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# Orthopedic surgeon-scientist representation is low among National Institutes of Health grants for rotator cuff research

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**Background:** The purpose of this study is to characterize National Institutes of Health (NIH) funding for rotator cuff research and evaluate the impact of orthopedic surgeons on this portfolio.
**Methods:** The NIH's Research Portfolio Online Reporting Tools Expenditures and Results database was queried for "rotator cuff repair" or "rotator cuff tear" from the 2011 to 2021 fiscal years. Compound annual growth rates were calculated and grants were categorized by basic, clinical, or translational research. Funding totals were compared by Principal Investigator (PI) and grant characteristics.
**Results:** A total of 52 grants were awarded to 38 PIs between 2011 and 2021, totaling $40,156,859. Annual NIH funding for rotator cuff tear and rotator cuff repair increased by a Compound annual growth rate of 11.0% from 2011 to 2021, compared to 3.4% for the total NIH budget. Orthopedic surgeon-scientists received $9,208,212 (22.9%), most commonly through R01 (80.5%) and K08 (7.1%) mechanisms. No significant difference in funding was found by PI sex ($P = .332$), degree ($P = .460$), academic rank ($P = .118$), or researcher type ($P = .227$). Professors had a higher h-index than associate and assistant professors ($P = .001$). Orthopedic surgeon-scientists had a higher h-index (mean 36.3 ± 9.4) compared to clinician-scientists (mean 8.0 ± 1.4) and research-scientists (35.5 ± 40.7) ($P = .044$). Clinical topics receiving the highest funding were rehabilitation (23.9%), diagnosis, (22.3%) and surgical technique (14.8%). Orthopedic surgeon-scientists acquired funding for diagnosis (57.1%), rehabilitation (17.0%), and surgical technique (14.5%).
**Discussion:** While NIH funding for rotator cuff research is growing, orthopedic surgeon representation is low. Future studies should evaluate barriers to obtaining funding for orthopedic surgeon-scientists.


Rotator cuff tears (RCTs) are among the most common shoulder injuries, with up to 4.5 million related visits annually in the United States.[22] The prevalence of RCTs rises with age,[24] affecting up to 62% of patients over the age of 80.[35] Although RCTs are often treated with conservative modalities,[5,24] an increasing number of patients are undergoing surgical intervention.[36]

The rising incidence and economic burden of RCTs with an aging population has been met with a corresponding increase in research focus.[14,15,17,34,37,38] Funding sources for orthopedic research include payments from industry, noncommercial grants, or grants from the National Institutes of Health (NIH). The role of industry in supporting orthopedic research has expanded over time, with up to 39% of published studies reporting a conflict of interest.[23] It has been shown that commercially funded studies are more likely to report positive outcomes.[2,16] Funding from public entities, such as the NIH, minimize financial conflicts of interest and may produce research with greater academic impact.[39]

With an annual investment of over $32 billion, the NIH is the world's largest public funder of biomedical research.[9] Despite this, NIH funding for orthopedic surgery departments lags behind those of other surgical disciplines. As orthopedic surgeon-scientists involved in research may be able to provide a unique clinical perspective, understanding their role in obtaining NIH funding for common orthopedic pathologies is crucial. The purpose of this

Institutional review board approval was not required for this study as no human subjects were involved.

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study is to characterize NIH funding for rotator cuff research and evaluate the impact of orthopedic surgeons on this portfolio.

## Materials and methods

### *Data source*

The NIH's Research Portfolio Online Reporting Tools Expenditures and Results database (available at https://reporter.nih.gov; accessed July 25, 2022)[25] was queried for all grants awarded for "rotator cuff repair" or "rotator cuff tear" from the 2011 to 2021 fiscal years.

Grant abstracts were manually reviewed and included only if the proposal was relevant to rotator cuff pathology. Non-NIH grants including those from other federal, private, and industry sources were excluded aside from grants from the Agency for Healthcare Research and Quality. The Agency for Healthcare Research and Quality is a freestanding agency within the US Department of Health and Human Services but shares a similar grant award process.[8] Data extracted included grant type, principal investigator (PI), fiscal year, awarding NIH institute, the recipient institute, and total costs. Grants with no total cost data were further excluded.

The total amounts of NIH funding for rotator cuff pathology from 2011 to 2021 were extracted. For total NIH funding, compound annual growth rates (CAGRs) were calculated. The overall NIH budget by year from 2011-2021 was also obtained.[19]

### *Grant characteristics*

Grants were categorized into basic, clinical, or translational research as established by Hu et al.[10] Basic science was defined as laboratory-based research without application to patient care. Clinical research included investigations involving human subjects. Translational research included studies analyzing diagnosis or treatment for pathology. Grants that did not fit these categories were classified as "other." Funding was then classified by clinical topics of interest, including diagnostic techniques, surgical technique, implant design, education, nonoperative management, postoperative complications, rehabilitation, and public health adapted from Silvestre et al.[32] Discrepancies were resolved through discussion between study investigators.

### *Principal investigator characteristics*

PI information was collected from academic websites or from publicly available websites and confirmed through their recently authored publications. Data extracted included age, sex, academic rank, degrees, and fellowship training. Bibliometric data including the Hirsch index (h-index) was obtained from the Scopus database. PIs were classified as research-scientists, clinician-scientists, or orthopedic surgeon-scientists. Research-scientists were individuals who had a Doctorate of Philosophy or Doctor of Science degree but did not complete a residency program. PIs who completed a non-orthopedic residency were classified as clinician-scientists, while those who completed an orthopedic surgery residency were categorized as orthopedic surgeon-scientists. Researchers who held other clinical degrees such as Doctor of Physical Therapy or Doctor of Veterinary Medicine were classified as "other."

### *Statistical analysis*

Data is presented as means and standard deviations. The D'Agostino-Pearson test was used to assess normality. NIH funding totals based on PI characteristics were compared using Analysis of variance or independent samples two-tailed t-tests for parametric data and the Kruskal-Wallis test or Mann-Whitney test for nonparametric data. A $P$ value of <.05 was considered statistically significant.

## Results

A total of 306 grants were identified and reviewed. After screening, 52 unique grants awarded to 38 PIs were included in the final analysis, totaling $40,156,859. Annual NIH funding totals awarded for rotator cuff research are available in Figure 1. The annual NIH funding for RCTs and rotator cuff repairs (RCRs) increased by a CAGR of 11.0%, compared to the 3.4% increase in CAGR for the total NIH budget, which rose from $30.9 billion in 2011 to $42.7 billion in 2021.

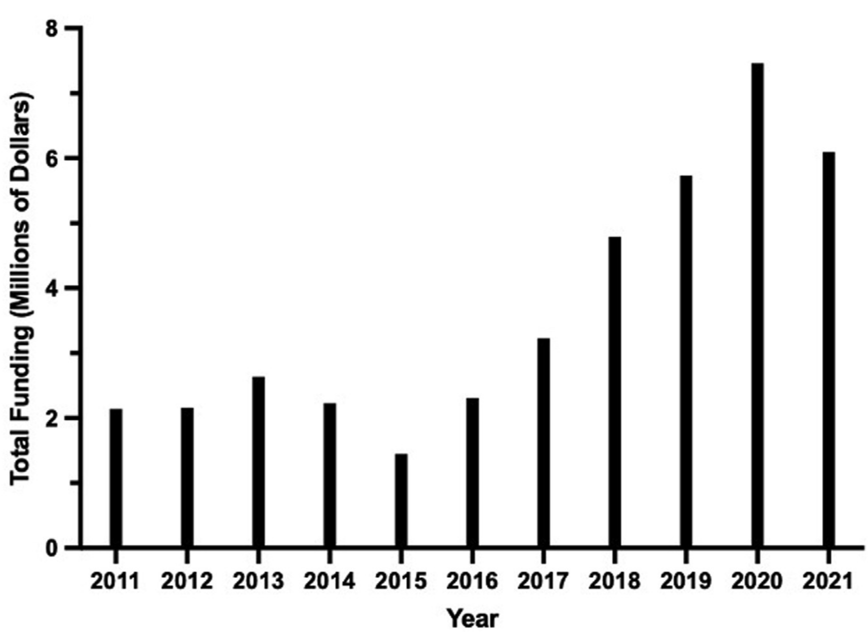


**Figure 1** Annual totals for grants awarded for rotator cuff tears or repairs.

**Table I**
NIH funding totals for rotator cuff tear and repair by grant mechanism.

| Grant mechanism | Number of grants | Total funding, $ (%) | Total funding with orthopedic surgeon-scientist as PI, $ (%) |
|---|---|---|---|
| R01 | 18 | $28,567,715 (71.1) | $7,413,024 (80.5) |
| R21 | 10 | $3,359,163 (8.4) | $0 |
| R03 | 3 | $613,343 (1.5) | $226,343 (2.5) |
| R56 | 3 | $1,109,371 (2.8) | $0 |
| R44 | 2 | $1,810,971 (4.5) | $0 |
| K08 | 2 | $1,049,204 (2.6) | $656,212 (7.1) |
| K99 | 2 | $682,076 (1.7) | $0 |
| F31 | 2 | $185,238 (0.5) | $0 |
| F32 | 2 | $267,397 (0.7) | $0 |
| R41 | 2 | $433,204 (1.1) | $0 |
| R43 | 2 | $474,652 (1.2) | $0 |
| U34 | 1 | $395,000 (1.0) | $395,000 (4.3) |
| K01 | 1 | $263,792 (0.7) | $0 |
| K23 | 1 | $517,633 (1.3) | $517,633 (5.6) |
| R15 | 1 | $428,100 (1.1) | $0 |
| Total | 52 | $40,156,859 | $9,208,212 |

*NIH*, National Institutes of Health; *PI*, Principal Investigator.

Funding totals by mechanism are available in Table I. The most commonly awarded grants were R01 (71.1%) and R21 (8.4%) for a total of $28,567,715 and $3,359,163, respectively. Grants supported basic science (50.0%), translational (30.8%), and clinical (17.3%) research. One grant could not be categorized (1.9%). Orthopedic surgeon-scientists were awarded a total of $9,208,212 out of $40,156,859 (22.9%) total NIH funding for RCTs and RCR. Grants for orthopedic surgeon-scientists were most commonly awarded through the R01 (80.5%) and K08 (7.1%) mechanisms. Orthopedic surgeon-scientists received 7 unique grants for basic science (57.1%) and clinical (42.9%) projects.

Three institutes awarded at least one grant (Table II). The majority of grants (92.8%) were awarded by the National Institute of Arthritis and Musculoskeletal and Skin Diseases, followed by the National Institute of Aging (NIA) (2.6%).

The most commonly awarded institutes are available in Table III. Washington University was awarded $6,503,657, representing 16.2% of funding, followed by the Cleveland Clinic Lerner College of Medicine, which received $4,505,660 (11.2%).

PI characteristics are available in Table IV. Data was found for 37 PIs (97.4%). Orthopedic surgeon-scientists represented 16.2% (n = 6) of PIs. There was no significant difference in NIH funding totals from 2011-2021 by PI sex ($P = .332$), degree ($P = .460$), academic rank ($P = .118$), or research category ($P = .227$). The mean h-index for all PIs was 33.5 ± 36.2. No significant difference in h-index was found based on PI sex ($P = .113$) or degree ($P = .276$). The mean h-index for professors was higher than that of associate professors and assistant professors ($P = .001$). Orthopedic surgeon-scientists had the highest h-index (mean 36.3 ± 9.4) compared to clinician-scientists (mean 8.0 ± 1.4) and research-scientists (mean 35.5 ± 40.7) ($P = .044$).

Funding by clinical area of interest is available in Table V. The clinical topics with the highest funding were rehabilitation (23.9%), diagnosis of RCTs (22.3%), and surgical technique (14.8%). Orthopedic surgeon-scientists acquired the most funding for grants focused on diagnosis of RCTs (57.1%), rehabilitation (17.0%), and surgical technique (14.5%).

## Discussion

From 2011 to 2021, a total of $40,156,859 in NIH funding was awarded for RCT and RCR, at a CAGR three times higher than the overall budget of the NIH. Despite constituting only 16.2% of PIs, orthopedic surgeon-scientists received 22.9% of NIH funding for grants awarded for RCT and RCR, most commonly through R01 and K08 grants. Orthopedic surgeon-scientists received the most funding for research on diagnosis of RCTs, rehabilitation, and surgical technique.

Given the rising incidence and economic impact of rotator cuff disease, there is an increasing need for research on this topic. Little is known about how the NIH prioritizes allocation of funds, but award amounts have previously been correlated with disease burden.[26] NIH funding for rotator cuff research has appropriately increased in line with rising disease burden over the past decade. Overall, most NIH funding for rotator cuff pathology was distributed to research topics pertaining to diagnosis and rehabilitation, with far less funding allocated to interventional topics, such as implant design, surgical technique, and nonoperative management. This suggests that the while the treatment algorithm and technical aspects of RCTs are well-studied, there may be opportunity to enhance the identification of rotator cuff pathology[7,27,33] and postoperative aspects of their care.[12,28] Interestingly, while these funding patterns are relatively consistent among orthopedic surgeon-scientists, there appears to be a much a larger focus on the diagnosis of rotator cuff pathology, which accounted for nearly 60% of grants awarded to orthopedic surgeons. Perhaps earlier identification and diagnosis of RCTs may allow for expedited care in affected patients, improving their quality of life and minimizing costs.[18]

**Table II**
NIH funding by administering institute.

| Administering institute | Number of grants | Funding total, $ (%) |
|---|---|---|
| National Institute of Arthritis and Musculoskeletal and Skin Diseases (NIAMS) | 45 | $37,339,906 (92.8) |
| National Institute of Aging (NIA) | 4 | $1,059,163 (2.6) |
| Eunice Kennedy Shriver National Institute of Child Health and Human Development (NICHD) | 2 | $1,581,674 (3.9) |
| National Institute of Biomedical Imaging and Bioengineering (NIBIB) | 1 | $176,116 (0.4) |
| Total | 52 | $40,156,859 |

*NIH*, National Institutes of Health.

**Table III**
NIH funding awarded by recipient institute.

| Recipient institute | Number of grants | Funding total (%) |
|---|---|---|
| Washington University | 3 | $6,503,657 (16.2) |
| Cleveland Clinic – Lerner College of Medicine | 3 | $4,505,660 (11.2) |
| Georgia Institute of Technology | 3 | $3,935,981 (9.8) |
| Columbia University Health Sciences | 4 | $2,848,192 (7.1) |
| Henry Ford Health System | 4 | $2,454,027 (6.1) |
| University of California – San Diego | 2 | $1,856,702 (4.6) |
| Mayo Clinic Rochester | 2 | $1,423,686 (3.6) |
| University of Illinois at Urbana Champaign | 2 | $764,530 (1.9) |
| University of Pennsylvania | 3 | $517,246 (1.3) |
| Vanderbilt University | 2 | $514,529 (1.3) |
| University of California – San Francisco | 2 | $490,135 (1.2) |

*NIH*, National Institutes of Health.

**Table IV**
Characteristics of PIs awarded NIH funding for rotator cuff tear and repair.

| | Number | Mean NIH funding ($) | *P* value | Mean H-index | *P* value |
|---|---|---|---|---|---|
| Sex | | | | | |
| Male | 26 | $1,071,843 ± $1,086,394 | .332 | 39.1 ± 41.8 | .113 |
| Female | 11 | $961,634 ± $1,382,452 | | 20.3 ± 8.2 | |
| Degree | | | | | |
| MD | 7 | $1,359,602 ± $793,948 | .460 | 32.4 ± 13.4 | .276 |
| DO | 1 | $556,636 | | 7.0 | |
| PhD | 27 | $1,014,167 ± $1,289,351 | | 35.3 ± 41.5 | |
| DVM | 1 | $225,000 | | 12.0 | |
| ScD | 1 | $764,530 | | 41.0 | |
| Academic rank | | | | | |
| Professor | 15 | $1,318,710 ± $1,218,448 | .118 | 55.5 ± 48.6 | .001* |
| Associate professor | 7 | $1,157,380 ± $941,711 | | 23.6 ± 10.2 | |
| Assistant professor | 6 | $258,332 ± $228,085 | | 13.2 ± 2.9 | |
| Researcher category | | | | | |
| Orthopedic surgeon-scientist | 6 | $1,534,702 ± $706,313 | .227 | 36.3 ± 9.4 | .044* |
| Clinician-scientist | 2 | $432,818 ± $175,105 | | 8.0 ± 1.4 | |
| Research-scientist | 28 | $1,005,251 ± $1,266,128 | | 35.5 ± 40.7 | |
| Other | 1 | $225,000 | | 12.0 | |

*DO*, Doctorate of Osteopathic Medicine; *MD*, Doctorate of Medicine; *NIH*, National Institutes of Health; *PI*, Principal Investigator; *PhD*, Doctorate of Philosophy; *ScD*, Doctor of Science; *DVM*, Doctor of Veterinary Medicine.
*Significant at $P < .05$.

The NIH supports mostly basic science projects,[6,21] even for rotator cuff research, which may be more time-consuming than clinical or translational research. Thus, it is logical that orthopedic surgeon-scientists seek alternative sources of funding, most commonly industry payments.[11,29] Higher industry payments are also correlated with greater research productivity,[4] confounding the effect of NIH funding on research output for orthopedic surgeon-scientists. However, only 14% of NIH funding for rotator cuff repairs was allocated to grants assessing novel structural designs, where limiting financial conflicts of interest is of paramount importance.

Orthopedic surgeon-scientists are a minority of PIs receiving grants for RCT and RCR, comprising 16.2% of funded PIs. This finding is consistent with NIH funding for surgeons and orthopedic surgery departments overall.[20,29] However, despite receiving similar mean amounts of NIH funding compared to clinician-scientists and research scientists, orthopedic surgeon-scientists had a higher mean h-index than their colleagues. Thus, although there are fewer orthopedic surgeon-scientists conducting research on RCT and RCR, these individuals may have a stronger academic influence. The recruitment and retention of orthopedic surgeon-scientists is crucial due to their unique ability to integrate clinical expertise with research methodology, producing work that may expedite impact on patient care. The NIH recognizes the significance of involving physician-scientists in research by funding the Medical Student Training Program, dual-degree programs where MD/Doctorate of Philosophy students can develop and cultivate skills to consolidate clinical medicine with scientific expertise.[3] Additionally, higher NIH funding for orthopedic surgery departments and faculty has previously been associated with greater h-indices,[39] indicating increased funding for these institutions would likely further improve their research productivity.

In contrast to other surgical subspecialties, the proportion of NIH funding awarded to orthopedic surgeon-scientists compared to their departments has decreased over time.[13] The source of this disparity has not been explored but has been purported to be due to the rigor of clinical training and lack of protected research time during residency.[30] K awards, including K08 and K23 grants, are research career development grants that provide mentored research time to support early-career scientists in their path to independent investigators and are crucial as a pipeline for developing surgeon-scientists.[1] Although orthopedic surgeon-scientists have similar rates of advancement to independent funding as individuals in other surgical specialties, as evidenced by transition from K to R grants, the prevalence of K grants among full-time faculty is lower in orthopedic surgery departments.[30] In this study, orthopedic surgeon-scientists most commonly received R01 and K08 grants, demonstrating progress in the recruitment of early career scientists for rotator cuff research.

**Table V**
NIH funding for rotator cuff tear and repair by clinical topic.

| Clinical topic | Total funding, $ (%) | Total funding with orthopedic surgeon-scientist as PI, $ (%) |
|---|---|---|
| Diagnosis | $8,955,833 (22.3) | $5,261,539 (57.1) |
| Education | $1,710,971 (4.3) | $0 |
| Implant design | $5,563,107 (13.9) | $1,038,906 (11.3) |
| Nonoperative management | $4,722,198 (11.8) | $0 |
| Postoperative complications | $3,162,424 (7.9) | $0 |
| Public health | $492,216 (1.2) | $0 |
| Rehabilitation | $9,602,474 (23.9) | $1,568,845 (17.0) |
| Surgical technique | $5,947,636 (14.8) | $1,338,922 (14.5) |
| Total | $40,156,859 | $9,208,212 |

*NIH*, National Institutes of Health; *PI*, Principal Investigator.

## *Limitations*

Although the h-index is a widely-used measure of academic influence, it may be artificially inflated by self-citation and time,[31] and does not take into account the authorship order. The NIH Research Portfolio Online Reporting Tools Expenditures and Results database does not describe success rates of grant application, which may account for the lower proportion of orthopedic surgeon-scientists receiving funding. It is possible the success rates for surgeons applying for grants are high, but the number of grants submitted is low. This study also did not evaluate the role of surgeons as non-PI participants in research. Lastly, other elements of rotator cuff syndrome, such as partial tears, shoulder impingement, subacromial bursitis, and proximal biceps pathology, were not included in analysis. This may undervalue the total NIH funding awarded for rotator cuff funding.

## Conclusion

While NIH funding for rotator cuff research is growing, orthopedic surgeon representation is low. Future studies should evaluate barriers to obtaining funding for orthopedic surgeon-scientists.

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## References

1. Activity. Activity codes search results. Available at: https://grants.nih.gov/grants/funding/ac_search_results.htm. Accessed October 9, 2022.
2. Amiri AR, Kanesalingam K, Cro S, Casey AT. Does source of funding and conflict of interest influence the outcome and quality of spinal research? Spine J 2014;14:308-14. https://doi.org/10.1016/j.spinee.2013.10.047.
3. Barker JC, Jalilvand A, Onuma A, Shelby R, Shah K, Daulton R, et al. Facilitating success of the early stage surgeon scientist trainee: growing the surgeon scientist pipeline. Ann Surg 2022;275:e334-44. https://doi.org/10.1097/SLA.0000000000004924.
4. Boddapati V, Sachdev R, Fu MC, Camp CL, Marx RG, Dines JS. Increasing industry support is associated with higher research productivity in orthopaedic surgery. J Bone Joint Surg Am 2018;100:e36. https://doi.org/10.2106/JBJS.17.00910.
5. Brindisino F, Salomon M, Giagio S, Pastore C, Innocenti T. Rotator cuff repair vs. nonoperative treatment: a systematic review with meta-analysis. J Shoulder Elbow Surg 2021;30:2648-59. https://doi.org/10.1016/j.jse.2021.04.040.
6. Demblowski LA, Busse B, Santangelo G, Blakely AM, Turner PL, Hoyt DB, et al. NIH funding for surgeon-scientists in the US: what is the current status? J Am Coll Surg 2021;232:265-274.e2. https://doi.org/10.1016/j.jamcollsurg.2020.12.015.
7. Fanelli MG, Field LD. The arthroscopic “Bellows” sign identifies hidden rotator cuff tears. Arthrosco Tech 2022;11:e723-5. https://doi.org/10.1016/j.eats.2022.01.003.
8. Funding. Funding & grants. Available at: https://www.ahrq.gov/funding/index.html. Accessed July 26, 2022.
9. Grants. Grants & funding. Available at: https://www.nih.gov/grants-funding. Accessed July 22, 2022.
10. Hu Y, Edwards BL, Brooks KD, Newhook TE, Slingluff CL Jr. Recent trends in national institutes of health funding for surgery: 2003 to 2013. Am J Surg 2015;209:1083-9. https://doi.org/10.1016/j.amjsurg.2015.01.015.
11. Iyer S, Derman P, Sandhu HS. Orthopaedics and the physician payments sunshine act: an examination of payments to U.S. Orthopaedic surgeons in the open payments database. J Bone Joint Surg Am 2016;98:e18. https://doi.org/10.2106/jbjs.O.00343.
12. Keener JD, Galatz LM, Stobbs-Cucchi G, Patton R, Yamaguchi K. Rehabilitation following arthroscopic rotator cuff repair: a prospective randomized trial of immobilization compared with early motion. J Bone Joint Surg Am 2014;96:11-9. https://doi.org/10.2106/jbjs.M.00034.
13. Langston RG, Zhao EH, Wong KH, Rodriguez A. Recent trends in NIH funding for top surgeon-scientists. Am J Surg 2021;222:281-5. https://doi.org/10.1016/j.amjsurg.2020.12.004.
14. Lawrence RL, Moutzouros V, Bey MJ. Asymptomatic rotator cuff tears. JBJS Rev 2019;7:e9. https://doi.org/10.2106/jbjs.Rvw.18.00149.
15. Lei L, Zhang C, Sun FH, Xie Y, Liang B, Wang L, et al. Research trends on the rotator cuff tendon: a bibliometric analysis of the past 2 decades. Orthop J Sports Med 2021;9:2325967120973688. https://doi.org/10.1177/2325967120973688.
16. Leopold SS, Warme WJ, Braunlich EF, Shott S. Association between funding source and study outcome in orthopaedic research. Clin Orthop Relat Res 2003;415:293-301. https://doi.org/10.1097/01.blo.0000093888.12372.d9.
17. Li L, Bokshan SL, Ready LV, Owens BD. The primary cost drivers of arthroscopic rotator cuff repair surgery: a cost-minimization analysis of 40,618 cases. J Shoulder Elbow Surg 2019;28:1977-82. https://doi.org/10.1016/j.jse.2019.03.004.
18. Mather RC 3rd, Koenig L, Acevedo D, Dall TM, Gallo P, Romeo A, et al. The societal and economic value of rotator cuff repair. J Bone Joint Surg Am 2013;95:1993-2000. https://doi.org/10.2106/JBJS.L.01495.
19. Mechanism. Mechanism detail for total NIH, FY 2000 – FY 2021. National Institutes of Health (NIH). Available at: https://officeofbudget.od.nih.gov/pdfs/FY22/spending-hist/Mechanism%20Detail%20for%20Total%20NIH%20FY%202000%20-%20FY%202021%20(V2).pdf. Accessed October 9, 2022.
20. Narahari AK, Mehaffey JH, Hawkins RB, Charles EJ, Baderdinni PK, Chandrabhatla AS, et al. Surgeon scientists are disproportionately affected by declining NIH funding rates. J Am Coll Surg 2018;226:474-81. https://doi.org/10.1016/j.jamcollsurg.2017.12.047.
21. Nikaj S, Lund PK. The impact of individual mentored career development (K) awards on the research trajectories of early-career scientists. Acad Med 2019;94:708-14. https://doi.org/10.1097/acm.0000000000002543.
22. Oh LS, Wolf BR, Hall MP, Levy BA, Marx RG. Indications for rotator cuff repair: a systematic review. Clin Orthop Relat Res 2007;455:52-63. https://doi.org/10.1097/BLO.0b013e31802fc175.
23. Okike K, Kocher MS, Mehlman CT, Bhandari M. Conflict of interest in orthopaedic research. An association between findings and funding in scientific presentations. J Bone Joint Surg Am 2007;89:608-13. https://doi.org/10.2106/JBJS.F.00994.
24. Plancher KD, Shanmugam J, Briggs K, Petterson SC. Diagnosis and management of partial thickness rotator cuff tears: a comprehensive review. J Am Acad Orthop Surg 2021;29:1031-43. https://doi.org/10.5435/JAAOS-D-20-01092.
25. Research. Research portfolio online reporting tools expenditures and results (RePORTER) national institutes of health. Available at: https://report.nih.gov. Accessed October 9, 2022.
26. Sampat BN, Buterbaugh K, Perl M. New evidence on the allocation of NIH funds across diseases. Milbank Q 2013;91:163-85. https://doi.org/10.1111/milq.12005.
27. Sarıkaya B, Bahadır B, Kaya İ, Oklaz B, Sarıkaya PZB, Kanatlı U. Can subcoracoid effusion be a more specific finding for subscapularis tear among rotator cuff pathologies on magnetic resonance imaging? J Shoulder Elbow Surg 2023;32:17-23. https://doi.org/10.1016/j.jse.2022.06.009.
28. Sheps DM, Silveira A, Beaupre L, Styles-Tripp F, Balyk R, Lalani A, et al. Early active motion versus sling immobilization after arthroscopic rotator cuff repair: a randomized controlled trial. Arthroscopy 2019;35:749-760.e2. https://doi.org/10.1016/j.arthro.2018.10.139.
29. Silvestre J, Ahn J, Levin LS. National institutes of health funding to departments of orthopaedic surgery at U.S. Medical Schools. J Bone Joint Surg Am 2017;99:e5. https://doi.org/10.2106/jbjs.16.00088.
30. Silvestre J, Hines SM, Chang B, Ahn J. Transition to independent research funding among national institutes of health K grant awardees at departments of orthopaedic surgery. J Bone Joint Surg Am 2021;103:e90. https://doi.org/10.2106/JBJS.20.01754.
31. Silvestre J, Kamath AF. Prevalence and impact of self-citation in academic orthopedic surgery. Am J Orthop (Belle Mead NJ) 2018;47. https://doi.org/10.12788/ajo.2018.0015.
32. Silvestre J, Martinez R, Thompson TL, Wilson RH, Nelson CL. Impact of orthopaedic surgeons on national institutes of health funding for hip and knee arthroplasty research. J Bone Joint Surg Am 2022;10:2106. https://doi.org/10.2106/JBJS.22.00025.
33. Tang Y, Hou J, Li Q, Li F, Zhang C, Li W, et al. The effectiveness of using the critical shoulder angle and acromion index for predicting rotator cuff tears: accurate diagnosis based on standard and nonstandard anteroposterior radiographs. Arthroscopy 2019;35:2553-61. https://doi.org/10.1016/j.arthro.2019.03.050.
34. Tempelhof S, Rupp S, Seil R. Age-related prevalence of rotator cuff tears in asymptomatic shoulders. J Shoulder Elbow Surg 1999;8:296-9.
35. Teunis T, Lubberts B, Reilly BT, Ring D. A systematic review and pooled analysis of the prevalence of rotator cuff disease with increasing age. J Shoulder Elbow Surg 2014;23:1913-21. https://doi.org/10.1016/j.jse.2014.08.001.
36. Varkey DT, Patterson BM, Creighton RA, Spang JT, Kamath GV. Initial medical management of rotator cuff tears: a demographic analysis of surgical and nonsurgical treatment in the United States Medicare Population. J Shoulder Elbow Surg 2016;25:e378-85. https://doi.org/10.1016/j.jse.2016.05.001.
37. Viswanath A, Monga P. Trends in rotator cuff surgery: research through the decades. J Clin Orthop Trauma 2021;18:105-13. https://doi.org/10.1016/j.jcot.2021.04.011.
38. Yamamoto A, Takagishi K, Osawa T, Yanagawa T, Nakajima D, Shitara H, et al. Prevalence and risk factors of a rotator cuff tear in the general population. J Shoulder Elbow Surg 2010;19:116-20. https://doi.org/10.1016/j.jse.2009.04.006.
39. Zhu E, Shemesh S, Iatridis J, Moucha C. The association between scholarly impact and national institutes of health funding in orthopaedic surgery. Bull Hosp Jt Dis 2017;75:257-63.