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Research Paper

Predictive value of medical school ranking in the academic scholarship of ophthalmology residents

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ABSTRACT

Objective: To determine whether a resident's medical school ranking predicts their scholarship during residency.
Design: The authors stratified ophthalmology residents in ACGME accredited programs into tiers based off their medical school background's US News & World Report ranking: T1 (schools 1–20), T2 (21–50), and T3 (51–90). Investigators queried PubMed and Scopus for number of total publications, first/second author publications, publications in the top 10 impact factor journals in ophthalmology, and publications with the senior author affiliated with the resident's residency program/medical school. Authors collected data from start of ophthalmology residency to December 5th, 2021, and performed Pearson chi squared, ANOVA, Eta squared, Tukey, and multivariable logistic regression tests.
Results: 1054 residents were included for analysis, with 370 from T1 schools, 296 from T2 schools, and 388 from T3 schools. T3 residents had a significantly decreased likelihood of publishing at least one (OR = 0.659;95%CI = 0.481,0.905;p = .010), two (OR = 0.643;95%CI = 0.436,0.949;p = .026), or five (OR = 0.407;95%CI = 0.187,0.886;p = .024) total publications compared to T1 residents. T3 residents also were partially predicted to publish fewer first author works, high impact journal articles, and articles with senior authors affiliated with their medical school. T2 residents were more likely to publish at least one second author work than T1 residents (OR = 1.604;95%CI = 1.101,2.337;p = .014). There was no significant difference between tiers in publications with senior authors affiliated with the same residency program.
Conclusions: The authors observed little difference in scholarship between residents from T1 and T2 schools, but some differences may exist between T3 and T1/T2 residents. Merit of rankings should be further explored.

Introduction

The mentors and educational experiences available to medical students just starting their medical careers often influence future endeavors [1,2]. Research mentorship in medical school has specifically been associated with lower rates of attrition, higher rates of promotion, and higher rates of pursuing an academic career [3,4].

Medical school ranking, a quantifiable measure of perceived reputation, is a factor considered in residency admissions. Medical school rankings were on track to become even more important with the recent transition of the United States Medical Licensing Examination (USMLE) Step 1 to a pass/fail scoring system, however in just the past few months several institutions have begun to withdraw from one of the most used medical school ranking systems in the nation [5–9]. The US News and World Report (USNWR) medical school research rankings represent an example of a well-recognized measure for the accessibility of research opportunities to medical students. Attending a medical school with higher USNWR ranking is considered predictive for increased access to research opportunities [10–13]. For instance, attending a highly ranked medical school has directly been implicated in improved match outcomes for highly competitive specialties such as dermatology and orthopedic surgery, and enhanced research productivity following completion of cardiothoracic surgery residency [1,5,12,14]. While participation in research during medical school has been suggested to predict research productivity during residency, it remains unclear if attending a highly ranked medical school results in increased research productivity during residency [15,16]. As of January 2023, multiple medical schools have chosen to withdraw from the USNWR ranking by no longer sharing data with them. The methodology of the USNWR ranking has been condemned in the past but the schools withdrawing

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currently are also doing so based on ethics. The USNWR rankings are claimed to perpetuate inequity in medical school admissions and do not provide the necessary information for applicants to make informed decisions.

Identifying factors associated with academic success in ophthalmology residency is especially important because the field offers many opportunities to residents and physicians for entrepreneurship and innovation. The early development of phacoemulsification and more recent advancements in imaging, artificial intelligence, and machine learning for diagnosis of ophthalmic disease evidence the historical importance of innovation in ophthalmology [17,18]. Our study aims to evaluate if ophthalmology residents who attended a highly ranked US medical school exhibit greater research productivity during residency than those who did not. In addition, we attempt to define the predictive value of medical school ranking in the research productivity of ophthalmology residents.

Methods

We evaluated 110 publicly available United States ophthalmology residency program websites for current residents in December of 2021. Information collected included resident names, year of training, gender, and medical school attended. Resident gender was recorded by searching the resident's name in the National Provider Identifier Registry public search tool. We collected residency program information including program reputation ranking, size, and region from Doximity. Medical school rankings were obtained from the USNWR. Medical schools were stratified into Tier 1 (T1), Tier 2 (T2), Tier 3 (T3). T1 schools were ranked between 1 and 20, T2 were ranked between 21 and 50, and T3 schools were ranked between 51 and 90. Tiers were split as such because of the popularity of the phrases "T20" or "T50" medical school. The USNWR only provides individual ranks for approximately the top 90 medical schools. Past that, schools are grouped into ranges or simply labeled as "unranked", and it is difficult to discern if the institution's rank is attributable to a lack of data collected or an actual ranking lower than 90. Therefore, residents graduating from medical schools ranked below 90 were excluded from analysis to ensure there were no additional confounding factors, whether it be uncertain interpretation of low/unranked school or simply the differences in experiences of international medical school graduated. Residents with one or more variables that could not be confidently determined were also excluded from analysis.

Resident publication data was measured by searching their name and cross-referencing each resident's publications on Scopus and PubMed. Search queries were uniform for all residents and restricted to the start of their respective ophthalmology residency training periods on July 1st to December 5th, 2021. Publication data from intern year was excluded as it was difficult to discern which residents did preliminary years at sites different from their ophthalmology residency although we do acknowledge due to publication delays, research done during medical school or intern year may have been included. Additionally, letters, rapid communications, responses, textbook chapters, and all publications that were not original research manuscripts, case reports, or literature reviews were excluded. For each resident, research productivity was measured in the following categorizations: total number of publications (a measure of quantity), numbers of first and second author publications (a measure of initiative), the number of publications in the top 10 highest impact factor (IF) ophthalmology journals on Scopus (a measure of high impact research within their chosen specialty), and the number of publications with senior authors affiliated with either the resident's medical school or residency program (a measure of social/mentorship opportunities available to residents). Residents for which no publications were available on either PubMed or Scopus were listed with 0 publications.

Statistical analysis was entirely performed in IBM SPSS 24 (SPSS Inc., Chicago IL, USA, version 24). Descriptive statistics were used to quantify mean and total research productivity for each medical school tier. Pearson chi squared were used to assess if there were significant differences between the frequencies of demographic characteristics, while one-way ANOVA tests evaluated for significant differences between means of each measure of research productivity. For ANOVA analysis of each research categorization, if Levene's test of homogeneity of variances was significant, the p value associated with Welch test was reported instead of the significance associated with the ANOVA. Post-Hoc analysis was performed to discern significance between specific tiers rather than overall with Tukey's test. Eta squared values were calculated to quantify the magnitude of significance.

Univariable and multivariable binary logistic regression were utilized to assess if medical school background was a significant predictor of resident research productivity as measured by odds ratios. In multivariable regression there was an adjustment for program region, resident year, gender, if the program was greater or below average in size, and if the residency program was ranked in the top 20. For total publications, publishing one or fewer items during residency was associated with approximately 75 % of residents, while 2 or fewer was associated with about 85 % and 5 or fewer with approximately 95 %. Regressions were run for each of these binary outcomes. For all other research categorizations, regressions were not run for 5 publications due to only a small subset of residents reaching such a quantity. See online supplement eTable 1.

Results

1054 residents were included for analysis, with 370 from T1 schools, 296 from T2 schools, and 388 from T3 schools. Significant differences in frequencies and means of demographic and scholarship data can be observed in Tables 1 and 2 respectively. There was significant deviation from expected ratios between medical school tiers in program region, the number of residents from T20 residency programs, and significant difference between tiers in average program size. While there were more females than males in T2 schools but more males than females in T1 and T3 schools, there were no significant differences between all three tiers in the average number of publications across all six research categorizations were also observed. Across all metrics Eta squared values were <0.03, suggesting that while significant differences exist in research productivity across all categorizations, the associated effect size is small for all categorizations.

We then aimed to identify the significant differences between each specific pair combination to further our understanding. Results can be

Table 1
Demographics of ophthalmology residents by medical school tier.

Variable	T1 (n = 370)	T2 (n = 296)	T3 (n = 388)	p value
Gender				.851
Male	207 (55.9)	124 (41.9)	222 (57.2)	
Female	163 (44.1)	172 (58.1)	166 (42.8)	
M:F ratio	1.27:1	0.72:1	1.34:1	
Region				**<.001**
MW	92 (24.9)	82 (27.7)	98 (25.3)	
NE	111 (30.0)	60 (20.3)	144 (37.1)	
S	103 (27.8)	90 (30.4)	120 (30.9)	
W	64 (17.3)	64 (21.6)	26 (6.7)	
Year				.934
1	129 (34.9)	95 (32.1)	127 (32.7)	
2	122 (33.0)	104 (35.1)	130 (33.5)	
3	119 (32.2)	97 (32.8)	131 (33.8)	
T20 residency program	133 (35.9)	105 (35.5)	48 (12.4)	**<.001**
Average program size[a]	17.66 (6.610)	17.14 (6.144)	15.81 (6.045)	**<.001**

Bold represents significance where $p < .050$.

[a] Average program size (Standard deviation) was calculated by recording the program size for each resident and then calculating the mean; ANOVA test besides chi squared was used.

Table 2
Average scholarly productivity of ophthalmology residents by medical school tier (standard deviation).

Variable	T1	T2	T3	p value	Eta squared
Total publications	1.27 (1.999)	1.48 (2.109)	0.75 (1.307)	**<.001**	0.028
First author	0.56 (1.066)	0.63 (1.194)	0.32 (0.708)	**<.001**	0.018
Second author	0.29 (0.667)	0.40 (0.743)	0.18 (0.524)	**<.001**	0.019
High impact journal	0.22 (0.652)	0.23 (0.669)	0.10 (0.353)	**<.001**	0.011
Senior author from residency	0.61 (1.333)	0.68 (1.401)	0.35 (0.899)	**<.001**	0.013
Senior author from medical school	0.48 (1.072)	0.55 (1.004)	0.25 (0.770)	**<.001**	0.018

Bold represents significance where $p < .050$.

seen in Table 3, where there was no significant difference between the means of research productivity across all six metrics for residents from T1 and T2 schools. Conversely, residents graduating from both T1 and T2 schools had significantly different productivity than residents graduating from T3 medical schools.

Univariable and multivariable logistic regression analyses were then performed to identify significant predictive relationships between medical school background and stepwise intervals of research productivity. See Tables 4 and 5. In multivariable regression, relative to residents from T1 schools, residents from T3 schools were predicted to be significantly less likely to produce at least 1, 2, or 5 total publications during residency. Additionally, residents with T3 school backgrounds were noted to have significantly lower odds of publishing at least 1 first author article, at least 2 articles published in top 10 journals, and either at least 1 or 2 items published with senior authors affiliated with their medical school compared to residents with T1 school backgrounds. Conversely, a T2 school background compared to T1 significantly predicted greater odds of having at least one second author publication and at least one article with a senior author affiliated with their medical school. No significant predictive relationships were discerned between medical school background and publishing with senior authors associated with the residency program.

Discussion

Medical school represents an important foundation in the training of an academic ophthalmologist. While medical school ranking may be a factor in determining the quality of a prospective applicant, ranking does not appear to portend future research productivity in residency. Therefore, the predictive value of medical school ranking in determining research productivity during residency merits further consideration. To our knowledge, this study is the first to explore the correlation between USNWR medical school rankings and research productivity during residency in ophthalmology. USNWR medical school rankings are derived from a numerous factors, but nearly half of the ranking determinants are based directly on a school's research activity [19]. Previous studies report associations between medical school ranking, research productivity during medical school, and match outcomes across several surgical specialties [1,5,12,14–16,20]. In addition, these studies offer evidence that highly ranked medical schools offer stronger research opportunities through curriculum requirements, scholarly concentrations, funding capabilities, and opportunities for research showcases [10,16,21,22].

Although USNWR rankings are widely used and considered by medical school applicants and residency programs, as of January 2023, many medical schools have decided to withdraw from the ranking. Elite medical schools, beginning with Harvard Medical School, have made the choice to no longer provide data to US News and World Report so they will no longer be included in the ranking. Many other medical schools have begun to follow suit since this first withdrawal. These decisions are both methodological and ethical as the ranking has long been questioned in its methods and medical schools are doubting its equity when representing them to prospective applicants. As of January 31, 2023, thirteen schools have withdrawn from the ranking. We look forward to seeing how this situation evolves and how it may affect residency admissions and research productivity.

The h-index, defined as the maximum value of h such that the h papers have each been cited at least h times, remains a widely accepted author-level metric for quantifying research productivity and citation impact [23]. Despite top ranked medical schools offering accessible research opportunities, there is evidence that suggests a higher applicant h-index is more associated with residency program reputation than medical ranking in ophthalmology [15]. Our study elaborates on this literature by suggesting a more limited role of medical school ranking in the prediction of research productivity during residency.

In this study, as demonstrated in Table 2, significant relationships were observed between medical school background and all 6 metrics of research productivity. However, Eta squared coefficients suggested that the relationships were of small magnitude. Furthermore, Tukey test and multivariable regression results revealed that research productivity generally did not differ significantly among graduates of first and second-tier medical schools. In addition, the majority of statistically significant differences in resident research productivity were between graduates of first and third-tier medical schools. Multivariable subanalysis testing associations with increasing number of publications, displayed in Table 5, confirm the relatively limited predictive value of medical school ranking in resident research productivity.

Residents graduating from second-tier medical schools had similar number of total publications, first-author publications, high impact publications, and publications with a senior author affiliated with their residency program as those graduating from first-tier medical schools. Conflictingly, residents graduating from second-tier medical schools had greater number of second-author publications and number of publications with a senior author affiliated with their medical school. These findings suggest that graduates of first and second-tier medical schools are similar in their abilities to assume roles of leadership in their scholarly activities during residency, but graduates of second-tier medical schools may more often maintain longitudinal research relationships with their medical schools throughout residency. This is suggested by the significant results observed in Table 5, where residents from T2 schools were nearly 1.5 times as likely to publish at least one article with a senior author affiliated with their medical school as residents from T1 schools. Current perceptions of medical school rankings may suggest more favorable match outcomes correlating with medical students graduating from higher ranked medical schools. This may contribute to applicants from lower ranked medical schools prioritizing continued research as a potential compensatory mechanism.

Residents graduating from third-tier medical schools had lower number of total publications, first-author publications, and publications with a senior author affiliated with their medical school. Residents graduating from third-tier medical schools had similar number of second-author publications and publications with a senior author affiliated with their residency. These findings suggest that while higher

Table 3
Significant differences between medical school tiers in scholarly productivity of ophthalmology residents.

Variable	T1 vs T2	T2 vs T3	T1 vs T3
Total publications	0.290	**<0.001**	**<0.001**
First author	0.596	**<0.001**	**0.002**
Second author	0.086	**<0.001**	**0.039**
High impact journal	0.971	**0.009**	**0.011**
Senior author from residency	0.772	**0.010**	**0.002**
Senior author from medical school	0.610	**<0.001**	**0.002**

Bold represents significance where $p < .050$.

Table 4
Univariable logistic regression of medical school ranking as a predictor of scholarly research productivity.

	Tier	At least one	p value	At least 2	p value	At least 5	p value
Total publications	1	ref					
	2	1.292 (0.950,1.757)	.103	1.274 (0.910,1.782)	.158	1.275 (0.731,2.225)	.392
	3	0.604 (0.452,0.806)	**.001**	0.541 (0.380,0.770)	**.001**	0.336 (0.160,0.704)	**.004**
First author	1	Ref					
	2	1.075 (0.779,1.482)	.661	1.188 (0.750,1.883)	.463		
	3	0.557 (0.403,0.769)	**<.001**	0.546 (0.328,0.909)	**.020**		
Second author	1	Ref					
	2	1.558 (1.091,2.226)	**.015**	1.333 (0.727,2.442)	.353		
	3	0.625 (0.427,0.917)	**.016**	0.376 (0.171,0.827)	**.015**		
High impact journal	1	Ref					
	2	1.151 (0.748,1.772)	.523	0.726 (0.327,1.610)	.431		
	3	0.581 (0.366,0.924)	**.022**	0.162 (0.047,0.557)	**.004**		
Senior author from residency	1	Ref					
	2	1.123 (0.804,1.568)	.495	1.200 (0.771,1.869)	.420		
	3	0.657 (0.471,0.917)	**.013**	0.514 (0.313,0.845)	**.009**		
Senior author from medical school	1	Ref					
	2	1.395 (0.999,1.948)	.051	1.146 (0.714,1.840)	.572		
	3	0.538 (0.377,0.767)	**.001**	0.368 (0.205,0.660)	**.001**		

Bold represents significance where $p < .050$.

Table 5
Multivariable logistic regression of medical school ranking as a predictor of scholarly research productivity.

	Tier	At least one	p value	At least 2	p value	At least 5	p value
Total publications	1	Ref					
	2	1.334 (0.958,1.857)	.088	1.287 (0.891, 1.857)	.178	1.246 (0.694,2.235)	.461
	3	0.659 (0.481,0.905)	**.010**	0.643 (0.436,0.949)	**.026**	0.407 (0.187,0.886)	**.024**
First author	1	Ref					
	2	1.049 (0.739,1.490)	.788	1.216 (0.742,1.992)	.439		
	3	0.681 (0.477,0.971)	**.034**	0.675 (0.387,1.176)	.165		
Second author	1	Ref					
	2	1.604 (1.101,2.337)	**.014**	1.235 (0.658,2.318)	.510		
	3	0.732 (0.386,1.102)	.135	0.457 (0.200,1.046)	.064		
High impact journal	1	Ref					
	2	1.135 (0.713,1.806)	.593	0.784 (0.341,1.802)	.566		
	3	0.782 (0.472,1.297)	.341	0.253 (0.070,0.920)	**.037**		
Senior author from residency	1	Ref					
	2	1.130 (0.779,1.637)	.519	1.192 (0.738,1.928)	.473		
	3	0.750 (0.515,1.090)	.132	0.621 (0.361,1.066)	.084		
Senior author from medical school	1	Ref					
	2	1.450 (1.025,2.052)	**.036**	1.120 (0.681,1.841)	.656		
	3	0.610 (0.420,0.887)	**.010**	0.471 (0.254,0.873)	**.017**		

Bold represents significance where $p < .050$.

medical school ranking may confer access to increased financial and social opportunity for scholarly development and leadership, ranking is not significantly predictive for starting and publishing research during residency. Graduates from lower ranked medical schools may be similarly equipped to contribute to research during residency as graduates from higher ranked medical schools when given equal access to the same faculty and opportunities to work with more experienced, research-oriented ophthalmologists. This is supported by results displayed in Table 5, where there was no significant difference in the number of publications between tiers with senior authors affiliated with the residency program. Statistically significant differences in the number of total publications between graduates of first and third-tier medical schools during residency that persist with increasing thresholds may be explained by research started prior to residency publishing during residency and other associated publishing delays. Moreover, there is active debate regarding publishing bias that may favor medical students and faculty affiliated with higher ranked medical schools at the expense of article quality, which also has the potential to influence research output outcomes [24,25]. Regardless, lower ranked schools may in turn consider investing more resources in research and extracurricular scholarly activities to improve the competitiveness of their medical students in residency admissions.

The National Resident Matching Program (NRMP) surveys directors of all programs participating in the Main Residency Match [26,27]. The primary purpose of the Program Director Survey is to characterize the factors that Program Directors consider when (1) selecting applicants to interview and (2) ranking applicants for the Main Residency Match [26,27]. According to the 2020 and 2021 Program Director Surveys, medical school ranking is considered by fewer than 40 % and 25 % of program directors when deciding applicants to interview and rank, respectively [26,27]. Medical school ranking is considered by program directors to be less important than the Medical Student Performance Evaluation, grades in required clerkships, USMLE scores, failed attempts at the USMLE, medical school accreditation status, and several perceived subjective qualities such as leadership, resiliency, commitment, professionalism, and ethics [26,27]. Of note, ophthalmology residency programs do not participate in the NRMP which complicates the comparison of factors influencing match outcomes between ophthalmology and other specialties, however the results of the NRMP surveys may be generalizable to ophthalmology as a competitive surgical sub-specialty. Several factors such as Alpha Omega Alpha (AOA) membership, USMLE scores, presence of an ophthalmology residency at medical school, medical school ranking in the top 25, and allopathic degree have nevertheless been implicated in conferring an advantage for matching into ophthalmology specifically [28]. Our data support residency programs limiting the consideration given to medical school ranking in the selection of residents.

History of publications during medical school may also contribute to increased research productivity of ophthalmology residents. A study done in radiation oncology found a 15-fold increased likelihood of publishing during residency for those residents who published at least once during medical school [29]. The tier of residency program may also influence research productivity, as larger, higher ranked programs may possess more research opportunities for their residents to take advantage of when publishing research works. One study found that on multivariate adjustment, program size was a significant predictor of Doximity program rank, representing a direct correlation between program size and prestige [30]. Such prestige may attract research funding and motivated faculty critical to a scholarly productive program.

Several limitations in our study warrant acknowledgement. While USNWR medical school research rankings are abstracted from a comprehensive set of factors such as medical school reputation, National Institutes of Health (NIH) funding, student selectivity, standardized examination scores, medical school acceptance race, and resources available to faculty members, these rankings have been criticized for not accurately identifying the best medical schools [1,31–33]. The inclusion of research activity in the criteria used to generate USNWR rankings potentially confounds the relationships between medical school ranking, number of publications, and impact of publications. Despite criticism of the USNWR medical school research rankings, these rankings are generally accepted by professionals and the public alike [1,33]. Ranking medical schools by NIH funding may offer a better indication of the best medical school but this method does not account for nonfederal sources of research funding. As such, it is valuable to practice caution when using NIH funding as a metric since it may not accurately reflect the actual volume of research productivity of an institution.

Collecting data from publicly available sources inherently presents challenges that introduce inaccuracy; when establishing our database, information was verified among multiple sources and carefully reviewed for errors. While our cohort selection was designed to mitigate confounding factors including the potential variability in research experiences between international medical graduates and those graduating medical school in the US, future studies should specifically explore the differences in these experiences and how they may impact scholarly productivity during residency.

Our study investigated the potential correlation between attending a highly ranked medical school and research productivity during ophthalmology residency. Our results imply that medical school ranking has limited importance in predicting research productivity during residency among graduates of first and second-tier medical schools. The finding of graduates of all medical schools having similar number of publications with a senior author affiliated with the residency program suggests that all ophthalmology residents have largely similar ability, competence, and preparedness to participate in scholarship. Disparities in other metrics of research productivity during residency may be attributed to unequal access and exposure to opportunities and resources while in medical school. Residency programs committed to increasing diversity and improving their training quality should reflect on if medical school ranking is an impactful factor in the selection of residents.

Declaration of competing interest

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Author contributions

All authors contributed to the project conception, design, and data collection. Hassaam Choudhry contributed to data analysis. Hassaam Choudhry, Aman Patel, and Hannaan Choudhry contributed to manuscript drafting. Roshun Sangani, Christopher Seery, and Albert Khouri contributed to the manuscript revisions.

Ethics approval

Exempt as no personal identifiable information was disclosed and all data collected was publicly available on the internet.

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