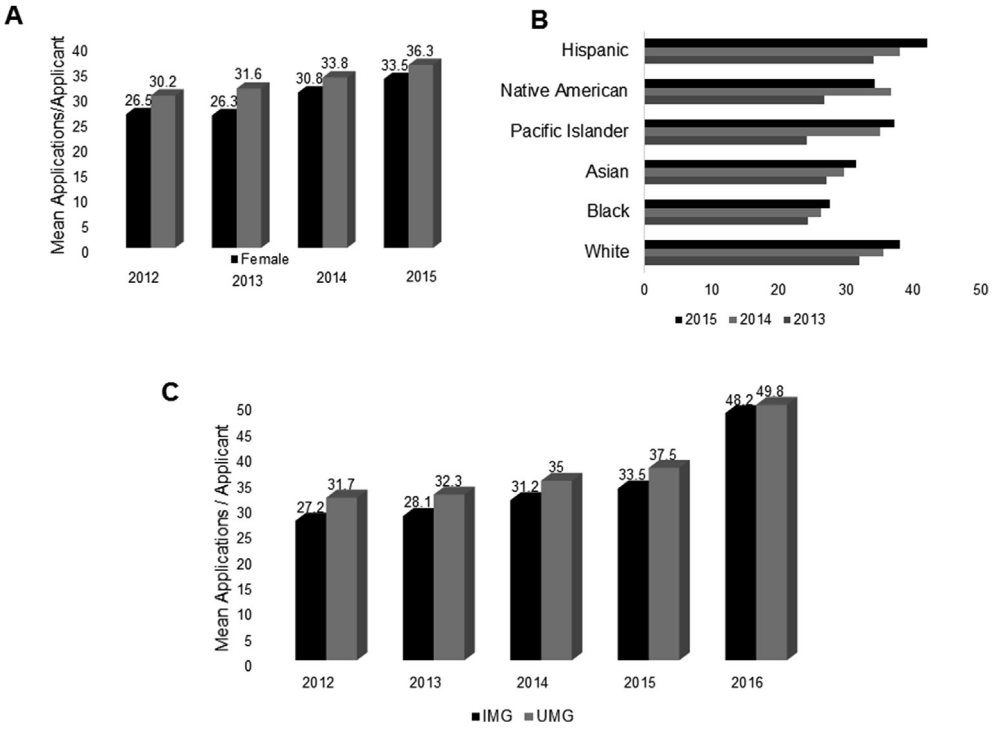


**Fig. 5.** Application Patterns. (A) Mean applications per applicant by sex and year (2012–2015). (B) Mean applications per applicant by race and year (2013–2015). (C) Mean applications per applicant by graduating medical school. IMG: International Medical Graduate. UMG: US Medical Graduate.

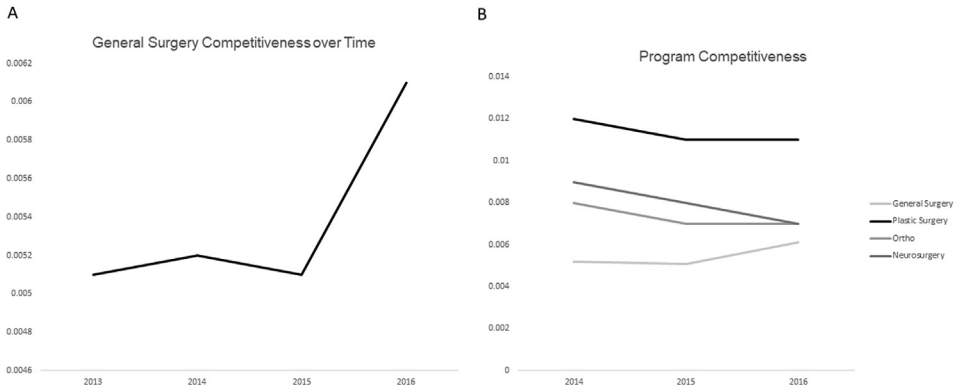


**Fig. 6.** Surgical program competitiveness based on calculated metric. (A) General Surgery competitiveness over time. (B) Program competitiveness over time. Years 2014–2018 included as that is what is provided on ERAS website.

*Matched v. unmatched trainees*

As mentioned above, the 2013 applicant pool consisted of 7732 applicants. The subsequent 2014 PGY1 categorical GS applicants when parsed among matched/unmatched exhibited: Step 1 score (mean) = 232/213; Step 2 score = 245/226; research experience = 3.1/2.6; abstracts/publications/presentation = 4.4/2.7; % AOA = 15.3/2.0; work experience = 3.0/3.3, volunteer experience = 6.7/6.5, and %NIH Top 40 school = 32.5/15.8 (Fig. 7). We compared the 2015 PGY1 GS match trainees with their matched peers in CIM, Integrated Plastic Surgery (PlasInt), Neurosurgery, OB/Gyn, Ortho, and ENT. PlasInt, Ortho, ENT and Neurosurgery trainees had significantly higher Step 1 (233 vs. 246/245/247/246 $p < .0001$) and 2 scores (245 vs 251/250/252/247 $p < .0001$), abstracts/publications (4.5 vs. 12.3/7.7/8.3/11.7 $p < .001$). They also had a higher proportion of applicants with AOA status (15.3% vs. 39%/32%/39%/28%), and that came from a school in the Top 40 of NIH funding (32.5% vs. 46%/33%/42%/41% $p < .001$).[16,17] In contrast, neither CIM nor OB/Gyn were statistically different from GS along similar parameters. There were no statistically significant differences in work or volunteer experiences when comparing GS residents to PlastInt or Neurosurgery, but OB/Gyn, Ortho and ENT applicants had a significantly higher number of work of volunteer experiences. However, when compared to CIM trainees, GS trainees had higher averages for MCAT scores (30.9 vs. 29.7 $p < .0001$), research experience (2.8 vs. 2.1 $p < .0001$), abstracts/publications (4.5 vs. 3.7 $p < .0001$), and volunteer experiences (6.7 vs. 5.4 $p < .0001$). (Table 2).

*Applicant attitudes*

On the 2013 NRMP Applicant Survey,[16] applicants ranked the most important factors on a 5-pt scale as: house staff morale (4.6), quality of faculty (4.5), cultural/racial-ethnic/gender diversity (4.5),

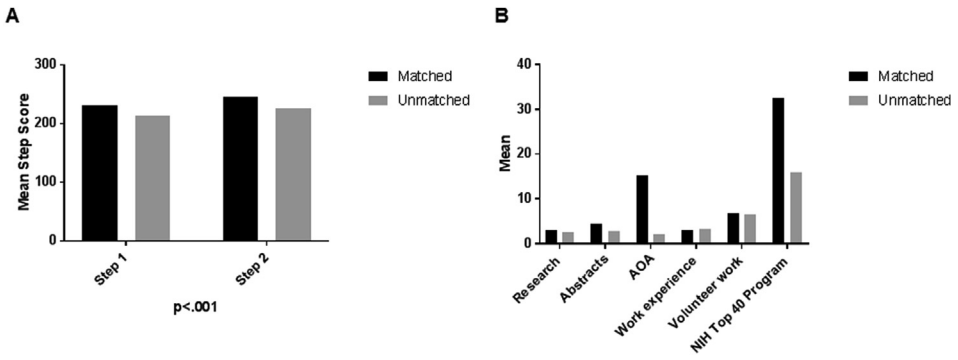


**Fig. 7.** (A) USMLE Scores. (B) Application elements for matched versus unmatched applicants.

**Table 2**
Comparison of application elements across specialties for 2015–2016 PGY1 trainees.

| Specialty | General Surgery N = 1224 mean (SD) | Integrated Plastic Surgery N = 148 mean (SD) | p value | Neurosurgery N = 210 mean (SD) | p value | Internal Medicine N = 6770 mean (SD) | p value | Obstetrics/ Gynecology N = 1255 mean (SD) | p value | Orthopedic Surgery N = 703 mean (SD) | p value | Otolaryngology N = 299 mean (SD) | p value |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Application Element | | | | | | | | | | | | | |
| MCAT | 30.9 (3.9) | 32.4 (3.5) | <.001 | 33 (3.8) | <.001 | 29.7 (5.1) | <.001 | 29.5 (4.2) | <0.001 | 32 (3.7) | <0.001 | 32.5 (3.5) | <0.001 |
| Step 1 | 233.3 (15.9) | 245.6[13] | <.001 | 246.7 (12.9) | <.001 | 230.5 (17.9) | <.001 | 226.6 (15.8) | <0.001 | 245 (12.5) | <0.001 | 247.3 (11.8) | <0.001 |
| Step 2 | 244.3 (13.9) | 250.9 (12.4) | <.001 | 246.9 (14.5) | 0.0164 | 242.6 (15.9) | 0.0001 | 241.8 (14.1) | <0.001 | 250.2 (13.4) | <0.001 | 252.4 (12.9) | <0.001 |
| Research Experience | 2.8 (1.9) | 4.3 (2.4) | <.001 | 4.2 (2.7) | <.001 | 2.1 (1.9) | <.001 | 2.6 (1.8) | 0.0072 | 3.5 (2.2) | <0.001 | 4.6 (2.2) | <0.001 |
| Abstracts/ Publications | 4.5 (5.3) | 12.3 (15.1) | <.001 | 15.9 (20.1) | <.001 | 3.7[6] | <.001 | 3.7[5] | 0.0001 | 7.7 (11.9) | <0.001 | 8.3 (8.2) | <0.001 |
| Work Experience | 3.1 (2.5) | 3 (2.3) | 0.621 | 3 (2.5) | 0.5927 | 3.6 (3.2) | <.001 | 3.3 (2.5) | 0.0465 | 2.9 (2.1) | 0.061 | 3 (2.3) | 0.5081 |
| Volunteer Work | 6.7 (4.4) | 7.4 (3.5) | 0.027 | 5.7[4] | 0.0011 | 5.4[4] | <.001 | 7.9 (4.5) | <0.001 | 7.5 (4.7) | 0.0002 | 8.2 (4.5) | <0.001 |

*p values refer to differences between general surgery trainees and the respective trainees from other programs.

AMC (4.4), quality of the program director (4.4) and international experience (4.4). While some factors such as house staff morale remained important for applicants choosing categorical GS programs, the 2015 survey listed perceived goodness of fit (4.6) as the top priority for applicants followed by quality of residents in the program (4.5). Preparation for fellowship and quality of the education curriculum were also deemed important by applicants (Table 3).

## Discussion

General surgery continues to evolve. The structure of training programs has changed, certain demographics have changed, and an additional set of priorities impact aspiring categorical GS trainees. The addition of work hour limitations,[18,19] high rates of specialization, and increasing desires for a "controllable lifestyle"[20] may have impacted potential trainees' decisions to pursue GS training. Our study takes a descriptive look at contemporary medical school applicants to categorical GS and subsequent PGY1 cohorts.

### *Demographics*

General surgery has been and continues to be a largely white male dominated field. The current surgeon workforce is not representative of the general population by way of gender or racial distribution. There was a period from 1996 to 2002 that saw growth in the diversity of the GS resident workforce, with a 22% increase in the number of women and an 11% increase in the proportion of African-American surgery residents.[21] However, progress has been stagnant since that time. This study along with others[21,22] have noted an increase in the percentage of female applicants to GS. However, women make up approximately 50% of most medical school classes, but only about 35% of GS applicants and an even lower proportion of board-certified surgeons. Women consistently submitted fewer applications than their male counterparts. Unfortunately, the data provided do not indicate whether women match less often as a result. This is often attributed to female concerns with work-life balance and family responsibilities, but it is also important to consider the higher proportion of women entering other surgical specialties like OB/Gyn (73%).

**Table 3**
NRMP applicant survey data for 2013 and 2015.

| 2013 Factors | Mean Importance | 2015 Factors | Mean Importance |
|---|---|---|---|
| House staff Morale | 4.6 | Perceived goodness of fit | 4.6 |
| Quality of faculty | 4.5 | Quality of residents in program | 4.5 |
| Cultural/racial/gender diversity | 4.5 | House staff morale | 4.5 |
| Academic medical center | 4.4 | Preparation for fellowship | 4.5 |
| Quality Program Director | 4.4 | Quality of education curriculum | 4.4 |
| International experience | 4.4 | Quality of faculty | 4.4 |

Otolaryngology and Integrated Plastics are also fairly popular among female applicants with 32% and 32.4% of the applicant pool being female respectively.[3,13,14]

There also remains much work to be done in addressing the racial disparities in the surgical workforce. African-Americans, Hispanics, Native Americans, and Pacific Islanders are consistently underrepresented in GS training programs. Hispanics and Native Americans apply to more programs than any other racial group, but still remain poorly represented. Our group found that rates of underrepresented minorities have not changed significantly in recent years, while the proportion of white trainees continues to significantly increase.

The American Surgical Association has taken notice of this and has set forth recommendations for increasing diversity and inclusion in the surgical workforce. Maier et al. not only recognize the paucity of diversity (racial/ethnic, gender, LGBT), but provide insight on how to identify institutional barriers and action items to overcome them.[23] They also cite the importance creating a culture of respect, equity and inclusion within the traditional hierarchical surgical framework.

It is difficult to tease out the exact reason why this disparity persists. Studies have shown that diversification of the workforce does not lead to poorer quality and may facilitate a more culturally dexterous healthcare environment for patients.[24,25] The presence of role models and potential mentors are cited as factors that help shape the career decisions and recruitment of diverse trainees.[24] Cochran and Neumayer[26] discuss the concept of critical mass wherein a minority group should have at least 30% representation in a group to feel supported, and we are far from that. Increasing diversity on several levels (gender, race, background, sexual orientation) will require buy in and participation from the leadership of GS programs who make the recruitment of diverse faculty and trainees a priority.

### *Applicant patterns*

The average number of applications submitted by potential GS trainees continues to increase over time, indicating the increasing competitiveness of general surgery. While applicants in 2012 submitted 29 applications on average, applicants in 2016 submitted an average of 49 applications per applicant. Cross-specialty application remained popular for those applying to GS. Our alternative metric for competitiveness also demonstrated the increased competitiveness of general surgery. We represent a limited number of years here, but we assert that even these few years indicate an upward inflection in the competitiveness of general surgery training. Given the decrease in interest in surgical training noted during the early 2000s the inflection is likely more dramatic than what we've presented here. This may be a result of applicants being ready with a back-up plan in the event of not matching into their first-choice specialty. This information is useful for the surgeon mentor who is long removed from the application process in providing advice for prospective GS trainees. Medical school seniors should mentally and financially prepare to apply to more programs for the best chance at matching.

### *Match vs. unmatched applicants*

This study found that the most distinguishing characteristics between applicants that matched compared to those that did not were Step1 scores, research productivity in the form of abstracts and publications, coming from a medical school in the Top 40 for NIH funding, and AOA status. Work experience and volunteer experiences, however, remained similar between the groups. These are consistent with other studies that indicate characteristics of highly ranked applicants.[27] Measures of academic prowess continue to distinguish these two groups, but one must bear in mind that this may partially be because this is the most regularly collected, objective data. As each subsequent pool of applicants gets brighter with increasing numbers of publications and higher proportions of applicants achieving AOA membership, we must consider other factors that may separate ideal candidates from others. Until those factors are elucidated, programs must do the best with what they have. General surgery residents are on par with if not exceeding common measures when compared to CIM and OB/Gyn residents, albeit slightly behind our colleagues in integrated programs and other surgical specialties such as neurosurgery, orthopedics, and ENT.

We believe the value in these data lies in the information that it provides both prospective applicants as well as program directors. While some of the conclusions are intuitive, I think students are eager to know what makes the difference between those that match and those that don't. As an attending, the 50 ft view seems clear, but some students may not be able to see the forest for the trees. A paper like this that evaluates the data and shows which aspects of your application may make a difference in your matching or not. At the risk of being too anecdotal, I would have been happy to read a paper like this as a prospective applicant. I got advice from others, but none of it rooted in data. The additional information may have pushed me to focus more on securing a publication rather than just participating in research.

### *Limitations*

This study remains largely descriptive in nature and only really considers applicants through 2015. We also used data from several sources including ERAS and NRMP to maximize the information available regarding applicants, but were diligent to state which data were being considered. Its retrospective nature limits the assumption of causal relationships yet it sets the stage for a more in depth look at applicant characteristics as surgical training evolves. Future work would include expanding the current study to include the most recent year's data as well as performing a subgroup analysis to specifically profile applicants from underrepresented groups.

Additionally, comparing today's applicants to those from an earlier era when general surgery struggled to fill the match would have also been informative. Unfortunately, ERAS only provides information for the years 2013–2018 on their website. The archives are not available for further investigation. This additional data would provide more insight into the evolution of the general surgery residency applicant.

## Conclusions

General surgery is an increasingly competitive specialty. PGY1 trainees compare well with their CIM and OB/Gyn peers, but lag behind their Plastic surgery and surgical subspecialty colleagues. Board scores, research productivity (not experiences) in the form of abstracts, presentations and publications, AOA status and NIH top 40 schools distinguish matched from unmatched applicants. In contrast, work and volunteer experiences are not different. General Surgery remains a competitive field, attracting increasing numbers of applicants with impressive credentials. Lastly, we need to continue to work toward diversifying the surgical workforce highly qualified applicants of various backgrounds.

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## Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.amjsurg.2018.11.022.

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