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The Law of Diminishing Returns in the Integrated Plastic Surgery Residency Match: A Deeper Look at the Numbers

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Background: The highly competitive nature of the integrated plastic surgery residency match justifies the need for objective data that provide insights into some of the residents' selection criteria. Many studies have sought to provide information on these criteria, but to our knowledge, none has described the inflection point where the match probability does not further increase. Although our study provides this information to potential applicants, it will also help them assess and optimize their chances of a successful match.

Methods: We pooled and analyzed the data available on matched and unmatched integrated plastic surgery applicants on the national residency match program database between 2016 and 2022.

Results: Step 2 score of 250 or more ($P < 0.0001$), number of publications more than 15 ($P = 0.0007$), number of research experiences five or more ($P = 0.018$), number of contiguous ranks more than 10 ($P < 0.0001$), number of volunteer experiences five or more ($P < 0.0001$), being a US MD applicant ($P < 0.0001$), and Alpha Omega Alpha membership ($P < 0.0001$) were all associated with increased probability of matching into the integrated plastic surgery program. Match probability did not further increase after 15 publications, five research experiences, 15 contiguous ranks, and 10 volunteer experiences have been reached. Having a PhD ($P = 0.149$) or a non-PhD graduate degree ($P = 0.07$) was not associated with increased match probability.

Conclusion: The law of diminishing returns sets in for applicants to the integrated plastic surgery match after 15 publications, 15 contiguous ranks, five research experiences, and 10 volunteer experiences have been reached. *(Plast Reconstr Surg Glob Open 2024; 12:e5937; doi: 10.1097/GOX.0000000000005937; Published online 3 July 2024.)*

INTRODUCTION

Integrated plastic surgery residency remains one of the most competitive specialties in the national resident matching program (NRMP).[1–3] According to the NRMP matched data, the integrated plastic surgery match rate has been declining since 2019, despite an increase in the number of residency programs over this period, with the match rate in 2022 being 55.3%.[4]

Many studies have sought to analyze various factors contributing to this competitiveness. The number of publications, research experience, US Medical Licensing Examination (USMLE) scores, having other graduate degrees, and Alpha Omega Alpha (AOA) membership status all contribute to a successful match.[3,5–8] The number of contiguous ranks by an applicant has been found to directly correlate with the chances of a successful match,[9,10] which holds true for independent pathway applicants.[11] Although this is the justification for many applicants accepting as many interviews as they receive, historic data from the independent match have shown that chances of matching do not increase significantly beyond a certain number of interviews (five) or program ranks (seven).[11] We postulate that this holds true for the integrated pathway plastic surgery applicants, though likely with a different number of interviews, as the landscape of number of programs and applicants differs.

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The Association of American Medical Colleges publishes free, publicly accessible NRMP data each year which can be explored using the online Interactive Charting Outcomes in the Match (ICTO) tool to compare matched and unmatched applicant characteristics.[4,12–25] Few published studies have utilized these publicly available data to analyze the integrated plastic surgery match over the past years.

Our study aims to use these data to identify the inflection point of where the law of diminishing returns applies to conventional criteria used in resident selection decisions. Specifically, we aim to determine the point beyond which additional publications may not be essential to increase match rates, and the corresponding thresholds for step 2 scores and other relevant factors.

Takeaways

Questions: Where does the law of diminishing returns apply to conventional criteria used in resident selection decisions?

Findings: Using the National Resident Matching Program and ERAS data between 2016 and 2022, we found that match probabilities do not further increase after 15 publications, five research experiences, 15 contiguous ranks, 10 volunteer experiences, and US Medical Licensing Exam step 2 score of 250 have been reached.

Meaning: These are the inflection points where the law of diminishing returns sets in for applicants in the integrated plastic surgery match.

METHODS

Data were collected on characteristics of matched and unmatched integrated plastic surgery residency applicants between 2016 and 2022 using the publicly available NRMP ICTO tool. Applicants were stratified by USMLE scores, numbers of publications, research experience, volunteer and work experience, contiguous rank and specialties ranked, AOA membership, having a PhD or other graduate degrees, and applicants type. "Number of publications" refers to the number of abstracts, presentations, and publications. "Contiguous rank" is defined as the number of programs ranked within one specialty by an applicant and is often used as a proxy for interviews accepted, whereas "specialties ranked" represented the number of different specialties a given applicant applied into. The "number of research, volunteer, or work experiences" refers to the total number of research, volunteer, or work experiences reported by applicants to NRMP based on their Electronic Residency Application Service (ERAS) application. Applicant types include US MD seniors, US DO seniors, US MD graduates, US DO graduates, US international medical graduates (IMGs), Non-US IMGs, and US 5th pathway applicants. "US 5th pathway applicants" attended international medical schools that issue MD degrees jointly with a US medical school.

Statistical Analysis

Risk difference with 95% confidence intervals were tabulated to compare the match rate for each characteristic subgroup with the overall national average. Paired *t* tests detected significant differences between subgroups and the national average for continuous variables. Chi-square tests were performed to test the significance of observed trends for qualitative independent variables (applicant type, AOA status, PhD degree, and other graduate degree), and for comparing perceived differences within specified pooled quantitative variables to determine the inflection points. These points were chosen by further subgroup analysis to determine the point of the law of diminishing returns and was conducted by comparing independent subgroups using chi-square analysis. Starting from the subgroup with positive risk difference (match probability), comparisons were made with the rest of the subgroups, progressively analyzing higher subgroups until a point of no significant difference was found. The subgroup analysis is explained with a specific example in Supplemental Digital Content 1. (**See table, Supplemental Digital Content 1**, which displays the statistical method. **http://links.lww.com/PRSGO/D320**.)

Statistical significance was set at an α value of 0.05 for all analyses.

RESULTS

The national average plastic surgery match rate between 2016 and 2022 was 64.9% (which is used as the benchmark reference points for all analysis described herein), with the lowest match rate being 2022 (55.3%) and highest match rate recorded in 2019 (73.5%). There were 69 integrated plastic surgery residency programs with 152 available positions in 2016, which has progressively increased to 86 programs with 194 positions in 2022. There has been a consistent decline in match rate despite this increase in the number of programs. Data on characteristics of matched and unmatched candidates between 2016 and 2022 were available on the NRMP ICTO database for ~80.4% of applicants (Table 1). (**See table,**

Table 1. Cumulative Data (2016–2022)

Year	Matched	Unmatched	Total	% Matched	No. Programs	ERAS Total	%
2016	151	65	216	69.9	69		
2017	157	89	246	63.8	73	564	27.8
2018	167	62	229	72.9	77	527	31.7
2019	172	62	234	73.5	78	301	57.1
2020	180	111	291	61.9	84	358	50.3
2021	187	142	329	56.8	85	416	44.9
2022	194	157	351	55.3	86	420	46.2
	1208	688	1896	NAT AVG 64.9%			

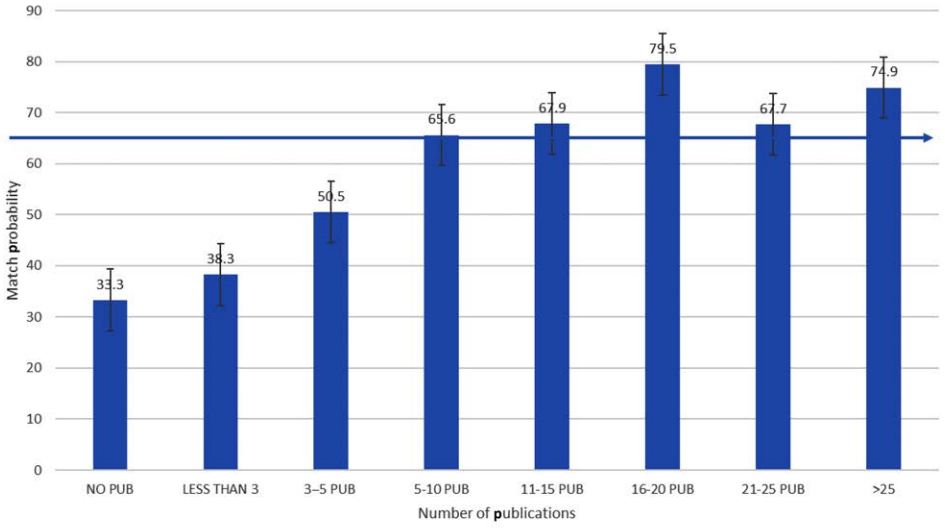

Fig. 1. Probability of matching based on the number of publications compared with average match rate for all applicants of 64.9% (blue line). PUB, publication.

Supplemental Digital Content 2, which displays the data from the NRPM using the ICTO tool. **http://links.lww.com/PRSGO/D321**)

USMLE Scores

Applicants who scored less than 250 on USMLE step 2 represent 38.1% of the cohort. All applicants who scored less than 240 on USMLE step 2 had a significantly decreased probability of matching compared with the national average of 64.9% ($P < 0.0001$). Applicants who scored 240–249 had a 1.7% decreased probability of matching compared with national average, but this was not statistically significant ($P = 0.90$). Applicants who scored 250 or more (61.9% of the cohort) had 11.8% increased probability of matching ($P < 0.0001$).

Number of Publications

Applicants who had fewer than five publications represent 6.8% of the cohort, whereas 59.9% of the cohort had 15 or more publications. Applicants with fewer than five publications, had a 26.6% decreased probability of matching compared with the national average of 64.9% ($P = 0.0004$). Applicants with 16–20 publications, who represent 12.8% of the entire NRMP cohort, had a 14.6% increased probability of matching ($P = 0.0007$) (Fig. 1). Further comparative analysis showed that no significant change in probability in match rate was observed once 15 or more publications were obtained ($P = 0.23$).

Number of Research Experiences

Applicants who had fewer than (three) research experiences represent 11.9% of the cohort, whereas 43.8% had five or more research experiences. Applicants with fewer than three research experiences have a 13.9% decrease in probability of matching compared with the national average of 64.9% ($P = 0.012$). Applicants with 16–20 and 21–25 research experiences have increased probability of matching compared with the national average; however, this result was not statistically significant (15.1% $P = 0.19$ and 35.1% $P = 0.286$, respectively) (Fig. 2). Further comparative analysis showed that there was no significant change in the match probability once five or more research experiences is reached ($P = 0.61$).

Number of Contiguous Rank

Applicants with five or fewer contiguous ranks represent 30.8% of the cohort, whereas applicants with at least 15 contiguous represent 47.7% of the entire cohort. Applicants with fewer than three and three to five contiguous ranks all have a significant decreased in match probabilities (46.3% $P < 0.0001$ and 32.1% $P < 0.0001$, respectively). Significant increases in match probability were observed among applicants with 11–15 (24.8%; $P < 0.0001$), 16–20 (31.9%; $P < 0.0001$), 21–25 (35.1%; $P < 0.0001$) (Fig. 3). After comparative analysis, we also found no significant change in match probability once 15 contiguous ranks are reached ($P = 0.45$).

Volunteer and Work Experience

Applicants with fewer than five volunteer experiences represent 51.8% of the cohort, whereas 22.9% of the cohort had more than 10 volunteer experiences. Applicants with no volunteer experience have a 44.9% decreased probability of matching compared with national average of 64.9% ($P = 0.04$), whereas applicants with fewer than five volunteer experiences have a 7.9% decreased probability of matching ($P = 0.03$). Applicants with 5–10 volunteer experience have 9.5% increased probability of matching ($P < 0.0001$) (Fig. 4). Beyond 10 volunteer experience, no significant increase or change in match probability was observed ($P = 0.97$).

Applicants with five or fewer work experiences (78.3% of the cohort) have a 3.1% increased probability of matching compared with the national average ($P = 0.045$).

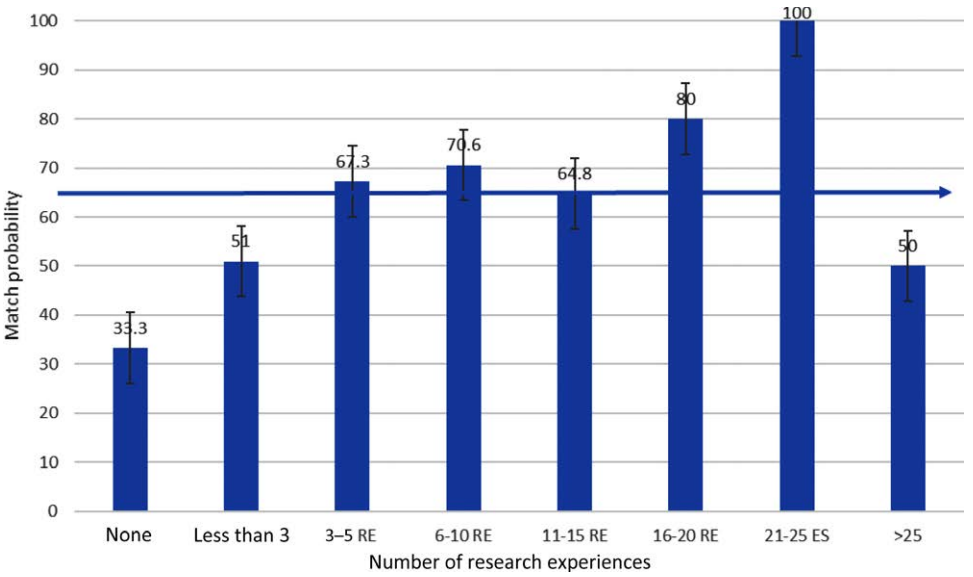

Fig. 2. Probability of matching based on the number of research experiences compared with average match rate for all applicants of 73.1% (blue line). RE, research experience.

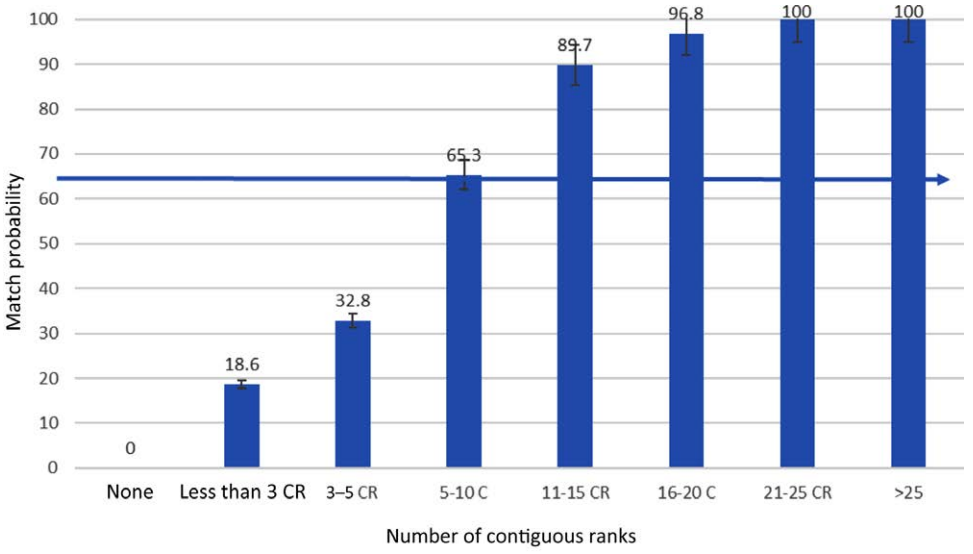

Fig. 3. Probability of matching based on the number of contiguous ranks compared with average match rate for all applicants of 73.1% (blue line). CR, contiguous rank.

Applicants with more than five work experiences have a decreased probability of matching, but this was not statistically significant ($P = 0.59$) (Fig. 5).

Applicants Type

US MD senior applicants represent 83.1% of the cohorts (**Supplemental Digital Content 2**, **http://links.lww.com/PRSGO/D321**). US MD senior applicants have a 10.5% increased probability of matching into the integrated plastic surgery residency compared with the national average of 64.9% ($P < 0.0001$). US DO seniors, US MD graduates, US DO graduates, US IMGs, and Non-US-IMGs all have a decreased probability of matching ($P = 0.004$). US DO seniors have a 64.9% decreased probability of matching ($P < 0.0001$) compared with the national average, and this is the lowest recorded. The NRMP did not provide any ICTO data regarding applicants through the Canadian or US 5th pathway applicants.

Number of Specialties Ranked

Applicants who ranked just one specialty represent 63.5% of the cohort (**Supplemental Digital Content 2**, **http://links.lww.com/PRSGO/D321**). Applicants who ranked just one specialty had a 14.9% increased probability of matching compared with the national average of 64.9% ($P < 0.0001$). Applicants who ranked two specialties

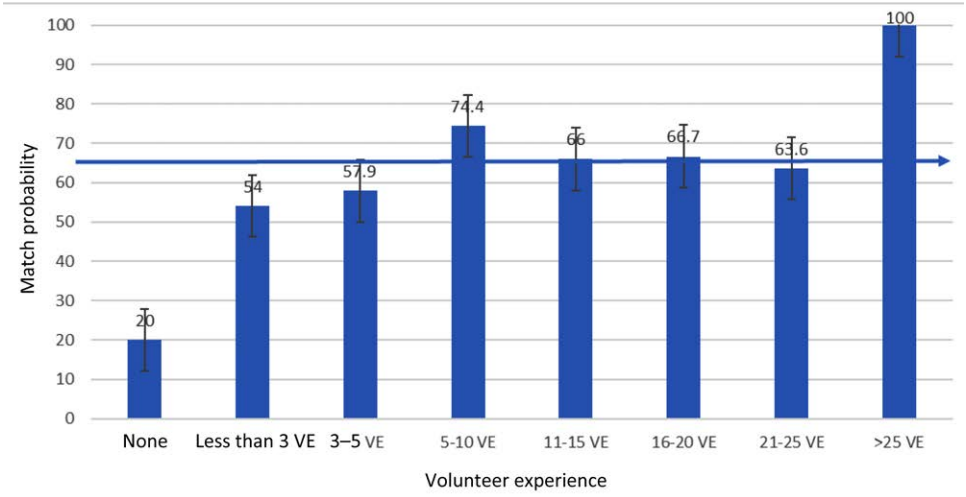

Fig. 4. Probability of matching based on the number of volunteer experiences compared with average match rate for all applicants of 73.1% (blue line). VE, volunteer experience.

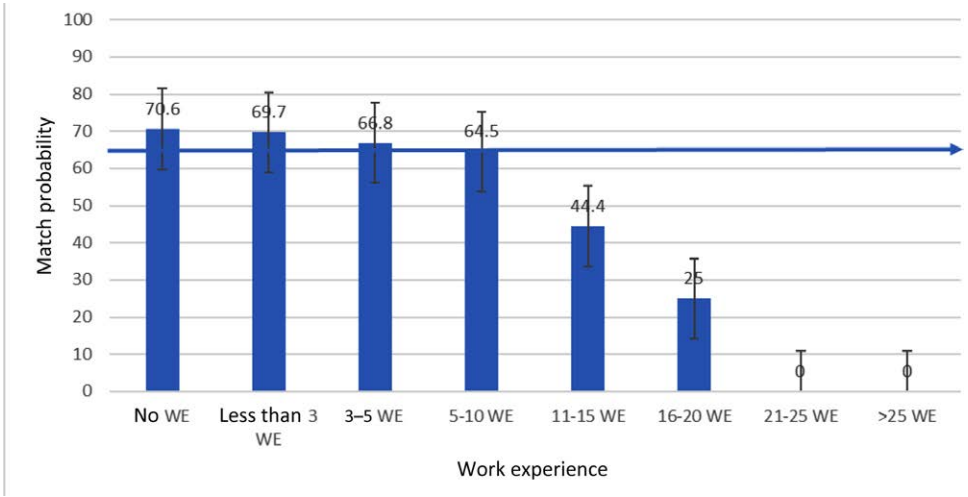

Fig. 5. Probability of matching based on the number of work experiences compared with average match rate for all applicants of 73.1% (blue line). WE, work experience.

had a 21% decrease in match probability ($P < 0.0001$), and those who ranked four specialties had a 48.2% decrease in match probability ($P = 0.017$).

Graduate Degrees and AOA Membership

Having a PhD degree is not associated with a significantly increased probability of matching ($P = 0.149$). Similarly, having other graduate degrees is also not associated with a significant increase in match probability compared with national average ($P = 0.07$).

Applicants who had AOA membership represent 31.2% of the study cohort. AOA membership is associated with 21.6% increased probability of matching compared with the national average of 64.9% ($P < 0.0001$). Applicants who are not AOA members have 7.5% decreased probability of matching ($P = 0.006$). However, there are an increasing number of medical schools who no longer have AOA chapters, and these data were not able to take into account students who do not have chapters at their respective schools.

DISCUSSION

The integrated plastic surgery match rate was 73.5% in 2019,[26,27] which was the highest ever recorded, whereas it was 55.3% in 2022,[27] which was the lowest. This steady decline is reflective of the increasing competitiveness of the plastic surgery match. There was a total of 34 first-year plastic surgery residency positions added between 2016 and 2021, amounting to a 22% increase.[2,4] However, for every single program added from 2020, there were an additional 31 applicants added to the applicants' pool. Furthermore, no position remained unfilled at the end of the main integrated plastic surgery residency match over these periods.

Due to the competitiveness, it is difficult to successfully match despite the impressive qualifications of the applicant

pool, which has created an "arms race" among applicants to improve their applications before residency. This arms race has been called into question, especially of late, given that this trend is very concerning in terms of narrowing the phenotype of applicants that matriculate into plastic surgery, and serves as a referendum on what constitutes a "qualified applicant."[28,29] It also begs the question of whether there is a "law of diminishing returns" on some of the criteria whereby additional qualifications do not translate into increased match rates. Many applicants take an academic year to increase their research productivity, gain more specialty exposure or get an additional degree.[29,30] It goes without saying that many applicants who matriculated into plastic surgery achieved all of these without taking an academic year.[29–31] These inflection points reflect the current phenotypes that resident selection committees seek out in potential integrated plastic surgery residents. However, this could have serious implications on the existing arms race and inequities in the application process, and is not intended as a recommendation for applicants.

We found that step 2 USMLE score directly correlated with match success into the integrated plastic surgery program, as those with scores of 250 and above have an increased probability of matching. This is similar to the reported average for US MD seniors, applicants with or without a home program, and residency reapplicants.[1,8,32] Although there are concerns regarding an increased emphasis on step 2 scores, because step 1 transitioned to pass/fail,[33,34] and the possibility that the average step 2 score would increase further,[35,36] attention is now shifted toward considering other selection criteria.

The number of publications has traditionally been correlated with increased match competitiveness, with the mean number of abstracts, presentations, and publications steadily increasing from 14.2 in 2018 to 28.4 in 2022 (Table 2).[5,35] This is a progressive trend across time, as the mean number of publications for integrated plastic surgery applicants was 8.1 in 2011. Schultz et al[1] also reported the average number of publications to be 14 for both matched and unmatched applicants. Our study found that there was no difference in the match probability once 15 publications have been reached. This is especially true for US MD applicants. Interestingly, our study found that no US DO seniors have matched into the integrated plastic surgery residency in the 2016 and 2022 period. Although we acknowledge that the DO integrated plastic surgery applicant match is a different conversation, similar match rates have been reported for DO applicants into other surgical subspecialties.[37]

Applicants with more publications also tend to have more research experience because they present more at meetings and conferences. Some take a research year to increase their research productivity. This drastically increases their match probabilities, and studies have also found that IMGs that have matched into the integrated plastic surgery program have done at least 2 years of research fellowship.[38,39] It is noteworthy that for all applicant types, it has been found that letters of recommendation are the most important factor in the residency application.[40–43] The dedicated years of research fellowship enable them to gain reasonable mentorship and form meaningful relationships with their potential letters of recommendation writers.

We also found that having more than five poster or abstract presentations does not increase applicants' match probabilities further. Having a PhD and other non-PhD graduate degrees do not increase the chances of matching. AOA membership status, offered mainly to students with demonstrated leadership, teaching ability, and academic prowess, significantly increases the probability of matching.

The number of interviews an applicant receives enables them to optimize their chances of matching. Virtual residency interviews have made it easier for applicants to accept and attend as many interviews as possible.[44,45] Although this may translate to a higher chance of matching and reduction in interview-related expenses, it also resulted in what many have called "interview hoarding."[46–50] Applicants have also expressed concerns about either not getting to know the program well and not being able to meet and interact with their potential co-residents.[41] Although our study found a significant increase in the chances of matching when an applicant has ranked at least 15 programs, we also found that beyond 15 contiguous ranks, no further increase in probability of matching was observed. Applicants limiting their number of accepted interviews could potentially open more interview spots to other top tier candidates.[47,48] Capping the number of interviews applicants can accept may limit overapplication and the number of interviews applicants can attend. This not only allows redistribution of interviews leading to more interview slots availability to other applicants, but also save applicants from excessive application and interview-related costs.[51,52] This model has been in use in the ophthalmology residency match since 2020.[51,52]

Our study provides information to potential integrated plastic surgery residency applicants about when the law of diminishing returns sets in on the known criteria used by program directors for resident selection

Table 2. Mean Number of Publications, Abstracts, and Presentations.

Year	US MD Senior, Matched vs Unmatched	US DO Senior, Matched vs Unmatched	IMG (US and Non-US), Matched vs Unmatched
2016	11.9 vs 6.5	NA	39.4 vs 28.5
2018	14.2 vs 14.9	NA	28.0 vs 14.9
2020	19.1 vs 11.6	NA	49.7 vs 25.2
2022	28.4 (matched)	NA	NA

NA, not available.

Table 3. Chart Summarizing the Inflection Points, and the Minimum Number Identified for Each Resident Selection Criteria

Resident Selection Criteria	Number When the Law of Diminishing Returns Sets in
No. publications	15
No. research experience	5
No. contiguous ranks	15
No. volunteer experience	10
USMLE step 2 score	250

(Table 3). This also enables applicants to know what "deficit" to correct, before applying, at least according to the current rubric. We should be careful to note, however, that a more holistic review of applicants that takes additional qualities into account not reflected in the NRMP data is currently afoot.[53–58] Reghunathan et al[28] suggested a checklist that contains both preinterview and interview day components, which would allow programs to achieve this holistic review of applications. This includes creation of a diverse selection committee, reviewing as many applications as possible, and blinding of USMLE step scores and other academic metrics. The approach described allows programs to select candidates that fit best into their programs, and further eliminates the unconscious bias created by some of the common resident selection criteria.

This study is not without limitations, one of which is that the available NRMP data for plastic surgery match are only available for approximately 80% of candidates and do not include applicants' data who opted out. Additionally, we could not analyze each candidate's characteristics by multivariate logistic regression to conclusively determine contributors to match success, as some factors may be more impactful to a successful match than others. Finally, the data do not provide information about candidates who had more than 25 publications and research experiences.

CONCLUSIONS

We present deeper insights into the integrated plastic surgery resident selection process, establishing where the law of diminishing returns sets in. This will be invaluable to potential applicants, and paddle residency program directors to focusing and applying a holistic method of resident selection.

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DISCLOSURES

Dr. Janis receives royalties from Thieme and Spring Publishing and is a co-founder of the Plastic Surgery Central Application. The other authors have no financial interest to declare.

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