# Tips for writing research papers

Susan Anenberg
George Washington University Milken Institute School of Public Health
Updated June 2020

Writing a clear, compelling, and rigorous research manuscript is not easy! Good scientific writing takes hard work, but it pays off. Papers that are communicated well are viewed more favorably by reviewers and make a bigger impact. So, put just as much care into writing clearly and accurately as you do in the analysis itself.

To avoid paralysis, I usually draft a paper outline towards the beginning of the project. I then start populating the different manuscript sections with bulleted notes as I make decisions on methods, think through uncertainties and limitations, etc. It is much easier to build a full manuscript from these notes compared with staring at a blank screen and writing from intro to conclusion! Plus, the notes help make sure you don't miss important points in the final manuscript.

Self-editing is critical. I often write a whole manuscript, and then revise it on my own line by line at least 3 times before sending to any co-author (if I'm being honest, I usually do this 5-10 times). I check to make sure there are no errors, the language I used is precise and concise, and that the organization flows well. I am brutal with my own writing. Almost nothing in my first draft makes it to the draft I send to my co-authors.

That said, there is a balance here. Some people don't do enough self-editing, while others hesitate to relinquish control while they strive for perfection. If you are in this camp, you will, at some point, reach the point of diminishing returns. If you're too close to the text, you will no longer see any gaps, errors, or other issues. Your co-authors will be better positioned to spot issues and suggest ways to improve them. Opening your draft up to others will be your best step forward.

So, what should your paper contain?

Your paper should clearly answer the following questions (adapted from Dan Moran's excellent 9 tough questions):
1. What's the issue or problem?
2. What did you do to address the problem?
3. What did you find?
4. So what? Why does it matter?
5. Who benefits from the results?

**Writing Tips**

<u>Content</u>

- Typically papers will have the following organization:
  - Abstract
  - Introduction
  - Methods
  - Results
  - Discussion
  - Conclusion
- Many people will only read the abstract. So your abstract needs to be crisp. It should concisely report the answers to each of the questions above with no superfluous detail.
- Your introduction should be written at a level of an educated non-expert. Do not assume that the reader has read any of the articles that you are citing. You must be able to describe the issue and why your work is needed in a way that doesn't require a PhD in your exact field.
- The Methods section should have enough detail for others to be able to reproduce your analysis.
- Organize your results section logically. You do not want results of different parts of the analysis to be jumbled together. Sometimes it helps to have a lead-in sentence to each paragraph, for example, "In terms of health impacts of PM2.5 on children, we found that…"
- The Discussion section should put your analysis and results in the context of the broader field. How do your results compare with previous studies? What do your results mean for environmental health, policy, etc.?
- Be up front about the limitations and uncertainties. You do not want to be in the business of burying the realities of your analysis. Astute reviewers will find the skeletons in the closet, and they will be annoyed that you didn't acknowledge them. You may even consider including a section of the Discussion on uncertainties and limitations.
- You can make liberal use of supplemental material. Supplemental Material typically has no space limitation.

<u>Style</u>

- Synthesizing is better than summarizing. For example, "PM2.5 is associated with premature mortality (Pope et al. 2002, Krewski et al. 2009)" is more compelling than "Pope et al. (2002) conducted an epidemiological analysis and found that PM2.5 is linked with premature mortality. Krewski et al. (2009) provided an updated epidemiological analysis and found consistent results that PM2.5 is linked with premature mortality." Synthesize across multiple articles; don't just summarize what each article did/found.
- Use precise language. Do not say PM2.5 when you mean black carbon. Do not say premature mortality when you mean only cardiovascular mortality. Do not say significant

unless you mean statistically significant (and then provide the p value you used to judge that). These are just a few examples.

- Do not use extra words that don't add any meaning or value. Do not use "in order to" when "to" works. Do not use "our analysis found that…" when you can write "we found that…"
- Instead of "Table 1 shows that…" or "Figure 1 shows that…" you can just say what it shows and include "(Table 1)" or "(Figure 1)" at the end of the sentence.
- Use active voice. Don't fall into the "decisions were made" trap. It is appropriate to write "We used the GEOS-Chem chemical transport model…" rather than "The GEOS-Chem chemical transport model was used to…" Also you can use "We estimated that…" etc.
- The results section should report numerical values where possible. For example, it is not enough to say "We found that X is larger than Y." How much larger? How much is X and how much is Y? It often works to put numerical values in parentheses so as to not break up the flow of the language.
- Do not overstate the certainty of your results. It is usually more appropriate to use "may" or "can" rather than "is" or "will".
- Include in-text citations at the end of sentences. If there are multiple concepts in each sentence with different citations, each citation should immediately follow the relevant concept rather than jumbling the citations together at the end of the sentence.
- Typically you want to stay away from using non-standard acronyms. It is too much to ask readers to remember novel acronyms coined in an article. The exception is if one phrase is long and repeated often throughout the article. Then it may feel too repetitive to write out the whole thing, and might be better written with an acronym.

Formatting
- Follow the journal's formatting guide. Every journal has different formatting requirements. Do not go over the word/figure/table limit. You do not need to format the text to look like published articles. Each journal has a production team that does that.
- Number pages, tables, and figures. Table and Figure captions should include as much description as is necessary to interpret them without reading through the manuscript text. They can be long if needed.
- Figure and table text needs to be legible. Use high resolution (vector format preferred) and a large enough font size.
- Table captions should be above the table. Figure captions should be below the figure.

Think you're ready to submit?
- After you've written your whole manuscript, return to the questions above and make sure you have clearly addressed them.
- Double, triple, and quadruple check all numbers, tables, and figures before each submission. If an error gets into a published article, you'll have to ask the editors to publish an addendum.

**What happens after submitting?**

- The manuscript is assigned to an Editor or Associate Editor, who does a first pass and decides whether to send the paper out for peer review. If they don't, it is called a "desk reject." If you have written your paper clearly and chosen an appropriate journal, this should not happen. It does happen sometimes with high level journals who may desk reject a large portion of first submissions.
- If the paper goes out for peer-review, it will be sent to 2-3 expert reviewers. They typically have 2-6 weeks to do their review, depending on the journal.
- The peer reviews will be sent back to the Editor or Associate Editor, who will make a decision on the manuscript. Decisions include "accept" (nearly never happens for first submissions), "major revisions", "minor revisions", or "reject." Sometimes there is also a "reject and resubmit" decision. Anything other than reject is good news. That means that the journal wants to publish your paper, but it is just not yet in shape for publication.
- The Editor/Associate Editors decision will be sent to the corresponding author of the paper with the full reviews of the peer-reviewers. Again, do not freak out if there are a lot of comments - there usually are! Anything other than reject is good news. All comments are helpful because addressing them will produce a better published article. In other words, feedback is good - embrace it!
- It is now your responsibility to respond to each and every one of the reviewers' comments. And you do need to respond to each and every one. Many will require changes to the manuscript. Some will not, but will still require a thoughtful explanation. Do NOT be dismissive of reviewers' comments; they will be annoyed.
- You will need to prepare a track changed version of the manuscript, plus a point by point response to each and every one of the reviewers' comments. Simply copy and paste from the journal's decision letter into a new document, and begin responding to each comment.
- After resubmitting the manuscript, the Editor or Associate Editor will make a decision, or they will decide whether to send the manuscript back to the reviewers. The reviewers will then re-review and provide additional comments if they wish. There are usually 1-2 rounds of reviews, and sometimes 3.
- Hopefully, you have responded adequately to all the issues raised, and the Editor/Associate Editor decides to accept your manuscript. Some journals will then copy edit your article and ask a bunch of questions to make sure the writing is rigorous and clear. The next step is that the journal typesets the article and you review it to make sure there are no errors.
- Some journals publish the articles online as soon as the article is accepted. Others do not publish the article until it has gone through production.
- The whole process from original submission to publication can take 3-9 months.