International Journal of Information Systems and Project Management (IJISPM)
2026, 14(1), e140101, DOI: 10.12821/ijispm140101

VIEWPOINT ARTICLE

Questionable research practices in engineering research

Ana Alice Baptista
ALGORITMI research center, University of Minho, Campus de Azurém, 4804-533, Guimarães, Portugal, analice@dsi.uminho.pt

Filipe Pereira
Mechanical Engineering Department, Porto School of Engineering, R. Dr. António Bernardino de Almeida 431, 4249-015 Porto, Portugal, fal@isep.ipp.pt

Abstract
Misconduct in science is often associated with data fabrication, data falsification, and plagiarism. However, other practices are far more frequent and prevalent. Questionable Research Practices (QRPs) are in the grey area between misconduct and responsible research conduct. The goal of this study was to investigate estimated and self-admission prevalence of engineering researchers' engagement in QRPs. We applied a survey through a questionnaire that used 10 QRPs identified in relevant literature. The questionnaire was adapted to include several categories: individual, research group, research center, and country. Results indicate that self-admission engagement in QRPs is generally higher than in similar studies. Also, respondents are more keen to estimate that others engage in QRPs than they or their research group do. Respondents admit engagement in all QRPs presented, such as failing to report all of a study´s dependent measures relevant to a finding, selectively reporting studies related to a specific finding that "worked," or even falsifying data. While some consider these practices unjustifiable, others justify them with publication and time pressures. More studies on the QRP engagement of engineering researchers are needed to get a more precise picture.

Keywords
ethics; scientific misconduct; questionable research practices; engineering.

Received: 13 November 2024 | Accepted: 22 April 2025

1. Introduction

The frequent appearance of news regarding scientific misconduct in recent times suggests an underlying, considerable problem. Scientific research has been founded on high ethical standards, but researchers still adhere to scientific misconduct, violating standard codes of conduct and ethical behavior in many ways. In this scope, misconduct could be of various types and due to various reasons: pressures to publish, competition for funding, tenure, and need for recognition and prestige, among others.

Scientific misconduct is often associated with behaviors considered by many to be the most serious: data fabrication, data falsification, and plagiarism (FFP). However, there are other practices that, while not considered as severe, are far more frequent and prevalent (Larsson et al., 2023) and can, therefore, cause more harm to science and society (Steneck, 2006). The Questionable Research Practices (QRPs) are in the "grey area of acceptable practice"(Fiedler & Schwarz, 2016; John et al., 2012). They are at the heart of competition between researchers and provide a significant advantage to those who adopt them, to the detriment of those who strictly conform to the rules of the game (John et al., 2012).

This study investigates estimated and self-admission prevalence of engineering researchers' engagement in Questionable Research Practices (QRP). Measuring the actual prevalence of these practices, as well as of any potentially reprehensible practices, is very difficult, if not impossible, because those who commit them do not always admit it, even under anonymity (Fanelli, 2009; John et al., 2012; Banks, Rogelberg, et al., 2016). Instead of studying self-admission, it is often decided to study the estimated prevalence, which can be studied in different ways, such as behavioral observations, sensitivity analysis, self-report surveys, or estimated prevalence surveys (Banks, Rogelberg, et al., 2016). Our study focused primarily on the prevalence estimated by researchers from all engineering research centers, the same research center, and the same research group. However, we also wanted to know what the researchers said about their adherence to these practices, thus shaping the self-admission prevalence. Often, not even the co-authors themselves are aware of QRPs' engagement. Therefore, self-admissions can identify involvement in QRPs that may not be identified otherwise (Banks, Rogelberg, et al., 2016).

Most studies on the prevalence of QRPs focus on the natural and social sciences (Banks, Rogelberg, et al., 2016), with some cross-domain studies. To the best of our knowledge, there are few studies in engineering. Engineering has its own specificities because it is a very vast and diverse domain of knowledge where a wide range of research methods and techniques are used (Ahmed, 2007; Horvath, 2008; Pedersen et al., 2000). We, therefore, see this study as exploratory as it "aims not to give conclusive results but to identify patterns, discover, describe, or gain insight about an issue, perform a tentative analysis, and lay the groundwork for future investigation (Swedberg, 2020 as cited in Haile, 2023). We have adapted an instrument used in other studies to contribute to form a first idea, albeit imprecise, about the general panorama in engineering. Subsequent studies can and should amplify and refine methods and techniques to obtain more accurate pictures. Our study can then contribute to a wake-up call for more studies.

The outline of this paper is as follows. Section 2 introduces and discusses state-of-the-art research on QRPs. Section 3 presents the methodology used in our study, followed by the presentation and discussion of results in Section 4. Finally, Section 5 presents the conclusions and future work.

2. Questionable Research Practices as forms of misconduct in science

Scientific research is subject to fraud, just like other human activities. Exceptional or singular scientific discoveries can result in the acknowledgment of the researchers and the accumulation of significant monetary resources and influence. While this is often a motivation for good research, occasionally it leads scientists to commit fraud (Koshland, 1987). In the codes of research conduct, it is common to find strong references to FFP, which many consider to be the most serious flaws. The National Science Foundation (USA), for instance, defines research misconduct as: "fabrication – making up

data or results and recording or reporting them; falsification – manipulating research materials, equipment or processes, or changing or omitting data or results such that the research is not accurately represented in the research record; plagiarism – appropriation of another person's ideas, processes, results or words without giving appropriate credit" (Koshland, 1987). Steneck (2006) distinguishes research integrity from research ethics, since ethics has to do with "the critical study of the moral problems associated with or that arise in the course of pursuing research", and research integrity has to do with compliance with "professional standards" as outlined by competent institutions. The prevalence of FFP estimated by different authors varies, generally hovering below 5%, with authors placing it at 1% to 2% (Steneck, 2006; Banks, O'Boyle, et al., 2016; John et al., 2012) and others just above 4% (Gopalakrishna et al., 2022), which are very worrying figures for such serious practices. However, not all research integrity failures have to do with FFP. Many stem from the grey area of Questionable Research Practices.

The term "Questionable Research Practices" was coined by a committee of the USA Academy of Sciences in 1992 and defined as "actions that violate traditional values of the research enterprise and may be detrimental to the research process" (Steneck, 2006). Banks, O'Boyke and colleagues (2016) define them as "design, analytic, or reporting practices that have been *questioned* because of the potential for the practice to be employed to present biased evidence in favor of an assertion," which is a sufficiently broad definition (design, analytic, reporting), concerned with intentionality (potential purpose) and directed towards the result of engaging in QRPs (presenting biased evidence).

QRPs include "selectively reporting studies related to a specific finding that 'worked,'" "reporting an unexpected finding as having been predicted from the start" (Fiedler & Schwarz, 2016), duplicating or slicing articles, citation errors, failing to provide enough information about methods, or improper statistics and data analysis (Steneck, 2006). Although QRPs have been viewed somewhat benevolently in the past (Steneck, 2006), concern about them has been growing because of the impressive results of some studies that place them with an estimated prevalence far beyond what could be expected. Depending on the studies and calculation formulations, the estimated prevalence of QRPs varies greatly, with some studies putting the estimates well above 50 percent for some QRPs. This variability may be explained by, for example, whether or not the frequency of their occurrence is included in the calculation of the estimated prevalence (Bouter, 2024; Fiedler & Schwarz, 2016; John et al., 2012). In their literature review, Banks, Rogelberg and colleagues (2016) found very few studies that identified little or no evidence of involvement in QRP.

In a questionnaire survey, John and colleagues (2012) drew attention to the field of psychology, with results estimating the prevalence of certain QRPs at over 50%. Even self-admissions, which are usually expected to be low, are above 30% in four QRPs. Despite the authors' emphasis that "not all self-admissions represent scientific felonies" and that some respondents gave defensible reasons for engaging in those practices, the figures are still worrisome. Fiedler and Schwarz (2016) question part of the methodological procedures of John and colleagues' (2012) study, especially concerning the wording of the QRPs and the way to estimate prevalence. After performing some changes, they did a similar study in Germany, using two distinct ways of calculating the estimated prevalence. In this study, results on self-admission rates (having engaged in it in at least one study) continue to be very high, surpassing 40% in two QRPs and 30% in five QRPs, half of the QRPs. The estimated prevalence drops dramatically in the new formulations, but even so, the figures are worrying, being above 5% in half of the QRPs and around 10% in two of them. Agnoli and colleagues (2017) replicated John and colleagues' (2012) study. They found that for five QRPs self-admission rates were lower, and for two (QRP8 – Claiming to have predicted an unexpected result, and QRP10 – Falsifying data) were significantly higher. The estimated prevalence in this study were higher for eight QRPs, with two QRPs having estimated prevalence above 60%. Rabelo and colleagues (2020) replicated the same study in Brazil, resulting in higher self-admission rates for some QRPs and lower for others. The same happens for estimated prevalence. All these studies were done in the field of psychology. Latan and colleagues (2023) calculated self-admissions and estimated prevalence both with and without the occurrence frequency for business scholars in Indonesia. This study also found high rates of self-admission and estimated prevalence. An interesting result that Banks, Rogelberg and colleagues (2016) point out is that the reporting of QRPs in self-report surveys did not vary with academic rank.

Several other studies on QRPs have been carried out using different research methods. Banks, O'Boyle and colleagues (2016) used surveys and analysis of guidelines from 160 management journals. They found that a significant percentage of management researchers reported being instructed by reviewers or editors to engage in certain QRPs, such as selectively reporting hypotheses, excluding data post hoc, engaging in HARKing (hypothesizing after the results are known), and selectively including control variables. In another study reported in the same article, the authors found that some researchers disagreed some QRPs were not appropriate: "rounding down" a significance test (13% disagreement), selectively reporting hypotheses on the basis of whether they were statistically significant (23% disagreement), excluding data after looking at the impact of doing so on the results (21% disagreement), HARKing (25% disagreement) and selective inclusion or exclusion of control variables to achieve statistical significance (21% disagreement). Kepes and colleagues (2022) compared archival records of dissertations and subsequent journal articles to investigate QRPs, particularly HARKing. Using a sample of researchers from 10 top research-productive management programs, they compared hypotheses tested in dissertations to those tested in journal articles derived from those dissertations. The results show that "a greater percentage of supported dissertation hypotheses (28.3%) than unsupported dissertation hypotheses (10.4%) appeared in journal articles" and that "a substantial percentage of supported journal article hypotheses has no corresponding dissertation hypothesis," making it reasonable to suspect of HARKing. They also found that articles in the Top 8 journals had higher rates of potentially HARKed hypotheses, changing sample sizes, and covariates, indicating that results published in the most prestigious management journals may be less credible than those published in less prestigious journals. Among other results, these authors also found that dropping the hypothesis is not random; instead, it is systematic, as it "systematically suppresses small effect sizes and, therefore, biases the publicly available scientific evidence." Kaiser and colleagues (2022) analyzed data from a quantitative survey of Norwegian researchers about their attitudes and the prevalence of FFP and nine QRPs. The study revealed a low rate of self-reported FFP, but a considerable percentage of researchers reported involvement at least once in the following QRPs: create the impression of having consulted a source by copying other's citations – 20.7%, gift authorship – 11.3%, salami slicing – 8.4%, and to include irrelevant or unnecessary references in a publication to increase the citation frequency of a colleague, a research environment or a journal – 12.5%. Several authors indicate that open science practices (OSP) could mitigate adherence to QRPs. Still, Chin and colleagues (2023) study in the field of criminology found that a large majority of quantitative criminologists (87%) in the sample were found to have used QRPs while a nearly equal majority (89%) were found to have used open science practices (OSPs).

As stated before, adherence to a given QRP cannot always be classified as misconduct; in some cases, it may be justifiable and acceptable (Fiedler & Schwarz, 2016; John et al., 2012). Even if it is not readily justifiable, it may not be intentional: it can stem from misinformation about procedures and codes of conduct (Andrade, 2021), distraction, and carelessness, among others (Steneck, 2006). The literature points to various reasons for deliberate misconduct. These are the same as those for engagement in FFP: pressure to publish, pressure to raise funds, the unpopularity of "negative results," perverse incentives, promotions, tenure, among others (Banks, O'Boyle, et al., 2016; Banks, Rogelberg, et al., 2016; John et al., 2012; Makel et al., 2021; O'Boyle et al., 2017). As Bouter (2024) puts it, "what is good for the quality and reliability of research is not always good for a scholarly career."

Adherence to QRPs can significantly impact research and society. According to Steneck (2006), irresponsible behavior impacts research in four ways: "1) undermine the reliability of the research record, 2) weaken the trust colleagues have in one another and the trust the public has in researchers, 3) waste research funds, and 4) lead to decisions that cause public and/or personal harm." He argues that QRPs are even more impactful than FFPs, as they are more frequent and prevalent. The practice of QRP is especially worrying in health-related research, as it can cause serious harm to humans and other living beings if not, directly or indirectly, death. Authors who have resorted to the practice of HARKing (Hypothesizing After the Results are Known), for example, mislead others into assuming that the study is confirmatory rather than exploratory, which indicates that the results are confirmed and not the result of serendipity, and they can build on them. Another example is cherry-picking, where, for example, a researcher selects only the results that support their

hypotheses, omitting the rest, or chooses to cite only articles that favor their views, misleading readers about the overall perspective (Andrade, 2021). The duplication of articles, a reporting QRP, for example, is considered by Steneck (2006) to be a waste of public money and effort (writing, peer review, editing) that could be invested with an adequate return for science and society. QRPs may "harm the development of theory, evidence-based practice and perceptions of the rigor and relevance of science" (Banks, Rogelberg, et al., 2016).

Science is built step by step, with successive additions to knowledge (contributions) by researchers, such as Sir Isaac Newton's famous "standing on the shoulders of giants." Trust in colleagues' professionalism and good faith is a cornerstone of this process. Quality control processes, such as peer review, identify and allow the elimination from the system of many research outputs (including articles) that are not of sufficient quality but cannot identify all of them. Many slip through the net of quality control, and the proof of this is the number of retractions that occur every year, many of which are in top journals. Research outputs obtained by engaging in QRPs and passing the quality control sieve are seen as good by other researchers, who use them to build new research, wasting their time and stalling scientific progress (John et al., 2012).

It is essential to combat adherence to QRPs because of their highly harmful short- and long-term effects. Relying on the virtuosity of researchers is not the solution. Several studies have already identified the causes of undesirable behavior in research. Now they need to be mitigated and, if possible, canceled. To this end, several authors advocate open science practices as the pre-registration of the research (Bouter, 2024; Peels & Bouter, 2023; Kepes et al., 2022). The requirement to deposit raw data in a data repository such as Zenodo can also help mitigate some QRPs related to data analysis. Other measures could include greater dissemination and training on codes of conduct in research, adopting dissuasive policies, reviewing procedures for obtaining research funding and career progression, improving the quality of peer review and reforming research assessment (Bouter, 2024; Andrade, 2021; Banks, O'Boyle, et al., 2016; Banks, Rogelberg, et al., 2016; Makel et al., 2021; Sørensen et al., 2021).

3. Methodological procedures

We conducted a questionnaire survey based on the 10 QRPs used by John and colleagues (2012) and later modified by Fiedler and Schwarz (2016). Anonymous surveys can be a good way of more reliably identifying the engagement in QRPs of an individual or people they know (Fiedler & Schwarz, 2016), their motives, and the potentially associated external pressures they face (Banks, Rogelberg, et al., 2016). The QRPs are the following:

QRP1 – Failing to report all of a study's dependent measures that are relevant for a finding.

QRP2 – Collect more data in order to render non-significant results significant.

QRP3 – Failing to report all of a study's conditions that are relevant for a finding

QRP4 – Stopping collecting data earlier than planned because the expected result concerning a specific finding were already obtained.

QRP5 – 'Rounding off' a p value (e.g. reporting that a p value of .054 is less than .05).

QRP6 – Selectively reporting studies related to a specific finding that "worked."

QRP7 – Deciding whether to exclude data after looking at the impact of doing so on the desired results.

QRP8 – Reporting an unexpected finding as having been predicted from the start.

QRP9 – In a paper, claiming that results are unaffected by demographic variables (e.g. gender) although one is actually unsure (or knows that they do).

QRP10 – Falsifying data.

QRPs were written in Portuguese, followed by their original English version in a smaller font size. For each QRP, respondents were asked to respond to the question, "What is your estimate of the prevalence (in %) of this practice, across all hypothesis tests conducted by ..." (Fiedler & Schwarz, 2016). Unlike other studies that only asked about the respondent and all researchers, we decided to ask respondents to enter information about the following categories:

- All engineering researchers from Portuguese research centers;

- All engineering researchers from their research center;

- All engineering researchers from their research group;

- The respondent.

With the following response options for the estimated prevalence: 0%;]0% - 20%],]20% - 40%],]40% - 60%],]60% - 80%],]80% - 100%[, 100%. Then, still, for each QRP, the following additional question was asked: In your opinion, what circumstances can justify this practice?

Demographic questions included age, number of years as a researcher, gender, country of research, and scientific field of research. In this respect, we considered the scientific fields of engineering that the Portuguese Foundation for Science and Technology (FCT) recognizes for project submissions. Four generic fields were added so that non-engineering respondents could identify their field, minimizing the risk of being mistaken for engineering researchers. Two more options have been added to include all the possibilities: (1) another engineering and (2) another area.

The first version of the questionnaire was tested and validated with five respondents between 22 and 28 November 2019. The validation questionnaire was made available online, and respondents were asked to answer as if they were using the final version of the questionnaire so that their answers could be used if the validation resulted in minor changes (typos and minor formal issues). According to the respondents to the validation questionnaire, the QRP questionnaire was straightforward, and no changes were suggested. For this reason, there were no changes to the questionnaire, and the version applied was the first and, so far, only version of that questionnaire.

The questionnaire was made available on 15 January 2020 and was open continuously for several months. It was disseminated in various engineering research centers at several Portuguese universities, and respondents were asked to pass it on to colleagues. Engineering PhD students were also asked to complete the questionnaire and pass it on to colleagues.

The questionnaire had 72 answers, but three were empty, so 69 researchers answered it. Eight of these worked in fields other than engineering, so they were removed from the sample, leaving 61 answers. Two of these answers were the same, so one of them was eliminated, leaving 60 valid answers. The results were exported to Microsoft Excel, where they were aggregated for the analysis. The graphs were done using Apple Numbers. For clarity of reading and analysis, for each QRP we have presented the answers in two graphs, the first relating to all the engineering research centers and the respondent's research center, and the second relating to the respondent's research group and the respondent (self-admission). We used the same scale for each pair of graphs to make it easier to compare them. In self-admission, we prefer to use the term "prevalence" rather than "rate" because we believe it is infrequent for someone to rigorously count their past involvement in QRPs to report it in a questionnaire.

The questionnaire, the validation and contact forms, the questionnaire results, and the validation results were made openly available at: https://doi.org/10.5281/zenodo.15199607

4. Results

Most respondents are between 24 and 35 years old, 55% (33) are male, and the remaining 45% (27) are female. Most respondents have worked as researchers for up to 10 years, and all carry out research in Portugal (Fig. 1).

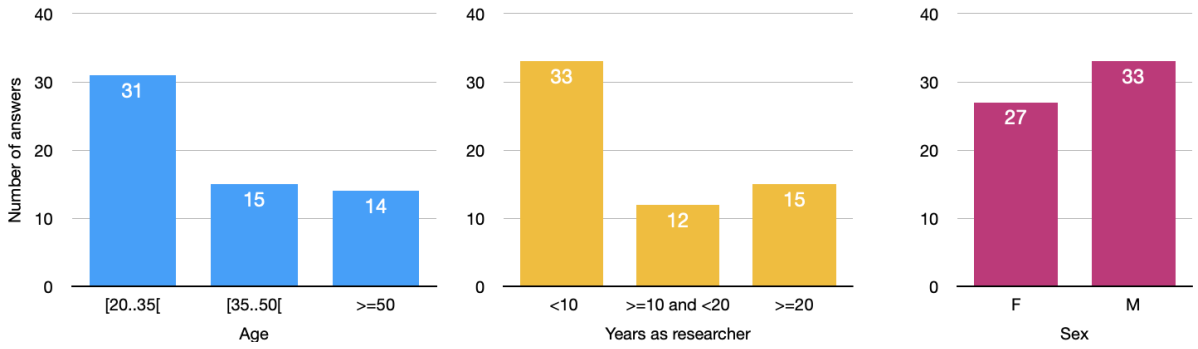

Fig. 1. Demographic data of the respondents

Of all the engineering fields considered, the one with the most respondents, by far, is Electrical Engineering and Computer Engineering (45%). Mechanical Engineering and Engineering Systems comprise 13% of the answers, and Bioengineering, Biotechnology, and Biochemistry comprise 12%. Materials Science and Engineering make up 10%, with all other options accounting for 7% each (Fig. 2).

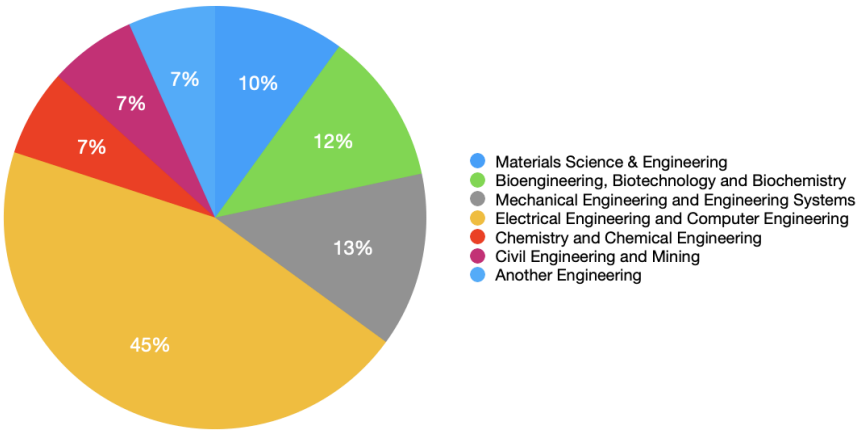

Fig. 2. Distribution of the respondents by knowledge domain.

Regarding QRP 1 - Failing to report all of a study´s dependent measures relevant to a finding, 22 respondents (36.7%) report having never been engaged in this QRP, leaving 63.3% of researchers admitting to having engaged in it in at least one study (prevalence greater than 0%) (Fig. 3). This self-admission prevalence is close to the findings of John and colleagues (2012) (63.4%) and higher than the findings of Agnoli and colleagues (2017) (47.9%) and Latan and colleagues (2023) (57.63%).

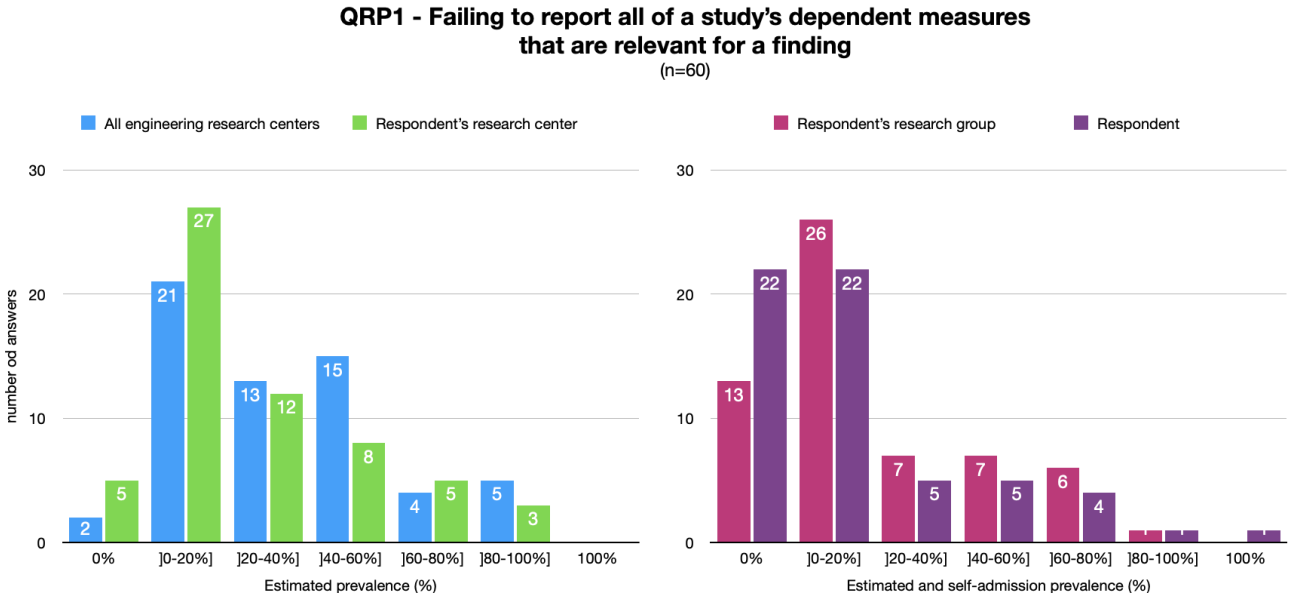

Fig. 3. Estimated and self-admission prevalence of QRP1.

The mode class of the estimated prevalence for engaging in QRP1 is]0%-20%] for all categories and also 0% for self-admission. The median is situated in the]0%-20%] range for all categories except all engineering research centers, which is]20%-40%] (Table 1).

The estimated prevalence for QRP1 by John and colleagues (2012) is 59.03%, by Agnoli and colleagues (2017) is 58.51%, and by Latan and colleagues (2023) is 61.41%.

Table 1 . Mode and median classes for the estimated prevalence of QRP1 in all categories.

Category	Mode class	Median class
All engineering research centers	]0-20%]	]20%-40%]
Respondent's research center	]0-20%]	]0-20%]
Respondent's research group	]0-20%]	]0-20%]
Respondent	0%,]0-20%]	]0-20%]

Analysing the answers to the open question (what circumstances could justify this practice?), we find that most answers relate to the pressure to publish something different and relevant in the area and the tight deadlines. Lack of time and space is also referred to: "Limits on space in publications; less important relevant details end up being cut." Respondents also refer to the protection of results for future research: "Fear of exploitation by research groups, with more human and technical capabilities," or "Try to protect some adjustments so that other centres do not overtake them." Other justifications are innocence, ignorance, competitiveness, convenience, inexperience, and uncertainty about the relevance of specific data for the research. There are still those (8.3%) who believe that nothing justifies this practice.

Concerning QRP2 - Collect more data to render non-significant results significant; when asked about the prevalence of this practice, self-admission amounts to 37 (61.7%), with 5 (8.3%) admitting a prevalence of more than 80% on their works (Fig. 4). This self-admission prevalence is higher than the findings of John and colleagues (2012) (55.9%), Agnoli and colleagues (2017) (53.2%), and Latan and colleagues (2023) (59.32%).

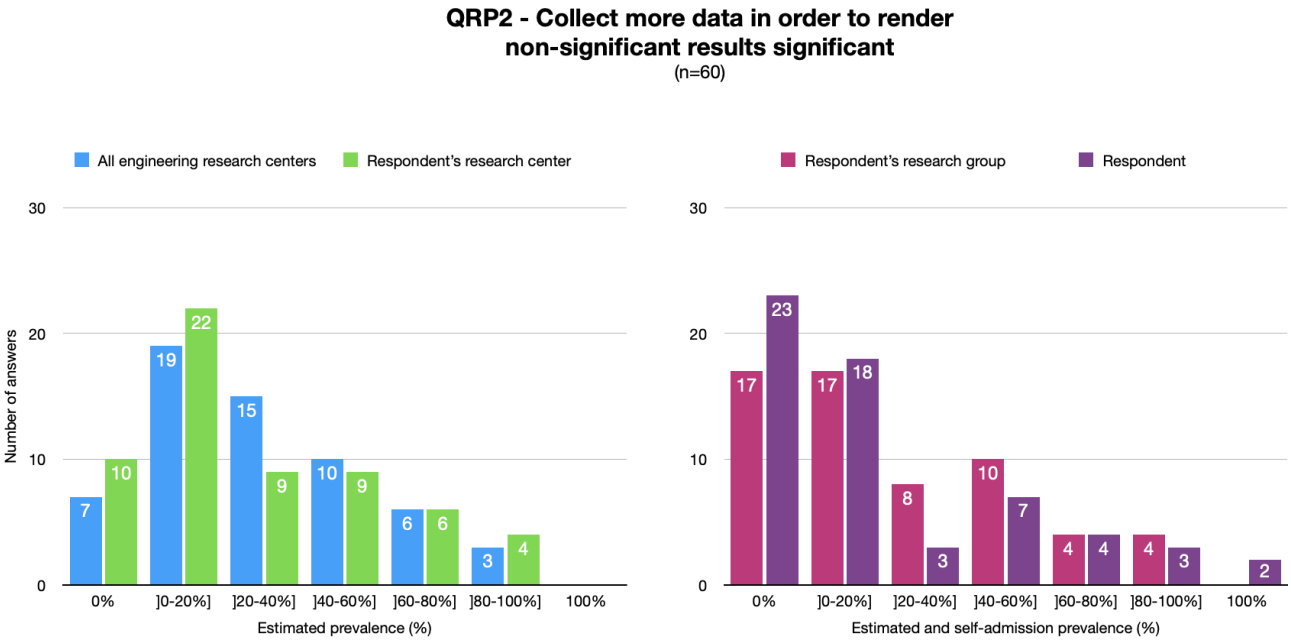

Fig. 4. Estimated and self-admission prevalences of QRP2.

The mode class of the estimated prevalence for engaging in QRP2 is 0% in self-admission and the respondent's research center and]0%-20%] also for the latter and remaining categories. The median is situated in the]0%-20%] range for all categories except all engineering research centers in which it is]20%-40%] (Table 2). The estimated prevalence for QRP2 by John and colleagues (2012) is 61.01%, by Agnoli and colleagues (2017) is 63.18%, and by Latan and colleagues (2023) is 63.14%.

Table 2. Mode and median classes for the estimated prevalence of QRP2 in all categories.

Category	Mode class	Median class
All engineering research centers	]0-20%]	]20%-40%]
Respondent's research center	]0-20%]	]0-20%]
Respondent's research group	0%,]0-20%]	]0-20%]
Respondent	0%	]0-20%]

Regarding the open question, some respondents do not accept a possible justification, and some have said this is fraud and a lack of professionalism. Some respondents also justify this practice with the need to obtain positive results, saying, "When results need to be confirmed" or "Need to make the work publishable."

However, some respondents draw attention to the sample size (without worrying about changing it throughout the research process). One says "Collecting more data does not seem a way of biasing the results, but rather a way of making the conclusions more solid. If increasing the sample size changes the conclusions, these should be the more sustained conclusions since more cases support them." Another argues that "Several statistical methods require a minimum cardinality. As such, collecting more data helps make these methods applicable and reduces the weight that possible outliers may have."

Another respondent says, "I don't understand; if anything happens, it's the opposite," possibly meaning that they do not know about cases where the sample size is increased during the research process but may know about cases where the sample is manipulated by reducing it in some way.

Analysing the answers given to QRP3- Failing to report all of the study´s conditions that are relevant to a finding, when asked about the prevalence of this practice, 36.7% of respondents admit to having done so with a prevalence of over 0 to 20%, and 34 (56.7%) admit to having resort to this practice in at least one study (Fig. 5). This self-admission prevalence is higher than the findings of John and colleagues (2012) (27.7%), Agnoli and colleagues (2017) (16.4%), and Latan and colleagues (2023) (42.8%).

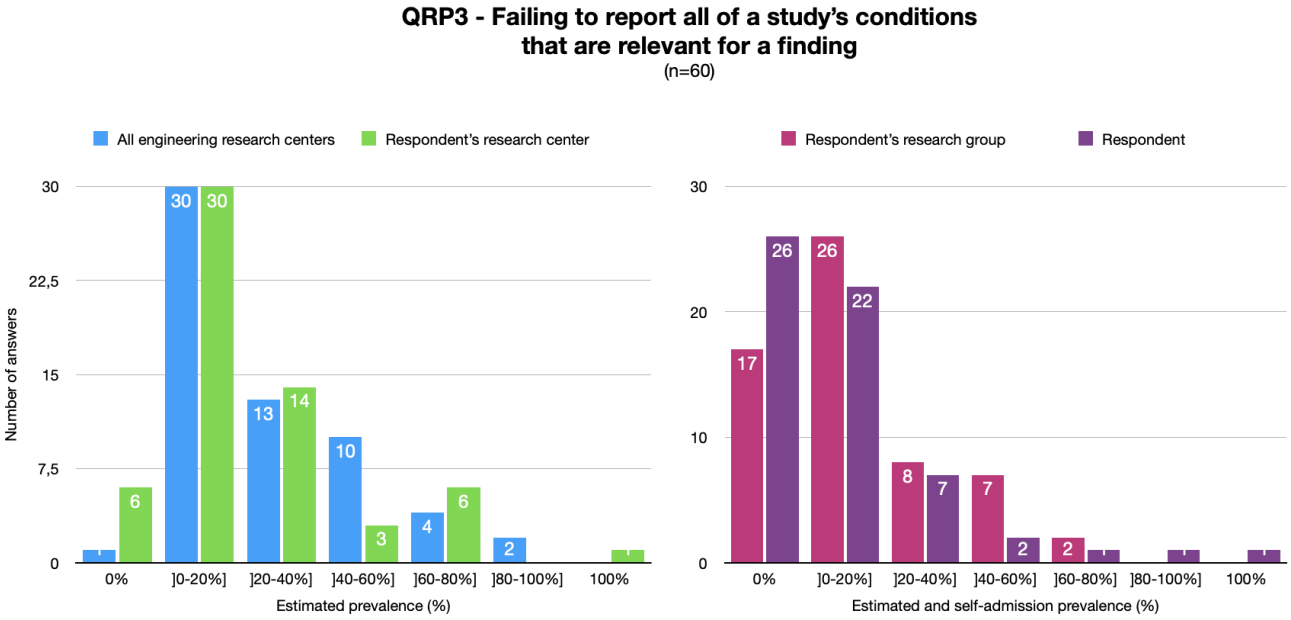

Fig. 5. Estimated and self-admission prevalences of QRP3

The mode class of the estimated prevalence for engaging in QRP3 is 0% in self-admission and]0%-20%] for the remaining categories. The median is situated in the]0%-20%] range for all categories (Table 3). The estimated prevalence for QRP3 by John and colleagues (2012) is 35.64%, by Agnoli and colleagues (2017) is 40.80%, and by Latan and colleagues (2023) is 44.59%.

Table 3. Mode and median classes for the estimated prevalence of QRP3 in all categories.

Category	Mode class	Median class
All engineering research centers	]0-20%]	]0-20%]
Respondent's research center	]0-20%]	]0-20%]
Respondent's research group	]0-20%]	]0-20%]
Respondent	0%	]0-20%]

Proceeding with the analysis of the reasons that could lead researchers to this practice, some justifications that come up are the lack of: experience, time and space (in articles), resources, proficiency in methods, and accuracy. Some refer to forgetting as justification. Some respondents justify this practice with confidentiality issues, or even "To avoid the reproducibility of published tests. To keep 'trade secrets'" or, again, "Fear of exploitation by research groups with more human and technical capacities." As a plausible justification, one respondent says, "Sometimes these conditions aren't reported because the trial didn't go so well, but you still want to publish the study because you are convinced that if the trial had gone well the results would have been as expected." Another respondent says, "Lack of availability of varied test scenarios does not allow complete conclusions to be drawn, so possible features are extrapolated from a single scenario, but it is generally claimed that the method is generalist."

About QRP4 - Stopping collecting data earlier than planned because the expected result concerning a specific finding was obtained; when asked about the prevalence of this practice, 43.3% of respondents claim never having resorted to this practice, leaving 56.7% admitting to having engaged in it in at least one study (Fig. 6). This self-admission prevalence is much higher than the findings of John and colleagues (2012) (15.6%), Agnoli and colleagues (2017) (10.4%) and Latan and colleagues (2023) (23.94%).

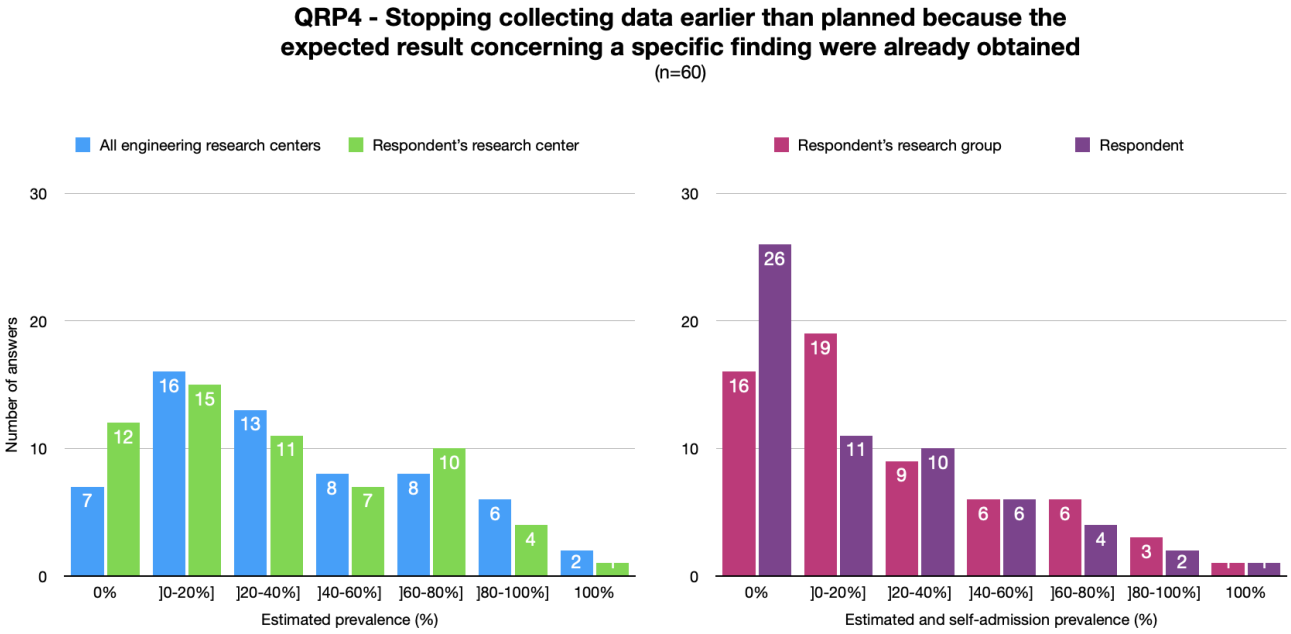

Fig. 6. Estimated and self-admission prevalences of QRP4

The mode class of the estimated prevalence for engaging in QRP4 is 0% in self-admission and]0%-20%] for the remaining categories. The median is situated in the]0%-20%] class for self-admission and the respondent's research group and in]20%-40%] for the two remaining categories (Table 4). The estimated prevalence for QRP4 by John and colleagues (2012) is 38.98%, by Agnoli and colleagues (2017) is 37.30%, and by Latan and colleagues (2023) is 44.56%.

Table 4 . Mode and median classes for the estimated prevalence of QRP4 in all categories.

Category	Mode class	Median class
All engineering research centers	]0-20%]	]20%-40%]
Respondent's research center	]0-20%]	]20%-40%]
Respondent's research group	]0-20%]	]0-20%]
Respondent	0%	]0-20%]

Regarding the open question, most respondents mention that a possible justification for this practice might be the need to finish the study as soon as possible, deadlines, lack of time, and lack of resources. Some claim that "It is not repeated after the positive result because it is expensive," and "to save money."

There are other justifications for adopting this practice. One respondent says, "Sometimes in vitro or in vivo tests don't justify continuing the study. This avoids animal sacrifice and costs". Another respondent claims, "There are many studies that are already planned to be finalized if the first trials turn out as expected." Another one says "Even if the expected result has already been obtained, the experience constitutes further proof. In fact, the conditions of two experiments are always different, even if only minimally." Yet another respondent argues the question is not clear enough as "there are many circumstances in which you can effectively end a study as soon as you find the desired result, such as finding a counterexample to a conjecture."

Regarding QRP5 "Round" a p-value (for example, reporting that a p-value of 0.054 is less than 0.05), when asked about the prevalence of this practice, the majority of respondents (58.3%) claim never to have resorted to it, leaving 41.7% to admit having engaged in it in at least one study (Fig. 7). This self-admission prevalence is much higher than the findings of John and colleagues (2012) (22.0%), Agnoli and colleagues (2017) (22.2%) and Latan and colleagues (2023) (22.67%).

Over one-fourth of respondents (26.7%) estimate the prevalence of this QRP for researchers from all research centres to be between over 0 and 20%. In comparison, 36.7% believe this to be the prevalence of resorting to this practice in their research centre.

The mode class of the estimated prevalence for engaging in QRP5 is 0% in self-admission and in the respondent's research groups and]0%-20%] for the remaining categories. The median is situated in the]0%-20%] class for all categories except self-admission, where it is 0% (Table 5). The estimated prevalence for QRP5 by John and colleagues (2012) is 40.55%, by Agnoli and colleagues (2017) is 46.79%, and by Latan and colleagues (2023) is 43.63%.

Regarding the open question, over 20% of the respondents consider the use of this practice to be unjustifiable. Others attribute it to imprecision or lack of scientific rigor, lack of ethics, ignorance, or just intentionally including a result in a specific category (other than the real category).

Some refer to the pressure to obtain results. One respondent claims, "In publications that require the sharing of data used to apply statistical methods, this practice is easily detected. Likewise, the absence of a statistically valid result can also be of interest, provided it is argued. Over-utilizing the application of statistical tools in studies to extract statistically valid

results that are difficult to interpret is a fairly common practice, and it is what motivates this type of practice. In my opinion, there is no justification for it". Like in other QRPs, some respondents claim that the pressure to publish or to obtain funds can be a justification for this practice.

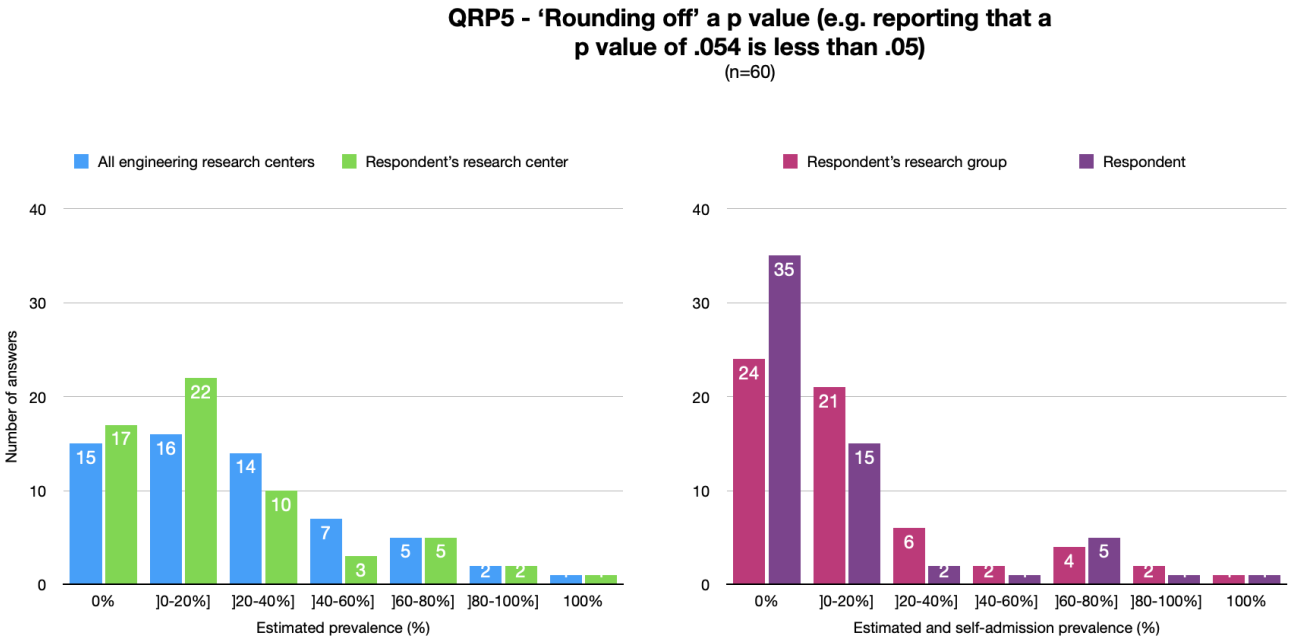

Fig. 7. Estimated and self-admission prevalences of QRP5

Table 5 . Mode and median classes for the estimated prevalence of QRP5 in all categories.

Category	Mode class	Median class
All engineering research centers	]0-20%]	]0-20%]
Respondent's research center	]0-20%]	]0-20%]
Respondent's research group	0%	]0-20%]
Respondent	0%	0%

Concerning QRP6 - Selectively reporting studies related to a specific finding that "worked," when asked about the prevalence of this practice, a large proportion of respondents (35.0%) say they have never resorted to this practice, leaving 65% of researchers having engaged in it in at least one study (Fig. 8). As with other QRPs, self-admission in this practice has a higher prevalence than in John and colleagues (2012) (45.8%), Agnoli and colleagues (2017) (40.1%) and Latan and colleagues (2023) (49.15%).

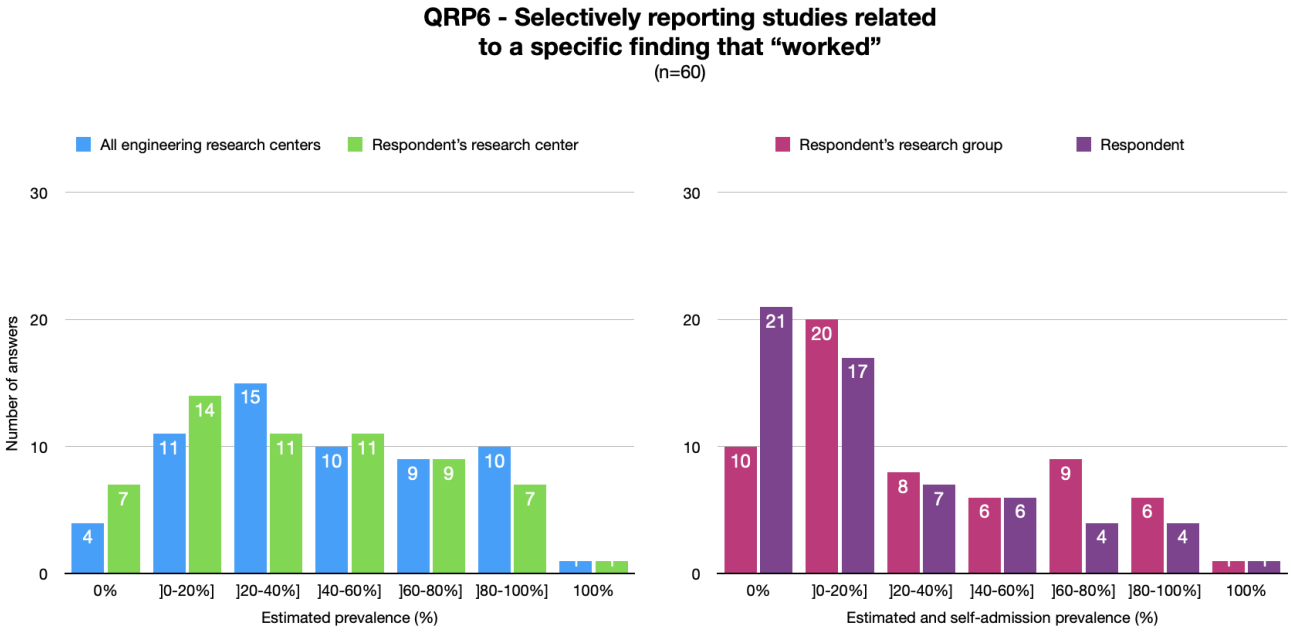

Fig. 8. Estimated and self-admission prevalences of QRP6

The mode class of the estimated prevalence for engaging in QRP6 is 0% in self-admission,]0%-20%] in the respondent's research group and center, and]20%-40%] for all engineering research centers. The median is situated in the]20%-40%] class for all and the respondent's research centers and in the]0%-20%] class for the respondent's research group and self-admission (Table 6). The estimated prevalence for QRP6 by John and colleagues (2012) is 59.90%, by Agnoli and colleagues (2017) is 65.82%, and by Latan and colleagues (2023) is 60.52%.

Table 6. Mode and median classes for the estimated prevalence of QRP6 in all categories.

Category	Mode class	Median class
All engineering research centers	]20%-40%]	]20%-40%]
Respondent's research center	]0-20%]	]20%-40%]
Respondent's research group	]0-20%]	]0-20%]
Respondent	0%	]0-20%]

Regarding what could justify this practice, some respondents claim nothing justifies it (10%). As with other QRPs, some justifications center around the need to present interesting results for publication. One respondent calls it "Strengthening the robustness of the results." Another argues, "Sometimes results are presented selectively because they need more substantiation or because it is impossible to put all the information in one article." Still, another respondent says, "Publications must be scientifically consistent. Reporting cases that discredit work done decreases the chances of publication."

There are, however, other perspectives. One respondent claims, "The practice of cherry picking is quite common and strongly related to the bias that is typical of a researcher. In my opinion, it is perfectly justified if this practice is not intended to show a trend (trends that should only be shown through a meta-analysis) but rather to list favorable examples. Trying to draw an inference in this way is a fallacy." Another respondent argues: "Again, I think it has to do with the fact that researchers think that results that don't support the hypotheses tested are 'bad results.' I think this is a huge mistake because the fact that a certain method doesn't work for a given purpose is a result of as much interest and relevance as the one that does."

Regarding QRP7 - Decide if you want to exclude data after analyzing the impact of this on the desired results; when asked about the prevalence of this practice, a large proportion of respondents (36.7%) say they have never resorted to it, leaving 63.3% admitting to having engaged in it in at least one study (Fig. 9). As with other QRPs, self-admission in this practice has a higher prevalence than in John and colleagues (2012) (38.2%), Agnoli and colleagues (2017) (39.7%) and Latan and colleagues (2023) (43.43%)

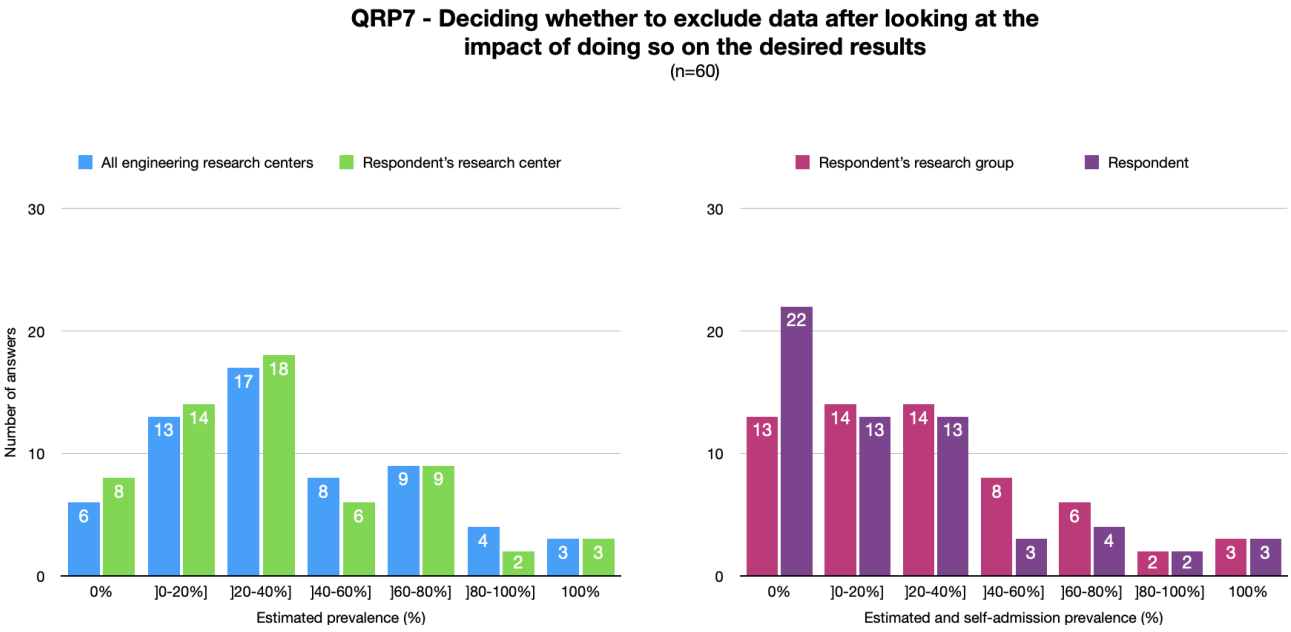

Fig. 9. Estimated and self-admission prevalences of QRP7

Over a quarter of the respondents (28.3%) estimate that the prevalence of this practice among researchers from all centres may be between 20 and 40%. The mode class of the estimated prevalence for engaging in QRP7 is 0% in self-admission; the respondent's research group has two modes,]0-20%] and]20%-40%], and]20%-40%] for the remaining categories. The median is situated in the]20%-40%] class for all categories except self-admission, where it is]0%-20%] (Table 7). The estimated prevalence for QRP7 by John and colleagues (2012) is 45.24%, by Agnoli and colleagues (2017) is 55.91%, and by Latan and colleagues (2023) is 50.35%.

Table 7. Mode and median classes for the estimated prevalence of QRP7 in all categories.

Category	Mode class	Median class
All engineering research centers	]20%-40%]	]20%-40%]
Respondent's research center	]20%-40%]	]20%-40%]
Respondent's research group	]0-20%],]20%-40%]	]20%-40%]
Respondent	0%	]0-20%]

Regarding the open question, some respondents (13.3%) related this QRP to the presence of outliers. For example, one respondent asks: "Is 'cleaning' outliers a bad practice? That's how I interpret this question. It depends greatly on the type of study you want to do". Another respondent said this QRP was justified "in cases of (severe) outliers so as not to influence averages, etc.". Convenience due to restrictions on the size of articles is also a justification, with one respondent saying, "Either it is non-relevant data with no impact that compromises the size of the article submission, or some use this method to polish outliers in the results."

Another respondent argues that "Data exclusion is a common practice. If there is space and interest in doing so, I always try to present the data exclusion criteria that serve as a legitimate basis for excluding certain data (outliers, erroneous data, flaws in the execution of experimental protocols, etc.). The discussion of this type of practice is, in my opinion, welcome in a publication, even though space and time are rarely available." Another respondent argues, "By performing certain statistics/controls, there are adequate scientific methods to exclude 'outliers,' which should always be performed to understand the origin of the variability of the data." However, another respondent says, "It is still the same question. Biasing the results towards what you think are 'good results' and 'good conclusions.' All results should be reported because they all help future work in the field."

Regarding QRP8 - Reporting an unexpected finding as having been predicted from the start, when asked about the prevalence of this practice, many respondents (48.3%) claim never to have resorted to it, leaving 51.7% admitting to having resorted to this QRP in at least one study (Fig. 10). As with other QRPs, self-admission in QRP8 has a higher prevalence than in John and colleagues (2012) (27.0%), Agnoli and colleagues (2017) (37.4%) and Latan and colleagues (2023) (37.29%).

When asked about researchers from all research centres, one-third of respondents (35.0%) estimate that the prevalence of this practice may be between over 0 and 20%. The mode class of the estimated prevalence for engaging in QRP8 is 0% in self-admission and]0-20%] for the remaining categories. The median is situated in the]0%-20%] class for all categories except all engineering research centres where it is]20%-40%] (Table 8). The estimated prevalence for QRP8 by John and colleagues (2012) is 47.73%, by Agnoli and colleagues (2017) is 59.41%, and by Latan and colleagues (2023) is 50.98%.

Once again, researchers present the pressure to publish as a possible justification. One respondent says, "This practice is justified by the ease of finding or disseminating a work. Serendipity can and should be mentioned in the text, but in the case of the abstract and title, it is understandable that the finding is included as expected."

Some refer to scientific pride or willingness to demonstrate competence as potential reasons. One respondent claims, "You also need to look competent. Reporting accidents diminishes the contribution, unfortunately. It did not used to be like that. All science starts from an initial fluke." In the opposite direction, probably because they work on another engineering topic, another respondent says, "In engineering, discovery is valued, so there is no incentive for this practice." Corroborating this opinion, another respondent says, "I do not see much 'advantage' in saying that you have been looking for a long time for a certain result that you found by chance."

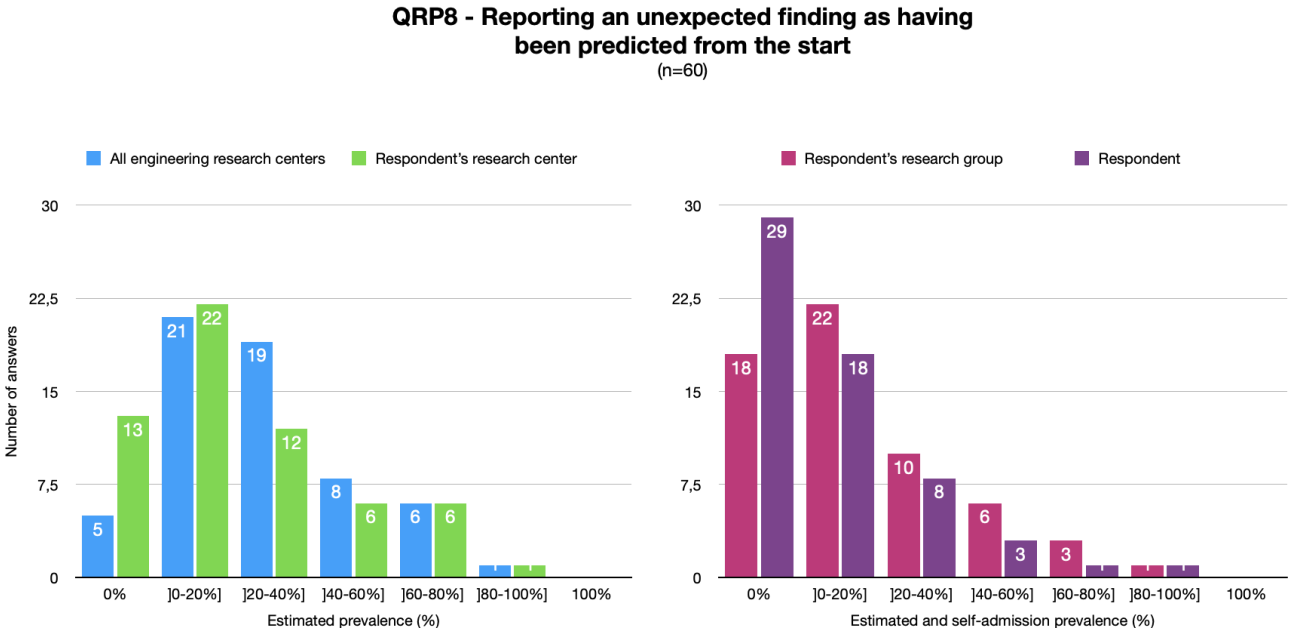

Fig. 10. Estimated and self-admission prevalence of QRP8

Table 8 . Mode and median classes for the estimated prevalence of QRP8 in all categories.

Category	Mode class	Median class
All engineering research centers	]0%-20%]	]20%-40%]
Respondent's research center	]0%-20%]	]0%-20%]
Respondent's research group	]0%-20%]	]0%-20%]
Respondent	0%	]0%-20%]

Others do not see justification: "I think that an unexpected result can have two causes: either it's due to poor contextualization and review of the literature on the subject; or it has to do with something that wasn't expected and there was no evidence that it could happen and, in the latter case, this "surprise" shouldn't be 'hidden,' i.e., it makes sense to report that it wasn't expected." Another one says: "it had never occurred to me – until I read this question in this questionnaire – that there could be a possibility of reporting an unexpected discovery as predicted from the start." Still, another opinion is that "A well-written and well-founded paper doesn't need this kind of fluff. If the discovery is unprecedented, I think the researcher should just try to explain it or leave it as 'future work'."

Concerning QRP9 - In a paper claiming that results are unaffected by demographic variables (e.g., gender), although one is unsure (or knows that they do), most respondents (75.0%) argue that they did not resort to this practice, leaving 25.0% admitting having engaged in QRP9 in at least one study (Fig. 11). As with other QRPs, self-admission in QRP9 has a higher prevalence than in John and colleagues (2012) (3.0%), Agnoli and colleagues (2017) (3.1%) and Latan and colleagues (2023) (20.34%).

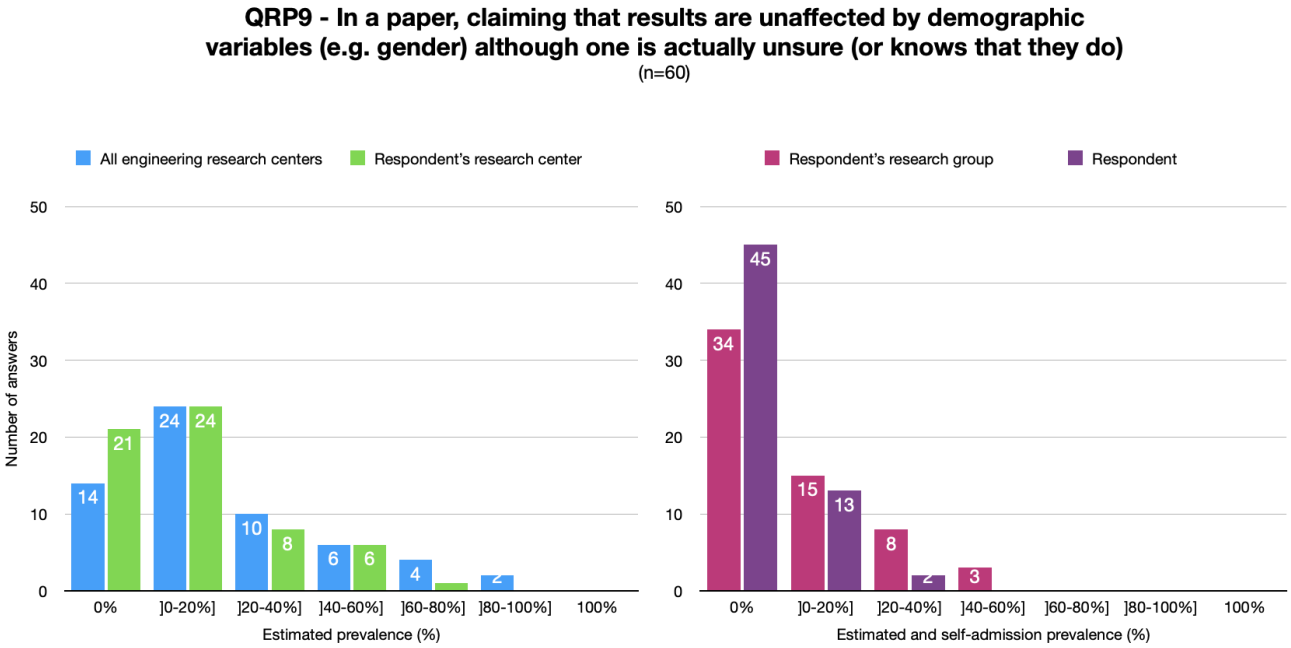

Fig. 11. Estimated and self-admission prevalence of QRP9

In addition, 56.7% of respondents also estimate that researchers in their research group do not resort to this practice. Only when asked about researchers from their and all research centres, do we find that 40.0% of respondents estimate the prevalence of this practice up to a percentage of over 0 to 20%. The mode class of the estimated prevalence for engaging in QRP9 is 0% in self-admission and in the respondent's research group and]0-20%] for the remaining categories. The median is situated in the]0%-20%] class for all engineering research centers and the respondent's research center, and the 0% class for the respondent and the respondent's research group (Table 9). The estimated prevalence for QRP9 by John and colleagues (2012) is 18.72%, by Agnoli and colleagues (2017) is 28.55%, and by Latan and colleagues (2023) is 36.72%.

Table 9 . Mode and median classes for the estimated prevalence of QRP9 in all categories.

Category	Mode class	Median class
All engineering research centers	]0%-20%]	]0%-20%]
Respondent's research center	]0%-20%]	]0%-20%]
Respondent's research group	0%	0%
Respondent	0%	0%

Some researchers (11.7%) state no circumstances justify using this practice. Others refer to the need to present results and the pressure to publish. One respondent says: "This question has to do with the literature review... this practice may occur because the researcher defends one of the perspectives, although he cannot say it is an unequivocal question. Alternatively, it may also be because, once again, the researcher considers that it is a dependency that the scientific

community does not expect or does not meet the results obtained and, therefore, either manipulates the results or reports dubious assumptions."

Another respondent states, "There is no problem, as long as it is stated that it is the researcher's opinion (opinion supported by personal experience is valid, as long as it is said that it is so)." Still, another respondent claims that data must support this kind of assertion but admits the possibility of using a dubious discourse: "A more reserved but also argumentatively supported statement may be preferable, such as 'Demographic variable X is not expected to have had a measurable impact on the results, since Y.'"

Some answers seem to indicate that some respondents related this QRP to gender inequality or gender bias. For example, one respondent claims that Engineering research is indifferent to gender issues. Another respondent states that this practice may be justified "To make the conclusion more interesting or to avoid the controversy of gender inequality." Another respondent argues, "It is something extremely difficult to prove or subject to 'fads.'"

Finally, analysing QRP10 - Falsifying data, when asked about the prevalence of this practice, almost all (93.3%) respondents said they never resort to this practice, leaving 6.7% admitting to having engaged in it in at least one study (Fig. 12). As with other QRPs, self-admission in QRP10 has a higher prevalence than in John and colleagues (2012) (0.6%), Agnoli and colleagues (2017) (2.3%), but not Latan and colleagues (2023) which present a very high self-admission prevalence for QRP10 (44.70%).

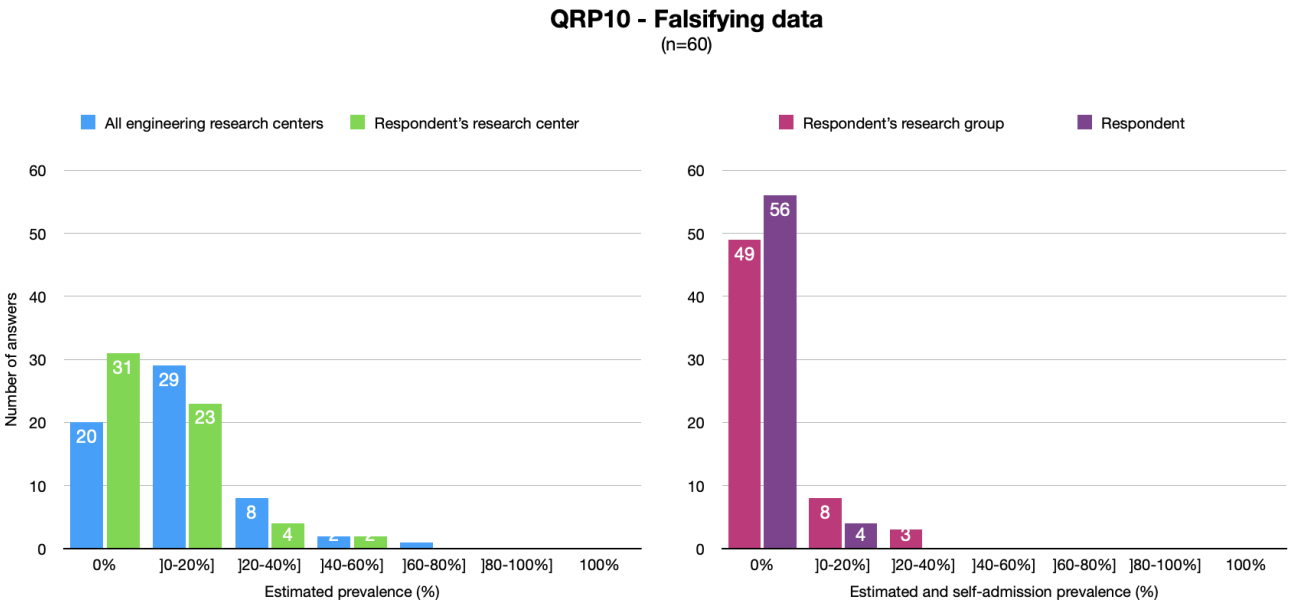

Fig. 12. Estimated and self-admission prevalences of QRP10

However, when asked about researchers from all research centres, we find that a large percentage (48.3%) estimate a prevalence of this practice of over 0 to 20%. The mode class of the estimated prevalence for engaging in QRP10 is 0% for all categories, except in all engineering research centers, which is]0-20%] (Table 10). The same is true for the median class. The estimated prevalence for QRP10 by John and colleagues (2012) is 9.33%, by Agnoli and colleagues (2017) is 18.65%, and by Latan and colleagues (2023) is 51.31%.

Table 10. Mode and median classes for the estimated prevalence of QRP10 in all categories.

Category	Mode class	Median class
All engineering research centers	]0%-20%]	]0%-20%]
Respondent's research center	0%	0%
Respondent's research group	0%	0%
Respondent	0%	0%

Many respondents (31.7%) considered this QRP unacceptable: "Lack of professionalism, and nothing justifies this practice," "under no circumstances," or just "Inadmissible." A respondent claims this QRP happens "largely because [...] results are not in line with what would be expected."

Some refer to the lack of support, lack of funds, and pressure to publish: "To have results that justify funding" or "Zero [situations in which it is justifiable], but that's the pressure we are under because of the lack of support and funding." Another respondent says, "None [situations in which it is justifiable]. It just happens to get good results and influence the community."

Some respondents relate this practice to generating data for tests: "Depending on the situation, it doesn't involve falsifying, but rather generating data for testing. [This is] Another common practice in this area, as long as it is explained as such". Another respondent says, "The omission, transformation, and aggregation of data is a common practice that may or may not be considered falsification [...] In the case of extensive and detailed datasets, it is common to work with metadata, subsets, or processed data. In these scenarios, you can involuntarily incur a scenario of data falsification by omitting processes and operations. Alternatively, data may have been erroneously transcribed or calculated, which explains a publication with false data."

5. Final Remarks

Misconduct in science is not new. The scientific community itself has taken on the role of preventing misconduct, scrutinizing processes, and punishing irregular practices. The reasons for adhering to misconduct are identified in the literature, including pressure to publish, pressure to raise funds, perverse incentives, and tenure. Research institutions, scientific associations, funding agencies, and other organizations create codes of conduct and carry out training on this subject. The main breaches of conduct are considered the FFP. There is consensus about classifying these as misconduct, but there are some practices (QRPs) that, while permissible in some contexts or situations, are not in others. These practices are in the grey area between misconduct and responsible research conduct.

There are several identified QRPs. John and colleagues (2012) measured the estimated prevalence of ten QRPs in psychology. Their results caused surprise and concern, which led other researchers in psychology and other fields of knowledge to replicate their study or carry out similar studies with variations in methodological procedures. Other observational studies have also been conducted for different purposes, objects, and methods. The results also vary, but the vast majority of authors agree that the level of engagement in these practices is far from rare and is higher than that found in FFP. Engineering is a field where similar studies are rare, so we considered it pertinent to carry out an exploratory study that would shed some light on the subject and allow us to compare the results with other results from previous studies.

Therefore, this study aimed to obtain a snapshot of the estimated prevalence of the ten QRPs in engineering. The scope of the study was initially limited to researchers at Portuguese engineering research centers for convenience and the

expected ease of obtaining responses. A questionnaire survey was administered in Portuguese, and researchers at Portuguese engineering research centers were asked to respond and disseminate the questionnaire to their colleagues. Of the 69 responses, 60 were considered valid.

The results indicate that some questionable research practices, such as failing to report all relevant dependent measures that are relevant for a finding, collecting more data to render non-significant results significant, and selectively reporting studies related to a specific finding that "worked," have a higher estimated prevalence than practices like data falsification, which are reported with lower estimated prevalence. It is also interesting to note that, for many of the QRPs, the percentage of respondents who report never having observed or practiced them ("0%") tends to be higher for the respondents themselves than for their group, center, or all engineering research centers. This might indicate a lower perception of the prevalence of these practices at the individual level or a reluctance to admit their involvement or knowledge of these occurrences. It is important to note that this data represents reports from respondents and not an objective verification of the occurrence of these practices. However, they provide valuable insight into the perception and potential prevalence of various questionable research practices in engineering research.

Most respondents justify the adherence to these practices with publication and time pressures, report findings consistent with their hypotheses, use methods that increase chances of publication, time and space constraints, journals, editors, or reviewers constraints. It is also apparent that some respondents have difficulty creating a border between what is ethical, dubious, or fraudulent and what is not.

Like any other scientific study, this one has limitations. Firstly, the study was carried out, by option, only in Portuguese engineering research centers. It would be interesting to open it up to other countries, and it would also be interesting to open it up to different areas in Portugal or Portuguese-speaking countries.

The answers to the open-ended question (what circumstances could justify this practice?) indicate that several respondents confused justification with explanation, i.e., they did not present conditions that they thought would make a QRP acceptable; instead, they tried to explain the causes of the practice. It will, therefore, be necessary to revise the questionnaire, clarify the wording of this question, and possibly include another question to determine the causes of adherence to each QRP. One respondent said several times that the meaning of the QRP was unclear to them. This can happen in the future with other respondents. To reduce the possibility of misinterpretation, adding information that briefly explains the meaning of each QRP with examples might make sense.

We also need to work on the lists of QRPs to study in engineering. The 10 QRPs we used in this study cross-cut across many fields of knowledge, but not all engineering disciplines. We can do sectoral studies or try to identify the QRPs that are most applicable across engineering. Either approach can contribute to a more accurate picture of engagement in QRPs in engineering.

The above paragraph in italics was almost all generated automatically using Notebook LM. “Notebook LM is an experimental AI tool developed by Google Labs, designed to assist in organizing and understanding information within documents.” This text in quotes was generated by Gemini, an Artificial Intelligence (AI) model developed and made available by Google. At a time when many of these tools are available to support research and other activities and are increasingly accurate in their analysis and reporting of results, it is worth questioning the limits of their use. What are the questionable research practices on using these tools, their limits on use, and how prevalent are they?

As stated above, this study was exploratory. It does not intend to provide final answers or to be generalizable. There are several reasons why it is not, starting with the sample size, the respondents' representativeness by field of expertise, age, and number of years doing research. Instead, it is an exploratory study that provides a first perspective, indicating that perhaps all is not well in engineering research. It calls for further studies, including qualitative ones, as we need to deeply understand the current situation and its potential causes and impacts.

As Banks, Rogelberg and colleagues argue (2016), the scientific literature is full of great examples of sound research practice. However, these authors also argue, and we second them, that the rates of involvement in QRPs "surpass what should be considered acceptable". Therefore, measures need to be taken. Some measures could include no longer giving publication preference to positive results in journals, removing perverse incentives by changing performance evaluation procedures at research institutions, or when awarding research grants or project funding at funding institutions. Science is fundamental to the well-being of individuals and societies, so fostering sound scientific practices is essential.

Acknowledgments

We thank Daniele Fanelli for introducing us to the studies on QRPs. We also thank the Editor-in-Chief, João Varajão, who generously reviewed a prior version of this article and invited us to publish it, as well as Gerarda Ribeiro, whom we consulted for statistical advice.

References

Agnoli, F., Wicherts, J. M., Veldkamp, C. L. S., Albiero, P., & Cubelli, R. (2017). Questionable research practices among italian research psychologists. *PLOS ONE*, *12*(3), e0172792. https://doi.org/10.1371/journal.pone.0172792

Ahmed, S. (2007). Empirical research in engineering practice. *Journal of Design Research*, *6*(3), 359-380. https://doi.org/10.1504/JDR.2007.016389

Andrade, C. (2021). HARKing, Cherry-Picking, P-Hacking, Fishing Expeditions, and Data Dredging and Mining as Questionable Research Practices. *The Journal of Clinical Psychiatry*, *82*(1). https://doi.org/10.4088/JCP.20f13804

Banks, G. C., O'Boyle, E. H., Pollack, J. M., White, C. D., Batchelor, J. H., Whelpley, C. E., Abston, K. A., Bennett, A. A., & Adkins, C. L. (2016). Questions About Questionable Research Practices in the Field of Management: A Guest Commentary. *Journal of Management*, *42*(1), 5–20. https://doi.org/10.1177/0149206315619011

Banks, G. C., Rogelberg, S. G., Woznyj, H. M., Landis, R. S., & Rupp, D. E. (2016). Editorial: Evidence on Questionable Research Practices: The Good, the Bad, and the Ugly. *Journal of Business and Psychology*, *31*(3), 323–338. https://doi.org/10.1007/s10869-016-9456-7

Bouter, L. (2024). Why research integrity matters and how it can be improved. *Accountability in Research*, *31*(8), 1277–1286. https://doi.org/10.1080/08989621.2023.2189010

Chin, J. M., Pickett, J. T., Vazire, S., & Holcombe, A. O. (2023). Questionable Research Practices and Open Science in Quantitative Criminology. *Journal of Quantitative Criminology*, *39*(1), 21–51. https://doi.org/10.1007/s10940-021-09525-6

Fanelli, D. (2009). How Many Scientists Fabricate and Falsify Research? A Systematic Review and Meta-Analysis of Survey Data. *PLOS ONE*, *4*(5), e5738. https://doi.org/10.1371/journal.pone.0005738

Fiedler, K., & Schwarz, N. (2016). Questionable Research Practices Revisited. *Social Psychological and Personality Science*, *7*(1), 45–52. https://doi.org/10.1177/1948550615612150

Gopalakrishna, G., Ter Riet, G., Vink, G., Stoop, I., Wicherts, J. M., & Bouter, L. M. (2022). Prevalence of questionable research practices, research misconduct and their potential explanatory factors: A survey among academic researchers in The Netherlands. *PLOS ONE*, *17*(2), e0263023. https://doi.org/10.1371/journal.pone.0263023

Haile, Z. T. (2023). Power Analysis and Exploratory Research. *Journal of Human Lactation*, *39*(4), 579–583. https://doi.org/10.1177/08903344231195625

Horvath, I. (2008). Differences between 'research in design context' and 'design inclusive research' in the domain of industrial design engineering. *Journal of Design Research*, *7*(1), 61-83. https://doi.org/10.1504/JDR.2008.018777

John, L. K., Loewenstein, G., & Prelec, D. (2012). Measuring the Prevalence of Questionable Research Practices With Incentives for Truth Telling. *Psychological Science*, *23*(5), 524–532. https://doi.org/10.1177/0956797611430953

Kaiser, M., Drivdal, L., Hjellbrekke, J., Ingierd, H., & Rekdal, O. B. (2022). Questionable Research Practices and Misconduct Among Norwegian Researchers. *Science and Engineering Ethics*, *28*(1), 2. https://doi.org/10.1007/s11948-021-00351-4

Kepes, S., Keener, S. K., McDaniel, M. A., & Hartman, N. S. (2022). Questionable research practices among researchers in the most research-productive management programs. *Journal of Organizational Behavior*, *43*(7), 1190–1208. https://doi.org/10.1002/job.2623

Koshland, D. E. (1987). Fraud in Science. *Science*, *235*(4785), 141–141. https://doi.org/10.1126/science.3798097

Larsson, T., Plonsky, L., Sterling, S., Kytö, M., Yaw, K., & Wood, M. (2023). On the frequency, prevalence, and perceived severity of questionable research practices. *Research Methods in Applied Linguistics*, *2*(3), 100064. https://doi.org/10.1016/j.rmal.2023.100064

Latan, H., Chiappetta Jabbour, C. J., Lopes De Sousa Jabbour, A. B., & Ali, M. (2023). Crossing the Red Line? Empirical Evidence and Useful Recommendations on Questionable Research Practices among Business Scholars. *Journal of Business Ethics*, *184*(3), 549–569. https://doi.org/10.1007/s10551-021-04961-7

Makel, M. C., Hodges, J., Cook, B. G., & Plucker, J. A. (2021). Both Questionable and Open Research Practices Are Prevalent in Education Research. *Educational Researcher*, *50*(8), 493–504. https://doi.org/10.3102/0013189X211001356

O'Boyle, E. H., Banks, G. C., & Gonzalez-Mulé, E. (2017). The Chrysalis Effect: How Ugly Initial Results Metamorphosize Into Beautiful Articles. *Journal of Management*, *43*(2), 376–399. https://doi.org/10.1177/0149206314527133

Pedersen, K., Emblemsvåg, J., Bailey, R., Allen, J. K., & Mistree, F. (2000). Validating Design Methods and Research: The Validation Square. *Volume 4: 12th International Conference on Design Theory and Methodology*, 379–390. https://doi.org/10.1115/DETC2000/DTM-14579

Peels, R., & Bouter, L. (2023). Replication and trustworthiness. *Accountability in Research*, *30*(2), 77–87. https://doi.org/10.1080/08989621.2021.1963708

Rabelo, A. L. A., Farias, J. E. M., Sarmet, M. M., Joaquim, T. C. R., Hoersting, R. C., Victorino, L., Modesto, J. G. N., & Pilati, R. (2020). Questionable research practices among Brazilian psychological researchers: Results from a replication study and an international comparison. *International Journal of Psychology*, *55*(4), 674–683. https://doi.org/10.1002/ijop.12632

Sørensen, M. P., Ravn, T., Marušić, A., Elizondo, A. R., Kavouras, P., Tijdink, J. K., & Bendtsen, A.-K. (2021). Strengthening research integrity: Which topic areas should organisations focus on? *Humanities and Social Sciences Communications*, *8*(1), 198. https://doi.org/10.1057/s41599-021-00874-y

Steneck, N. H. (2006). Fostering integrity in research: Definitions, current knowledge, and future directions. *Science and Engineering Ethics*, *12*(1), 53–74. https://doi.org/10.1007/PL00022268

Biographical notes

Ana Alice Baptista is a professor at the Information Systems Department and a researcher at ALGORITMI Center, both at University of Minho, Portugal. She graduated in computer engineering and has a PhD on Information Systems and Technologies. She was the chair of the Dublin Core Metadata Initiative (DCMI) and a member of the Elpub conference series Executive Committee. She participated as PI and as a regular researcher in several national and international R&D projects. She was an evaluator of project proposals under FP7 (EU), FNRS (Belgium) and SNSF (Switzerland). Her main areas of interest include Metadata, Linked Data and the Open Movement both under their technological and social perspectives. For more information please go to https://www.cienciavitae.pt/201D-B2FC-E126.

ORCID: 0000-0003-3525-0619

Filipe Alexandre de Sousa Pereira holds a PhD in Industrial Electronics and Computer Engineering from the University of Minho, with specializations in Control, Automation, and Robotics. With over 24 years of experience, he has authored more than 40 scientific publications and six books in Automation and Robotics. He is affiliated with the MEtRICs Research Center, an integrated member of LAETA at INEGI, and a recognized Specialist Technical Engineer by the Order of Technical Engineers (OET) in Portugal. Currently, he teaches at FEUP, the University of Minho, and ISEP as a Guest Professor, and serves as President of the Electronics and Telecommunications College at OET. A certified trainer by major industry leaders (e.g., SIEMENS, ABB, KUKA), he is also an expert in Industrial AI and a reviewer of over 200 scientific articles in top international journals in Automation, Robotics, and Artificial Intelligence.

ORCID: 0000-0001-7809-5554