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Awareness, usage and perceptions of authorship guidelines: an international survey of biomedical authors

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ABSTRACT (298/300 words)

Objectives
To investigate authors' awareness and use of authorship guidelines, and to assess their perceptions of the fairness of authorship decisions.

Design
Cross-sectional online survey.

Setting and participants
Corresponding authors of research papers submitted in 2014 to 18 BMJ journals.

Results
3859/12646 (31%) researchers responded. They worked in 93 countries and varied in research experience. Of these, 1326 (34%) reported their institution had an authorship policy providing criteria for authorship; 2871 (74%) were "very familiar" with the International Committee of Medical Journal Editors authorship criteria, and 3358 (87%) reported that guidelines were beneficial when preparing manuscripts. Furthermore, 2609 (68%) reported their use was "sometimes" or "frequently" encouraged in their research setting. However, 2859 respondents (74%) reported they had been involved in a study at least once where someone was added as an author who had not contributed substantially (honorary authorship), and 1305 (34%) where someone was not listed as an author but had contributed substantially (ghost authorship). Only 740 (19%) reported that they had never experienced either honorary or ghost authorship; 1115 (29%) reported that they had experienced both at least once. There was no clear pattern in experience of authorship misappropriation by continent. For their last coauthored article, 2187 (57%) reported explicit authorship criteria had been used to determine eligibility, and 3088 (80%) felt the decision made was fair. When institutions frequently encouraged use of authorship guidelines, authorship eligibility was more likely to be discussed early (817 of 1410, 58%) and perceived as fairer (1273 of 1410, 90%) compared with infrequent encouragement (974 of 2449, 40% and 1891 of 2449, 74%).

Conclusions
Despite a high level of awareness of authorship guidelines and criteria, these are not so widely used; more explicit encouragement of their use by institutions may result in more favourable use of guidelines by authors.

Keywords: authorship guidelines, survey, biomedical research

Article Summary

Strengths and limitations of this study

- Very large international survey of active researchers describing their current practice.
- We address authorship practice which is an important ethical matter because authorship ensures credit and accountability for research.
- We report self-administered survey data, and given the sensitivity of the questions, social desirability bias may have led respondents to over-report their awareness and usage of authorship guidelines.

INTRODUCTION

The research process, including publication, is based on trust. Authorship is both about being credited for the work you have done and being responsible and accountable for the integrity of what is published.[1-3] Responsible authorship is a key component of publication ethics and transparent reporting.[4] Infringing the rules of authorship in scientific papers can negatively impact on the credibility of the findings as well as on the honesty of the authors. However, the temptation for scientists to abuse authorship is significant since their publication record and collaboration with coauthors can determine academic rewards such as medical qualifications and professional appointments, as well as research funding.[5] Studies reviewing published papers have identified a high prevalence of authorship problems.[6-9]

The average number of authors per published article has grown over time[10, 11] and this has raised questions around authorship in terms of eligibility, definition of their roles, and establishment of a fair sequence of authors' names according to their role.[12] Decisions about authorship eligibility can be subjective and contentious, since an author could contribute to the research without being involved in the actual writing, for example by collecting data or conducting the statistical analysis. There is a huge variation in the operational definition of authorship[4] and preference for authorship order varies by country and discipline.[12-14] In biomedicine, it is generally assumed that individuals are listed in decreasing order of level of their contribution with the exception of the last and the corresponding authors to whom importance is also attached.[15] In other disciplines such as psychology, it is the first author who assumes responsibility for the publication and handles responses to inquiries after publication and coauthors are listed in order of level of contribution.

While authorship eligibility and order can reflect legitimate regional or discipline-specific practices, some scientists also intentionally misappropriate authorship. Honorary authors are those who did not contribute substantially to the conception or design of the work; or the acquisition, analysis, or interpretation of data for the work; or the writing of the article and are unable to take public responsibility for the work.[16] Honorary authorship may occur as a result of many factors including: nepotism; reciprocation of favours for previous authorships; institutional politics and power struggles; economic reasons to justify obtained grants or demands for new funding; and trying to improve the chance of manuscript acceptance by including senior researchers.[4, 9] Ghost authors are those who are not listed as authors despite contributing substantially in these areas.[16] Ghost authorship is especially undesirable when it masks the involvement of a commercial sponsor or other competing interests that could bias the study or reporting.[17] Both honorary and ghost authorship are considered forms of research misconduct. Estimates from author surveys of the prevalence of honorary authors in high impact biomedical journals during the last 30 years have ranged from 19% to 39%[7, 16, 18] and ghost authors from 8% to 11%.[7, 16, 18]

To help scientists define authorship and limit misconduct, multiple guidelines have been produced and journals have introduced various measures to try to encourage ethical authorship practice.[19] The International Committee of Medical Journal Editors (ICMJE) criteria, adopted by many international biomedical journals and generally considered the “gold standard” for determining authorship eligibility, enumerate specific requirements for authorship, as well as stipulating that all authors should participate sufficiently in the work reported in an article to be able to take public responsibility for the content or an important part of the content.[20] While

many journals continue to encourage the use of ICMJE criteria, previous studies of selected samples of researchers have shown poor awareness of them,[21, 22] dislike of them,[22, 23] failure to comply with them[6] and preference for other authorship policies and practices.[24] One critic has even described them as illogical and unethical.[25] Some journals have introduced their own authorship criteria.[26] Others have shown that ICMJE criteria are intuitive and that the ICMJE-listed contributions are perceived as important.[27, 28] However, there are no uniform rules for authorship order.[14] We describe a large international survey of active biomedical authors in a range of specialties undertaken to determine awareness and use of authorship guidelines and criteria in a contemporary sample of authors submitting papers to a broad range of medical journals.

METHODS

Questionnaire development

We developed a 12-item online questionnaire (Appendix 1) with five additional demographic questions and a free-text item for additional comments. We piloted the questionnaire with 16 researchers to check for ambiguous items and revised the questionnaire in light of feedback. The final questionnaire included items addressing familiarity with and use of authorship criteria, experience of authorship misappropriation, frequency and timing of authorship discussions, perceived fairness of authorship decisions, and institutional encouragement to use authorship criteria.

Sample

We included authors submitting research articles in 2014 to 18 journals covering a range of specialties published by BMJ Publishing Group. See Appendix 2 for the complete list. We intentionally selected some journals with high impact factors (IFs), some with no IF and some with middle ranking IFs. All journals adhered to the ICMJE guidelines by asking corresponding authors to assure that they are respected.

Procedures

All corresponding authors of accepted and rejected research manuscripts submitted in 2014 were identified from each of the journal manuscript tracking systems, and the data merged. Duplicate authors were removed so that each author was invited to take part in the survey only once. Eligible authors were invited in 2016 by email to complete the survey hosted by SurveyMonkey. Authors were informed that participation was voluntary and that responses would be treated confidentially. Non-responders were sent reminders at two and four weeks after the initial mailing.

Patient and public involvement

We did not involve patients or the public in this research as the survey was about academic researchers' perceptions and practice around authorship of research articles. While patients may have opinions about authorship practice this was not the focus of the study.

Statistical analysis

Responses from all journals were collated and the anonymised combined sample analysed using SPSS version 18.

RESULTS

Sample

Of the 12658 email invitations sent, 259 were not delivered by SurveyMonkey, 17 generated automated responses that recipients were on long term leave or had retired, and three recipients indicated they had been invited via a different email address. We received an actual response from 3859 (31%) of the remaining 12379 authors. Response rates by journal ranged between 20% and 41%. All results are presented as the number or proportion of all 3859 respondents unless explicitly stated otherwise.

<Insert Table 1 about here>

Table 1 shows the characteristics of the sample. The majority of authors had submitted a paper that had been rejected by the sampled journal in 2014. A higher proportion of respondents were male (56%) than female (41%) and the majority (71%) were based in a university setting. Respondents varied in research and publication experience and worked in 93 countries, with the highest proportions based in the UK (20%), US (10%), Australia (6%) and The Netherlands (5%). Overall, the majority of respondents were based in Europe (54%).

Familiarity with and use of authorship criteria

After being presented with the ICMJE criteria, 258 (7%) reported they had never heard of them, 706 (18%) had heard of them but were not familiar with their content, and 2871 (74%) were very familiar with them. Of those who were very familiar with ICMJE criteria, 90% (2572/2871) reported that authorship guidelines and criteria were beneficial to research teams when preparing papers and deciding on authorship.

In relation to the last paper they coauthored, 2187/3859 (57%) reported that explicit authorship criteria were used to decide who should be an author, 1284/3859 (33%) said they were not used and 296/3859 (8%) did not know. Only 1827 (64%) of the 2871 who were very familiar with ICMJE criteria reported that explicit authorship criteria were used to decide who should be an author in their last coauthored paper.

Authorship misappropriation

Only around a quarter of researchers (929/3859) reported that they had never been involved in a study where someone was added as an author who did not contribute substantially (honorary authorship) (Table 2). The frequency of involvement in studies with ghost authors was less than for honorary authors with nearly two-thirds of authors (2481/3859) never having been involved in a study where someone was not listed as an author when they had contributed substantially.

<Insert Table 2 about here>

Only around a fifth of all respondents (740/3859, 19%) reported they had never experienced either guest or ghost authorship, whereas nearly a third (1115/3859, 29%) reported they had experienced both at least once in their careers. Researchers who had been active for more than 10 years reported a higher frequency of experience of authorship misappropriation than those who had been active for less than 10 years. Respondents who reported their institution had an

authorship policy were more likely (374/1326, 28%) to have never been involved in a study with honorary authorship than those who reported their institution did not have an authorship policy (301/1592, 19%). We found no clear pattern of perceived authorship misappropriation by continent (Appendix 3).

Timing of authorship discussions

Authorship eligibility and authorship order were discussed at an early stage more often when institutions had authorship policies, when authors were very familiar with ICMJE criteria when institutions encouraged use of authorship guidelines frequently, and when explicit authorship criteria were used to decide who should be an author, compared with not (Appendices 4 and 5).

Authorship eligibility was discussed at both an early stage and during the course of the study for a small proportion of recently coauthored articles and authorship order was discussed at both these points even less frequently, even when authorship institutional policies were in place.

Perceived fairness of authorship decisions

In relation to the last paper they coauthored, 80% (3088/3859) of respondents felt the decision on who was made an author was fair (486, 13% not fair) and 82% (3157) felt the decision on authorship order was fair (409, 11% not fair). When explicit criteria were used in authorship decisions, a higher proportion reported the decision made on authorship eligibility (2043/2187, 93%) and authorship order (2015/2187, 92%) was fair, compared with when they were not used (879/1284, 69%) and (946/1284, 74%), respectively, as shown in Appendix 6. More experienced researchers and those working in settings where the use of criteria was actively encouraged reported higher rates of fairness for authorship decisions on their last coauthored paper than less experienced researchers and those working in settings where the use of criteria was not actively encouraged.

Institutional policy

Only 34% (1326/3859) of respondents reported that their institution had an authorship policy; 41% (1592) said there was no such policy, and 919 (24%) did not know. For institutions with an authorship policy, 724/1326 (55%) frequently encouraged researchers to use it and 434/1326 (33%) sometimes.

Overall, when institutions frequently encouraged the use of authorship guidelines, decisions were more likely to be discussed at an early stage, were perceived as fairer, and incidences of honorary and ghost authorship were reported as less common compared with when frequent institutional encouragement was not reported (infrequent, no encouragement, not sure and other) (Table 3).

<Insert Table 2 about here>

Additional comments from authors about using authorship guidelines and criteria in practice

Some respondents used the additional comments section to describe barriers to using authorship guidelines and criteria in practice (See Box 1 for some illustrative verbatim quotes).

Barriers included the pervasiveness of poor authorship practice, the need for senior staff to enforce the guidelines, inability to put guidelines into practice, cultural values around acceptable practice, a lack of accountability for those who disregard them, and ineffective mandatory reporting by journals.

DISCUSSION

Our large survey of nearly 4000 active researchers from 93 countries found that almost three-quarters were very familiar with the ICMJE authorship criteria and a higher proportion viewed these and other authorship guidelines as beneficial. Around two-thirds reported that their institution frequently or sometimes encouraged the use of these or similar authorship criteria. Yet, only just over half used explicit authorship criteria when making a decision on authorship for their last coauthored paper. When institutions frequently encouraged the use of authorship guidelines, authorship eligibility was more likely to be discussed early and was perceived as fairer. Reported incidences of authorship misappropriation over the course of researchers' careers were high; around three-quarters of respondents had experienced honorary authorship and one-third ghost authorship. Respondents self-reported multiple barriers to using authorship criteria in practice.

Comparison with other studies

Our results build on the results of earlier surveys[7, 16, 18] by providing a snapshot of authorship practice from a very large international sample of active researchers in a broad range of biomedical specialties. Similar to previous studies,[7, 16, 18] we found reported rates of honorary authorship were higher than for ghost authorship. The proportion who had experienced honorary and ghost authorship was higher than previous surveys conducted between 1998 and 2011,[7, 18] but our respondents were asked about experience across their careers rather than about a specific publication and we did not just include high impact journals. We found no clear pattern of perceived authorship misappropriation by continent, which is in contrast to the findings of a systematic review in 2011, which found authorship problems and misuse were reported more often by researchers outside of the USA and UK.[9]

Researchers in our study reported a higher level of familiarity and use of authorship guidelines and criteria than previous studies.[21, 22] This may partly be explained by wider promotion of these criteria than before and the fact that our sample was larger and composed of corresponding authors of articles submitted to journals promoting ICMJE guidelines and requesting compliance with them prior to publication. Almost 90% of our sample reported explicit use of authorship guidelines and criteria was beneficial when preparing papers and deciding on authorship. However, despite such familiarity, more than one-third of our sample declared that explicit authorship criteria were not used to decide who should be an author on their most recent article. Similarly, Bonekamp et al.[24] found a high rate of awareness (81%) of ICMJE criteria amongst submitting authors, yet 25% reported that at least one of their coauthors on the submission did not merit authorship. Our respondents described the difficulties of applying authorship criteria when for example colleagues disregard them, there are power imbalances and a strong cultural norm to attribute authorship in certain ways.

Study limitations

Our study has several limitations. Firstly, we received a low (31%) response rate, which may have caused selection bias. However, response rates to surveys of doctors and researchers are often low.[29-32] Only a fifth of invited authors had their papers accepted by the journals in the sampling period and this may have affected their willingness to help. Also, some authors informed us that they only received the last reminder email, suggesting that some institutional

email filters were treating the emails as spam. Despite the low response rate, we did receive nearly 4,000 responses from all continents, which is a substantial survey sample.

Secondlyg. However, by surveying submitting authors and not just those who had papers accepted for publication at the participating journals, we sought to capture the experience of researchers from numerous countries and of varying levels of research and publication experience; some respondents will have never published with BMJ Publishing Group before. We also sampled authors submitting to a range of journals in different specialties and with a range of Impact Factors.

Thirdly, analyses are based on self-reported data from corresponding authors. We assured participants of confidentiality, but the survey was not anonymous and given the sensitivity of the questions, we cannot rule out social desirability bias with respondents over-reporting their awareness and usage of authorship criteria. We chose to contact corresponding authors as they coordinate the activities of other authors and are the person most likely to have knowledge of the roles and contributions of other authors.[16]

Study implications

Understanding authorship practice is an important ethical matter because authorship ensures credit and accountability for research. Ethical authorship practice is essential for the promotion and maintenance of the scientific integrity of biomedical research. We found that authorship guidelines and criteria are known by the majority of researchers and their application is considered beneficial when preparing manuscripts. However, authorship misconduct is still prevalent; even those new to research reported experience of it. Thus, it is not simply a matter of authors needing to be informed about guidelines and criteria, but of having the opportunity to apply them in a supportive environment that is suited to their discipline.

While both institutions and journals have important duties relating to authorship misconduct,[19] institutions are ultimately responsible for the conduct of their researchers.[33] In 2000, a Taskforce on Authorship reporting to the Council of Science Editors stated that all universities, medical schools, research institutes and commercial companies that conduct and publish research should have explicit policies on authorship.[13] Yet 16 years later, only a third of respondents reported that their institution had an authorship policy. Where institutions encouraged the use of authorship guideline and criteria, perceptions of fairness of authorship decisions were higher and discussions on authorship eligibility and authorship order were more frequent. Therefore, institutions should be more active in supporting the use of authorship guidelines and criteria, especially to support younger researchers and to reduce power differentials among authorship teams.[15] While it might be ideal but not feasible to have universal criteria for how researchers are recognised in publications, having well-designed institutional systems for agreeing and enforcing local and specific authorship policies at the start of projects and throughout the research process could help in avoiding disputes or resolving them quickly.[15]

Proponents of good authorship practice recommend early discussion of authorship in the research process,[34] something that could easily be encouraged by institutions. Authorship eligibility was discussed at an early stage and during the study for only a small proportion of recently coauthored articles in our sample. Whilst courses in research ethics are now more

common, few institutions teach publication ethics and good authorship practice. In particular, no guidelines exist on authorship order which remains one of the major issues for most institutions.

Finally, journals should not adjudicate authorship disputes or police authorship practice but should provide clear advice to authors and reviewers and have appropriate policies for editors and staff relating to all aspects of publication ethics.[33] In 1997, recognising the need for systemic reform, Rennie et al[2] proposed the introduction of contributorship statements whereby individuals are named against their specific contributions and individuals can be mentioned without being authors on the byline, but most journals have not adopted this approach. This is also not accepted in most promotion committees for academic awards, where the position counts. Recognising the ICMJE criteria may be unworkable in practice, some journals prefer to introduce their own criteria for authorship. For example, *Neurology* recently revised its authorship policy, to recognise an author as someone who has substantially contributed to one or more of the following: design or conceptualisation of the study; or major role in the acquisition of data; or analysis or interpretation of the data; or drafting or revising the manuscript for intellectual content.[26] ICMJE requires authors to fulfil all four of its criteria whereas Neurology requires just one of its criteria to be met. Some argue that institutions, journal editors and funding agencies could introduce more stringent policies and punishments around authorship misappropriation.[19] Modifying the “microsystem” of authorship in biomedical research is a challenge that needs to be promptly addressed.

Contributors
TK had the idea for the study. IM reviewed the literature. SS and IM wrote the first draft of the manuscript and are joint first authors on this paper. SS managed the survey and collected and analysed the data. All authors participated in the design of the survey, interpretation of the results, revising the manuscript, and review and approval of the final manuscript. SS had full access to all the data and can take responsibility for the integrity of the data and the accuracy of the data analysis. All authors meet the ICMJE authorship criteria and authorship eligibility.

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Competing interests
All authors have completed the Unified Competing Interest form at www.icmje.org/coi_disclosure.pdf (available on request from the corresponding author) and declare that SS is a full-time employee at *The BMJ*. TK reports having contributed to an advisory board of CoLucid and a research project funded by Amgen, for which the Charité – Universitätsmedizin Berlin received an unrestricted compensation. TK further reports having received honoraria from Lilly, Newsenselab, and Total for providing methodological advice, from Novartis and from Daiichi Sankyo for providing a lecture on neuroepidemiology and research methods, and from the *BMJ* for editorial services. EL receives salary from *The BMJ* for services as head of research, paid to her employer the Brigham and Women's Physician Organization. IM reports having worked as an independent medical writer for Novartis, Sanofi SA and Bristol Myers Squibb. ME has no competing interests. ES has received honoraria from Fresenius Medical Care, Fresenius Kabi and Siemens Healthineers for lectures.

Ethical approval
The study protocol was reviewed by *The BMJ's* ethics committee (7/10/15) and it did not have any major ethical concerns. Participation in the survey was voluntary and participants were told that they could withdraw at any stage. Participants were assured that the survey was confidential. Data were managed in compliance with GDPR.

Data sharing
Anonymised individual respondent data will be shared on reasonable request.

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Table 1: Respondent characteristics (n=3,859)

	n	%
Editorial decision made on submitted article		
Accept	839	22
Reject	3020	78
Gender		
Male	2150	56
Female	1585	41
Institution of work		
University setting	2739	71
Private research centre	113	3
Public research centre	511	13
Industry	29	1
Other	349	9
Number of years as an active researcher		
<5 years	846	22
6-10 years	1021	27
11-15 years	628	16
16-20 years	462	12
More than 20 years	772	20
Number of papers published		
≤ 5	509	13
6-10	478	12
11-20	521	14
21-30	416	11
31-40	274	7
41-50	229	6
51-100	592	15
>100	689	18
Continent		
Africa	79	2
Asia	652	17
Europe	2073	54
North America	594	15
South America	90	2
Oceania	243	6

Note: Percentages do not sum to 100% due to missing data.

Table 2: Experience of authorship misappropriation by years of research experience

	Honorary authorship n (%)				Ghost authorship n (%)			
	All respondents (n=3859)	**Active research for 5 years or less (n=861)**	**Active research for 10 years or less (n=1867)**	**Active researcher for more than 10 years (n=1862)**	**All respondents (n=3859)**	**Active research for 5 years or less (n=861)**	**Active research for 10 years or less (n=1867)**	**Active researcher for more than 10 years (n=1862)**
Never	929 (24)	250 (30)	498 (27)	404 (22)	2481 (64)	604 (71)	1288 (69)	1152 (62)
Once	427 (11)	168 (20)	283 (15)	134 (7)	415 (11)	99 (12)	209 (11)	197 (11)
A few times	1911 (50)	337 (40)	853 (46)	1032 (55)	823 (21)	129 (15)	341 (18)	466 (25)
Lots of times	521 (14)	90 (11)	229 (12)	287 (15)	67 (2)	12 (1)	26 (1)	41 (2)

Note: Percentages do not sum to 100% due to missing data.

Table 3: Stratification of responses by whether use of explicit authorship guidelines and criteria in current research setting is frequently encouraged or not

	n (%)	
	Use of explicit authorship guidelines frequently encouraged (n=1410)	**Use of explicit authorship guidelines not frequently encouraged (n=2404) ***
Agrees that the explicit use of authorship guidelines and criteria are beneficial to research teams when preparing a paper and deciding on authorship	1330 (94)	2025 (84)
Never been involved in a study where someone has been added as an author who did not contribute substantially (honorary authorship)	426 (30)	501 (21)
Never been involved in a study where someone was not listed as an author when they contributed substantially (ghost authorship)	951 (67)	1526 (64)
Never experienced honorary or ghost authorship	350 (25)	388 (16)
Experienced both honorary and ghost authorship	370 (26)	744 (31)
Authorship eligibility discussed at an early stage during study design	817 (58)	970 (40)
Authorship order discussed at an early stage during study design	497 (35)	566 (24)
Used explicit authorship criteria to decide WHO should be an author on their last coauthored paper	1161 (82)	1023 (43)
Felt decision on WHO should be an author on their last coauthored paper was a fair reflection of who did what?	1273 (90)	1810 (75)
Felt decision on ORDER of authorship on their last coauthored paper was a fair reflection of who did what?	1266 (90)	1886 (79)

* Includes responses of “other”, “not sure”, “not encouraged” and “sometimes encouraged”.

Box 1: Illustrative verbatim quotes from respondents about barriers to using authorship guidelines and criteria

Pervasiveness of poor authorship practice "In Italy, especially in the University setting, is very frequent that papers are submitted with a huge list of authors, despite most of them have not contributed at all; this is integrant part of an unequal system, hardly removable." (Author from Italy) "I am pretty jaded about authorship… the addition of senior names is a rote exercise rather than a reflection of true intellectual contribution. Politics trumps guidelines in my experience." (Author from Ireland)
Need enforcement from senior staff "Authorship guidelines will only work as a means of determining who is an author if they are enforced by the senior people in the institution. Ironically, they are often the ones that contribute least to a paper. It's a difficult situation to fix when unfair practices are entrenched by the hierarchy." (Author from Australia) "Insecurity of jobs and the asymmetry of power between co-authors mean that authorship criteria have minimal effect. My institution pays lip service only to authorship rules. Real fundamental change at least requires scrapping of the system of ordering authors." (Author from UK)
Unworkable in practice "The ICMJE guidelines are imprecise and hence difficult to follow. They also reflect a very Anglo-American view of research culture which does not reflect the values of all cultures. This is clearly inappropriate." (Author from Australia) "The problem with the criteria is that it includes all the points in the list. However, often there are e.g. younger researchers (students) who may do a substantial job lasting for months in collecting the data etc yet they do not participate in drafting the manuscript… So the final decision comes on the amount of work the persons put, not that they contribute to each of the points. That is fair and that is how researchers get started." (Author from Finland)
Cultural values around acceptable practice "In our country it is still "usual" to have the chief of the service/unit be included as an author even if he/she did little or nothing." (Author from Argentina) "Well gift authorship (including head of the Department as a co-author) is quite 'the norm' rather than an exception." (Author from India)
Lack of accountability "The ICMJE authorship criteria represent an important research and ethical standard to uphold…Better education on the ICMJE criteria and the importance of transparency in publication could help address this problem but there needs to be some sort of accountability for those who flagrantly disregard it for personal, professional or political gain." (Researcher from Canada)
Ineffective mandatory reporting by journals "I am aware there is a need for guidelines... but some journals nowadays require mandatory specification that the 4 criteria are met by every co-author. The practical result is that everyone clicks the buttons, whatever they actually did. Such stringent application of the criteria as mentioned in this survey serves no useful purpose in my opinion." (Researcher from Canada)

Welcome

1. Does your institution / main work location have an authorship policy providing criteria researchers should use when deciding on who should be an author on a research paper?

- ○ Yes
- ○ No
- ○ I don't know
- ○ Not applicable

ICMJE criteria for authorship

The International Committee of Medical Journal Editors (ICMJE) recommends that authorship be based on the following 4 criteria:

- Substantial contributions to the conception or design of the work; or the acquisition, analysis, or interpretation of data for the work; AND
- Drafting the work or revising it critically for important intellectual content; AND
- Final approval of the version to be published; AND
- Agreement to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.

2. How familiar are you with the ICMJE criteria for authorship listed above?

- ◯ I have never heard of them
- ◯ I have heard of them, but I wasn't familiar with the content
- ◯ I am very familiar with the content

3. In your current research setting, are the use of explicit authorship guidelines / criteria (e.g. ICMJE or institutional guidelines) actively encouraged?

- ◯ Yes, they are frequently encouraged
- ◯ Yes, they are sometimes encouraged
- ◯ No, they are not encouraged
- ◯ I'm not sure
- ◯ Other (please specify):

4. Do you think the explicit use of authorship guidelines / criteria are beneficial to research teams when preparing / writing a scientific paper and deciding on authorship?

◯ Yes ◯ No ◯ I don't know

5. How frequently have you been involved in a study where someone has been added as an author who did not contribute substantially to the conception or design of the work; or the acquisition, analysis, or interpretation of data for the work; or the writing of the article?

- Never
- Once
- A few times
- Lots of times

6. How frequently have you been involved in a study where someone was not listed as an author when they contributed substantially to the conception or design of the work; or the acquisition, analysis, or interpretation of data for the work; or the writing of the article?

- Never
- Once
- A few times
- Lots of times

Thinking of the last paper you coauthored....

7. Thinking of the last paper you coauthored, at what point in time were details about WHO should be an author discussed? [Tick all that apply]

- [ ] At an early stage during the design of the study
- [ ] During the course of the study
- [ ] Once the study was completed and before writing the paper
- [ ] During paper writing
- [ ] After the paper was written
- [ ] It was never discussed

8. Thinking of the last paper you coauthored, at what point in time were details about the ORDER of authorship discussed? [Tick all that apply]

- [ ] At an early stage during the design of the study
- [ ] During the course of the study
- [ ] Once the study was completed and before writing the paper
- [ ] During paper writing
- [ ] After the paper was written
- [ ] It was never discussed

Thinking of the last paper you coauthored....

9. Thinking of the last paper you coauthored, were explicit authorship criteria used to decide WHO should be an author?

Yes No I don't know

10. Thinking of the last paper you coauthored, do you feel that the decision on WHO should be an author was a fair reflection of who did what?

Yes No I don't know

11. Thinking of the last paper you coauthored, approximately how many times was authorship ORDER discussed by the research team?

Never Only once A few times Lots of times

12. Thinking of the last paper you coauthored, do you feel that the decision on the ORDER of authorship was a fair reflection of who did what?

Yes No I don't know

And finally some questions about yourself:

13. For which institution do you mainly work?

14. Where is your (main) institution located?

15. Approximately how many years have you been an active researcher?

16. Approximately how many papers have you published in a peer reviewed journal as either an author or a coauthor?

17. Are you?

◯ Female ◯ Male

18. Do you have any further comments?

Thank you

Thank you for your help with this research.

Please now click "submit" to complete the survey.

Appendix 2: List of included journals and their impact factors

Archives of Disease in Childhood
Annals of the Rheumatic Diseases
BMJ Open Diabetes Research & Care
BMJ Supportive & Palliative Care
Emergency Medicine Journal
Frontline Gastroenterology
Journal of Clinical Pathology
Journal of Neurology, Neurosurgery & Psychiatry
Occupational and Environmental Medicine

*Time of the sampling

Appendix 3: Frequency of involvement in authorship misappropraition by continent of author's main institution

Appendix 4: Timing of discussions around authorship eligibility

Appendix 5: Timing of decisions around authorship order

Appendix 6: Perceived fairness of authorship decisions on last coauthored paper

	Decision made on authorship eligibility was fair (%)	Decision made on order of authorship was fair (%)
Use of explicit authorship criteria		
Explicit criteria used (n=2187)	2043 (93)	2015 (92)
Explicit criteria not used (n=1284)	879 (69)	946 (74)
Years of research experience		
More than 10 years of experience (n=1862)	1596 (86)	1610 (86)
Ten years or less of experience (n=1867)	1461 (78)	1515 (81)
Use of explicit authorship guidelines / criteria actively encouraged in current research setting		
Frequently encouraged (n=1410)	1273 (90)	1266 (90)
Not frequently encouraged (n=2404)*	1810 (75)	1886 (78)

Values are numbers (percent).

* Includes responses of “other”, “not sure”, “not encouraged” and “sometimes encouraged”.

The corresponding author Ilaria Montagni

STROBE Statement—checklist of items that should be included in reports of observational studies

	Item No	Recommendation
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found
Introduction		
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported
Objectives	3	State specific objectives, including any prespecified hypotheses
Methods		
Study design	4	Present key elements of study design early in the paper
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection
Participants	6	(*a*) *Cohort study*—Give the eligibility criteria, and the sources and methods of selection of participants. Describe methods of follow-up *Case-control study*—Give the eligibility criteria, and the sources and methods of case ascertainment and control selection. Give the rationale for the choice of cases and controls *Cross-sectional study*—Give the eligibility criteria, and the sources and methods of selection of participants
		(*b*) *Cohort study*—For matched studies, give matching criteria and number of exposed and unexposed *Case-control study*—For matched studies, give matching criteria and the number of controls per case
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group
Bias	9	Describe any efforts to address potential sources of bias
Study size	10	Explain how the study size was arrived at
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding
		(*b*) Describe any methods used to examine subgroups and interactions
		(*c*) Explain how missing data were addressed
		(*d*) *Cohort study*—If applicable, explain how loss to follow-up was addressed *Case-control study*—If applicable, explain how matching of cases and controls was addressed *Cross-sectional study*—If applicable, describe analytical methods taking account of sampling strategy
		(*e*) Describe any sensitivity analyses

Continued on next page

Results		
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed
		(b) Give reasons for non-participation at each stage
		(c) Consider use of a flow diagram
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders
		(b) Indicate number of participants with missing data for each variable of interest
		(c) *Cohort study*—Summarise follow-up time (eg, average and total amount)
Outcome data	15*	*Cohort study*—Report numbers of outcome events or summary measures over time
		Case-control study—Report numbers in each exposure category, or summary measures of exposure
		Cross-sectional study—Report numbers of outcome events or summary measures
Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included
		(*b*) Report category boundaries when continuous variables were categorized
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses
Discussion		
Key results	18	Summarise key results with reference to study objectives
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence
Generalisability	21	Discuss the generalisability (external validity) of the study results
Other information		
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based

*Give information separately for cases and controls in case-control studies and, if applicable, for exposed and unexposed groups in cohort and cross-sectional studies.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at www.strobe-statement.org.

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Awareness, usage and perceptions of authorship guidelines: an international survey of biomedical authors

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ABSTRACT (298/300 words)

Objectives
To investigate authors' awareness and use of authorship guidelines, and to assess their perceptions of the fairness of authorship decisions.

Design
Cross-sectional online survey.

Setting and participants
Corresponding authors of research papers submitted in 2014 to 18 BMJ journals.

Results
3859/12646 (31%) researchers responded. They worked in 93 countries and varied in research experience. Of these, 1326 (34%) reported their institution had an authorship policy providing criteria for authorship; 2871 (74%) were "very familiar" with the International Committee of Medical Journal Editors authorship criteria, and 3358 (87%) reported that guidelines were beneficial when preparing manuscripts. Furthermore, 2609 (68%) reported their use was "sometimes" or "frequently" encouraged in their research setting. However, 2859 respondents (74%) reported they had been involved in a study at least once where someone was added as an author who had not contributed substantially (honorary authorship), and 1305 (34%) where someone was not listed as an author but had contributed substantially (ghost authorship). Only 740 (19%) reported that they had never experienced either honorary or ghost authorship; 1115 (29%) reported that they had experienced both at least once. There was no clear pattern in experience of authorship misappropriation by continent. For their last coauthored article, 2187 (57%) reported explicit authorship criteria had been used to determine eligibility, and 3088 (80%) felt the decision made was fair. When institutions frequently encouraged use of authorship guidelines, authorship eligibility was more likely to be discussed early (817 of 1410, 58%) and perceived as fairer (1273 of 1410, 90%) compared with infrequent encouragement (974 of 2449, 40% and 1891 of 2449, 74%).

Conclusions
Despite a high level of awareness of authorship guidelines and criteria, these are not so widely used; more explicit encouragement of their use by institutions may result in more favourable use of guidelines by authors.

Keywords: authorship guidelines, survey, biomedical research

Article Summary

Strengths and limitations of this study

- Very large international survey of active researchers describing their current practice.
- We address authorship practice which is an important ethical matter because authorship ensures credit and accountability for research.
- We report self-administered survey data, and given the sensitivity of the questions, social desirability bias may have led respondents to over-report their awareness and usage of authorship guidelines.

INTRODUCTION

The research process, including publication, is based on trust. Authorship is both about being credited for the work you have done and being responsible and accountable for the integrity of what is published.(1-3) Responsible authorship is a key component of publication ethics and transparent reporting.(4) Infringing the rules of authorship in scientific papers can negatively impact on the credibility of the findings as well as on the honesty of the authors. However, the temptation for scientists to abuse authorship is significant since their publication record and collaboration with coauthors can determine academic rewards such as medical qualifications and professional appointments, as well as research funding.(5) Studies reviewing published papers have identified a high prevalence of authorship problems.(6-9)

The average number of authors per published article has grown over time(10, 11) and this has raised questions around authorship in terms of eligibility, definition of their roles, and establishment of a fair sequence of authors' names according to their role.(12) Decisions about authorship eligibility can be subjective and contentious, since an author could contribute to the research without being involved in the actual writing, for example by collecting data or conducting the statistical analysis. There is huge variation in the operational definition of authorship(4) and preference for authorship order varies by country and discipline.(12-14) In biomedicine, it is generally assumed that individuals are listed in decreasing order of level of their contribution with the exception of the last and the corresponding authors to whom importance is also attached.(15) In other disciplines such as psychology, it is the first author who assumes responsibility for the publication and handles responses to inquiries after publication and coauthors are listed in order of level of contribution.

While authorship eligibility and order can reflect legitimate regional or discipline-specific practices, some scientists also intentionally misappropriate authorship. Honorary authors are those who did not contribute substantially to the conception or design of the work; or the acquisition, analysis, or interpretation of data for the work; or the writing of the article and are unable to take public responsibility for the work.(16) Honorary authorship may occur as a result of many factors including: nepotism; reciprocation of favours for previous authorships; institutional politics and power struggles; economic reasons to justify obtained grants or demands for new funding; and trying to improve the chance of manuscript acceptance by including senior researchers.(4, 9) Ghost authors are those who are not listed as authors despite contributing substantially in these areas.(16) Ghost authorship is especially undesirable when it masks the involvement of a commercial sponsor or other competing interests that could bias the study or reporting.(17) Both honorary and ghost authorship are considered forms of research misconduct. Estimates from author surveys of the prevalence of honorary authors in high impact biomedical journals during the last 30 years have ranged from 19% to 39%(7, 16, 18) and ghost authors from 8% to 11%.(7, 16, 18)

To help scientists define authorship and limit misconduct, multiple guidelines have been produced and journals have introduced various measures to try to encourage ethical authorship practice.(19) The International Committee of Medical Journal Editors (ICMJE) criteria, adopted by many international biomedical journals and generally considered the “gold standard” for determining authorship eligibility, enumerate specific requirements for authorship, as well as stipulating that all authors should participate sufficiently in the work reported in an article to be able to take public responsibility for the content or an important part of the content.(20) While

many journals continue to encourage the use of ICMJE criteria, previous studies of selected samples of researchers have shown poor awareness of them,(21, 22) dislike of them,(22, 23) failure to comply with them(6) and preference for other authorship policies and practices.(24) One critic has even described them as illogical and unethical.(25) Some journals have introduced their own authorship criteria.(26) Others have shown that ICMJE criteria are intuitive and that the ICMJE-listed contributions are perceived as important.(27, 28) However, there are no uniform rules for authorship order.(14) We describe a large international survey of active biomedical authors in a range of specialties undertaken to determine awareness and use of authorship guidelines and criteria in a contemporary sample of authors submitting papers to a broad range of biomedical journals.

METHODS

Questionnaire development

We developed a 12-item online closed questionnaire (Appendix 1) with five additional demographic questions and a free-text item for additional comments. We piloted the questionnaire with 16 researchers to check for ambiguous items and revised the questionnaire in light of feedback. The final questionnaire included items addressing familiarity with and use of authorship criteria, experience of authorship misappropriation, frequency and timing of authorship discussions, perceived fairness of authorship decisions, and institutional encouragement to use authorship criteria.

Sample

We included authors submitting research articles in 2014 to 18 journals covering a range of specialties published by BMJ Publishing Group (see Appendix 2). To try to get a broad sample of biomedical journals of varying size and prestige, we intentionally selected journals with high, middle, and low impact factors (IFs). As a deviation from our protocol, we also sampled some recently acquired journals with no IF. All journals adhered to the ICMJE guidelines by asking corresponding authors to assure that they are respected.

Procedures

All corresponding authors of accepted and rejected research manuscripts submitted in 2014 were identified from each of the journal manuscript tracking systems, and the data merged. Duplicate authors were removed so that each author was invited to take part in the survey only once. We selected one journal to act as a pilot to gauge response rate and invited eligible authors of this journal by an email on 14 March 2016 from SS, an employee of BMJ Publishing Group, to complete the survey hosted by SurveyMonkey; eligible authors of the other 17 journals were invited on 14 September 2016. Authors were informed that participation was voluntary and that responses would be anonymised and treated confidentially. Participants were not asked to give consent to take part; they were informed that completion of the survey would indicate that they had consented to take part. Non-responders were sent reminders at two and four weeks after the initial mailing and the survey was open for completion for a six-week period. To try to maximise recruitment, we gave an incentive of the chance to win a prize draw for a £100 voucher.

Patient and public involvement

We did not involve patients in the research team or development of the questionnaire as the focus was on academic researchers' perceptions and their institutional experiences. We recognise that patients are sometimes authors and may have different experiences as authors, but this forms only a small proportion of the published literature and patients' experience as authors was not the intended focus of the paper. To adequately capture patients' experience of authorship would require a different set of questions.

Statistical analysis

Responses from all journals were collated and the anonymised combined sample analysed using SPSS version 18. Quantitative data were summarised as frequencies and percentages.

Verbatim from the free-text item were read by SS and IM who then selected illustrative quotes about barriers to using authorship guidelines and criteria.

RESULTS

Sample

Of the 12658 email invitations sent, 259 were not delivered by SurveyMonkey, 17 generated automated responses that recipients were on long term leave or had retired, and three recipients indicated they had been invited via a different email address. We received an actual response from 3859 (31%) of the remaining 12379 authors. Response rates by journal ranged between 20% and 41%. All results are presented as the number or proportion of all 3859 respondents unless explicitly stated otherwise.

Table 1 shows the characteristics of the sample. The majority of authors had submitted a paper that had been rejected by the sampled journal in 2014. A higher proportion of respondents were male (56%) than female (41%) and the majority (71%) were based in a university setting. Respondents varied in research and publication experience and worked in 93 countries, with the highest proportions based in the UK (20%), US (10%), Australia (6%) and The Netherlands (5%). Overall, the majority of respondents were based in Europe (54%).

Familiarity with and use of authorship criteria

After being presented with the ICMJE criteria, 258 (7%) reported they had never heard of them, 706 (18%) had heard of them but were not familiar with their content, and 2871 (74%) were very familiar with them. Of those who were very familiar with ICMJE criteria, 90% (2572/2871) reported that authorship guidelines and criteria were beneficial to research teams when preparing papers and deciding on authorship.

In relation to the last paper they coauthored, 2187/3859 (57%) reported that explicit authorship criteria were used to decide who should be an author, 1284/3859 (33%) said they were not used and 296/3859 (8%) did not know. Only 1827 (64%) of the 2871 who were very familiar with ICMJE criteria reported that explicit authorship criteria were used to decide who should be an author in their last coauthored paper.

Authorship misappropriation

Only around a quarter of researchers (929/3859) reported that they had never been involved in a study where someone was added as an author who did not contribute substantially (honorary authorship) (Table 2). The frequency of involvement in studies with ghost authors was less than for honorary authors with nearly two-thirds of authors (2481/3859) never having been involved in a study where someone was not listed as an author when they had contributed substantially.

Only around a fifth of all respondents (740/3859, 19%) reported they had never experienced either guest or ghost authorship, whereas nearly a third (1115/3859, 29%) reported they had experienced both at least once in their careers. Researchers who had been active for more than 10 years reported a higher frequency of experience of authorship misappropriation than those who had been active for less than 10 years. Respondents who reported their institution had an authorship policy were more likely (374/1326, 28%) to have never been involved in a study with honorary authorship than those who reported their institution did not have an authorship policy

(301/1592, 19%). We found no clear pattern of perceived authorship misappropriation by continent (Appendix 3).

Timing of authorship discussions

Authorship eligibility and authorship order were discussed at an early stage more often when institutions had authorship policies, when authors were very familiar with ICMJE criteria when institutions encouraged use of authorship guidelines frequently, and when explicit authorship criteria were used to decide who should be an author, compared with not (Appendices 4 and 5). Authorship eligibility was discussed at both an early stage and during the course of the study for a small proportion of recently coauthored articles and authorship order was discussed at both these points even less frequently, even when authorship institutional policies were in place.

Perceived fairness of authorship decisions

In relation to the last paper they coauthored, 80% (3088/3859) of respondents felt the decision on who was made an author was fair (486, 13% not fair) and 82% (3157) felt the decision on authorship order was fair (409, 11% not fair). When explicit criteria were used in authorship decisions, a higher proportion reported the decision made on authorship eligibility (2043/2187, 93%) and authorship order (2015/2187, 92%) was fair, compared with when they were not used (879/1284, 69%) and (946/1284, 74%), respectively, as shown in Appendix 6. More experienced researchers and those working in settings where the use of criteria was actively encouraged reported higher rates of fairness for authorship decisions on their last coauthored paper than less experienced researchers and those working in settings where the use of criteria was not actively encouraged.

Institutional policy

Only 34% (1326/3859) of respondents reported that their institution had an authorship policy; 41% (1592) said there was no such policy, and 919 (24%) did not know. For institutions with an authorship policy, 724/1326 (55%) frequently encouraged researchers to use it and 434/1326 (33%) sometimes.

Overall, when institutions frequently encouraged the use of authorship guidelines, decisions were more likely to be discussed at an early stage, were perceived as fairer, and incidences of honorary and ghost authorship were reported as less common compared with when frequent institutional encouragement was not reported (infrequent, no encouragement, not sure and other) (Table 3).

Additional comments from authors about using authorship guidelines and criteria in practice

631 respondents used the additional comments section to expand on their survey responses. Many described barriers to using authorship guidelines and criteria in practice (See Box 1 for some illustrative verbatim quotes).

Barriers included the paradox of the need for senior staff to enforce the guidelines while being the ones that contribute the least to a paper. Some authors reported that the guidelines were imprecise and then difficult to put into practice. Barriers also included pervasiveness of poor

authorship practice, cultural values around acceptable practice, a lack of accountability for those who disregard them, and ineffective mandatory reporting by journals. The comments also included potential solutions to overcome the barriers to using authorship guidelines and criteria. For example, additional training on importance of criteria, transparency and accountability in publication.

DISCUSSION

Our large survey of nearly 4000 active researchers from 93 countries found that almost three-quarters were very familiar with the ICMJE authorship criteria and a higher proportion viewed these and other authorship guidelines as beneficial. Around two-thirds reported that their institution frequently or sometimes encouraged the use of these or similar authorship criteria. Yet, only just over half used explicit authorship criteria when deciding on authorship for their last coauthored paper. When institutions frequently encouraged the use of authorship guidelines, authorship eligibility was more likely to be discussed early and was perceived as fairer. Reported incidences of authorship misappropriation over the course of researchers' careers were high; around three-quarters of respondents had experienced honorary authorship and one-third ghost authorship. Respondents self-reported multiple barriers to using authorship criteria in practice.

Comparison with other studies

Our results build on the results of earlier surveys(7, 16, 18) by providing a snapshot of authorship practice from a very large international sample of active researchers in a broad range of biomedical specialties. Similar to previous studies,(7, 16, 18) we found reported rates of honorary authorship were higher than for ghost authorship. The proportion who had experienced honorary and ghost authorship was higher than previous surveys conducted between 1998 and 2011,(7, 18) but our respondents were asked about experience across their careers rather than about a specific publication and we did not just include high impact journals. We found no clear pattern of perceived authorship misappropriation by continent, which is in contrast to the findings of a systematic review in 2011, which found authorship problems and misuse were reported more often by researchers outside of the USA and UK.(9)

Researchers in our study reported a higher level of familiarity and use of authorship guidelines and criteria than previous studies.(21, 22) This may partly be explained by wider promotion of these criteria and changes in authorship practice over time. For example, in some Nordic countries, compulsory courses on authorship guidelines have been introduced from the first year of the PhD program. Early researchers are trained to discuss with their supervisor how to establish an equitable authorship order for papers. We may also have observed a higher level of familiarity and use of authorship guidelines because our sample was larger and composed of corresponding authors of articles submitted to journals promoting ICMJE criteria and requesting compliance with these criteria prior to publication.

However, despite such familiarity, more than one-third of our sample declared that explicit authorship criteria were not used to decide who should be an author on their most recent article. Similarly, Bonekamp et al.(24) found a high rate of awareness (81%) of ICMJE criteria amongst submitting authors, yet 25% reported that at least one of their coauthors on the submission did not merit authorship. Our respondents described the difficulties of applying authorship criteria when for example colleagues disregard them, there are power imbalances and a strong cultural norm to attribute authorship in certain ways. Research culture is increasingly characterised by unhealthy competition, job insecurity, poor supervision and mentorship, discrimination, bullying and harassment(29) which can only have a negative impact on the quality of research and compliance with authorship guidelines and criteria. Early career researchers in particular can be pressured by supervisors to produce more research papers in journals with high Impact Factors.

The inclusion of senior researchers as co-authors, irrespective of their contribution, can increase the chances of publication in a competitive field. In addition, honorary authorship can give co-authors opportunities to strengthen collaborations with other researchers and increase the visibility of their work.

Study limitations

Our study has several limitations. Firstly, we received a low (31%) response rate, which may have caused selection bias. However, response rates to surveys of doctors and researchers are often low.(30-33) Only a fifth of invited authors had their papers accepted by the journals in the sampling period and this may have affected their willingness to help. Also, some authors informed us that they only received the last reminder email, suggesting that some institutional email filters were treating the emails as spam. Despite the low response rate, we did receive nearly 4,000 responses from all continents, which is a substantial survey sample.

Secondly. However, by surveying submitting authors and not just those who had papers accepted for publication at the participating journals, we sought to capture the experience of researchers from numerous countries and of varying levels of research and publication experience; some respondents will have never published with BMJ Publishing Group before. We also sampled authors submitting to a range of journals in different specialties and with a range of Impact Factors.

Thirdly, analyses are based on self-reported data from corresponding authors. We assured participants of confidentiality, but the survey was not anonymous and given the sensitivity of the questions, we cannot rule out social desirability bias with respondents over-reporting their awareness and usage of authorship criteria. We chose to contact corresponding authors as they coordinate the activities of other authors and are the person most likely to have knowledge of the roles and contributions of other authors.(16)

Finally, respondents completed the survey in 2016 and as such responses might not accurately reflect the current research ecosystem which is continuously evolving in terms of publication policies and strategies.

Study implications

Understanding authorship practice is an important ethical matter because appropriate authorship ensures credit and accountability for research. Ethical authorship practice is essential for the promotion and maintenance of the scientific integrity of biomedical research. We found that authorship guidelines and criteria are known by the majority of researchers and their application is considered beneficial when preparing manuscripts. However, authorship misconduct is still prevalent; even those new to research reported experience of it. Thus, it is not simply a matter of authors needing to be informed about guidelines and criteria, but of having the opportunity to apply them in a supportive environment that is suited to their discipline.

While both institutions and journals have important duties relating to authorship misconduct,(19) institutions are ultimately responsible for the conduct of their researchers.(34) In 2000, a Taskforce on Authorship reporting to the Council of Science Editors stated that all universities,

medical schools, research institutes and commercial companies that conduct and publish research should have explicit policies on authorship.(13) Yet 16 years later, only a third of respondents reported that their institution had an authorship policy, although this might partly be explained by researchers being unaware of existing institutional policies and the need for better promotion of these. Where institutions encouraged the use of authorship guidelines and criteria, perceptions of fairness of authorship decisions were higher and discussions on authorship eligibility and authorship order were more frequent. Little guidance exists on authorship order which remains one of the major issues for most institutions. Institutions should be more active in supporting the use of authorship guidelines and criteria, especially to support early career researchers and to reduce power differentials among authorship teams.(15) Authorship eligibility was discussed at an early stage and during the study for only a small proportion of recently coauthored articles in our sample. Proponents of good authorship practice recommend early discussion of authorship in the research process,(35) something that could easily be encouraged by institutions. While it might be ideal but not feasible to have universal criteria for how researchers are recognised in publications, having well-designed institutional systems for agreeing and enforcing local and specific authorship policies at the start of projects and throughout the research process could help in avoiding disputes or resolving them quickly.(15)

On the other side, editors and publishers of some biomedical journals are already encouraging the use of authorship guidelines. In some journals, when submitting manuscripts authors must indicate explicitly that all authors meet the journal's criteria for authorship, some even request completion of individual authorship confirmation forms. Other journals indicate in their instructions to authors that papers must meet authorship criteria, but do not explicitly enforce this and leave the responsibility of respecting these criteria to the authors. Recognising the ICMJE criteria may be unworkable in practice, some journals have preferred to introduce their own criteria for authorship. For example, *Neurology* recently revised its authorship policy, to recognise an author as someone who has substantially contributed to one or more of the following: design or conceptualisation of the study; or major role in the acquisition of data; or analysis or interpretation of the data; or drafting or revising the manuscript for intellectual content.(26) ICMJE requires authors to fulfil all four of its criteria whereas Neurology requires just one of its criteria to be met.

In 1997, recognising the need for systemic reform, Rennie et al(2) proposed the introduction of published contributorship statements whereby individuals are named against their specific contributions and individuals can be mentioned without being authors on the byline, but most journals have not adopted this approach. This is also not accepted in most promotion committees for academic awards, where the authorship position counts. However, CRediT (Contributor Roles Taxonomy)(36) has more recently been widely adopted by a range of publishers. CRediT has 14 different roles within the taxonomy and its approach is a step towards more transparency in the definition of co-authors since the roles of each author need to be recognised, categorised and listed when submitting to a journal. However, many argue that journal policies around authorship criteria lead to a meaningless tick box exercise and studies have shown that published contributions often do not meet ICMJE criteria.(8) Much of science is based on trust and journal editors should not adjudicate authorship disputes or police authorship practice but they should provide clear advice to authors and reviewers and have appropriate policies for editors and staff relating to all aspects of publication ethics.(34) Journals should stipulate that authorship is about accountability as well as credit and authorship misappropriation is considered a form of research misconduct.

Whilst courses in research ethics are now more common, many research institutions do not teach courses on publication ethics and only a small minority of international researchers report having substantial knowledge of publication ethics.(37) The Committee on Publication Ethics (COPE) was set up to educate and support editors and publishers and those involved in publication ethics to foster good ethical practice in scientific publication. It provides, among others, guidelines to ensure that authorship and contributorship are in place, as well as clear policies that allow for transparency around who contributed to the work and in what capacity. Whilst its members are mainly editors and publishers, COPE recently launched a new initiative to work in collaboration with several research institutions in Australia, Canada and the US to help address issues around publication ethics commonly seen in journals further upstream (https://publicationethics.org/news/cope-pilot-initiative-institutional-membership). Dealing with transgressions in publication ethics at the time of publication is often too late so embedding good research practice within research institutions is crucial.

Modifying the “microsystem” of authorship in biomedical research is a challenge that needs to be promptly addressed. Some argue that institutions, journal editors and funding agencies could introduce more stringent policies and punishments around authorship misappropriation.(19) But it is the research culture that we need to change and individual researchers’ perceptions of moral behaviour. Guidelines cannot ensure morally responsible research, especially when they are limited to a checklist-like approach instead of an “abstraction” level.(38) The existence of these guidelines can paradoxically lead to a vision of researchers as people to distrust since they need a jurisdictional framework to practice their profession. Authorship guidelines and criteria should not be considered as merely strict rules to be respected in a normative way, but a ground for discussion about ethical choices and responsibilities of individual authors.

Despite a high level of awareness of authorship guidelines and criteria, these are not so widely used. More explicit encouragement by institutions to discuss authorship early and frequently may result in decisions that are perceived as fairer.

Contributors
Tobias Kurth (TK) had the idea for the study (conception and design). Ilaria Montagni (IM) reviewed the literature. Sara Schroter (SS) and IM wrote the first draft of the manuscript and are joint first authors on this paper. SS managed the survey and collected and analysed the data. All coauthors, including Matthias Eikermann (ME), Elizabeth Loder (EL) and Elke Schaeffner (ES), participated in the design of the survey, interpretation of the results, revising the manuscript, and review and approval of the final manuscript. SS had full access to all the data and can take responsibility for the integrity of the data and the accuracy of the data analysis. All authors meet the ICMJE authorship criteria and authorship eligibility.

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Competing interests
All authors have completed the Unified Competing Interest form at www.icmje.org/coi_disclosure.pdf (available on request from the corresponding author) and declare that SS is a full-time employee at *The BMJ*. TK reports having contributed to an advisory board of CoLucid and a research project funded by Amgen, for which the Charité – Universitätsmedizin Berlin received an unrestricted compensation. TK further reports having received honoraria from Lilly, Newsenselab, and Total for providing methodological advice, from Novartis and from Daiichi Sankyo for providing a lecture on neuroepidemiology and research methods, and from the *BMJ* for editorial services. EL receives salary from *The BMJ* for services as head of research, paid to her employer the Brigham and Women's Physician Organization. IM reports having worked as an independent medical writer for Novartis, Sanofi SA and Bristol Myers Squibb. ME has no competing interests. ES has received honoraria from Fresenius Medical Care, Fresenius Kabi and Siemens Healthineers for lectures.

Ethical approval
The study protocol was reviewed by *The BMJ's* ethics committee (7/10/15) and it did not have any major ethical concerns. Participation in the survey was voluntary and participants were told that they could withdraw at any stage. Participants were assured that the survey was confidential. Data were managed in compliance with GDPR.

Data sharing
Anonymised individual respondent data will be shared on reasonable request.

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Table 1: Respondent characteristics (n=3,859)

	n	%
Editorial decision made on submitted article		
Accept	839	22
Reject	3020	78
Gender		
Male	2150	56
Female	1585	41
Institution of work		
University setting	2739	71
Private research centre	113	3
Public research centre	511	13
Industry	29	1
Other	349	9
Number of years as an active researcher		
<5 years	846	22
6-10 years	1021	27
11-15 years	628	16
16-20 years	462	12
More than 20 years	772	20
Number of papers published		
≤ 5	509	13
6-10	478	12
11-20	521	14
21-30	416	11
31-40	274	7
41-50	229	6
51-100	592	15
>100	689	18
Continent		
Africa	79	2
Asia	652	17
Europe	2073	54
North America	594	15
South America	90	2
Oceania	243	6

Note: Percentages do not sum to 100% due to missing data.

Table 2: Experience of authorship misappropriation by years of research experience

	Honorary authorship n (%)				Ghost authorship n (%)			
	All respondents (n=3859)	**Active research for 5 years or less (n=861)**	**Active research for 10 years or less (n=1867)**	**Active researcher for more than 10 years (n=1862)**	**All respondents (n=3859)**	**Active research for 5 years or less (n=861)**	**Active research for 10 years or less (n=1867)**	**Active researcher for more than 10 years (n=1862)**
Never	929 (24)	250 (30)	498 (27)	404 (22)	2481 (64)	604 (71)	1288 (69)	1152 (62)
Once	427 (11)	168 (20)	283 (15)	134 (7)	415 (11)	99 (12)	209 (11)	197 (11)
A few times	1911 (50)	337 (40)	853 (46)	1032 (55)	823 (21)	129 (15)	341 (18)	466 (25)
Lots of times	521 (14)	90 (11)	229 (12)	287 (15)	67 (2)	12 (1)	26 (1)	41 (2)

Note: Percentages do not sum to 100% due to missing data.

Table 3: Stratification of responses by whether use of explicit authorship guidelines and criteria in current research setting is frequently encouraged or not

	n (%)	
	Use of explicit authorship guidelines frequently encouraged (n=1410)	**Use of explicit authorship guidelines not frequently encouraged (n=2404) ***
Agrees that the explicit use of authorship guidelines and criteria are beneficial to research teams when preparing a paper and deciding on authorship	1330 (94)	2025 (84)
Never been involved in a study where someone has been added as an author who did not contribute substantially (honorary authorship)	426 (30)	501 (21)
Never been involved in a study where someone was not listed as an author when they contributed substantially (ghost authorship)	951 (67)	1526 (64)
Never experienced honorary or ghost authorship	350 (25)	388 (16)
Experienced both honorary and ghost authorship	370 (26)	744 (31)
Authorship eligibility discussed at an early stage during study design	817 (58)	970 (40)
Authorship order discussed at an early stage during study design	497 (35)	566 (24)
Used explicit authorship criteria to decide WHO should be an author on their last coauthored paper	1161 (82)	1023 (43)
Felt decision on WHO should be an author on their last coauthored paper was a fair reflection of who did what?	1273 (90)	1810 (75)
Felt decision on ORDER of authorship on their last coauthored paper was a fair reflection of who did what?	1266 (90)	1886 (79)

* Includes responses of “other”, “not sure”, “not encouraged” and “sometimes encouraged”.

Box 1: Illustrative verbatim quotes from respondents about barriers to using authorship guidelines and criteria

Pervasiveness of poor authorship practice "In Italy, especially in the University setting, is very frequent that papers are submitted with a huge list of authors, despite most of them have not contributed at all; this is integrant part of an unequal system, hardly removable." (Author from Italy) "I am pretty jaded about authorship… the addition of senior names is a rote exercise rather than a reflection of true intellectual contribution. Politics trumps guidelines in my experience." (Author from Ireland)
Need enforcement from senior staff "Authorship guidelines will only work as a means of determining who is an author if they are enforced by the senior people in the institution. Ironically, they are often the ones that contribute least to a paper. It's a difficult situation to fix when unfair practices are entrenched by the hierarchy." (Author from Australia) "Insecurity of jobs and the asymmetry of power between co-authors mean that authorship criteria have minimal effect. My institution pays lip service only to authorship rules. Real fundamental change at least requires scrapping of the system of ordering authors." (Author from UK)
Unworkable in practice "The ICMJE guidelines are imprecise and hence difficult to follow. They also reflect a very Anglo-American view of research culture which does not reflect the values of all cultures. This is clearly inappropriate." (Author from Australia) "The problem with the criteria is that it includes all the points in the list. However, often there are e.g. younger researchers (students) who may do a substantial job lasting for months in collecting the data etc yet they do not participate in drafting the manuscript… So the final decision comes on the amount of work the persons put, not that they contribute to each of the points. That is fair and that is how researchers get started." (Author from Finland)
Cultural values around acceptable practice "In our country it is still "usual" to have the chief of the service/unit be included as an author even if he/she did little or nothing." (Author from Argentina) "Well gift authorship (including head of the Department as a co-author) is quite 'the norm' rather than an exception." (Author from India)
Lack of accountability "The ICMJE authorship criteria represent an important research and ethical standard to uphold…Better education on the ICMJE criteria and the importance of transparency in publication could help address this problem but there needs to be some sort of accountability for those who flagrantly disregard it for personal, professional or political gain." (Researcher from Canada)
Ineffective mandatory reporting by journals "I am aware there is a need for guidelines... but some journals nowadays require mandatory specification that the 4 criteria are met by every co-author. The practical result is that everyone clicks the buttons, whatever they actually did. Such stringent application of the criteria as mentioned in this survey serves no useful purpose in my opinion." (Researcher from Canada)

Authorship criteria survey

Welcome

Welcome to this BMJ survey on authorship criteria.

All survey data will be treated confidentially and only the research team will see your response. Responses will only be presented in aggregate form; no individuals will be named. All participants will be sent a summary of the key results.

As an incentive, participants will be entered into a prize draw to win a £100 Amazon voucher.

Do feel free to email Sara Schroter (sschroter@bmj.com) in confidence if you have any queries or concerns in relation to the study. You are free to opt out if you do not wish to participate.

Authorship criteria survey

1. Does your institution / main work location have an authorship policy providing criteria researchers should use when deciding on who should be an author on a research paper?

- ◯ Yes
- ◯ No
- ◯ I don't know
- ◯ Not applicable

Authorship criteria survey

ICMJE criteria for authorship

The International Committee of Medical Journal Editors (ICMJE) recommends that authorship be based on the following 4 criteria:

- Substantial contributions to the conception or design of the work; or the acquisition, analysis, or interpretation of data for the work; AND
- Drafting the work or revising it critically for important intellectual content; AND
- Final approval of the version to be published; AND
- Agreement to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.

2. How familiar are you with the ICMJE criteria for authorship listed above?

- ◯ I have never heard of them
- ◯ I have heard of them, but I wasn't familiar with the content
- ◯ I am very familiar with the content

Authorship criteria survey

3. In your current research setting, are the use of explicit authorship guidelines / criteria (e.g. ICMJE or institutional guidelines) actively encouraged?

- ◯ Yes, they are frequently encouraged
- ◯ Yes, they are sometimes encouraged
- ◯ No, they are not encouraged
- ◯ I'm not sure
- ◯ Other (please specify):

4. Do you think the explicit use of authorship guidelines / criteria are beneficial to research teams when preparing / writing a scientific paper and deciding on authorship?

◯ Yes ◯ No ◯ I don't know

Authorship criteria survey

5. How frequently have you been involved in a study where someone has been added as an author who did not contribute substantially to the conception or design of the work; or the acquisition, analysis, or interpretation of data for the work; or the writing of the article?

- ◯ Never
- ◯ Once
- ◯ A few times
- ◯ Lots of times

6. How frequently have you been involved in a study where someone was not listed as an author when they contributed substantially to the conception or design of the work; or the acquisition, analysis, or interpretation of data for the work; or the writing of the article?

- ◯ Never
- ◯ Once
- ◯ A few times
- ◯ Lots of times

Authorship criteria survey

Thinking of the last paper you coauthored....

7. Thinking of the last paper you coauthored, at what point in time were details about WHO should be an author discussed? [Tick all that apply]

- [ ] At an early stage during the design of the study
- [ ] During the course of the study
- [ ] Once the study was completed and before writing the paper
- [ ] During paper writing
- [ ] After the paper was written
- [ ] It was never discussed

8. Thinking of the last paper you coauthored, at what point in time were details about the ORDER of authorship discussed? [Tick all that apply]

- [ ] At an early stage during the design of the study
- [ ] During the course of the study
- [ ] Once the study was completed and before writing the paper
- [ ] During paper writing
- [ ] After the paper was written
- [ ] It was never discussed

Authorship criteria survey

Thinking of the last paper you coauthored....

9. Thinking of the last paper you coauthored, were explicit authorship criteria used to decide WHO should be an author?

Yes No I don't know

10. Thinking of the last paper you coauthored, do you feel that the decision on WHO should be an author was a fair reflection of who did what?

Yes No I don't know

11. Thinking of the last paper you coauthored, approximately how many times was authorship ORDER discussed by the research team?

Never Only once A few times Lots of times

12. Thinking of the last paper you coauthored, do you feel that the decision on the ORDER of authorship was a fair reflection of who did what?

Yes No I don't know

Authorship criteria survey

And finally some questions about yourself:

13. For which institution do you mainly work?

14. Where is your (main) institution located?

15. Approximately how many years have you been an active researcher?

16. Approximately how many papers have you published in a peer reviewed journal as either an author or a coauthor?

17. Are you?

Female Male

18. Do you have any further comments?

Authorship criteria survey

Thank you

Thank you for your help with this research.

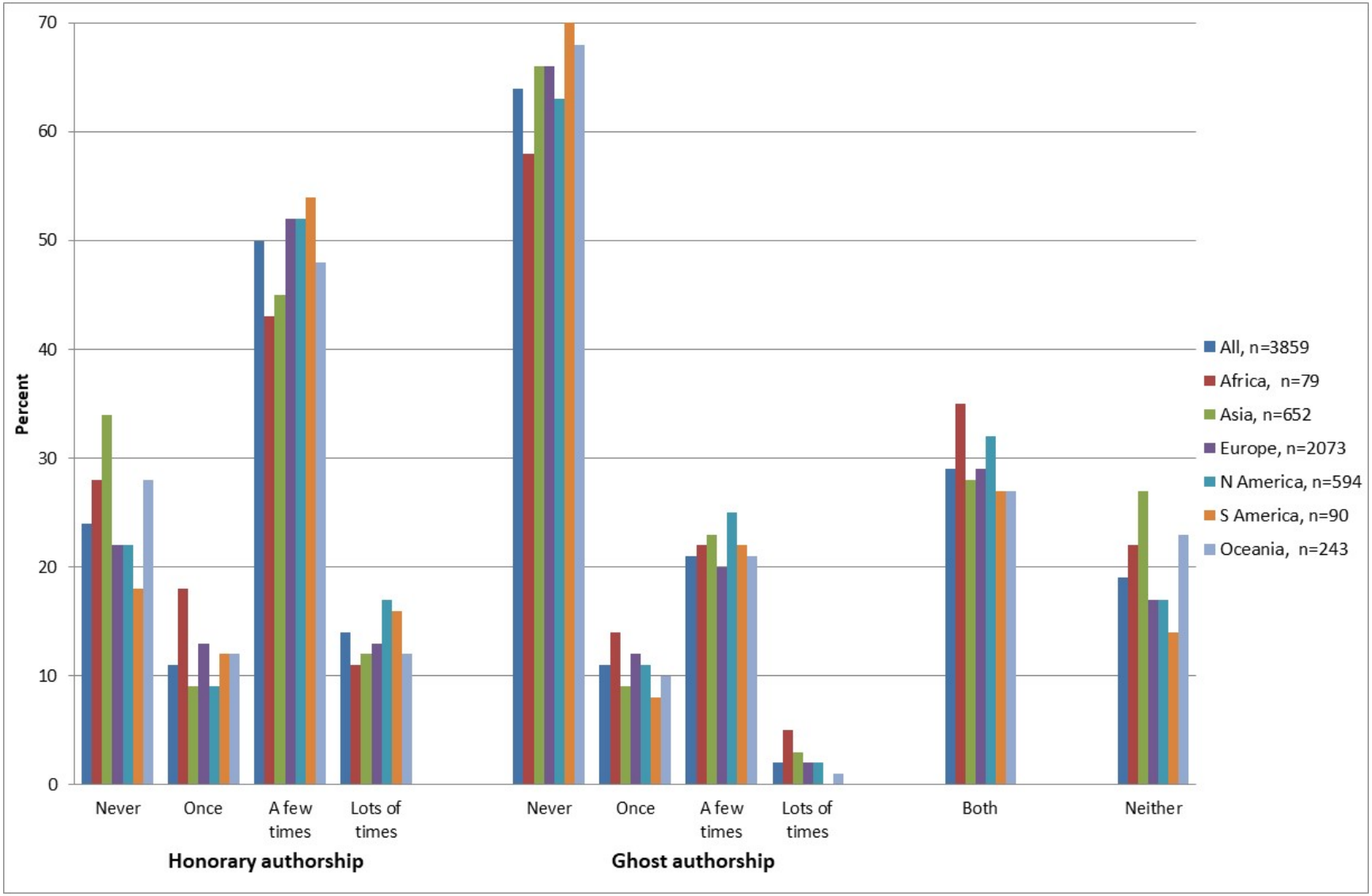
Please now click "submit" to complete the survey.

Appendix 2: List of included journals and their impact factors

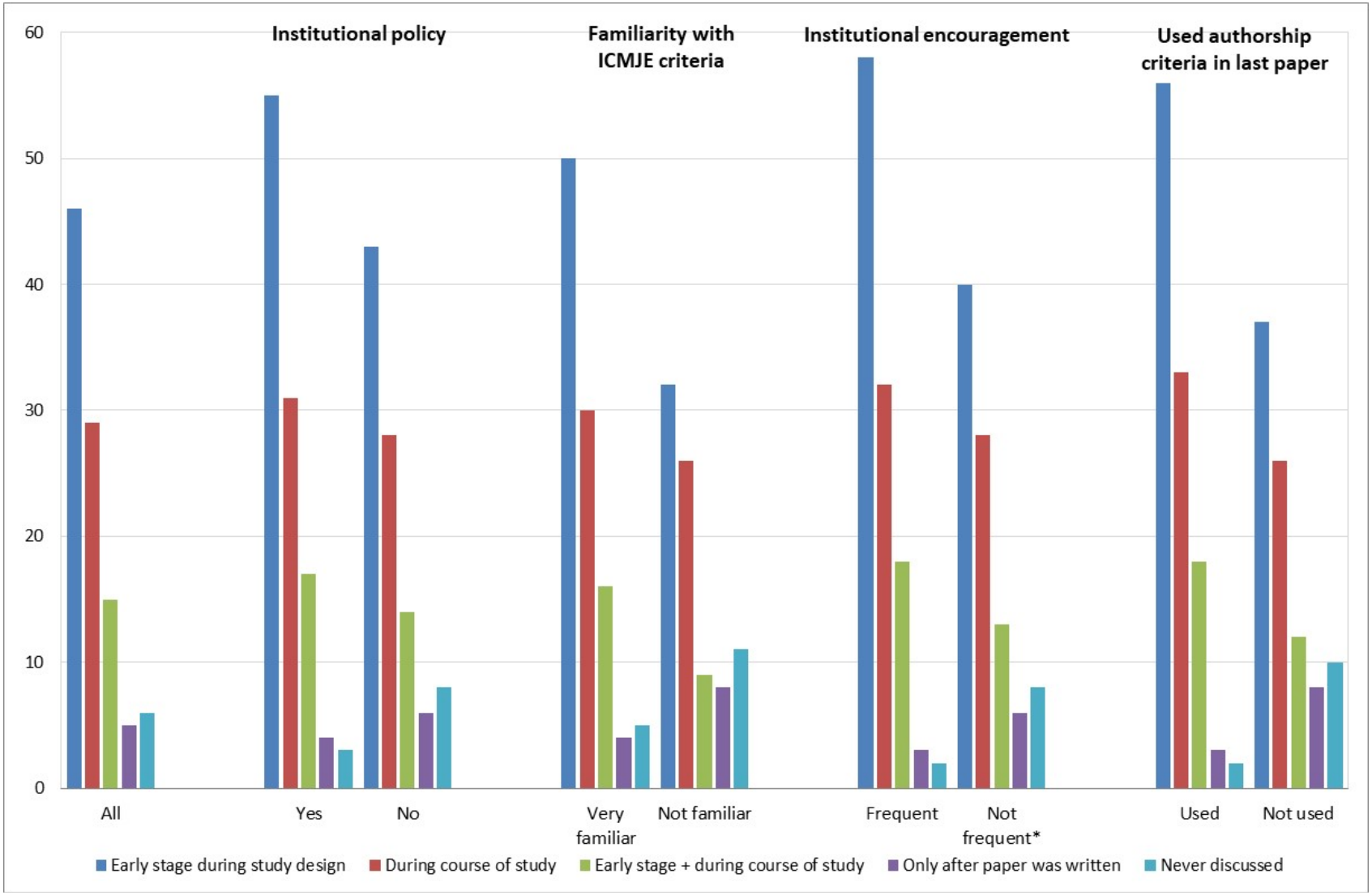
JOURNAL NAME	2014* Impact Factor
Archives of Disease in Childhood	2.899
Archives of Disease in Childhood: Fetal & Neonatal	3.120
Annals of the Rheumatic Diseases	10.377
BMJ Open	2.271
BMJ Open Diabetes Research & Care	-
BMJ Supportive & Palliative Care	-
Emergency Medicine Journal	1.843
Frontline Gastroenterology	-
Gut	14.660
Heart Asia	-
Injury Prevention	1.891
Journal of Clinical Pathology	2.915
Journal of Family Planning and Reproductive Health Care	1.600
Journal of Neurology, Neurosurgery & Psychiatry	6.807
Occupational and Environmental Medicine	3.267
Postgraduate Medical Journal	1.448
The BMJ	17.445
Thorax	8.290

*Time of the sampling

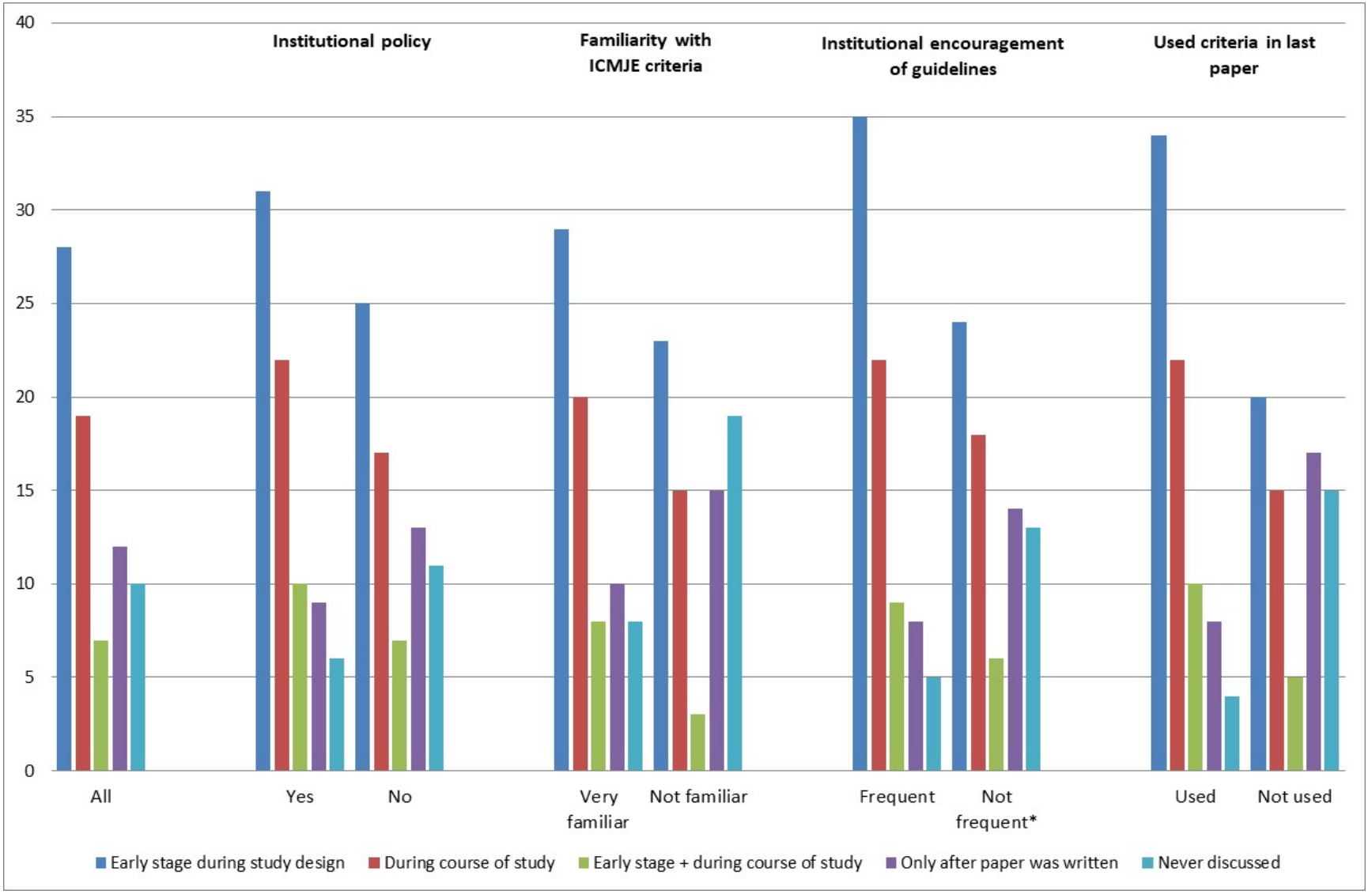
Appendix 3: Frequency of involvement in authorship misappropraition by continent of author's main institution



Appendix 4: Timing of discussions around authorship eligibility



Appendix 5: Timing of decisions around authorship order



Appendix 6: Perceived fairness of authorship decisions on last coauthored paper

	Decision made on authorship eligibility was fair (%)	Decision made on order of authorship was fair (%)
Use of explicit authorship criteria		
Explicit criteria used (n=2187)	2043 (93)	2015 (92)
Explicit criteria not used (n=1284)	879 (69)	946 (74)
Years of research experience		
More than 10 years of experience (n=1862)	1596 (86)	1610 (86)
Ten years or less of experience (n=1867)	1461 (78)	1515 (81)
Use of explicit authorship guidelines / criteria actively encouraged in current research setting		
Frequently encouraged (n=1410)	1273 (90)	1266 (90)
Not frequently encouraged (n=2404)*	1810 (75)	1886 (78)

Values are numbers (percent).

* Includes responses of “other”, “not sure”, “not encouraged” and “sometimes encouraged”.

THE COAUTHORS ASSURE THAT THEIR PAPER COMPLY WITH THE CHERRIES GUIDELINE

The corresponding author Ilaria MONTAGNI

Item category	Checklist Item	Page nr.	Description
Design	Study design	6	One-shot online survey (cross-sectional) of published and rejected journals from the BMJ sample.
Ethics	Ethics approval	6	The protocol was reviewed and approved by the BMJ' ethics committee.
	Informed consent	6	Authors were informed that participation was voluntary and that responses would be anonymised and treated confidentially. Participants were not be asked to give consent to take part; completion of the survey indicated that they had consented to take part.
	Data protection	7	Responses from all journals were collated and the anonymised combined sample.
Development and pre-testing		6	We developed a 12-item online closed questionnaire (Appendix 1) with five additional

			demographic open questions and a free-text item for additional comments. We piloted the questionnaire with 16 researchers to check for ambiguous items and revised the questionnaire in light of feedback.
Recruitment process	Open vs closed survey	6	This survey was addressed to authors of journals pre-selected from a sample of BMJ journals.
	Contact mode	6	Eligible authors were invited in 2016 by an email sent by the first author of this paper to complete the survey hosted by SurveyMonkey.
	Advertising the survey	NA	The survey was not advertised, members of the original sample were invited to participate.
Survey administration	Web/email	6	An email was sent by the first author of this paper to complete the survey hosted by SurveyMonkey.
	Context	6	We included authors submitting research articles in 2014 to 18 journals covering a range of specialties published by BMJ Publishing Group.
	Mandatory/voluntary	6	Authors were informed that participation was voluntary

	Incentives	6	In order to maximise the recruitment, we proposed an incentive to participants who were entered into a prize draw to a £100 voucher.
	Time/date	6	Responses were collected in November 2016
	Item randomisation	NA	No randomisation of items was used.
	Adaptive questioning	NA	No adaptive questioning was used
	Number of items	6	We developed a 12-item online closed questionnaire (Appendix 1) with five additional demographic open questions and a free-text item for additional comments.
	Number of screens	Appendix 1	9
	Completeness check	Appendix 1	All survey items were deemed to be mandatory, and respondents prompted to complete outstanding items before leaving the survey page on which the item was contained.
	Review steps	Appendix 1	Respondents were unable to change their responses once submitted.
Response rates	Unique site visitor	6	Duplicate authors were removed so that each author was invited

			to take part in the survey only once.
	View rate	NA	No
	Participation rate	8	We received an actual response from 3859 (31%) of the remaining 12379 authors.
	Completion rate	8	3859 respondents
Preventing multiple entries from same individual	Cookies used	NA	No
	IP check	NA	No
	Log file analysis	NA	Not used
	Registration	NA	Not used
Analysis	Handling of incomplete questionnaires	6	Not included in the study
	Questionnaires with atypical timestamp	NA	No
	Statistical correction	NA	Not used

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Awareness, usage and perceptions of authorship guidelines: an international survey of biomedical authors

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Awareness, usage and perceptions of authorship guidelines: an international survey of biomedical authors

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ABSTRACT (298/300 words)

Objectives
To investigate authors' awareness and use of authorship guidelines, and to assess their perceptions of the fairness of authorship decisions.

Design
Cross-sectional online survey.

Setting and participants
Corresponding authors of research papers submitted in 2014 to 18 BMJ journals.

Results
3859/12646 (31%) researchers responded. They worked in 93 countries and varied in research experience. Of these, 1326 (34%) reported their institution had an authorship policy providing criteria for authorship; 2871 (74%) were "very familiar" with the International Committee of Medical Journal Editors authorship criteria, and 3358 (87%) reported that guidelines were beneficial when preparing manuscripts. Furthermore, 2609 (68%) reported their use was "sometimes" or "frequently" encouraged in their research setting. However, 2859 respondents (74%) reported they had been involved in a study at least once where someone was added as an author who had not contributed substantially (honorary authorship), and 1305 (34%) where someone was not listed as an author but had contributed substantially (ghost authorship). Only 740 (19%) reported that they had never experienced either honorary or ghost authorship; 1115 (29%) reported that they had experienced both at least once. There was no clear pattern in experience of authorship misappropriation by continent. For their last coauthored article, 2187 (57%) reported explicit authorship criteria had been used to determine eligibility, and 3088 (80%) felt the decision made was fair. When institutions frequently encouraged use of authorship guidelines, authorship eligibility was more likely to be discussed early (817 of 1410, 58%) and perceived as fairer (1273 of 1410, 90%) compared with infrequent encouragement (974 of 2449, 40% and 1891 of 2449, 74%).

Conclusions
Despite a high level of awareness of authorship guidelines and criteria, these are not so widely used; more explicit encouragement of their use by institutions may result in more favourable use of guidelines by authors.

Keywords: authorship guidelines, survey, biomedical research

Article Summary

Strengths and limitations of this study

- Very large international survey of active researchers describing their current practice.
- We address authorship practice which is an important ethical matter because authorship ensures credit and accountability for research.
- We report self-administered survey data, and given the sensitivity of the questions, social desirability bias may have led respondents to over-report their awareness and usage of authorship guidelines.

INTRODUCTION

The research process, including publication, is based on trust. Authorship is both about being credited for the work you have done and being responsible and accountable for the integrity of what is published.(1-3) Responsible authorship is a key component of publication ethics and transparent reporting.(4) Infringing the rules of authorship in scientific papers can negatively impact on the credibility of the findings as well as on the honesty of the authors. However, the temptation for scientists to abuse authorship is significant since their publication record and collaboration with coauthors can determine academic rewards such as medical qualifications and professional appointments, as well as research funding.(5) Studies reviewing published papers have identified a high prevalence of authorship problems.(6-9)

The average number of authors per published article has grown over time(10, 11) and this has raised questions around authorship in terms of eligibility, definition of their roles, and establishment of a fair sequence of authors' names according to their role.(12) Decisions about authorship eligibility can be subjective and contentious, since an author could contribute to the research without being involved in the actual writing, for example by collecting data or conducting the statistical analysis. There is huge variation in the operational definition of authorship(4) and preference for authorship order varies by country and discipline.(12-14) In biomedicine, it is generally assumed that individuals are listed in decreasing order of level of their contribution with the exception of the last and the corresponding authors to whom importance is also attached.(15) In other disciplines such as psychology, it is the first author who assumes responsibility for the publication and handles responses to inquiries after publication and coauthors are listed in order of level of contribution.

While authorship eligibility and order can reflect legitimate regional or discipline-specific practices, some scientists also intentionally misappropriate authorship. Honorary authors are those who did not contribute substantially to the conception or design of the work; or the acquisition, analysis, or interpretation of data for the work; or the writing of the article and are unable to take public responsibility for the work.(16) Honorary authorship may occur as a result of many factors including: nepotism; reciprocation of favours for previous authorships; institutional politics and power struggles; economic reasons to justify obtained grants or demands for new funding; and trying to improve the chance of manuscript acceptance by including senior researchers.(4, 9) Ghost authors are those who are not listed as authors despite contributing substantially in these areas.(16) Ghost authorship is especially undesirable when it masks the involvement of a commercial sponsor or other competing interests that could bias the study or reporting.(17) Both honorary and ghost authorship are considered forms of research misconduct. Estimates from author surveys of the prevalence of honorary authors in high impact biomedical journals during the last 30 years have ranged from 19% to 39%(7, 16, 18) and ghost authors from 8% to 11%.(7, 16, 18)

To help scientists define authorship and limit misconduct, multiple guidelines have been produced and journals have introduced various measures to try to encourage ethical authorship practice.(19) The International Committee of Medical Journal Editors (ICMJE) criteria, adopted by many international biomedical journals and generally considered the “gold standard” for determining authorship eligibility, enumerate specific requirements for authorship, as well as stipulating that all authors should participate sufficiently in the work reported in an article to be able to take public responsibility for the content or an important part of the content.(20) While

many journals continue to encourage the use of ICMJE criteria, previous studies of selected samples of researchers have shown poor awareness of them,(21, 22) dislike of them,(22, 23) failure to comply with them(6) and preference for other authorship policies and practices.(24) One critic has even described them as illogical and unethical.(25) Some journals have introduced their own authorship criteria.(26) Others have shown that ICMJE criteria are intuitive and that the ICMJE-listed contributions are perceived as important.(27, 28) However, there are no uniform rules for authorship order.(14) We describe a large international survey of active biomedical authors in a range of specialties undertaken to determine awareness and use of authorship guidelines and criteria in a contemporary sample of authors submitting papers to a broad range of biomedical journals.

METHODS

Questionnaire development

We developed a 12-item online closed questionnaire (Appendix 1) with five additional demographic questions and a free-text item for additional comments. We piloted the questionnaire with 16 researchers to check for ambiguous items and revised the questionnaire in light of feedback. The final questionnaire included items addressing familiarity with and use of authorship criteria, experience of authorship misappropriation, frequency and timing of authorship discussions, perceived fairness of authorship decisions, and institutional encouragement to use authorship criteria.

Sample

We included authors submitting research articles in 2014 to 18 journals covering a range of specialties published by BMJ Publishing Group (see Appendix 2). To try to get a broad sample of biomedical journals of varying size and prestige, we intentionally selected journals with high, middle, and low impact factors (IFs). As a deviation from our protocol, we also sampled some recently acquired journals with no IF. All journals adhered to the ICMJE guidelines by asking corresponding authors to assure that they are respected.

Procedures

All corresponding authors of accepted and rejected research manuscripts submitted in 2014 were identified from each of the journal manuscript tracking systems, and the data merged. Duplicate authors were removed so that each author was invited to take part in the survey only once. We selected one journal to act as a pilot to gauge response rate and invited eligible authors of this journal by an email on 14 March 2016 from SS, an employee of BMJ Publishing Group, to complete the survey hosted by SurveyMonkey; eligible authors of the other 17 journals were invited on 14 September 2016. Authors were informed that participation was voluntary and that responses would be anonymised and treated confidentially. Participants were not asked to give consent to take part; they were informed that completion of the survey would indicate that they had consented to take part. Non-responders were sent reminders at two and four weeks after the initial mailing and the survey was open for completion for a six-week period. To try to maximise recruitment, we gave an incentive of the chance to win a prize draw for a £100 voucher.

Patient and public involvement

We did not involve patients in the research team or development of the questionnaire as the focus was on academic researchers' perceptions and their institutional experiences. We recognise that patients are sometimes authors and may have different experiences as authors, but this forms only a small proportion of the published literature and patients' experience as authors was not the intended focus of the paper. To adequately capture patients' experience of authorship would require a different set of questions.

Statistical analysis

Responses from all journals were collated and the anonymised combined sample analysed using SPSS version 18. Quantitative data were summarised as frequencies and percentages.

RESULTS

Sample

Of the 12658 email invitations sent, 259 were not delivered by SurveyMonkey, 17 generated automated responses that recipients were on long term leave or had retired, and three recipients indicated they had been invited via a different email address. We received an actual response from 3859 (31%) of the remaining 12379 authors. Response rates by journal ranged between 20% and 41%. All results are presented as the number or proportion of all 3859 respondents unless explicitly stated otherwise.

Table 1 shows the characteristics of the sample. The majority of authors had submitted a paper that had been rejected by the sampled journal in 2014. A higher proportion of respondents were male (56%) than female (41%) and the majority (71%) were based in a university setting. Respondents varied in research and publication experience and worked in 93 countries, with the highest proportions based in the UK (20%), US (10%), Australia (6%) and The Netherlands (5%). Overall, the majority of respondents were based in Europe (54%).

Familiarity with and use of authorship criteria

After being presented with the ICMJE criteria, 258 (7%) reported they had never heard of them, 706 (18%) had heard of them but were not familiar with their content, and 2871 (74%) were very familiar with them. Of those who were very familiar with ICMJE criteria, 90% (2572/2871) reported that authorship guidelines and criteria were beneficial to research teams when preparing papers and deciding on authorship.

In relation to the last paper they coauthored, 2187/3859 (57%) reported that explicit authorship criteria were used to decide who should be an author, 1284/3859 (33%) said they were not used and 296/3859 (8%) did not know. Only 1827 (64%) of the 2871 who were very familiar with ICMJE criteria reported that explicit authorship criteria were used to decide who should be an author in their last coauthored paper.

Authorship misappropriation

Only around a quarter of researchers (929/3859) reported that they had never been involved in a study where someone was added as an author who did not contribute substantially (honorary authorship) (Table 2). The frequency of involvement in studies with ghost authors was less than for honorary authors with nearly two-thirds of authors (2481/3859) never having been involved in a study where someone was not listed as an author when they had contributed substantially.

Only around a fifth of all respondents (740/3859, 19%) reported they had never experienced either guest or ghost authorship, whereas nearly a third (1115/3859, 29%) reported they had experienced both at least once in their careers. Researchers who had been active for more than 10 years reported a higher frequency of experience of authorship misappropriation than those who had been active for less than 10 years. Respondents who reported their institution had an authorship policy were more likely (374/1326, 28%) to have never been involved in a study with honorary authorship than those who reported their institution did not have an authorship policy

(301/1592, 19%). We found no clear pattern of perceived authorship misappropriation by continent (Appendix 3).

Timing of authorship discussions

Authorship eligibility and authorship order were discussed at an early stage more often when institutions had authorship policies, when authors were very familiar with ICMJE criteria when institutions encouraged use of authorship guidelines frequently, and when explicit authorship criteria were used to decide who should be an author, compared with not (Appendices 4 and 5). Authorship eligibility was discussed at both an early stage and during the course of the study for a small proportion of recently coauthored articles and authorship order was discussed at both these points even less frequently, even when authorship institutional policies were in place.

Perceived fairness of authorship decisions

In relation to the last paper they coauthored, 80% (3088/3859) of respondents felt the decision on who was made an author was fair (486, 13% not fair) and 82% (3157) felt the decision on authorship order was fair (409, 11% not fair). When explicit criteria were used in authorship decisions, a higher proportion reported the decision made on authorship eligibility (2043/2187, 93%) and authorship order (2015/2187, 92%) was fair, compared with when they were not used (879/1284, 69%) and (946/1284, 74%), respectively, as shown in Appendix 6. More experienced researchers and those working in settings where the use of criteria was actively encouraged reported higher rates of fairness for authorship decisions on their last coauthored paper than less experienced researchers and those working in settings where the use of criteria was not actively encouraged.

Institutional policy

Only 34% (1326/3859) of respondents reported that their institution had an authorship policy; 41% (1592) said there was no such policy, and 919 (24%) did not know. For institutions with an authorship policy, 724/1326 (55%) frequently encouraged researchers to use it and 434/1326 (33%) sometimes.

Overall, when institutions frequently encouraged the use of authorship guidelines, decisions were more likely to be discussed at an early stage, were perceived as fairer, and incidences of honorary and ghost authorship were reported as less common compared with when frequent institutional encouragement was not reported (infrequent, no encouragement, not sure and other) (Table 3).

DISCUSSION

Our large survey of nearly 4000 active researchers from 93 countries found that almost three-quarters were very familiar with the ICMJE authorship criteria and a higher proportion viewed these and other authorship guidelines as beneficial. Around two-thirds reported that their institution frequently or sometimes encouraged the use of these or similar authorship criteria. Yet, only just over half used explicit authorship criteria when deciding on authorship for their last coauthored paper. When institutions frequently encouraged the use of authorship guidelines, authorship eligibility was more likely to be discussed early and was perceived as fairer. Reported incidences of authorship misappropriation over the course of researchers' careers were high; around three-quarters of respondents had experienced honorary authorship and one-third ghost authorship. Respondents self-reported multiple barriers to using authorship criteria in practice.

Comparison with other studies

Our results build on the results of earlier surveys(7, 16, 18) by providing a snapshot of authorship practice from a very large international sample of active researchers in a broad range of biomedical specialties. Similar to previous studies,(7, 16, 18) we found reported rates of honorary authorship were higher than for ghost authorship. The proportion who had experienced honorary and ghost authorship was higher than previous surveys conducted between 1998 and 2011,(7, 18) but our respondents were asked about experience across their careers rather than about a specific publication and we did not just include high impact journals. We found no clear pattern of perceived authorship misappropriation by continent, which is in contrast to the findings of a systematic review in 2011, which found authorship problems and misuse were reported more often by researchers outside of the USA and UK.(9)

Researchers in our study reported a higher level of familiarity and use of authorship guidelines and criteria than previous studies.(21, 22) This may partly be explained by wider promotion of these criteria and changes in authorship practice over time. For example, in some Nordic countries, compulsory courses on authorship guidelines have been introduced from the first year of the PhD program. Early researchers are trained to discuss with their supervisor how to establish an equitable authorship order for papers. We may also have observed a higher level of familiarity and use of authorship guidelines because our sample was larger and composed of corresponding authors of articles submitted to journals promoting ICMJE criteria and requesting compliance with these criteria prior to publication.

However, despite such familiarity, more than one-third of our sample declared that explicit authorship criteria were not used to decide who should be an author on their most recent article. Similarly, Bonekamp et al.(24) found a high rate of awareness (81%) of ICMJE criteria amongst submitting authors, yet 25% reported that at least one of their coauthors on the submission did not merit authorship. Our respondents described the difficulties of applying authorship criteria when for example colleagues disregard them, there are power imbalances and a strong cultural norm to attribute authorship in certain ways. Research culture is increasingly characterised by unhealthy competition, job insecurity, poor supervision and mentorship, discrimination, bullying and harassment(29) which can only have a negative impact on the quality of research and compliance with authorship guidelines and criteria. Early career researchers in particular can be pressured by supervisors to produce more research papers in journals with high Impact Factors.

The inclusion of senior researchers as co-authors, irrespective of their contribution, can increase the chances of publication in a competitive field. In addition, honorary authorship can give co-authors opportunities to strengthen collaborations with other researchers and increase the visibility of their work.

Study limitations

Our study has several limitations. Firstly, we received a low (31%) response rate, which may have caused selection bias. However, response rates to surveys of doctors and researchers are often low.(30-33) Only a fifth of invited authors had their papers accepted by the journals in the sampling period and this may have affected their willingness to help. Also, some authors informed us that they only received the last reminder email, suggesting that some institutional email filters were treating the emails as spam. Despite the low response rate, we did receive nearly 4,000 responses from all continents, which is a substantial survey sample.

Secondly. However, by surveying submitting authors and not just those who had papers accepted for publication at the participating journals, we sought to capture the experience of researchers from numerous countries and of varying levels of research and publication experience; some respondents will have never published with BMJ Publishing Group before. We also sampled authors submitting to a range of journals in different specialties and with a range of Impact Factors.

Thirdly, analyses are based on self-reported data from corresponding authors. We assured participants of confidentiality, but the survey was not anonymous and given the sensitivity of the questions, we cannot rule out social desirability bias with respondents over-reporting their awareness and usage of authorship criteria. We chose to contact corresponding authors as they coordinate the activities of other authors and are the person most likely to have knowledge of the roles and contributions of other authors.(16)

Finally, respondents completed the survey in 2016 and as such responses might not accurately reflect the current research ecosystem which is continuously evolving in terms of publication policies and strategies.

Study implications

Understanding authorship practice is an important ethical matter because appropriate authorship ensures credit and accountability for research. Ethical authorship practice is essential for the promotion and maintenance of the scientific integrity of biomedical research. We found that authorship guidelines and criteria are known by the majority of researchers and their application is considered beneficial when preparing manuscripts. However, authorship misconduct is still prevalent; even those new to research reported experience of it. Thus, it is not simply a matter of authors needing to be informed about guidelines and criteria, but of having the opportunity to apply them in a supportive environment that is suited to their discipline.

While both institutions and journals have important duties relating to authorship misconduct,(19) institutions are ultimately responsible for the conduct of their researchers.(34) In 2000, a Taskforce on Authorship reporting to the Council of Science Editors stated that all universities,

medical schools, research institutes and commercial companies that conduct and publish research should have explicit policies on authorship.(13) Yet 16 years later, only a third of respondents reported that their institution had an authorship policy, although this might partly be explained by researchers being unaware of existing institutional policies and the need for better promotion of these. Where institutions encouraged the use of authorship guidelines and criteria, perceptions of fairness of authorship decisions were higher and discussions on authorship eligibility and authorship order were more frequent. Little guidance exists on authorship order which remains one of the major issues for most institutions. Institutions should be more active in supporting the use of authorship guidelines and criteria, especially to support early career researchers and to reduce power differentials among authorship teams.(15) Authorship eligibility was discussed at an early stage and during the study for only a small proportion of recently coauthored articles in our sample. Proponents of good authorship practice recommend early discussion of authorship in the research process,(35) something that could easily be encouraged by institutions. While it might be ideal but not feasible to have universal criteria for how researchers are recognised in publications, having well-designed institutional systems for agreeing and enforcing local and specific authorship policies at the start of projects and throughout the research process could help in avoiding disputes or resolving them quickly.(15)

On the other side, editors and publishers of some biomedical journals are already encouraging the use of authorship guidelines. In some journals, when submitting manuscripts authors must indicate explicitly that all authors meet the journal's criteria for authorship, some even request completion of individual authorship confirmation forms. Other journals indicate in their instructions to authors that papers must meet authorship criteria, but do not explicitly enforce this and leave the responsibility of respecting these criteria to the authors. Recognising the ICMJE criteria may be unworkable in practice, some journals have preferred to introduce their own criteria for authorship. For example, *Neurology* recently revised its authorship policy, to recognise an author as someone who has substantially contributed to one or more of the following: design or conceptualisation of the study; or major role in the acquisition of data; or analysis or interpretation of the data; or drafting or revising the manuscript for intellectual content.(26) ICMJE requires authors to fulfil all four of its criteria whereas Neurology requires just one of its criteria to be met.

In 1997, recognising the need for systemic reform, Rennie et al(2) proposed the introduction of published contributorship statements whereby individuals are named against their specific contributions and individuals can be mentioned without being authors on the byline, but most journals have not adopted this approach. This is also not accepted in most promotion committees for academic awards, where the authorship position counts. However, CRediT (Contributor Roles Taxonomy)(36) has more recently been widely adopted by a range of publishers. CRediT has 14 different roles within the taxonomy and its approach is a step towards more transparency in the definition of co-authors since the roles of each author need to be recognised, categorised and listed when submitting to a journal. However, many argue that journal policies around authorship criteria lead to a meaningless tick box exercise and studies have shown that published contributions often do not meet ICMJE criteria.(8) Much of science is based on trust and journal editors should not adjudicate authorship disputes or police authorship practice but they should provide clear advice to authors and reviewers and have appropriate policies for editors and staff relating to all aspects of publication ethics.(34) Journals should stipulate that authorship is about accountability as well as credit and authorship misappropriation is considered a form of research misconduct.

Whilst courses in research ethics are now more common, many research institutions do not teach courses on publication ethics and only a small minority of international researchers report having substantial knowledge of publication ethics.(37) The Committee on Publication Ethics (COPE) was set up to educate and support editors and publishers and those involved in publication ethics to foster good ethical practice in scientific publication. It provides, among others, guidelines to ensure that authorship and contributorship are in place, as well as clear policies that allow for transparency around who contributed to the work and in what capacity. Whilst its members are mainly editors and publishers, COPE recently launched a new initiative to work in collaboration with several research institutions in Australia, Canada and the US to help address issues around publication ethics commonly seen in journals further upstream (https://publicationethics.org/news/cope-pilot-initiative-institutional-membership). Dealing with transgressions in publication ethics at the time of publication is often too late so embedding good research practice within research institutions is crucial.

Modifying the “microsystem” of authorship in biomedical research is a challenge that needs to be promptly addressed. Some argue that institutions, journal editors and funding agencies could introduce more stringent policies and punishments around authorship misappropriation.(19) But it is the research culture that we need to change and individual researchers’ perceptions of moral behaviour. Guidelines cannot ensure morally responsible research, especially when they are limited to a checklist-like approach instead of an “abstraction” level.(38) The existence of these guidelines can paradoxically lead to a vision of researchers as people to distrust since they need a jurisdictional framework to practice their profession. Authorship guidelines and criteria should not be considered as merely strict rules to be respected in a normative way, but a ground for discussion about ethical choices and responsibilities of individual authors.

Despite a high level of awareness of authorship guidelines and criteria, these are not so widely used. More explicit encouragement by institutions to discuss authorship early and frequently may result in decisions that are perceived as fairer.

Contributors
Tobias Kurth (TK) had the idea for the study (conception and design). Ilaria Montagni (IM) reviewed the literature. Sara Schroter (SS) and IM wrote the first draft of the manuscript and are joint first authors on this paper. SS managed the survey and collected and analysed the data. All coauthors, including Matthias Eikermann (ME), Elizabeth Loder (EL) and Elke Schaeffner (ES), participated in the design of the survey, interpretation of the results, revising the manuscript, and review and approval of the final manuscript. SS had full access to all the data and can take responsibility for the integrity of the data and the accuracy of the data analysis. All authors meet the ICMJE authorship criteria and authorship eligibility.

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Competing interests
All authors have completed the Unified Competing Interest form at www.icmje.org/coi_disclosure.pdf (available on request from the corresponding author) and declare that SS is a full-time employee at *The BMJ*. TK reports having contributed to an advisory board of CoLucid and a research project funded by Amgen, for which the Charité – Universitätsmedizin Berlin received an unrestricted compensation. TK further reports having received honoraria from Lilly, Newsenselab, and Total for providing methodological advice, from Novartis and from Daiichi Sankyo for providing a lecture on neuroepidemiology and research methods, and from the *BMJ* for editorial services. EL receives salary from *The BMJ* for services as head of research, paid to her employer the Brigham and Women's Physician Organization. IM reports having worked as an independent medical writer for Novartis, Sanofi SA and Bristol Myers Squibb. ME has no competing interests. ES has received honoraria from Fresenius Medical Care, Fresenius Kabi and Siemens Healthineers for lectures.

Ethical approval
The study protocol was reviewed by *The BMJ's* ethics committee (7/10/15) and it did not have any major ethical concerns. Participation in the survey was voluntary and participants were told that they could withdraw at any stage. Participants were assured that the survey was confidential. Data were managed in compliance with GDPR.

Data sharing
Anonymised individual respondent data will be shared on reasonable request.

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Table 1: Respondent characteristics (n=3,859)

	n	%
Editorial decision made on submitted article		
Accept	839	22
Reject	3020	78
Gender		
Male	2150	56
Female	1585	41
Institution of work		
University setting	2739	71
Private research centre	113	3
Public research centre	511	13
Industry	29	1
Other	349	9
Number of years as an active researcher		
<5 years	846	22
6-10 years	1021	27
11-15 years	628	16
16-20 years	462	12
More than 20 years	772	20
Number of papers published		
≤ 5	509	13
6-10	478	12
11-20	521	14
21-30	416	11
31-40	274	7
41-50	229	6
51-100	592	15
>100	689	18
Continent		
Africa	79	2
Asia	652	17
Europe	2073	54
North America	594	15
South America	90	2
Oceania	243	6

Note: Percentages do not sum to 100% due to missing data.

Table 2: Experience of authorship misappropriation by years of research experience

	Honorary authorship n (%)				Ghost authorship n (%)			
	All respondents (n=3859)	**Active research for 5 years or less (n=861)**	**Active research for 10 years or less (n=1867)**	**Active researcher for more than 10 years (n=1862)**	**All respondents (n=3859)**	**Active research for 5 years or less (n=861)**	**Active research for 10 years or less (n=1867)**	**Active researcher for more than 10 years (n=1862)**
Never	929 (24)	250 (30)	498 (27)	404 (22)	2481 (64)	604 (71)	1288 (69)	1152 (62)
Once	427 (11)	168 (20)	283 (15)	134 (7)	415 (11)	99 (12)	209 (11)	197 (11)
A few times	1911 (50)	337 (40)	853 (46)	1032 (55)	823 (21)	129 (15)	341 (18)	466 (25)
Lots of times	521 (14)	90 (11)	229 (12)	287 (15)	67 (2)	12 (1)	26 (1)	41 (2)

Note: Percentages do not sum to 100% due to missing data.

Table 3: Stratification of responses by whether use of explicit authorship guidelines and criteria in current research setting is frequently encouraged or not

	n (%)	
	Use of explicit authorship guidelines frequently encouraged (n=1410)	**Use of explicit authorship guidelines not frequently encouraged (n=2404) ***
Agrees that the explicit use of authorship guidelines and criteria are beneficial to research teams when preparing a paper and deciding on authorship	1330 (94)	2025 (84)
Never been involved in a study where someone has been added as an author who did not contribute substantially (honorary authorship)	426 (30)	501 (21)
Never been involved in a study where someone was not listed as an author when they contributed substantially (ghost authorship)	951 (67)	1526 (64)
Never experienced honorary or ghost authorship	350 (25)	388 (16)
Experienced both honorary and ghost authorship	370 (26)	744 (31)
Authorship eligibility discussed at an early stage during study design	817 (58)	970 (40)
Authorship order discussed at an early stage during study design	497 (35)	566 (24)
Used explicit authorship criteria to decide WHO should be an author on their last coauthored paper	1161 (82)	1023 (43)
Felt decision on WHO should be an author on their last coauthored paper was a fair reflection of who did what?	1273 (90)	1810 (75)
Felt decision on ORDER of authorship on their last coauthored paper was a fair reflection of who did what?	1266 (90)	1886 (79)

* Includes responses of “other”, “not sure”, “not encouraged” and “sometimes encouraged”

Authorship criteria survey

Welcome

Welcome to this BMJ survey on authorship criteria.

All survey data will be treated confidentially and only the research team will see your response. Responses will only be presented in aggregate form; no individuals will be named. All participants will be sent a summary of the key results.

As an incentive, participants will be entered into a prize draw to win a £100 Amazon voucher.

Do feel free to email Sara Schroter (sschroter@bmj.com) in confidence if you have any queries or concerns in relation to the study. You are free to opt out if you do not wish to participate.

Authorship criteria survey

1. Does your institution / main work location have an authorship policy providing criteria researchers should use when deciding on who should be an author on a research paper?

- ◯ Yes
- ◯ No
- ◯ I don't know
- ◯ Not applicable

Authorship criteria survey

ICMJE criteria for authorship

The International Committee of Medical Journal Editors (ICMJE) recommends that authorship be based on the following 4 criteria:

- Substantial contributions to the conception or design of the work; or the acquisition, analysis, or interpretation of data for the work; AND
- Drafting the work or revising it critically for important intellectual content; AND
- Final approval of the version to be published; AND
- Agreement to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.

2. How familiar are you with the ICMJE criteria for authorship listed above?

- ◯ I have never heard of them
- ◯ I have heard of them, but I wasn't familiar with the content
- ◯ I am very familiar with the content

Authorship criteria survey

3. In your current research setting, are the use of explicit authorship guidelines / criteria (e.g. ICMJE or institutional guidelines) actively encouraged?

- ◯ Yes, they are frequently encouraged
- ◯ Yes, they are sometimes encouraged
- ◯ No, they are not encouraged
- ◯ I'm not sure
- ◯ Other (please specify):

4. Do you think the explicit use of authorship guidelines / criteria are beneficial to research teams when preparing / writing a scientific paper and deciding on authorship?

◯ Yes ◯ No ◯ I don't know

Authorship criteria survey

5. How frequently have you been involved in a study where someone has been added as an author who did not contribute substantially to the conception or design of the work; or the acquisition, analysis, or interpretation of data for the work; or the writing of the article?

- ◯ Never
- ◯ Once
- ◯ A few times
- ◯ Lots of times

6. How frequently have you been involved in a study where someone was not listed as an author when they contributed substantially to the conception or design of the work; or the acquisition, analysis, or interpretation of data for the work; or the writing of the article?

- ◯ Never
- ◯ Once
- ◯ A few times
- ◯ Lots of times

Authorship criteria survey

Thinking of the last paper you coauthored....

7. Thinking of the last paper you coauthored, at what point in time were details about WHO should be an author discussed? [Tick all that apply]

- [ ] At an early stage during the design of the study
- [ ] During the course of the study
- [ ] Once the study was completed and before writing the paper
- [ ] During paper writing
- [ ] After the paper was written
- [ ] It was never discussed

8. Thinking of the last paper you coauthored, at what point in time were details about the ORDER of authorship discussed? [Tick all that apply]

- [ ] At an early stage during the design of the study
- [ ] During the course of the study
- [ ] Once the study was completed and before writing the paper
- [ ] During paper writing
- [ ] After the paper was written
- [ ] It was never discussed

Authorship criteria survey

Thinking of the last paper you coauthored....

9. Thinking of the last paper you coauthored, were explicit authorship criteria used to decide WHO should be an author?

◯ Yes ◯ No ◯ I don't know

10. Thinking of the last paper you coauthored, do you feel that the decision on WHO should be an author was a fair reflection of who did what?

◯ Yes ◯ No ◯ I don't know

11. Thinking of the last paper you coauthored, approximately how many times was authorship ORDER discussed by the research team?

◯ Never ◯ Only once ◯ A few times ◯ Lots of times

12. Thinking of the last paper you coauthored, do you feel that the decision on the ORDER of authorship was a fair reflection of who did what?

◯ Yes ◯ No ◯ I don't know

Authorship criteria survey

And finally some questions about yourself:

13. For which institution do you mainly work?

14. Where is your (main) institution located?

15. Approximately how many years have you been an active researcher?

16. Approximately how many papers have you published in a peer reviewed journal as either an author or a coauthor?

17. Are you?

◯ Female ◯ Male

18. Do you have any further comments?

Authorship criteria survey

Thank you

Thank you for your help with this research.

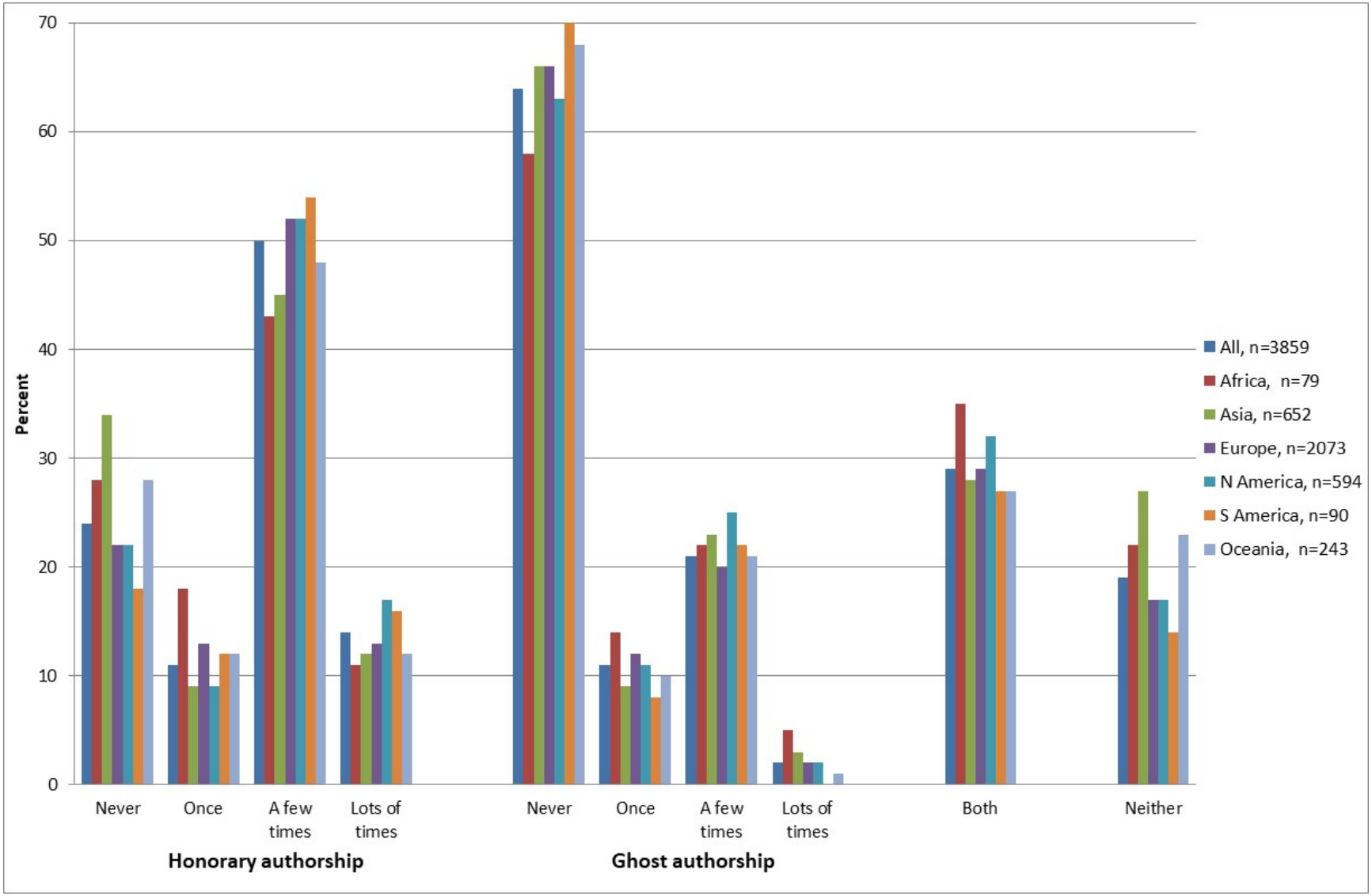
Please now click "submit" to complete the survey.

Appendix 2: List of included journals and their impact factors

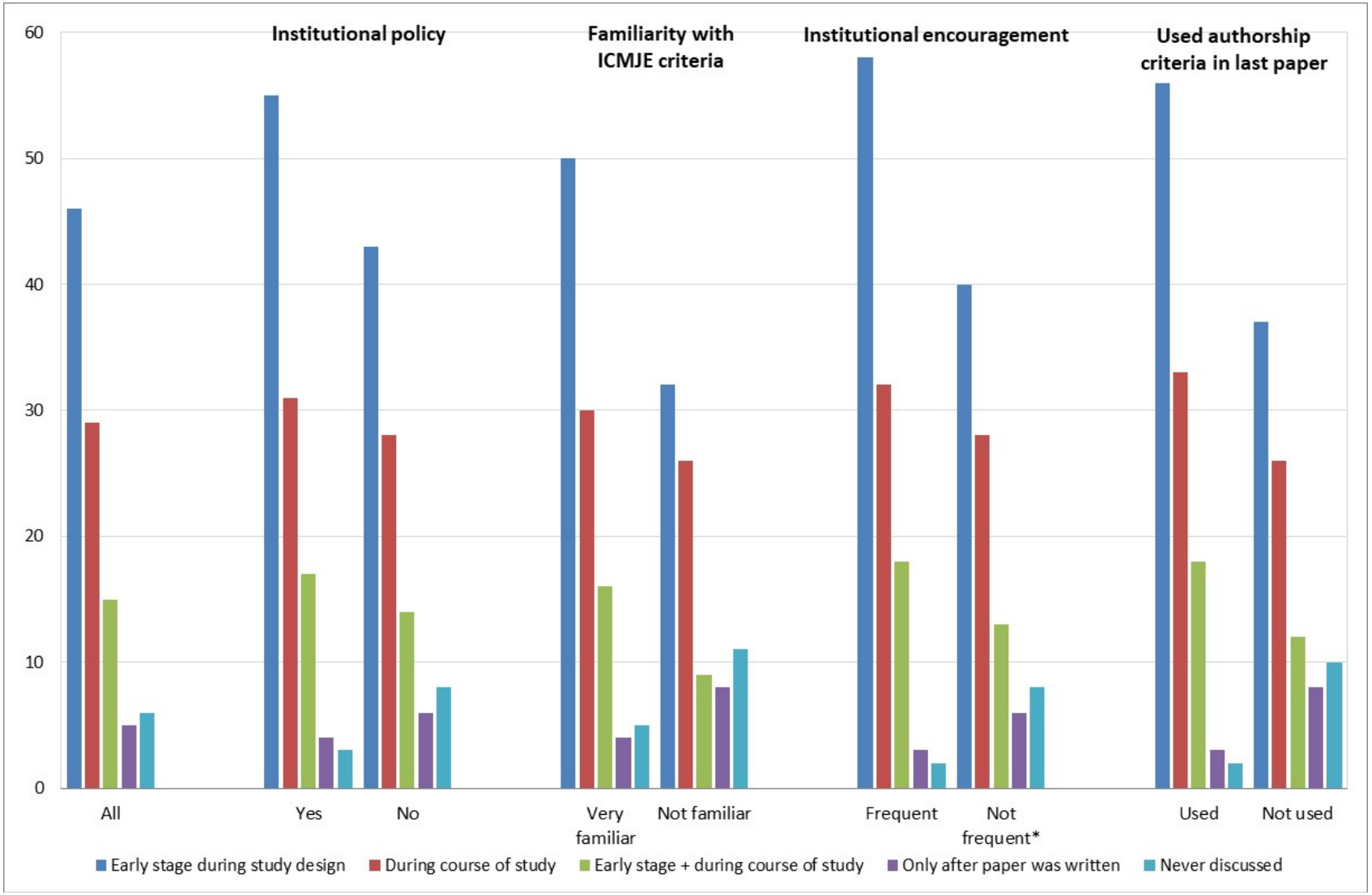
JOURNAL NAME	2014* Impact Factor
Archives of Disease in Childhood	2.899
Archives of Disease in Childhood: Fetal & Neonatal	3.120
Annals of the Rheumatic Diseases	10.377
BMJ Open	2.271
BMJ Open Diabetes Research & Care	-
BMJ Supportive & Palliative Care	-
Emergency Medicine Journal	1.843
Frontline Gastroenterology	-
Gut	14.660
Heart Asia	-
Injury Prevention	1.891
Journal of Clinical Pathology	2.915
Journal of Family Planning and Reproductive Health Care	1.600
Journal of Neurology, Neurosurgery & Psychiatry	6.807
Occupational and Environmental Medicine	3.267
Postgraduate Medical Journal	1.448
The BMJ	17.445
Thorax	8.290

*Time of the sampling

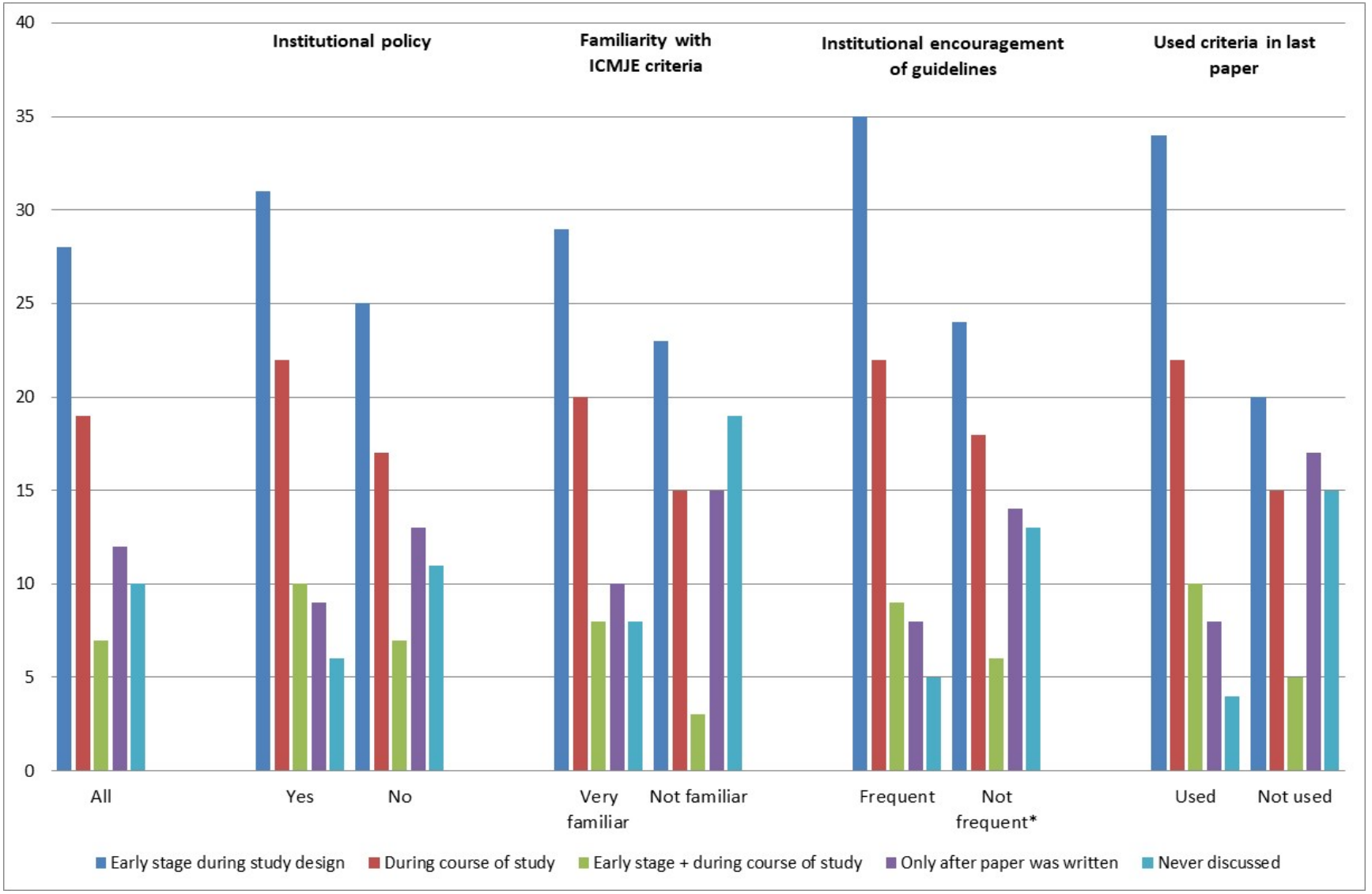
Appendix 3: Frequency of involvement in authorship misappropraition by continent of author's main institution



Appendix 4: Timing of discussions around authorship eligibility



Appendix 5: Timing of decisions around authorship order



Appendix 6: Perceived fairness of authorship decisions on last coauthored paper

	Decision made on authorship eligibility was fair (%)	Decision made on order of authorship was fair (%)
Use of explicit authorship criteria		
Explicit criteria used (n=2187)	2043 (93)	2015 (92)
Explicit criteria not used (n=1284)	879 (69)	946 (74)
Years of research experience		
More than 10 years of experience (n=1862)	1596 (86)	1610 (86)
Ten years or less of experience (n=1867)	1461 (78)	1515 (81)
Use of explicit authorship guidelines / criteria actively encouraged in current research setting		
Frequently encouraged (n=1410)	1273 (90)	1266 (90)
Not frequently encouraged (n=2404)*	1810 (75)	1886 (78)

Values are numbers (percent).

* Includes responses of “other”, “not sure”, “not encouraged” and “sometimes encouraged”.

THE COAUTHORS ASSURE THAT THEIR PAPER COMPLY WITH THE CHERRIES GUIDELINE

The corresponding author Ilaria MONTAGNI

Item category	Checklist Item	Page nr.	Description
Design	Study design	6	One-shot online survey (cross-sectional) of published and rejected journals from the BMJ sample.
Ethics	Ethics approval	6	The protocol was reviewed and approved by the BMJ' ethics committee.
	Informed consent	6	Authors were informed that participation was voluntary and that responses would be anonymised and treated confidentially. Participants were not be asked to give consent to take part; completion of the survey indicated that they had consented to take part.
	Data protection	7	Responses from all journals were collated and the anonymised combined sample.
Development and pre-testing		6	We developed a 12-item online closed questionnaire (Appendix 1) with five additional

			demographic open questions and a free-text item for additional comments. We piloted the questionnaire with 16 researchers to check for ambiguous items and revised the questionnaire in light of feedback.
Recruitment process	Open vs closed survey	6	This survey was addressed to authors of journals pre-selected from a sample of BMJ journals.
	Contact mode	6	Eligible authors were invited in 2016 by an email sent by the first author of this paper to complete the survey hosted by SurveyMonkey.
	Advertising the survey	NA	The survey was not advertised, members of the original sample were invited to participate.
Survey administration	Web/email	6	An email was sent by the first author of this paper to complete the survey hosted by SurveyMonkey.
	Context	6	We included authors submitting research articles in 2014 to 18 journals covering a range of specialties published by BMJ Publishing Group.
	Mandatory/voluntary	6	Authors were informed that participation was voluntary

	Incentives	6	In order to maximise the recruitment, we proposed an incentive to participants who were entered into a prize draw to a £100 voucher.
	Time/date	6	Responses were collected in November 2016
	Item randomisation	NA	No randomisation of items was used.
	Adaptive questioning	NA	No adaptive questioning was used
	Number of items	6	We developed a 12-item online closed questionnaire (Appendix 1) with five additional demographic open questions and a free-text item for additional comments.
	Number of screens	Appendix 1	9
	Completeness check	Appendix 1	All survey items were deemed to be mandatory, and respondents prompted to complete outstanding items before leaving the survey page on which the item was contained.
	Review steps	Appendix 1	Respondents were unable to change their responses once submitted.
Response rates	Unique site visitor	6	Duplicate authors were removed so that each author was invited

			to take part in the survey only once.
	View rate	NA	No
	Participation rate	8	We received an actual response from 3859 (31%) of the remaining 12379 authors.
	Completion rate	8	3859 respondents
Preventing multiple entries from same individual	Cookies used	NA	No
	IP check	NA	No
	Log file analysis	NA	Not used
	Registration	NA	Not used
Analysis	Handling of incomplete questionnaires	6	Not included in the study
	Questionnaires with atypical timestamp	NA	No
	Statistical correction	NA	Not used