PEER REVIEW HISTORY

ARTICLE DETAILS

TITLE (PROVISIONAL)	Does NIH funding differ between medical specialties? A longitudinal analysis of NIH grant data by specialty and type of grant, 2011-2020
AUTHORS	Schlafly, Andrew; Sebro, Ronnie

VERSION 1 – REVIEW

REVIEWER	Robert Roskoski Blue Ridge Institute for Medical Research
REVIEW RETURNED	25-Apr-2022

GENERAL COMMENTS	This is a very nice and comprehensive article. The authors should include a table that describes the correspondence between Grant label numbers and type of grant. For example, what are F32, K08, P30, U01, etc. grants? Although most biomedical scientists are familiar with the R01 grants, it is a rare person who would know offhand what F32, K08, P30, and other grant categories represent. The authors should define $1 MM US dollars. All data should be accessible in Excel format so that readers can download the files and make analyses that are not made by these authors. The data should be presented as inflation-adjusted dollars for each year from 2011 to 2020 using the data posted in https://officeofbudget.od.nih.gov/gbipriceindexes.html. For example, to convert 2011 dollars to 2020 dollars, multiply by 1.16007. Looking at Figure 1a, for example, the funding of Departments of Medicine increased from $3600 million (2011) to $5700 million (2020) corresponding to an increase of 58%. When based upon inflation-adjusted 2020 dollars, the funding went from $4170 million to $5700 million corresponding to an increase of 36%. The latter figures better represent funding trends. Assuming that these changes are made, the authors should indicate in their tables whether the dollars are inflation-adjusted or not. Using inflation-adjusted dollars does not require any change in the number of grants in any of the tables or text. I was unable to evaluate supplementary figures 3-12 because the x- and y-axis labels were unreadable. It's a minor point, but the classical book entitled "The Elements of Style" states that the "vile" expression "the fact that" should be revised out of every sentence in which it occurs. W. Strunk Jr., E.B. White, The Elements of Style, 4th ed., Pearson Education, Inc,

	Upper Saddle River, New Jersey, 2000.

REVIEWER	Veronica Irvin Oregon State University, College of Public Health and Human Sciences
REVIEW RETURNED	12-May-2022

GENERAL COMMENTS	Review - BMJ Open BMJOPEN-2020-058191 Differential NIH Funding by Grant Types Among Medical Specialties This study assessed the relationship between medical field specialties and receipt of NIH funding. Study outcomes included number and average size of grants per specialty as well as average funding per physician in that specialty. Strengths of this study include novel use of publically available grant funding datasets and appropriate methods for data management and analysis. The Discussion section was well-written and pertinent; the main findings of the study were supported by previous studies and other medical programming and training. Weaknesses include lack of justification that certain medical specialties are involved in research and should be financially supported by the NIH. Additional weaknesses include a litany of analyses, tables, and figures without proper format or narrative context. Authors should consider reducing the number of analyses and supplementary tables. For instance, authors could remove the analyses of mean dollar amount per grant by specialty by type. The findings are hard to interpret, and it is not clear if they are significant or meaningful. See below for specific changes requested. 1. Main findings revealed that there were variations in funding between specialties and that NIH funding should be re-distributed for equitable funding by physician specialty. Study authors should further justify the rationale for this need. Maybe some medical specialties conduct research that would better fit the NIH mission and funding priorities. Maybe some medical specialties do not engage in research, or their research may not fit NIH's mission and they should not be prioritized for funding. 2. Overall, the Results section needs to be revised for clarity and interest. The Results section is difficult to read because the sentence structures are so repetitive. As such, this section is not interesting and the reader misses the main point of the findings. In addition, some of the sections or sentences seem inconsistent or not relevant (see next points). 3. In Table 1, explain or define what the column titled "rank" assesses. It is not evident if it is ranking of total number or dollars or number of active physicians. It is not clear how this ranking is important to the main findings of the study. 4. Table 2, expand table title to be more descriptive. 5. In Results, page 13 lines 49-51, inconsistent finding. Clarify if Internal Medicine received the greatest number of grants. 6. In Results, page 17, remove or re-write the results from the analyses of mean dollar amount per grant by specialty by type. The findings are hard to interpret, and it is not clear if they are significant or meaningful. 7. In Results, page 17 lines 27-34, add lay language explanation for what the significant and non-significant Bonferroni corrections signify. Bonferroni correction was significant for R01 not other funding mechanisms. 8. In the Discussion section, comment on the trend for certain specialties (like Internal Medicine) that seemed to have established a research pathway. From Table 1, it seems like Internal Medicine

	has high number of training and career development grants which would support why this specialty would also have high number of research awards. 9. In the Discussion section, there may be an additional limitation. This study only assessed the medical specialty of the PI and does not consider the medical specialties of the co-Investigators. 10. Supplementary Figures 1a, 1b, and 2. Increase font. It is impossible to read the information in the figures. 11. Supplementary Figures 3 – 12. Remove or re-do the figures. The font size is too small, but even with a larger font size, it is not clear what type of data is being displayed. 12. Supplementary figures are excessive. Consider reducing the number of analyses and supplementary figures to only those most pertinent to the study purpose and findings. Minor edits: • Page 7, lines 37 and 42: remove extraneous commas • Page 11, line 46: replace the comma with a period • Page 12, line 57: states Excel version 2107. Please check. • Page 13 line 5: add digit to the percentage of Plastic Surgery grants. Currently shows 0%.

VERSION 1 – AUTHOR RESPONSE

Reviewer 1: This is a very nice and comprehensive article.
Authors' response: We thank the reviewer for appreciating our hard work.

Reviewer 1: The authors should include a table that describes the correspondence between Grant label numbers and type of grant. For example, what are F32, K08, P30, U01, etc. grants? Although most biomedical scientists are familiar with the R01 grants, it is a rare person who would know offhand what F32, K08, P30, and other grant categories represent.
Authors' response: We have included a Table (Supplemental Table 2) which describes the correspondence between the label numbers and grant-type in the revised manuscript.

Reviewer 1:The authors should define $1 MM US dollars.
Authors' response: We define 1 MM as 1 million US dollars in the revised manuscript.

Reviewer 1: All data should be accessible in Excel format so that readers can download the files and make analyses that are not made by these authors.
Authors' response: We went through tremendous effort to create several Supplemental Tables in Microsoft Excel format as requested.

Reviewer 1: The data should be presented as inflation-adjusted dollars for each year from 2011 to 2020 using the data posted in https://officeofbudget.od.nih.gov/gbipriceindexes.html. For example, to convert 2011 dollars to 2020 dollars, multiply by 1.16007. Looking at Figure 1a, for example, the funding of Departments of Medicine increased from $3600 million (2011) to $5700 million (2020) corresponding to an increase of 58%. When based upon inflation-adjusted 2020 dollars, the funding went from $4170 million to $5700 million corresponding to an increase of 36%. The latter figures better represent funding trends. Assuming that these changes are made, the authors should indicate in their tables whether the dollars are inflation-adjusted or not. Using inflation-adjusted dollars does not require any change in the number of grants in any of the tables or text.
Authors' response: This is a wonderful and fantastic idea!!! We really appreciate the reviewer suggesting that we look at inflation-adjusted dollars. We have revised the manuscript with this change (inflation-adjusted dollars)

Reviewer 1: I was unable to evaluate supplementary figures 3-12 because the x- and y-axis labels were unreadable.
Authors' response: We have removed most of the supplementary Figures. The two Supplementary Figures have been updated so that they are readable.

Reviewer 1: It's a minor point, but the classical book entitled "The Elements of Style" states that the "vile" expression "the fact that" should be revised out of every sentence in which it occurs. W. Strunk Jr., E.B. White, The Elements of Style, 4th ed., Pearson Education, Inc, Upper Saddle River, New Jersey, 2000.
Authors' response: Agreed. We have revised the manuscript to remove any instance of "the fact that". We thank the reviewer for their review – constructive while being humorous.

Reviewer 2:
Reviewer 2: Differential NIH Funding by Grant Types Among Medical Specialties
This study assessed the relationship between medical field specialties and receipt of NIH funding. Study outcomes included number and average size of grants per specialty as well as average funding per physician in that specialty. Strengths of this study include novel use of publically available grant funding datasets and appropriate methods for data management and analysis. The Discussion section was well written and pertinent; the main findings of the study were supported by previous studies and other medical programming and training. Weaknesses include lack of justification that certain medical specialties are involved in research and should be financially supported by the NIH.
Authors' response: We thank the reviewer for taking the time to review and provide comments on how to improve the manuscript.

Skip Brass, MD, PhD the current director of the MD/PhD program at the University of Pennsylvania noted that he could predict if his graduates would go on to have a successful career in academia based on the specialty the graduate chose. Graduates choosing family medicine and emergency medicine – generally did not have as much research effort time as individuals choosing careers in Neurology and Medicine. He noted this in his study [Brass LF, Akabas MH. The national MD-PhD program outcomes study: Relationships between medical specialty, training duration, research effort, and career paths. JCI Insight. 2019 Oct 3;4(19):e133009. doi: 10.1172/jci.insight.133009. PMID: 31578310; PMCID: PMC6795497]. Another paper by Andriole et al. showed that MD-PhD program graduates were more likely to choose pathology, and less likely to choose emergency medicine, or family medicine [Andriole DA, Whelan AJ, Jeffe DB. Characteristics and career intentions of the emerging MD/PhD workforce. JAMA. 2008 Sep 10;300(10):1165-73. doi: 10.1001/jama.300.10.1165. PMID: 18780845]. Individuals with MD/PhDs are generally interested in research, however, if their career path has limited to no funding, then it is almost deterministic that he/she will fail in an academic career.

All medical specialties are directly or indirectly involved in patient care. All physicians would like better outcomes for their patients and to advance clinical care. So, all physician specialties should be funded equally by the NIH to improve outcomes for all patients.

One can argue that family medicine physicians are less interested in research therefore there is less NIH research funding in family medicine. Alternatively, one can argue that there is less NIH research funding in family medicine therefore family medicine physicians are less interested in research. It is unclear which is the cause, and which is the effect.

We can find no literature to suggest that physicians going into careers in the less NIH-funded specialties have no interest in research. However, we do note that MD/PhDs (research oriented

physicians) have chosen to go into the these less NIH-funded specialties and their academic careers suffer.

We argue that the current status quo makes some specialties (better NIH-funded specialties) more attractive to physician-researchers. However, the inequity in NIH-funding may create significant societal problems. For example, one of the worst instances of healthcare inequalities in the United States is the inequality seen in the difference between Black and White maternal mortality [MacDorman MF, Thoma M, Declcerq E, Howell EA. Racial and Ethnic Disparities in Maternal Mortality in the United States Using Enhanced Vital Records, 2016–2017. Am J Public Health. 2021 Sep;111(9):1673-1681. doi: 10.2105/AJPH.2021.306375. Epub 2021 Aug 12. PMID: 34383557; PMCID: PMC8563010.]. The mortality rate for non-Hispanic Black women was 3.55 times that of non-Hispanic White women. Here, our data shows that Obstetrics and Gynecology was one of the worst NIH-funded specialties. One has to ask – how will the Obstetricians and Gynecologists ever solve these problems if there is little NIH-funding allocated to them?

Reviewer 2: Additional weaknesses include a litany of analyses, tables, and figures without proper format or narrative context. Authors should consider reducing the number of analyses and supplementary tables. For instance, authors could remove the analyses of mean dollar amount per grant by specialty by type. The findings are hard to interpret, and it is not clear if they are significant or meaningful.

Authors' response: We have revised the manuscript to make it clearer and to discuss the meaning of each of the 5 analyses that we do. We removed almost all of the supplementary figures and tables in the revised manuscript. We also think that a single definitive paper that outlines the problem would have far higher impact, get more citations and reads, and be the reference that the NIH uses in future to address these problems.

The actual manuscript has fewer than 5 tables and/or figures.

Several individuals who read this paper would be interested in downloading the supplementary material to do these analyses (see Reviewer #1's comments). These supplementary tables are really a service to the research community as we provide the raw data for other researchers to replicate our analyses and to do further analyses.

The analyses of mean dollar-amount per grant by specialty by type is perhaps the most important analysis in the paper. A natural criticism of the analysis of the number of grants is that it doesn't consider the dollar-amount of each grant. Similarly, the natural criticism of the dollar-amount of each grant is that the analysis doesn't consider how large each physician specialty is.

In essence, the mean dollar-amount per grant by specialty assesses the number of dollars the NIH has funded per physician in that specialty. For example, for the K01 early career funding, the NIH has funded between $125.30 -$210.80 per neurologist; between $140.60 - $206.10 per internal medicine physician; but only $0.00 to $5.47 per emergency medicine physician. We think this comparison is stark and more accessible to some readers.

Reviewer #2: See below for specific changes requested.
1. Main findings revealed that there were variations in funding between specialties and that NIH funding should be re-distributed for equitable funding by physician specialty. Study authors should further justify the rationale for this need. Maybe some medical specialties conduct research that would better fit the NIH mission and funding priorities. Maybe some medical specialties do not engage in research, or their research may not fit NIH's mission and they

should not be prioritized for funding.

Response to Reviewer #2: The results show that there is significant variation in funding between specialties. We have revised the manuscript to state that further research needs to be done to understand why this discrepancy exists. We argue that the NIH should investigate this discrepancy. We noted that other researchers (PhDs, MBAs, RNs, etc.) are part of the research caucus and they may influence the discrepancy in NIH funding distribution.

“NIH is the steward of medical and behavioral research for the Nation. Its mission is to seek fundamental knowledge about the nature and behavior of living systems and the application of that knowledge to enhance health, lengthen life, and reduce illness and disability.” [https://www.nih.gov/about-nih/what-we-do/nih-almanac/about-nih].

Clearly the NIHs mission is 100% completely aligned with the mission of physicians. There is no medical specialty that does not align with the NIH mission. We would like the NIH to justify the rationale for this tremendous discrepancy. The NIH has all of the data, and it is difficult for any group of researchers to speak for all 19 medical specialties investigated.

The reviewer may be correct – “maybe some medical specialties conduct research that would better fit the NIH mission and funding priorities. Maybe some medical specialties do not engage in research, or their research may not fit NIH’s mission and they should not be prioritized for funding.” However, the reviewer may be wrong – and in this case this discrepancy has had and will continue to have substantial negative patient care and physician-researcher ramifications.

Reviewer 2: 2. Overall, the Results section needs to be revised for clarity and interest. The Results section is difficult to read because the sentence structures are so repetitive. As such, this section is not interesting and the reader misses the main point of the findings. In addition, some of the sections or sentences seem inconsistent or not relevant (see next points).
Authors’ response: The entire Results section has been rewritten and revised for clarity. All results are consistent with tables and relevant to the paper.

Reviewer 2: 3. In Table 1, explain or define what the column titled “rank” assesses. It is not evident if it is ranking of total number or dollars or number of active physicians. It is not clear how this ranking is important to the main findings of the study.
Authors’ response: The rank is based on average dollars of funding per active physician per year. We have noted this in Table 1 of the revised manuscript. This Table lets the reader identify which specialties have the most and least NIH funding per active physician rapidly, and allows comparisons between specialties.

Reviewer 2: 4. Table 2, expand table title to be more descriptive.
Authors’ response: The title of table 2 has been updated in the revised manuscript.

Reviewer 2: 5. In Results, page 13 lines 49-51, inconsistent finding. Clarify if Internal Medicine received the greatest number of grants.
Authors’ response: Internal Medicine received the greatest number of grants. We have reworded this section in the Results section so that it is clearer.

Reviewer 2: 6. In Results, page 17, remove or re-write the results from the analyses of mean dollar amount per grant by specialty by type. The findings are hard to interpret, and it is not clear if they are significant or meaningful.

Authors' response: The results from the analyses of mean dollar amount per grant per specialty by type are rewritten in the revised manuscript, so that the findings are easier to interpret.

Reviewer 2: 7. In Results, page 17 lines 27-34, add lay language explanation for what the significant and non-significant Bonferroni corrections signify. Bonferroni correction was significant for R01 not other funding mechanisms.
Authors' response: We added lay language for what the Bonferroni corrections signify. We used the Bonferroni corrections because we were doing multiple pairwise tests between the 19 specialties, and we wanted to ensure that were did not have an increased Type I error rate because of multiple testing.

Reviewer 2: 8. In the Discussion section, comment on the trend for certain specialties (like Internal Medicine) that seemed to have established a research pathway. From Table 1, it seems like Internal Medicine has high number of training and career development grants which would support why this specialty would also have high number of research awards.
Authors' response: In the Discussion section of the revised manuscript, we have noted that certain specialties like Internal Medicine may have a better pipeline in developing future researchers.

Reviewer 2: 9. In the Discussion section, there may be an additional limitation. This study only assessed the medical specialty of the PI and does not consider the medical specialties of the co-Investigators.
Authors' response: We thank the reviewer for pointing this out. We have added this limitation to the discussion.

Reviewer 2: 10. Supplementary Figures 1a, 1b, and 2. Increase font. It is impossible to read the information in the figures.
Authors' response: All Figures have been revised in the revised manuscript so that they are more legible.

Reviewer 2: 11. Supplementary Figures 3 – 12. Remove or re-do the figures. The font size is too small, but even with a larger font size, it is not clear what type of data is being displayed.
Authors' response: All Figures have been revised in the revised manuscript so that they are more legible.

Reviewer 2: 12. Supplementary figures are excessive. Consider reducing the number of analyses and supplementary figures to only those most pertinent to the study purpose and findings.
Authors' response: Most supplementary figures and tables have been removed.

Reviewer 2: Minor edits:
• Page 7, lines 37 and 42: remove extraneous commas
Authors' response: Commas have been removed in the revised manuscript.

Reviewer 2:
• Page 11, line 46: replace the comma with a period
Authors' response: The change suggested by the reviewer was made in the revised manuscript.

Reviewer 2:
• Page 12, line 57: states Excel version 2107. Please check.
Authors' response: Microsoft Excel versions are named YearVersion. This is the 2021 version 7 of Microsft excel (which is version 2107 using the Microsoft nomenclature).

Reviewer 2: Page 13 line 5: add digit to the percentage of Plastic Surgery grants. Currently shows 0%.
Authors' response: We thank the reviewer for noticing this artifact due to rounding. The percentage of Plastic Surgery grants is <0.1%. This change has been corrected in the revised manuscript.

VERSION 2 – REVIEW

REVIEWER	Robert Roskoski Blue Ridge Institute for Medical Research
REVIEW RETURNED	02-Sep-2022

GENERAL COMMENTS	This is a comprehensive review of NIH funding to various medical disciplines. It demonstrates that Departments of Internal Medicine/Medicine receive the most funding followed by Psychiatry, Pediatrics, Pathology, and Neurology. This is a timely review of an area of great interest to the medical profession. Although figures are one of the best ways to illustrate trends, Supplementary figures 1 and 2 are barely decipherable. The authors should come up with an alternate arrangement. One possibility would be to place the x-coordinates depicting the years closer together and place one point for each value for each specialty and connect the corresponding points. The with more room on the right, each line could be labeled with Anesthesiology, Family Medicine, and so forth. The authors may have alternative possibilities for revising the figures. Also the fonts in many of the supplementary tables are too small to decipher; use larger fonts.

VERSION 2 – AUTHOR RESPONSE

Reviewer #1 comment: Reviewer:
Dr. Robert Roskoski, Blue Ridge Institute for Medical Research
Comments to the Author: This is a comprehensive review of NIH funding to various medical disciplines. It demonstrates that Departments of Internal Medicine/Medicine receive the most funding followed by Psychiatry, Pediatrics, Pathology, and Neurology. This is a timely review of an area of great interest to the medical profession.
Response to Reviewer #1: We thank the reviewer for appreciating the value of our work.

Reviewer #1 comment:
Although figures are one of the best ways to illustrate trends, Supplementary figures 1 and 2 are barely decipherable. The authors should come up with an alternate arrangement. One possibility would be to place the x-coordinates depicting the years closer together and place one point for each value for each specialty and connect the corresponding points. The with more room on the right, each line could be labeled with Anesthesiology, Family Medicine, and so forth. The authors may have alternative possibilities for revising the figures. Also the fonts in many of the supplementary tables are too small to decipher; use larger fonts.
Response to Reviewer #1: All figures and Supplementary Table data have been updated/revised so that they are more readable. Table fonts are Times New Roman font 12.

VERSION 3 – REVIEW

REVIEWER	Robert Roskoski Blue Ridge Institute for Medical Research
REVIEW RETURNED	25-Nov-2022

GENERAL COMMENTS	This is a comprehensive review of NIH funding to various medical disciplines. It demonstrates that Departments of Internal Medicine/Medicine receive the most funding followed by Psychiatry, Pediatrics, Pathology, and Neurology. This is a timely review of an area of great interest to the medical profession.