

Scholarly Engagement as an Educational Pathway to Surgical Residency Match: A Retrospective Cohort Study

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Research Article

Keywords: medical students, research productivity, graduate medical education, residency selection, scholarly engagement

Posted Date: September 29th, 2026

DOI: <https://doi.org/10.21203/rs.3.rs-10807809/v1>

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Additional Declarations: No competing interests reported.

Abstract

Background

Research engagement and scholarly productivity are increasingly emphasized during residency selection, particularly in competitive surgical specialties. However, it remains unclear which educational and scholarly characteristics are associated with matching into surgical versus non-surgical specialties among medical school graduates. This study compared these characteristics and identified factors independently associated with surgical residency match.

Methods

We conducted a retrospective cohort study of 590 medical students graduating from a large urban academic medical center between 2021 and 2025. Educational characteristics, academic performance, and research experiences were obtained from institutional records. Publication data were identified through structured PubMed searches and manually verified. Multivariable logistic regression was performed to identify factors independently associated with matching into a surgical specialty.

Results

Of 590 graduates, 181 (30.7%) matched into surgical specialties. Compared with graduates entering non-surgical specialties, those matching into surgical specialties were more likely to have completed a dedicated research year (37.6% vs. 22.0%, $p < 0.001$) and had significantly greater first-author publication productivity ($p < 0.001$). In multivariable analyses, completion of a research year was independently associated with surgical specialty match (odds ratio [OR] 1.82, 95% confidence interval [CI] 1.16–2.84). Compared with graduates without first-author publications, those with 2–4 first-author publications (OR 3.39, 95% CI 2.06–5.56) and ≥ 5 first-author publications (OR 5.04, 95% CI 2.49–10.18) were significantly more likely to match into surgical specialties. Undergraduate academic background and United States Medical Licensing Examination Step 2 Clinical Knowledge scores were not independently associated with surgical specialty match.

Conclusions

Among graduates from a single medical school, research engagement and first-author scholarly productivity were independently associated with matching into surgical specialties, whereas undergraduate academic background and Step 2 Clinical Knowledge performance were not. These findings may inform medical student advising, mentorship, and institutional efforts to promote equitable access to research opportunities that support career exploration and residency preparation.

Introduction

Residency match is a defining transition in medical education, linking undergraduate medical training to specialty choice. Students pursuing competitive procedural specialties often emphasize scholarly output, including publications, conference presentations, and dedicated research years, alongside academic performance and clinical preparation. However, most prior work has focused on specific surgical subspecialties or highly selected applicant pools, leaving it less clear how objectively verified scholarly engagement looks across an entire graduating class [1–6].

Beyond identifying which applicant characteristics correlate with competitive specialty match, understanding these relationships carries direct implications for how medical schools structure scholarly training. Dedicated research years and research mentorship are not fixed applicant traits; they are institutional programs that schools design, fund, and allocate, often with limited slots and uneven visibility across student populations. Understanding which forms of scholarly engagement are most strongly associated with residency outcomes can inform how schools prioritize advising resources, research funding, and mentorship infrastructure, rather than simply describing which students arrive at match day with stronger academic profiles. Because access to research mentorship, protected research time, and early specialty exposure may not be distributed equally across students, it is also important to understand whether scholarly engagement functions as an equalizing opportunity or as a further advantage for students who already have greater access to institutional resources.

Since opportunities for research, mentorship, and scholarly development are shaped by medical school environments, it remains unclear how educational experiences during medical school, including structured research opportunities and scholarly productivity, relate to residency specialty outcomes and how these findings can inform advising, mentorship, and equitable access to research experiences. First-author publication output may reflect more than publication counts alone; it may also represent sustained project ownership, intellectual leadership, collaboration within research teams, and completion of a scholarly product. Unlike self-reported residency application entries, objectively verified publication records can distinguish completed publications from duplicated, submitted, or abstract-level scholarly activities. At the same time, some commonly assumed markers of academic preparation, such as undergraduate major or standardized test performance, may contribute less than is often presumed [7–9].

We hypothesized that greater research engagement, reflected by dedicated research year participation and first-author publication productivity, would be independently associated with matching into surgical specialties, while undergraduate academic background and standardized examination performance would show weaker associations.

Methods

We conducted a retrospective cohort study of medical students graduating from a large urban medical school within an academic medical center model between 2021 and 2025. The primary outcome was

match into a surgical specialty. The primary exposures of interest were research year participation and first-author publication count. Students enrolled in an MD/PhD program were excluded because they represent a distinct training pathway that could confound study covariates and outcomes. Students whose degree program changed during training were also excluded. Of 661 students who graduated between 2021 and 2025, 53 were enrolled in the MD/PhD program and 3 had a degree program change during training; both groups were excluded, yielding 605 eligible students. Of these, 15 were excluded for missing residency specialty match data, yielding an analytic cohort of 590 students with a documented match outcome. Data were abstracted from institutional student records, including gender, undergraduate degree, admission pathway, residency specialty match, graduation year, and completion of a dedicated research year.

At our institution, the early assurance admissions pathway (FlexMed) allows students to apply during undergraduate training and is open to both humanities/social science and STEM majors. A research year was defined as an institutionally supported year away from the standard medical school curriculum for research or scholarly activity. Publication data were obtained through structured PubMed queries for each graduating student, limited to publications produced during medical school training, and verified manually using research topics, co-authorship patterns, institutional affiliations, ORCID profiles, and Scopus indexing when available. This multi-step verification process was used to reduce the risk of misclassification bias, such as attributing publications to the wrong individual due to common names or excluding legitimate publications missed by automated search alone.

We selected first-author publication count as the primary measure of scholarly productivity because first authorship generally reflects greater intellectual contribution, project leadership, collaboration within research teams, and completion of a publishable scholarly product. First-author publication counts were categorized as 0, 1, 2–4, and ≥ 5 publications. Undergraduate majors were grouped into life sciences/biomedical, other STEM/quantitative, and humanities/social sciences. Residency specialties were categorized as surgical or non-surgical based on whether operative intervention constitutes a core component of training; specialty classification is shown in **Supplementary Table 1**, and first-author publication output by matched specialty is summarized in **Supplementary Table 2**.

Supplementary Table 1. Classification of residency specialties as surgical or non-surgical

Specialty	Classification
Anesthesiology	Non-Surgical
Dermatology	Non-Surgical
Emergency Medicine	Non-Surgical
Family Medicine	Non-Surgical
General Surgery	Surgical
Geriatrics	Non-Surgical
Internal Medicine	Non-Surgical
Interventional Radiology	Non-Surgical
Medicine-Pediatrics	Non-Surgical
Medicine-Preventative Medicine	Non-Surgical
Neurology	Non-Surgical
Neurosurgery	Surgical
OB-GYN	Surgical
Ophthalmology	Surgical
Orthopedic Surgery	Surgical
Otolaryngology	Surgical
Pathology	Non-Surgical
Pediatrics	Non-Surgical
Pediatrics/Psychiatry/Child Psychiatry	Non-Surgical
Plastic Surgery	Surgical
Physical Medicine and Rehabilitation	Non-Surgical
Psychiatry	Non-Surgical
Radiology	Non-Surgical
Thoracic Surgery	Surgical
Urology	Surgical
Vascular Surgery	Surgical

Residency specialties were classified according to whether operative intervention constitutes a core component of residency training.

Supplementary Table 2. First-author publication productivity by matched residency specialty

Specialty	N of Graduates Matching to Specialty	Median N of First Authors Publications	Min	Max
Anesthesiology	63	.00	0	4
Dermatology	18	8.00	5	17
Emergency Medicine	42	.00	0	6
Family Medicine	20	.00	0	2
General Surgery	26	1.00	0	9
Internal Medicine	119	1.00	0	7
Interventional Radiology	6	1.50	1	4
Med-Preventative Med	1	.00	0	0
Med-primary	7	1.00	0	4
Medicine-Pediatrics	9	1.00	0	5
Medicine-Primary	1	2.00	2	2
Neurological Surgery	2	12.50	11	14
Neurology	17	1.00	0	4
Neurosurgery	14	5.00	0	12
OBGYN	31	1.00	0	5
Obstetrics-Gynecology	2	1.50	0	3
Ophthalmology	17	2.00	0	10
Orthopedic Surgery	26	2.50	0	10
Otolaryngology	24	2.50	0	6
Pathology	4	2.00	0	5
Pediatrics	29	1.00	0	6
Peds/psych/child psych	4	.00	0	0
Phys Medicine & Rehab	6	1.00	0	3
Plastic Surgery	4	2.00	1	3
Psychiatry	44	.00	0	9

Specialty	N of Graduates Matching to Specialty	Median N of First Authors Publications	Min	Max
Radiology	17	1.00	0	7
Thoracic Surgery	3	.00	0	3
Transitional year	2	1.00	0	2
Urology	13	3.00	0	6
Vascular Surgery	4	2.00	1	3

Median first-author publication counts are shown for each matched residency specialty. Publication counts include PubMed-indexed first-author manuscripts produced during medical school and verified through structured PubMed searches and manual review.

Descriptive statistics were used to summarize cohort characteristics. Associations between categorical variables and match into surgical versus non-surgical specialties were examined using odds ratios, 95% confidence intervals, and chi-square as appropriate. Multivariable logistic regression analyses were used to explore characteristics associated with surgical specialty match. Covariates included gender, underrepresented in medicine status, admission pathway, research year participation, Step 2 CK score, undergraduate academic background, and first-author publication count. Linearity in the logit for Step 2 CK score was assessed using the Box-Tidwell approach; the interaction term was not significant ($p=.271$), supporting inclusion of Step 2 CK score as a continuous variable in the multivariable model. Model fit was assessed using the Hosmer-Lemeshow goodness-of-fit test, and multicollinearity among covariates was assessed using variance inflation factors (VIF). All analyses were performed using IBM SPSS Statistics version 28.0 (IBM Corp., Armonk, NY). This study was reviewed by the Icahn School of Medicine at Mount Sinai Institutional Review Board and determined to be exempt from human subjects research (STUDY-25-00529).

Results

A total of 590 medical students were included in the analytic cohort. Overall, 181 students (30.7%) matched into surgical specialties. Table 1 summarizes cohort characteristics.

Table 1
Characteristics of the study cohort (N = 590)

Characteristic	Value
Graduation Year	n (%)
2021	137 (17.9)
2022	108 (18.3)
2023	121 (21.2)
2024	125 (23.2)
2025	99 (16.8)
Gender	
Male	296 (50.2)
Underrepresented in Medicine Status	
Yes	110 (18.5)
First-Generation Status	
Yes	45 (7.6)
Admission Pathway*	
Traditional	393 (66.6)
Early Assurance Program	140 (23.7)
Degree Program	
MD	553 (93.7)
MD/MSCR	32 (5.4)
MD/MPH	5 (0.8)

Values are presented as n (%) unless otherwise indicated. MD, Doctor of Medicine; MD/MSCR, Doctor of Medicine/Master of Science in Clinical Research; MD/MPH, Doctor of Medicine/Master of Public Health.. * 57 missing

The cohort was distributed fairly evenly by gender, and 18.5% of students were classified as underrepresented in medicine. Most students completed undergraduate training in life sciences or biomedical disciplines, followed by humanities/social sciences and other STEM/quantitative disciplines. The majority completed the MD degree, and 26.8% participated in a dedicated research year. Comparisons by match outcome are shown in Table 2.

Table 2
Educational and scholarly characteristics by residency specialty match

Variable	Surgical (n = 181) n (%)	Non-Surgical (n = 409) n (%)	Pearson Chi square value	p- value
Gender			.001	0.93
Female	89 (49.4)	204 (49.9)		
Male	91 (50.6)	205 (50.2)		
Underrepresented in Medicine Status			.083	.774
No	146 (80.7)	334 (81.7)		
Yes	35 (19.3)	75 (18.3)		
First generation			< .001	.996
No	152 (91.6)	336 (91.6)		
Yes	14 (8.4)	31 (8.4)		
Research Year Taken			15.50	< .001
No	113 (63.4)	319 (78.0)		
Yes	68 (37.6)	90 (22.0)		
Undergraduate major			1.030	.598
Life Science/Biomedical	93 (56.0)	189 (51.5)		
Other STEM/Quantitative	24 (14.5)	55 (15.0)		
Non-STEM (Humanities/Soc sci/Business)	49 (29.5)	123 (33.5)		
Entry program			.116	.733
Standard	124 (74.7)	269 (73.3)		
Early Assurance	42 (25.3)	98 (26.7)		
Step 2 CK Score, median (Q1, Q3)	252.0 (244, 260)	250.0 (242, 259)	.467*	. 494
First-Author Publications (Fig. 1)			40.754	< 0.001
0	46 (25.4)	193 (47.2)		

Variable	Surgical (n = 181) n (%)	Non-Surgical (n = 409) n (%)	Pearson Chi square value	p-value
1	38 (21.0)	102 (24.9)		
2–4	68 (37.6)	89 (21.8)		
≥5	29 (16.0)	25 (6.1)		

Values are presented as n (%) unless otherwise indicated. Step 2ck score was continuous and not normally distributed, therefore the median and (Q1, Q3) variable and median test and value are presented

57 students missing on first gen, undergraduate major, and program entry, 1 missing on gender

Bars show the percentage of graduates matching into a surgical specialty within each first-author publication category (0, 1, 2–4, or ≥ 5 publications), with error bars representing 95% Wilson confidence intervals. Sample sizes for each category are shown in parentheses.

Graduates matching into surgical specialties were significantly more likely to have completed a dedicated research year during medical school than those matching into non-surgical specialties (37.6% vs 22.0%, $p < 0.001$). Graduates with higher first-author publication counts were progressively more likely to match into a surgical specialty, showing a clear dose-response pattern (Fig. 1). By contrast, no significant differences were observed in gender distribution, underrepresented in medicine status, Step 2 CK performance, or undergraduate academic background. Table 3 presents the multivariable logistic regression model.

Table 3
Multivariable logistic regression analysis of factors associated with surgical vs non-surgical specialty match (N = 532)

Variable	OR (95% CI)	p-value
Underrepresented in medicine (Yes vs No)	1.40 (0.83–2.36)	0.21
Male (vs Female)	0.84 (0.57–1.25)	0.39
Research Year Taken (Yes vs No)	1.82 (1.16–2.84)	0.01
Admission Pathway (Early Assurance vs Traditional)	0.69 (0.44–1.10)	0.12
Step 2CK Score (Continuous)	1.00 (0.98–1.01)	0.69
First-Author Publications (vs 0)		
1	1.44 (0.84–2.46)	0.19
2–4	3.39 (2.06–5.56)	< 0.001
≥5	5.04 (2.49–10.18)	< 0.001
Undergraduate Major (vs Humanities / Social Sciences)		
Life Sciences / Biomedical	1.18 (0.76–1.83)	0.46
Other STEM / Quantitative	0.97 (0.52–1.81)	0.92

Odds ratios (ORs) and 95% confidence intervals (CIs) were estimated using multivariable logistic regression. Reference categories were: not underrepresented in medicine, female, no dedicated research year, traditional admission pathway, 0 first-author publications, and humanities/social sciences undergraduate major. Step 2 CK was analyzed as a continuous variable. Fifty-eight students with missing undergraduate major data were excluded via listwise deletion in this model; a sensitivity analysis retaining these students as a separate category is described in the Limitations.

Completion of a research year was independently associated with surgical specialty match (OR 1.82, 95% CI 1.16–2.84, $p = 0.009$). First-author publication count also showed a strong dose-response association with surgical specialty match. Compared with students without first-author publications, those with one first-author publication had a positive trend that did not reach statistical significance, whereas students with 2–4 publications (OR 3.39, 95% CI 2.06–5.56, $p < 0.001$) and ≥ 5 publications (OR 5.04, 95% CI 2.49–10.18, $p < 0.001$) were substantially more likely to match into a surgical specialty. Underrepresented in medicine status, gender, admission pathway, Step 2 CK score, and undergraduate major were not significantly associated with the outcome after adjustment. The model demonstrated adequate fit (Hosmer-Lemeshow $\chi^2=14.10$, $df = 8$, $p=.079$) and explained a modest proportion of variance in match outcome (Nagelkerke $R^2=0.128$). Variance inflation factors for all covariates were below 1.2, indicating no evidence of multicollinearity.

Supplementary Table 2 shows first-author publication patterns by matched specialty. The distribution suggests variation across surgical and non-surgical specialties and indicates that the association observed in Table 3 is visible across multiple specialty categories rather than being driven by one outlier discipline.

Discussion

In this retrospective cohort study, objectively verified first-author publication productivity and dedicated research year participation both shaped by institutional research infrastructure and mentorship access rather than fixed at matriculation were the characteristics most strongly and independently associated with matching into surgical specialties, even after adjustment for demographic characteristics, undergraduate academic background, admission pathway, and USMLE Step 2 Clinical Knowledge performance. These findings suggest that where medical schools choose to invest scholarly resources through research year support, structured mentorship, and opportunities for sustained project ownership may meaningfully influence students' competitiveness for procedural specialties.

Our findings are consistent with previous studies demonstrating an association between research productivity and successful matching into competitive surgical specialties, including general surgery, orthopedic surgery, and other surgical disciplines [10–13]. However, unlike prior investigations that focused on applicants to individual specialties or relied on self-reported residency application data [14–17], our study examined an entire graduating medical school cohort using objectively verified publication records. This broader perspective shifts the focus from identifying factors associated with success within a single specialty to understanding how scholarly engagement relates to specialty outcomes across undergraduate medical education. By evaluating both surgical and non-surgical career pathways within one cohort, our findings may better inform institutional advising, mentorship, and research opportunities than studies limited to individual residency applicant pools.

An additional strength of this study is the use of objectively verified first-author publications rather than self-reported residency application entries. Previous studies have frequently relied on Electronic Residency Application Service (ERAS) research entries, which may include posters, abstracts, submitted manuscripts, and duplicate listings [18–20]. By identifying PubMed-indexed publications through structured searches and manual verification, we captured completed scholarly products rather than applicant-reported activities. We focused specifically on first-author publications because they more closely reflect intellectual leadership, sustained engagement, and successful completion of a scholarly project. Consequently, first-author publication productivity may represent a more reproducible and educationally meaningful measure of scholarly engagement than applicant-reported research experiences or total publication counts.

The association between first-author publication productivity and surgical specialty match should not be interpreted as evidence of a causal relationship. Students with higher publication output may have greater access to mentorship, longitudinal research experiences, institutional resources, or preexisting

interest in surgical careers. Likewise, dedicated research years may provide protected time for scholarship, specialty exploration, mentorship, and professional networking that facilitate both academic productivity and residency preparation. Prior studies have similarly demonstrated that research year participation is associated with increased likelihood of matching into competitive surgical specialties, including orthopedic surgery and plastic surgery [16, 17, 21]. Our findings extend these observations by demonstrating that this relationship persists across multiple surgical specialties within a single institutional cohort.

Interestingly, neither undergraduate academic background nor USMLE Step 2 Clinical Knowledge performance was independently associated with surgical specialty match. Although these findings should be interpreted cautiously given the relatively high academic performance and limited score variability within our cohort, they suggest that traditional academic metrics may contribute less to differentiating surgical and non-surgical specialty outcomes than sustained scholarly engagement [22, 23]. These findings also support growing emphasis on holistic review during residency selection, in which research experiences may reflect qualities such as initiative, perseverance, collaboration, and intellectual curiosity that are not fully captured by standardized test scores.

Underrepresented in medicine status was not independently associated with surgical specialty match in this cohort, suggesting that once research engagement is accounted for, race and ethnicity did not confer additional advantage or disadvantage in specialty outcomes among students who completed training at this institution. However, this cross-sectional finding at the point of match cannot address whether URM students had equitable access to research years, mentorship, or specialty-specific opportunities earlier in training, an important question for future work using earlier-stage outcomes such as research year enrollment or mentorship access itself as the dependent variable, particularly given documented variation in research experiences and publication output by race and ethnicity earlier in medical training [20].

Our findings also contribute to ongoing discussions regarding the increasingly prominent role of research in residency selection, known to many as the “research arms race” [18]. Although greater first-author publication productivity was associated with surgical specialty match, these results should not be interpreted as evidence that publication quantity alone determines residency success or that students should simply pursue more publications. Rather, first-author scholarly productivity may reflect broader educational experiences, including longitudinal mentorship, project ownership, teamwork, and successful completion of scholarly work. From a medical education perspective, these findings suggest that institutions should prioritize equitable access to meaningful research experiences, structured mentorship, and protected scholarly opportunities that support career exploration and professional development, rather than emphasizing publication volume alone.

Implications for Medical Education

These findings have several practical implications for medical school curricula and advising. First, because first-author publication productivity showed a clear dose-response relationship with surgical match while undergraduate background and Step 2 CK performance did not, schools may consider weighting research mentorship and structured scholarly opportunities more heavily than traditional academic screening when advising students toward competitive procedural specialties. Second, the independent association between dedicated research year participation and surgical match supports continued institutional investment in protected research time, particularly if access to research years can be expanded equitably rather than allocated based on preexisting connections or self-directed opportunity-seeking, consistent with calls for structured institutional investment in research infrastructure during training [14]. Third, because first-author productivity reflecting sustained project ownership and completion rather than research exposure alone was more strongly associated with match outcomes than research year participation itself, mentorship quality and structured project completion may matter more than time away from curriculum alone. This suggests that investment in mentorship infrastructure, rather than simply expanding the number of research year slots, may be a higher-yield institutional target. Advising programs that identify students' specialty interests early and connect them to structured, well-mentored scholarly projects rather than encouraging research participation in the abstract may better support both career exploration and residency preparation.

Limitations

This study has several limitations. As a single-institution retrospective analysis, the findings may not generalize to other schools with different advising systems, research structures, or specialty distributions. We also evaluated residency match rather than specialty preference, application behavior, interview performance, letters of recommendation, or rank lists, so we cannot determine where in the selection process scholarly productivity matters most. We were also unable to determine whether students developed an interest in surgery before medical school, during training, or after exposure to research and clinical experiences. Accordingly, we cannot determine whether scholarly engagement influenced specialty choice, reflected preexisting specialty interests, or both. Additionally, publication productivity was limited to PubMed-indexed manuscripts and therefore does not capture conference presentations, quality improvement projects, educational scholarship, or non-indexed scholarly work. Although structured searches and manual verification were used to reduce misclassification bias (see Methods), some residual risk of misattributed or missed publications cannot be excluded, particularly for students with common names. Also, first-author publication counts do not capture quality, impact, or authorship contribution beyond first authorship, and they may reflect institutional opportunity as much as individual performance. Finally, the classification of specialties into surgical and non-surgical groups simplifies important differences within training pathways, although the supplementary tables and figure provide additional cohort-level context. Fifty-eight students were missing undergraduate major data and were excluded from the primary multivariable model via listwise deletion. In a sensitivity analysis retaining these students by coding missing major as a separate category (N = 584), results were consistent with the primary model: research year participation and first-author publication productivity

remained the only characteristics independently associated with surgical specialty match, and the missing-major category itself was not significantly associated with match outcome (OR 0.61, 95% CI 0.28–1.31, $p = 0.20$), providing reassurance that this missingness did not meaningfully bias our findings.

Conclusion

Among graduates of a large academic medical school, dedicated research year participation and objectively verified first-author publication productivity were independently associated with matching into surgical specialties. These findings highlight the importance of providing equitable access to meaningful scholarly experiences and mentorship during medical school and may inform advising strategies that support students' specialty exploration and residency preparation.

Declarations

Ethics approval and consent to participate:

This study was reviewed by the Icahn School of Medicine at Mount Sinai Institutional Review Board and determined to be exempt from human subjects research (STUDY-25-00529). The requirement for informed consent was waived by the Institutional Review Board because the study involved retrospective analysis of existing institutional records and posed minimal risk to participants.

Consent for publication:

Not applicable.

Competing interests:

The authors declare that they have no competing interests.

Funding:

This study did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

Author Contribution

CJ and MR contributed to the study conception and design, collected and verified the publication data, performed the statistical analyses, interpreted the data, and drafted the manuscript. MR supervised the project, interpreted the findings, and critically revised the manuscript. RF and VP contributed to study

design, data interpretation, and manuscript revision. PRH, JMA, JM, and ACH contributed to study design, interpretation of the results, and critical revision of the manuscript for important intellectual content. All authors read and approved the final manuscript.

Acknowledgements:

None

Availability of data and materials:

The datasets generated and/or analyzed during the current study are not publicly available because they were derived from confidential institutional medical student records containing protected and potentially identifiable information.

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Figures

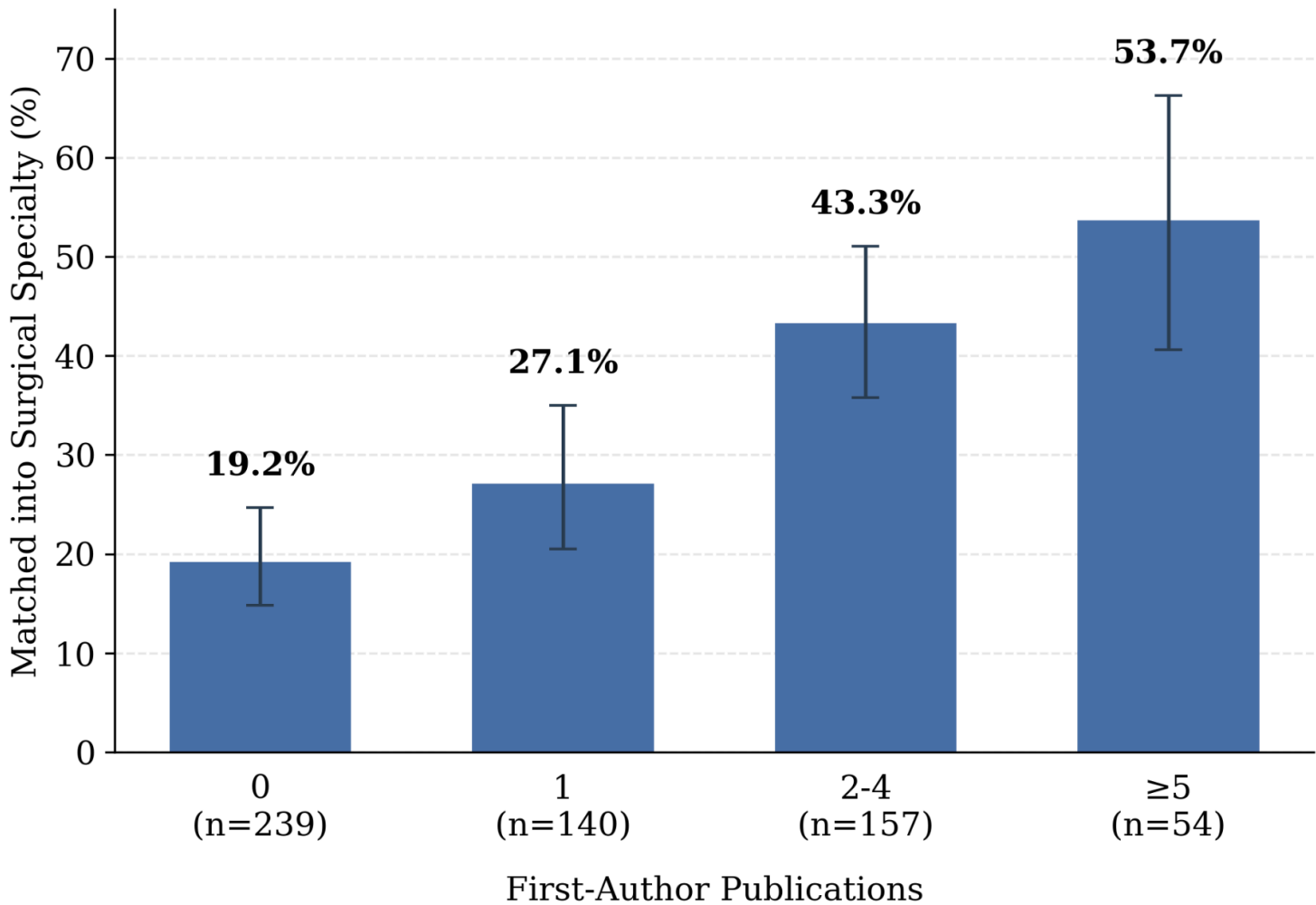


Figure 1

Proportion of graduates matching into a surgical specialty by first-author publication count.

Bars show the percentage of graduates matching into a surgical specialty within each first-author publication category (0, 1, 2-4, or ≥5 publications), with error bars representing 95% Wilson confidence intervals. Sample sizes for each category are shown in parentheses.