

Publication integrity: what is it, why does it matter, how it is safeguarded and how could we do better?*

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ABSTRACT

Trustworthy literature is an essential part of knowledge, evidence-based information, and science. However, publications can contain mistakes or have results from unreliable research, which may compromise their integrity. In this review, we discuss publication integrity, with a focus on our field of biomedicine, and how it could be improved. In our experience, compromised publication integrity is frequently poorly handled, and we, and others, have reported that responses to publication integrity concerns can be inefficient, inconsistent, slow, opaque, and incomplete. Checklists and tools are now available to assist in the assessment of publication integrity, but systemic changes are needed. However, this requires many of the key parties involved (journals, publishers, institutions, academic societies, and regulators) to acknowledge and engage with the problem. There is little evidence of a willingness to do this. We conclude that it has been recognised for many years that the system for dealing with publication integrity is broken, but currently, there appears little interest in trying to improve it.

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Trustworthy literature is an essential pillar of science and knowledge. The system that produces academic literature is also based largely on trust. Authors undertake research and write manuscripts, academic colleagues peer review the manuscript, editors make decisions about the suitability of the manuscript, and publishers produce the final output. At every point, the system relies on all parties being accurate, and acting honestly and in good faith. But sometimes things go wrong: a mistake is made, an incorrect analysis is done, and the ensuing results or conclusions are incorrect. A publication that has errors, or results from unreliable research is itself unreliable. Publication integrity embodies this concept: are the methods, data, analyses, results and conclusions from a publication reliable? It is important to distinguish between a publication being unreliable and *why* it is unreliable. To the reader of the article, it does not matter why publication integrity is compromised, simply knowing that it is compromised is enough. In this review, we

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will discuss compromised publication integrity, and highlight common examples, how it is detected, how it is dealt with, and why it happens. Since we think the current systems and processes for maintaining publication integrity are inadequate, we will make some suggestions for improvements. The review is based on our extensive experience of publication integrity cases in the biomedical literature, supplemented by a literature search of Pubmed (using the term 'publication integrity'). While our focus is biomedical literature, we think that the underlying concepts can be applied and adapted, where necessary, to any scientific publication or discipline.

Compromised publication integrity

Figure 1 shows the breadth of issues that might cause compromised publication integrity. They range from trivial to serious problems, and their causes range from unintentional, honest mistakes, through questionable research practices, to deliberate attempts to mislead.

Errors are common in academic papers. While undesirable, it is impractical to expect that mistakes and errors will not occur. Writing a publication is hard. It needs to be succinct, engaging, and accurate, with sufficient detail to allow replication. Often papers will condense many years of complex research and science into an article constrained by length, and idiosyncratic journal requirements. Changes are often introduced at a late stage by the peer review process or during editing by the publisher. In correcting a manuscript to meet the requirements of one reviewer, an error can be unintentionally introduced that is overlooked by the authors, and not detected by the editor or other reviewers. Given these factors, it is unsurprising that errors or mistakes are made which compromise publication integrity.

The simplest errors are typographical and transcription mistakes. While often trivial and inconsequential, they can be important: for example, the common mistake of mislabelling a standard deviation as a standard error of the mean, and vice-versa. Analytic errors include incorrect data, incorrect statistical code, and incorrect analyses. While

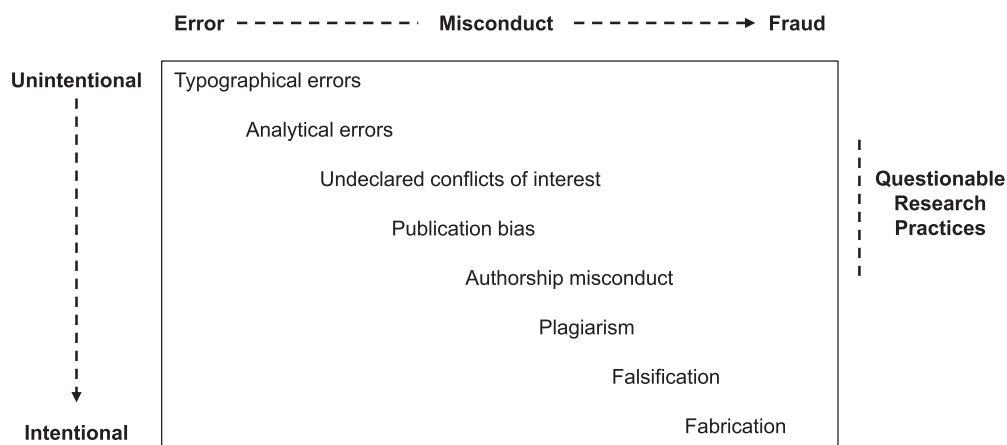


Figure 1. Range of issues causing compromised publication integrity. Adapted and modified from (Nylenna and Simonsen 2006).

these errors can sometimes be detected in publications, often they can only be found by analysis of the raw data underpinning the publication. Their effects vary from minor changes that have little impact on the conclusions to changes that completely alter the results and conclusions (Bauchner and Golub 2019).

Some analytic errors are honest mistakes, but others fall under the label of Questionable Research Practices (QRPs). For example, deleting outlier data to 'improve' results, performing multiple analyses but only reporting those that are statistically significant, and switching primary outcomes in analyses. QRPs are practices that are problematic and may compromise publication integrity but fall short of outright fabrication and fraud. Other examples of QRPs include failure to declare academic and financial conflicts of interest, 'salami' publications, where a single study is reported in multiple redundant publications, and missing publications, where research studies, or their outcome data, are unreported, usually because the results are neutral or do not align with the prevailing or anticipated view. Authorship transgressions including 'ghost' authorship, where an author makes a large contribution but is not acknowledged, or gift authorship, where an author has not made a significant contribution, are usually considered QRPs (Wislar et al. 2011). 'Paper Mills' are an extreme form of this, where authorship is sold to authors who are not involved with the publication (Else and Van Noorden 2021). Paper mills may also hijack peer-review by recommending to journals reviewers who provide favourable assessments of publications. The output of some paper mills is entirely fabricated, for example, the research study did not take place and some of the purported authors do not exist. Such examples would be considered an example of research misconduct.

Research misconduct is often defined as plagiarism, falsification (manipulation of methods, data or results) or fabrication (making up methods, data, or results). The lines between honest mistakes, questionable practices, and misconduct are blurred. But each produces the undesirable outcome of unreliable publications.

How common is compromised publication integrity?

Estimates of the frequency of compromised publication integrity vary widely and depend upon what measure is considered. For example, by 2012 about 2 million new records/year were added to the Web of Science collection, while about 6/1000 articles were corrections and 1-2/10,000 articles were retractions (Fanelli 2013). More recently, about 0.2% of articles published in 2022 were retracted, and in 2023, more than 10,000 articles were retracted (Van Noorden 2023). These rates would suggest that compromised publication integrity is rare. However, these cases are likely to be the tip of the iceberg.

When publications are closely examined, mathematical and factual discrepancies are common: for example, of 100 clinical trials, 42/50 (84%) retracted trials had such discrepancies, but 24/50 (48%) unretracted trials also had similar errors (Cole et al. 2015). When one editor systematically reviewed all clinical trials submitted to his journal and began requesting raw data for any trial that he had concerns about, he identified errors in 2% of trials based on the publication alone and 44% when raw data were provided (Carlisle 2021). These analyses were conducted on publications of clinical trials. Whether similar findings would occur in other research designs or disciplines is not known but such transdisciplinary research would be valuable. Finally, when researchers were asked about their behaviour,

about 2% said they had fabricated or falsified data or altered results to improve the outcome, and up to 34% admitted to other QRPs (Fanelli 2009; Williams and Roberts 2016). When asked the same questions about the behaviours of colleagues, about 14% said they knew of individuals whose behaviour would be considered misconduct, with the proportions for QRPs about 2–3 times higher (Fanelli 2009). Similar findings have been reported in more recent surveys (Gopalakrishna et al. 2022). Currently, the Retraction Watch database (<http://retractiondatabase.org>) contains >45,000 retractions, with >4000 retractions of papers published in 2022 (Van Noorden 2023).

How is compromised publication integrity prevented and detected?

There is no consistent or systematic approach. Some journals and publishers undertake pre-publication checks for plagiarism or image manipulation using specialist software, and a small number of journals screen baseline variables of clinical trials for data patterns that are inconsistent with randomisation (Loadman and McCulloch 2017). Peer review might identify concerns about publication integrity but after the rejection of the submission, journals and publishers do not consistently take action to prevent the paper being published elsewhere. After publication, journals and publishers rely on being notified by readers about potential problems. Journals take different approaches to notifications. Some consider anonymous or pseudonymous notifications either directly to the journal or on PubPeer (<https://pubpeer.com>), an online forum for post-publication comments. Others take note of social media comments, for example, tweets on twitter/X, while others will only act on specific notifications directly made to the journal made by someone whose identity is disclosed to the journal. These differences in approach make it very likely that there are large differences in thresholds before concerns are actually examined by journals or publishers. It seems clear that only a small minority of publication integrity issues are ever notified to, or considered by, journals.

How do readers detect compromised publication integrity?

To our knowledge, this has not been formally studied. Most cases probably occur serendipitously, when a knowledgeable reader notices a clear error, or that something is ‘not right’ with the publication. This might occur more frequently during the conduct of a systematic review, where publications may be examined very closely. More recently, individuals or groups, sometimes called ‘research sleuths’, have begun to regularly and/or systematically assess publications for integrity concerns (Retraction Watch 2018). They may assess image integrity, data, methods, and analyses within individual publications, or systematically review groups of publications from researchers or research groups. A number of tools have arisen from this work that facilitate the systematic assessment of publication integrity in biomedicine. They can be divided into two broad groups: checklists and specific tools. We published the REAPPRAISED checklist, which gives guidance on the systematic assessment of the integrity of a publication (Grey, Bolland, et al. 2020). Other checklists have now been released or are in development, including tools developed by a Cochrane group (Weibel et al. 2023), TRACT, a tool for assessing the trustworthiness of randomised trials (Mol et al. 2023), and INSPECT-SR, a tool designed to assess which trials should be included or excluded from systematic reviews (Cochrane Collaboration 2023).

The second group includes tools specifically designed to detect compromised integrity. Plagiarism tools have been around for a long time, and are now routinely implemented at many journals, but would not usually be available to most readers. Tools that look for ‘mangled’ or nonsensical text can detect publications generated by a computer program (Cabanac et al. 2022), and newer tools are specifically being created to detect text generated from artificial intelligence programs. Tools that detect errors in genetic sequences or the names of genes listed in publications are available (Labbe et al. 2019). Newer tools look for the typical signatures of a paper-mill publication (STM 2023). A number of statistical tools are now available to assess various aspects of publications. Tools can assess whether reported means and their standard deviations are mathematically possible (PrePubMed), or whether p -values reported in a publication are correct (Nuijten et al. 2016). Finally, a number of tools have been developed for the assessment of randomised trials. In such trials, each individual is allocated by chance to a treatment group by randomisation. Therefore, baseline variables for the groups of individuals will also vary by chance, and their distribution should follow the expected distributions produced by chance. Thus, for example, categorical variables follow the binomial distribution, whereas p -values for the difference between continuous baseline variables are uniformly distributed (Bolland, Gamble, Avenell, Grey 2019; Bolland, Gamble, Avenell, Grey, et al. 2019). Since the expected distribution is known, it can be compared with the observed distribution from a group of control trials. This approach has highlighted a number of examples of compromised publication integrity both in individual trials (Carlisle 2017), and in groups of trials (Carlisle 2012; Bolland et al. 2016; Carlisle and Loadsman 2017; Bolland, Gamble, Avenell, Grey 2019; Bolland, Gamble, Avenell, Grey, et al. 2019; Bolland et al. 2020; Bolland, Gamble, Avenell, Cooper, et al. 2021; Bolland, Gamble, Avenell, Grey 2021; Bolland et al. 2023). These tools are freely available in the reappraised package for the statistical program R (CRAN), meaning trial data can be easily scrutinised.

What happens after journal/publisher notification?

Ultimately, the final decision about the integrity of a publication sits with the publishing journal. Different journals and publishers have their own approach, but rapidly alerting readers to integrity concerns is not their main focus. Broadly speaking, the recommended approach (Committee on Publication Ethics (COPE) 2006) is that once a notification is received, the journal should internally review the issue, including communicating with the author(s) as needed. If the issue is resolved, the journal notifies all parties and undertakes any required action, such as a correction. If the issue cannot be resolved, then the journal contacts the institution(s) of the author(s) and requests that an investigation is undertaken. Once completed, all parties are informed of the outcome. The process can be complicated: the corresponding author may not reply to the journal, requiring co-authors to be approached; it can be very difficult to determine who should be contacted at an institution, and the institutions may be conflicted, not reply or conduct adequate investigations (Gunsalus et al. 2018). Occasionally, regulatory bodies are available and are contacted. Because of these complexities, some publishers have formed integrity groups to assist journals, and in many cases, the publisher largely handles the entire process. Generally, one of four outcomes occurs: no action is recommended, a

correction/erratum/corrigendum to the publication is issued that corrects any errors, an Expression of Concern is published that serves as a ‘placeholder’ indicating to readers that concerns have been raised and not resolved and further investigations are being undertaken, or publications are retracted with or without republication.

What is COPE?

An industry-funded organisation, COPE – Committee on Publication Ethics – has published guidelines that cover many of the situations that arise (Committee on publication ethics (COPE)). These guidelines focus on processes that journals should follow, but provide no advice on methodologies for assessing publication integrity. COPE has become central to publication integrity. It was initially an informal group of journal editors concerned about how journal editors should handle cases of misconduct. Since the first meeting in 1997, it has become an organisation, registered in the UK as a charitable company, that has about 15,000 members, including nearly 100 publishers, and nearly 14,000 journals. More recently, universities, corporates, and other relevant organisations as well as individuals have been allowed to become members: currently, about 60 individuals are listed as members. Initially, COPE published a Code of Conduct for Editors that set out minimum standards for editors, which COPE members were expected to adhere to. Over time, this document was replaced by a series of flowcharts, guidelines and recommendations for specific situations. These documents were informed by meetings and discussions facilitated by COPE. In addition, COPE provides a forum where members could ask for advice about individual cases, and the anonymised case details and advice given is published in a database of cases. COPE also has a complaint process for concerns to be raised about the behaviour of COPE members, but there is little public detail about how often this is used, the process and the outcomes. The benefits of COPE membership include the ability to advertise that the journal or publisher is a member, by displaying the COPE logo on their website, to receive advice on individual cases, quoting COPE guidance in their decisions, and attending COPE meetings.

Pitfalls in the process – a broken system?

Perhaps it is not surprising that problems are common, as there is a lot at stake. Expressions of concerns and retractions are tainted by the common association with misconduct. Often this is exacerbated by the conflation of publication integrity, that is whether the publication is reliable or not, and the underlying reasons for any issues. For example, if a publication has mathematically impossible data, its integrity is compromised without having to make any judgement about *why* this occurred, such as was it a simple, honest error, or was it a result of something intentional? As a consequence of this stigma, authors often resist or do not engage with any attempt to assess publication integrity and are anxious to avoid Expressions of Concern or Retractions. Some authors have taken legal action against journals or publisher in an attempt to prevent such an outcome (Retraction Watch).

However, the problems are not just related to authors. There are numerous published examples where journals, publishers, and institutions do not follow accepted

recommendations for investigating and reporting compromised publication integrity and publishers being reluctant to retract or correct publications (Saiz et al. 2018; Grey, Avenell, et al. 2020; Bolland, Grey, et al. 2021; Grey et al. 2021; Williams 2023). Journals and publishers may not investigate clearcut problems. When they do investigate, their actions and responses are often very slow, inefficient, inconsistent, inadequate, and opaque (Bolland, Grey, et al. 2021). In addition, journals and publishers can get caught up in trying to investigate *why* compromised integrity has arisen (rather than whether the publication is reliable or not) when they do not have the resources or authority to investigate. Thus, they may attempt to investigate *why* the issue arose rather than referring it to an institution to undertake an investigation, they may unnecessarily wait for the institutional report before taking action when data are clearly compromised, or they may decline to take action about clear cases of compromised publication integrity because they did not arise from research misconduct.

Many of these problems are illustrated by a detailed case initiated by us: over a 7-year period, 2013–2020, we notified 78 journals, 32 publishers, 4 institutions, 3 specialist societies and 2 governmental regulatory authorities, about 300 publications that we had systematically reviewed using iterations of the REAPPRAISED checklist and found to have wide ranging concerns about their publication integrity (Bolland et al. 2016; Kupferschmidt 2018; Grey et al. 2019; Grey, Avenell, et al. 2020). The co-authors had admitted to systematic authorship misconduct, and one author admitted to data fabrication for some of the clinical trials published by this group (Gross 2016). 10 years after these notifications started, 122 publications have been retracted, another 12 have expressions of concern, and 3 have corrections, leaving more than half the publications with no public information that concerns have been raised about them. About half the journals and/or publishers eventually responded to our notifications indicating that they would investigate, but it often took multiple emails to elicit any response. Of those that did respond, about 85% provided some form of response to the concerns. The average time to respond was >12 months, and the average time to retraction about 16 months. Paradoxically, as time went by and more evidence of compromised publication integrity accumulated, the times to respond and to retract became longer rather than shorter. Despite the large number of journals, publishers, and institutions involved, no co-ordinated investigations took place, with each organisation seeming to assess each publication independently, which is not consistent with COPE guidance (Committee on publication ethics (COPE) 2015). Most of the responses from the journals, publishers, and institutions were inadequate: they did not address all the concerns raised or adequately assess objective problems such as impossible data or apparent failure of randomisation. The reports from the five affected institutions did not assess all the publications at their institution and did not meet standards recommended for institutional reports (Grey et al. 2019). Thus, the outcome is that the majority of publications by this group have no indication that serious concerns exist about the authors' research in general, and also about the specific publications. We estimate that collectively we have spent more than 6,000 h (about 2 years of 8 h days) on the assessment, notification, and follow-up of these integrity concerns. Without this effort, no action would ever have been taken about any of the publications. It is unlikely that any future action for the remaining publications will ever occur unless concerned readers are able to convince the journals and publishers to act, which seems very unlikely at this point. Unfortunately,

our experiences with journals, publishers and institutions are not unique, and are not different to those of other ‘research sleuths’ (Saiz et al. 2018; Williams 2023).

A reasonable conclusion to draw is that currently a moderately high proportion of publications will have errors that range from trivial to those that seriously compromise publication integrity. Most of these errors will not be notified to journals or publishers, and of the issues that are identified, corrective action will only be taken for the minority. The >4000 retractions currently listed in the Retraction Watch database for 2022 publications will be only a tiny fraction of the publications that year which have compromised integrity.

Does compromised publication integrity matter?

A number of individuals at journals or publishers that we have contacted about various cases have expressed the view that the publications are quite old, and it is either too hard to act or there is little value in doing so. Likewise, a number of editors express distaste when compromised publication integrity is suggested (Williams 2023). The counterview is that publications, regardless of their age, are read, and do influence researchers, academics, and policy makers. Ultimately, the beneficiaries of scientific knowledge are people in the community – in our field those people are patients – and thus everyone is potentially affected when publications are unreliable.

The case of compromised publication integrity that has arguably caused the greatest harm involved fabricated data about a potential link between the MMR vaccine and autism. The data were published in 1998, only retracted in 2010 and have ongoing adverse effects (Deer 2011). Fears engendered by the publication caused numerous people to avoid that specific vaccination, and encouraged vaccine hesitancy in general, contributing to worldwide outbreaks of vaccination-preventable disease and many avoidable deaths (DeStefano and Shimabukuro 2019).

Cases with much lower profile and which were not identified for many years may also have potentially large effects. One example is the case of vitamin D supplementation for preventing falls and fractures. The effect of vitamin D supplements on falls has been studied in many clinical trials. Some initial studies suggest that they may prevent falls (Pfeifer et al. 2000), and, in combination with calcium supplements, prevent fractures (Chapuy et al. 1992), but the results from the individual trials were quite inconsistent. Systematic reviews and meta-analyses reported that when the trial data were pooled, vitamin D had clear benefits on falls (Michael et al. 2010). However, these meta-analyses were heavily influenced by two small trials that reported very strong benefits on falls and fractures. One of the trials has now been retracted (The Editors 2017), and the other has mathematically impossible data that the authors have not explained and the journal has declined to act on (Bolland and Grey 2015a, 2015b). When the two trials are excluded from meta-analyses, vitamin D supplements have no effect on falls or fractures (Bolland et al. 2018). The unretracted trial has been cited nearly 700 times, about 1/3 of which have occurred since letters of concerns about the trial were published in 2015. Vitamin D supplement use has increased at least 10–20 fold over the past decade in Westernised countries, costing at least £130 million/year and >£1 billion in the past decade in the UK (Bolland, Avenell, Smith, et al. 2021) and >\$1 billion/year in NZ (Bolland, Avenell, Grey 2021), even though the evidence suggests that its benefits are minimal, if any, for most people (Bolland et al. 2018). The two individual trials were not

the sole cause of this increase, but their substantial (and false) contributions to meta-analyses altered the pooled results towards favourable effects of vitamin D, and undoubtedly influenced the subsequent explosion in vitamin D prescribing.

In contrast to these examples, compromised publication integrity that is identified and corrected quickly may have limited impact outside damage to the reputation and career of the author(s). For example, in high-profile cases involving stem cells (Kennedy 2006; Cyranoski 2014), the false research findings probably had little sustained impact on the field because they were quickly identified as not reproducible. Likewise, when research misconduct by Surgisphere was uncovered during the COVID-19 pandemic, the high profile and rapid retraction of the (equally high profile) publications limited the impact of the false publications (Baker et al. 2020).

Are innocent authors unfairly targeted with criticism?

One viewpoint that is commonly expressed, often by individuals involved with journals or publishers, is that assessments of publication integrity can become a 'witch hunt'. They caution against 'vigilantes', who might remain anonymous or pseudonymous (for good reasons), making exaggerated, malicious claims about publications or their authors (Woolf 1988). It is difficult to know the prevalence of vexatious claims about publication integrity, as to our knowledge, this has never been reported. On the one hand, authors should not have to defend their publications against malicious or vexatious claims, especially when it affects their livelihoods, reputations and careers (Woolf 1988), but on the other hand, having put a publication into the public domain, it is reasonable to expect that it will be carefully scrutinised, and that any errors and inconsistencies will be found. Thus, authors should be able to reply to questions about their papers and correct errors within them. Public statements summarising concerns raised, how they were addressed, and attesting to the validity of the publication should allay author(s)' fears. In particular, if this process is transparent and the results are made public, it might make vexatious or malicious allegations less likely.

The easiest way to address many of the issues raised would be to publish the dataset and code that replicate all the analyses alongside the publication, allowing for independent scrutiny and analyses. Some journals require this, but in general, publication of raw data is uncommon. Authors may have legitimate reasons to resist routine publication of raw data – they have further work they wish to do using the dataset and they want to have time to complete those analyses before sharing data. They might be constrained by the ethics of sharing clinical data, or worried that other groups with no links to the original authors or the field (termed 'research parasites' by the *New England Journal of Medicine* editors (Longo and Drazen 2016)) might use the dataset in ways that prevent the original authors getting credit for gathering and sharing data. However, often there seems little reason that data, or parts of the full dataset, cannot be published. When individual data are available, the ability to detect compromised publication integrity increases dramatically (Carlisle 2021).

Why does compromised publication integrity occur?

Simple, honest errors will always happen, given the complexities and demands of scientific endeavour. Hopefully, researchers and authors will have systems in place to avoid

errors – for example, following best practices in research methods, data gathering and analysis, and writing manuscripts. But no system is foolproof, and errors will happen, and they will be published. But these should be easy to fix – publications are corrected, or withdrawn and republished if the error is serious enough. Correction of honest mistakes is unlikely to have any substantial impact on the career of a researcher, and might actually enhance their reputation by showing that they are an honest, credible scientist.

But the more challenging issue is why do more intentional problems, such as QRPs and misconduct, occur. [Figure 2](#) gives an overview of the competing demands and consequences that might contribute to compromised publication integrity. While the area is challenging to research, some studies have been conducted (Fanelli et al. 2015; Fanelli et al. 2019). Generally, it is suggested that there are many factors that contribute to compromised publication integrity. The research environment, both locally and nationally, is likely important. Institutions and countries with strong policies and regulatory environments that support research integrity and punish misconduct are assumed to be less susceptible (Fanelli et al. 2015). Beyond policies, local and national culture is also likely to be influential. Environments where there is good quality training and supervision and a culture that supports and rewards good research practices, checking of other's work, and open communication are less likely to lead to QRPs. On the other hand, situations where training and supervision are lacking or cursory, and without internal peer review, may make compromised publication integrity more likely (Fanelli et al. 2015). Cultural differences, where different academic practices and standards occur, might lead to authors having different expectations of the publication process than the journals they are seeking to publish in. Conflicts of interest, either financial or academic, may influence research conduct or reporting, which might bias results. Failure to declare conflicts of interest is common and might be deliberately deceptive or occur because the individual does not consider the conflict is important or has affected them or their research (Grey and Bolland 2015; Grey et al. 2017; Wang et al. 2017).

A common view is that the academic pressure to publish, often termed 'publish or perish' is an important contributing factor. If a successful career is defined by academic promotion, which in turn is heavily dependent on winning grants, securing other research funding, and publications, preferably numerous and in 'high impact' journals, that pressure might lead to scientists taking shortcuts, interfering with peer review, purchasing publications from paper mills, or committing outright misconduct. Financial incentives for publications provided by universities or at a national level have been associated with an increase in identified cases of compromised integrity (Qiu 2010; Fanelli et al. 2019; Sadeh et al. 2019). There is a need for better understanding of all the potential drivers of compromised integrity.

One way of considering the issue is as an example of the Prisoner's dilemma. In the classic situation, two people who have committed a crime are kept independently in prison cells. Each has the option to keep quiet (co-operate with their accomplice) or to confess to their crime and testify (defect from their accomplice): if both confess/defect, they both get a medium prison sentence; if one confesses/defects and the other keeps quiet (co-operates), the defector goes free and the other gets a long prison sentence; if both co-operate and keep quiet, both get a short sentence. Objectively, the best outcome for both people is to co-operate and take a short sentence. However, individually, the rational choice is to defect, because, no matter what the accomplice does,

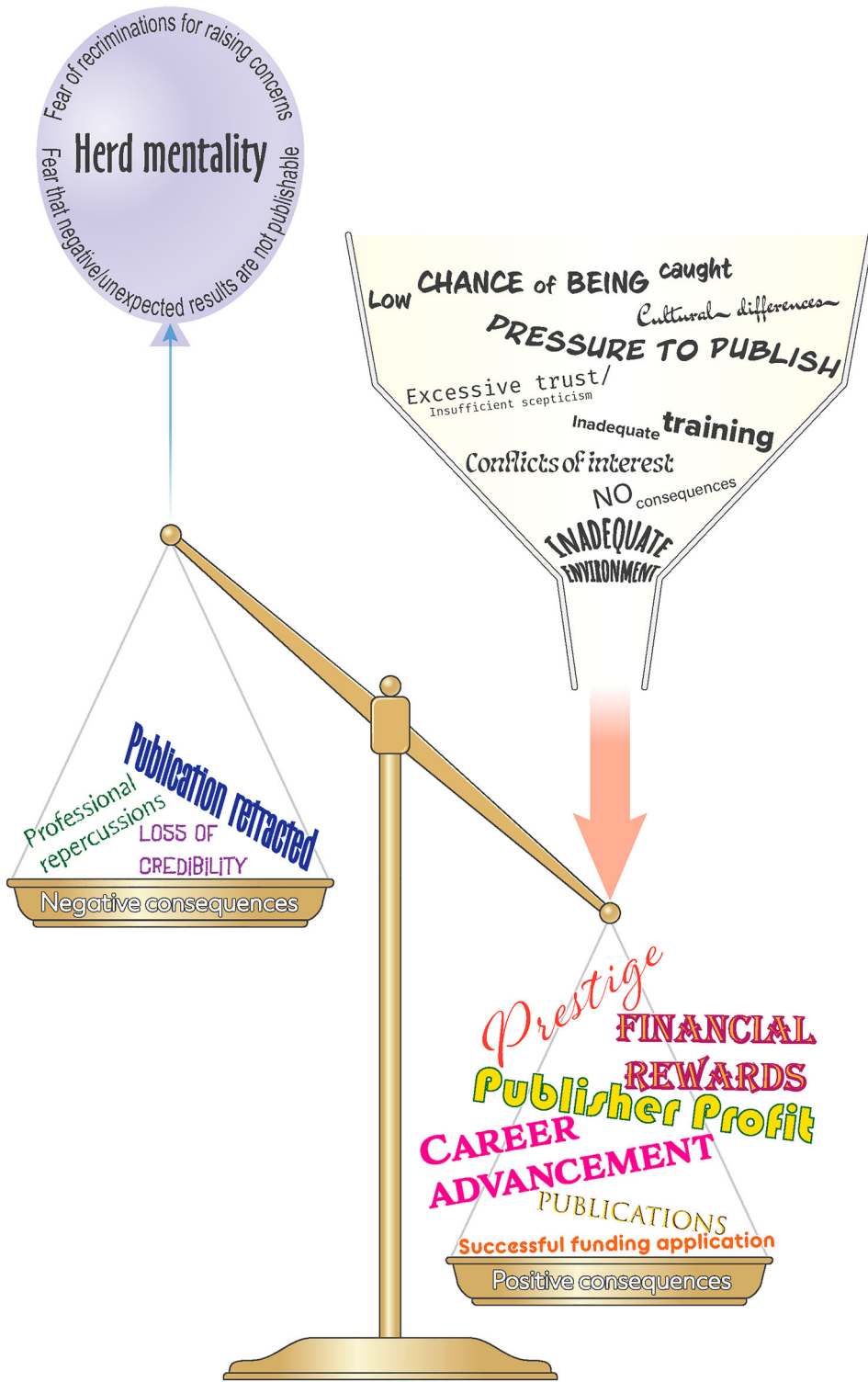


Figure 2. Competing demands and consequences that might contribute to compromised publication integrity. Copyright: M Bolland.

defecting gives a better individual outcome: (accomplice co-operates, defector goes free; accomplice defects, defector gets medium sentence, versus long sentence if co-operates). How might this apply to compromised publication integrity? The system for producing academic literature relies on all parties ‘co-operating’ at every stage. Researchers, authors, peer-reviewers, publishers all should act with the highest standards to produce a trustworthy academic literature, the best outcome for all. Currently, for individual protagonists, the incentives for ‘defecting’, that is carrying out QRPs or even outright misconduct, are high for all individuals: researchers and authors can win more grants, publish more papers, and get academic promotions; journals and publishers can publish more publications, start more journals, and make more profits; and institutions accrue reputational prestige and wealth by their staff publishing as many papers in high impact journals as possible and being awarded research funding, grants and academic prizes. Conversely, there are few disincentives. The likelihood of an individual who ‘defects’ being caught is low. Even if they are caught, it is not in the interest of the institution to generate negative publicity, so the individual may be permitted to leave the institution and move elsewhere without any public acknowledgement of the issue, meaning any academic sanction is small. There are no (or possibly only limited) consequences for journals and publishers who publish false information or fail to correct it. Certainly, it is unlikely to affect the bottom line – ie their profits. However, as in the classic Prisoner’s dilemma, if the protagonists choose to defect, which might be a rational choice, everyone suffers because the whole academic literature becomes untrustworthy, and in the end that impacts the invisible protagonist, the public, who ultimately are the beneficiaries of academic and scientific knowledge but also can be harmed when people act upon false information. [Figure 3](#) gives an overview of all parties involved in the production of and maintenance of a trustworthy academic literature, and the downstream parties affected by it.

What needs to change and what could be done differently?

We think there are a number of simple changes that can be made that will improve the current situation substantially. Firstly, we think that all involved parties should commit to maintaining a trustworthy academic literature. Thus, authors should expect to find or be notified of mistakes in their publications, and once identified correct the mistakes or withdraw the publication if it is no longer valid. Many publications are likely to contain errors: if authors committed to fixing *all* errors in their publications, there would be enough corrections and withdrawals to normalise the process and remove any stigma associated with it. It is likely that such a deluge of corrections would severely challenge the current systems of the journals and publishers. However, if all parties separated concerns about the integrity of the publication from considerations about *why* the compromised integrity arose, this would substantially simplify the process. Publications could be judged on their information and raw data and statistical code used to generate data in the publications. We have proposed an alternative pathway for detailing concerns about publication integrity. This involves the convening of panels of academics with expertise in the assessment of publication integrity when they are needed (Bolland, Grey, et al. 2021). [Figure 4](#) shows this generic approach, which has the advantages already detailed, but also closely resembles the current peer-review system which we think means it is more likely to be accepted by the scientific community and have credibility. The use



Figure 3. Parties involved in production and maintenance of trustworthy academic literature, and downstream parties affected by it. Copyright: M Bolland.

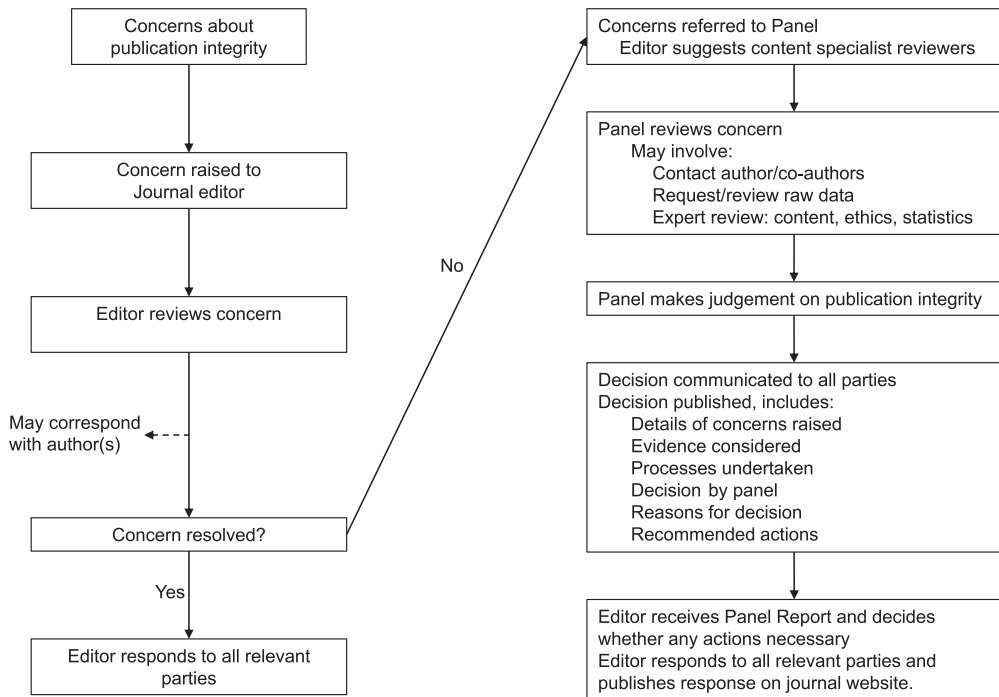


Figure 4. Proposed approach for assessing publication integrity through use of independent panels (adapted from Bolland et al. (2021)).

of independent panels has been adopted by some journals (Civitelli and Duffy 2018) with success (Civitelli and Duffy 2021). A second important suggestion is that all concerns, assessment processes and decisions are made publicly available, so that journal readers can best understand what transpired. Such transparency will help to minimise the vexatious raising of concerns.

When there are serious concerns about one or more publications by a research group, we think that there needs to be an assessment of all publications by that research group. Once investigations have been completed, statements that confirm the integrity of each publication (statements of reassurance) should be published for all publications where action is not required. When publications are in multiple journals of multiple publishers, resources should be pooled, and a co-ordinated investigation undertaken. Collectively, these steps should make the assessment of publication reliability simpler, faster, and more transparent.

Readers with concerns, systematic reviewers, and ‘research sleuths’ should undertake their assessments and communication of concerns using the various checklists and tools available (PrePubMed; Labbe et al. 2019; Grey, Bolland, et al. 2020; Cabanac et al. 2022; Cochrane Collaboration 2023; Mol et al. 2023; STM 2023; Weibel et al. 2023). A structured approach will assist journals and publishers in their deliberations. Journals and publishers should structure their responses using the same formats. In the future, it is likely that these checklists will be improved and incorporated into the standard methodology for a systematic review. Similarly, programs are likely to be developed that take a publication or submitted manuscript and automatically apply multiple statistical and

textual checks for potential compromised integrity. Examination of raw data is likely to be much more helpful for confirming or refuting potential integrity concerns (Carlisle 2021). Therefore, a forensic examination of raw data should be a mandatory component of most assessments. Journals and publishers could facilitate this by requiring that raw data and statistical code be provided at the time of manuscript submission.

However, some of these proposals have been around for a very long time (Sox and Rennie 2006), and little has changed. Simply put, journals and publishers are hugely profitable, have no incentive to change, and largely function without independent regulation or oversight by research funders. The existing options for journal readers to address and resolve publication integrity concerns are limited, and each is fraught (Box).

Box Options for journal readers with concerns about publication integrity

What people (can) do Contact journal/publisher/institution	What are the problems? Requires repeated contacts. Often no or inadequate response. When responses occur, usually prompted by enquiry meaning onus is on complainant to drive process. Journal/Publisher/Institution can choose not to respond at any stage thereby ending any dialogue. Journal/Publisher/Institution can declare 'case closed' at any stage, regardless of whether concerns are resolved. COPE guidelines mandate involvement of institutions when publication integrity can be assessed without it.
Post concerns on PubPeer Public notification of concerns eg on social media, twitter/X, blog posts Notify COPE	Most posts do not lead to action by journal/publisher. Most notifications do not lead to action by journal/publisher. Most notifications do not lead to action by COPE or journal/publisher. COPE responses are slow, erratic and opaque. COPE does not function as a regulator of publication integrity.

Given the ineffectiveness of these options, a number of other possibilities could be explored. The framing of publication integrity issues could be changed. Currently, there are few consequences for journals or publishers if they choose not to correct errors. We have argued that not correcting known mistakes could be considered disinformation (Scholarly Kitchen 2023). Misinformation is misleading or inaccurate information. If a journal/publisher has been informed that there are errors in a publication and they choose not to correct them, they are wilfully propagating misinformation by an act of omission (rather than deliberately propagating false information, an act of commission). Perhaps labelling this behaviour disinformation, which is the propagation of false information, might provoke journals/publishers to act. Regulations could be introduced, at a governmental or multinational level, that require journals and publishers to respond openly and in a timely fashion to concerns. For example, the UK Parliament's Science, Innovation and Technology Committee recommended in their report on reproducibility and research integrity that publishers should publish corrections or retract papers within two months of the concern being raised (U.K. House of Commons Science Innovation and Technology Committee 2023). Legal action could be taken against publishers. For example, if a patient received treatment and was harmed by it, or even derived no benefit from it, based upon information in a publication that was known to be incorrect (or likely to be incorrect), the patient could seek compensation from the publisher through the courts. Researchers, or their institutions, who undertook expensive research based upon false publications could seek recovery of some costs. There is a precedent for such actions where institutions

have been forced to repay funds awarded for research when the grant application or subsequent research was found to be fraudulent (U. S. Department of Justice Office of Public Affairs 2019). Journal citation databases such as PubMed/ MEDLINE/ Scopus/ Web of Science could mark an indexed article as potentially problematic, if objective criteria were met. Assessments of trustworthiness and publication integrity using checklists, or results from statistical tools, could be uploaded to a website like PubPeer or the Cochrane library, thus allowing a simple check to see whether integrity checks have previously been performed. A retraction index could be created (Fang and Casadevall 2011), analogous to measures like impact factors, where, for each journal, the number of corrections, expressions of concern, retractions and other post-publication notices could be compared with the number of publications. Journals with a retraction index that substantially exceeded or was substantially less than the average for their peers might consider whether their pre- and post-publication assessments and policies are adequate. However, doing any, some, or all of these things requires that the various parties involved in publication integrity actually care about the topic, and currently it is difficult to conclude that this is the case (Scholarly Kitchen 2022).

Conclusion

Publication integrity in biomedicine is essential to the health and wellbeing of the public, and, more broadly, it underpins all of the myriad of ways that science that affects people's lives. Compromised publication integrity is a common problem that undermines public health, and diminishes trust in science. Beyond the field of biomedicine, the same issues apply, with the downstream effects of compromised publication integrity impacting the public and undermining trust in academia.

Compromised publication integrity is often poorly dealt with. Responses to concerns raised about publications are inefficient, inconsistent, slow, opaque and incomplete. Checklists and tools have been developed that can help when assessing publication integrity. Systemic change is needed to improve matters, but requires the key protagonists to invest and engage. It is reasonable to conclude that the current system for dealing with publication integrity is broken, but although this has been recognised for a number of years, there appears little interest in trying to improve matters.

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