

## EDITORIAL

## Reproducibility and data presentation

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These are interesting times! We are participating in a revolution of biological knowledge and in the manipulation of medical phenomena. But accompanying these scientific developments, there is also a realization that the pace of change and the pressure to publish may undermine scientific rigour, prompting increased scrutiny and the challenge to find ways to improve reproducibility in scientific data and publication.

The increasing complexity of physiological sciences over that past decade or so is reflected in our research publications that are integrating multiple complementary methods and have numerous collaborators. There is also the broader political imperative to demonstrate that society is benefitting from the public money invested in scientific research.

Greater attention is being paid to the value of open science and data sharing, especially with high-throughput methods being adopted that are capable of generating large datasets. Physiology thrives on our collective vitality and creativity. In all this activity, there are inevitable questions about whether the scientific literature is keeping up with the times.

*The Journal of Physiology* has a long history of refining and improving the research that it publishes through peer review. Over the decades, the modes of research publication have evolved; there is a pressure to keep costs down, automation up and submission-to-publication times minimised, and yet each submitted article must still receive effective peer review: this is the fundamental pillar to evaluate and judge scientific quality. The Editorial Board of *The Journal of Physiology* has often discussed how best to improve statistical reporting, and over the past 8 years both *The Journal of Physiology* and the *British Journal of Pharmacology* have sought to encourage authors to voluntarily improve their statistical reporting through joint publication of a series of statistical ‘how-to’

guides (<https://bit.ly/StatisticalGuidelines>) and data presentation advice (<https://bit.ly/PresentingYourData>) aimed at providing instructions to authors and referees and raising data reporting standards. Sadly, however, these voluntary initiatives have failed to generate a meaningful change in the research papers that have been published, in spite of the effort we have put into educating our colleagues.

This conclusion was reached in a recent paper by Diong *et al.* (2018) that examined the quality of statistical reporting prior to the joint statistical guidelines initiative and afterwards. They compared 200 articles from both publications and showed there was little or no improvement in reporting practice for statistics or data presentation.

We must conclude that our ‘encouragement’ has demonstrably failed, so how should we respond? We need a system to standardize delivery of information; and one that has high ethical standards of reporting. We are committed to publishing the best physiology research, but without clear rules, change will not happen. We recognise that almost all authors are applying high ethical standards to their work, but habits are hard to break, especially when time is such a precious commodity. We must also ensure that our policies are fair and do not over burden our authors, editors and referees.

We have therefore decided to implement a new policy with which we expect all authors to comply. We realise that this will create more work for authors, but we hope that they recognise the need for better reporting, not just in our journal, but in physiology more generally. By taking a lead on this, we hope to educate and promote transparency in statistical reporting to the wider community.

*The Journal of Physiology* will continue to ask authors to present methods in sufficient detail to promote replication of the research and to have clear and transparent visualisation of data in figures. Our new policy enables editors to check facts without overburdening them, assist authors in accurately disclosing information via a standardized template, and, most importantly, provide readers with understandable evidence to support a manuscript’s conclusions.

We have moved from encouraging best practice to mandating it. This includes the use of figures that plot all data points (where  $n \leq 30$ ) alongside appropriate summary statistics as well as the use of standard deviation (rather than standard error of the mean), declared definitions of  $n$ , and reporting of statistical comparisons with exact values of  $P$ . A recent *Journal of Physiology* Editorial talks about the best way to present data visually (Schultz, 2018).

We are providing a framework for reporting and summarizing the key numerical data and statistics by introducing a ‘Statistical Summary’ table into every manuscript. This is effectively a ‘key-points’ for the numerical information presented in the manuscript. We will require a single table to which referees, editors and authors can refer. It will be published with the article when accepted, so that readers, too, can easily glean quantitative information about the statistical tests applied and the interpretation/conclusions that were drawn from them.

The Statistical Summary serves three roles – to summarize the conditions and potential biases; to list the observations and their statistical validation; and to provide a single place where authors and readers can check numerical information. As we roll out this new policy, and in order to help prepare our prospective authors, this data summary will not be mandated upon initial submission (although it is recommended as good practice), but it will be required on submission of revised papers.

Data quality and reproducibility is a big deal, not because of increasing fraud or poor intent, but because it improves and enhances the presentation and understanding of the science at a time when data are of increasing complexity. We believe that the new policy will foster best practice and further contribute to raising standards across physiology.

## References

- Diong J, Butler AA, Gandevia SC & Héroux ME (2018). Poor statistical reporting, inadequate data presentation and spin persist despite editorial advice. *PLoS One* 13, e0202121.
- Schultz HD (2018). Visualizing data in research articles. *J Physiol* 596, 3431–3432.