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Scientific fraud, publication bias, and honorary authorship in nuclear medicine

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Abstract

Rationale

To investigate nuclear medicine scientists' experience with scientific fraud, publication bias, and honorary authorship.

Methods

Corresponding authors who published an article in one of the 15 general nuclear medicine journals (according to the Journal Citation Reports) in 2021, received an invitation to participate in a survey on scientific integrity.

Results

A total of 254(12.4%) of 1,897 corresponding authors completed the survey, of whom 11 (4.3%) admitted to have committed scientific fraud and 54 (21.3%) reported to have witnessed or to suspect scientific fraud by someone in their department in the past 5 years. Publication bias was considered present by 222 (87.4%) and honorary authorship practices were experienced by 100 (39.4%) of respondents. Respondents assigned a median score of 8 (range: 2-10) on a 1-10 point scale to their overall confidence in the integrity of published work. On multivariate analysis, researchers in Asia had significantly more confidence in the integrity of published work, with a β coefficient of 0.983 (95% confidence interval: 0.512 to 1.454, $P<0.001$). A subset of 22 respondents raised additional concerns, mainly about authorship criteria and assignments, the generally poor quality of published studies, and perverse incentives of journals and publishers.

Conclusion

Scientific fraud, publication bias, and honorary authorship appear to be non-negligible practices in nuclear medicine. Overall confidence in the integrity of published work is high, particularly among researchers in Asia.

Key words

Fraud; Medical Imaging; Nuclear Medicine; Research; Scientific Misconduct

Introduction

The contribution of nuclear medicine to healthcare has tremendously developed over the past decades *(1)*. Continued innovations will further bolster the importance of the specialty in clinical medicine *(1)*. Scientific publications can be considered paramount to prove the benefit of new technology and clinical applications to nuclear medicine patient care. They also provide an important source of information and inspiration to other researchers to initiate further studies in the same field. To avoid potential patient harm and futile investments, it is crucial that scientific publications are trustworthy and ethical.

Scientific fraud, defined as the fabrication, falsification, or plagiarism in proposing, performing, or reviewing research, or in reporting research results, has been around for many centuries and persists until now *(2, 3)*. Publication bias, which refers to studies with positive results being more likely to get published than studies with negative results, is also considered as a persistent problem *(4)*. Both scientific fraud and publication bias lead to unreliable scientific data in medical journals. Honorary authorship, defined as the intentional misrepresentation of credit to an individual whose contributions to a biomedical article do not meet the criteria for authorship established by the International Committee of Medical Journal Editors (ICMJE) *(5)*, is a third major undesired phenomenon in the scientific community *(6)*. Although honorary authorship may not undermine the validity of scientific data, it is still considered unethical and to represent scientific misconduct *(6)*.

For nuclear medicine to prosper to its full potential, there should ideally be no place for scientific fraud, publication bias, and honorary authorship. Research into this topic in the field of unclear medicine has been lacking so far.

The purpose of this study was to investigate nuclear medicine scientists' experience with scientific fraud, publication bias, and honorary authorship.

Materials and Methods

Study design and participants

A survey study, which was approved by the institutional review board of the <BLINDED>, was conducted among corresponding authors of all articles that were published in the 15 general nuclear medicine (according to the Journal Citation Reports *(7)*), in 2021. These 15 nuclear medicine journals are displayed in Supplemental Table 1. Corresponding authors were excluded if their e-mail address could not be found, if a message could not be delivered to their e-mail address, or if they were from the same institution as the authors of the present work. The remaining corresponding authors received an e-mail with an invitation to participate in a survey on scientific integrity in the field of nuclear medicine, on a voluntary and anonymous basis. This e-mail contained a link to a digital survey that was composed with Qualtrics Core XM survey software (Qualtrics LLC, Provo, Utah). Eligible participants were first contacted on 18 May 2022, and received reminders on 1 June 2022, 15 June 2022, and 26 August 2022.

Questionnaire

The survey contained six (semi-)closed-ended questions on participant's characteristics (age, gender, country of work, academic degree, academic position, and years of research experience), two semi-closed-ended questions on scientific fraud in the past 5 years (by the participant and by colleagues in the participant's department), two closed-ended questions on publication bias and honorary authorship in the past 5 years, and one closed-ended question on the participant's overall confidence in the integrity of published scientific work in his or her field. Finally, all participants were given the opportunity to leave any comments in an open text field. All survey questions and possible answer options are displayed in Supplemental Table 2.

Data analysis

Participants' characteristics were descriptively summarized. Frequencies of reported scientific fraud, publication bias, and honorary authorship were calculated. Associations between overall confidence in the integrity of published work (1-10 point scale) vs. participant's age, gender, continent (countries were merged into continents), academic degree, academic position, and years of research experience, were determined using linear regression analysis. Variables that were significant on univariate analysis were subjected to multivariate analysis. The category with most observations was used as reference for each nominal variable. Categories with less than 10 counts were excluded. All narrative comments provided by the participants in the free text field at the end of the survey were qualitatively analyzed to identify common topics of concern. *P*-values <0.05 were considered statistically significant. Statistical analyses were performed with the IBM Statistical Package for the Social Sciences (SPSS) version 26 (SPSS, Chicago, IL, USA).

Results

Eligible participants

A total of 2,111 corresponding authors published an article in the aforementioned 15 general nuclear medicine journals in 2021. Of these 2,111 corresponding authors, 185 were excluded because of undeliverable e-mails and 29 were excluded because they were from the same institution as the authors of the present work, leaving 1,897 individuals who were contacted to participate in the survey.

Respondents

A total of 254 (12.4%) of 1,897 invited corresponding authors completed the survey. Most respondents were aged 35-44 years (31.1%) and male (77.6%), top-three countries of residence of

respondents were the United States (16.5%), Italy (12.6%), and Germany (11.8%), and most respondents had a medical doctor degree (60.2%), were full professor (32.7%), and had >10 years of research experience (71.3%) (Supplemental Table 3).

Scientific fraud

Eleven (4.3%) of 254 respondents admitted to have committed scientific fraud in the past 5 years, with data manipulation/falsification and misleading reporting as the most common types of scientific fraud (Table 1). Fifty-four (21.3%) of 254 respondents reported to have witnessed or to suspect scientific fraud by someone in their department in the past 5 years, with duplicate/redundant publication, misleading reporting, and data manipulation/falsification as the leading types of scientific fraud (Table 1).

Publication bias

Two hundred twenty-two (87.4%) of 254 respondents thought that a study with positive results is more likely to be accepted by a journal than a similar study with negative results, 21 (8.3%) thought that this is not the case, and 11 (4.3%) were unsure as to whether or not there is publication bias.

Honorary authorship

One hundred (39.4%) of 254 respondents indicated they had an author on one of their publications in the past 5 years who actually did not deserve this co-authorship based on the International Committee of Medical Journal Editors (ICMJE) criteria, 124 (48.8%) did not, and 30 (11.8%) were unsure as to whether or not they had experienced honorary authorship practices.

Overall confidence in the integrity of scientific publications

Respondents assigned a median score of 8 (range: 2-10) on a 1-10 point scale to their overall confidence in the integrity of published work (Figure 1). On multivariate regression, researchers in Asia had significantly more confidence in the integrity of published work, with a β coefficient of 0.983 (95% confidence interval: 0.512 to 1.454, $P<0.001$) (Supplemental Table 4).

Common topics of concern

Twenty-two respondents provided additional narrative comments, which are displayed in Supplemental Table 5. Authorship issues were most commonly addressed (with honorary authorship as the leading topic), followed by the generally poor quality of published studies (either due to unintentional or intentional scientific misconduct), and perverse incentives (e.g. financial) of journals and publishers that impede the publication and dissemination of unbiased, high quality scientific work.

Discussion

The reported scientific fraud rates, with duplicate/redundant publication, misleading reporting, and data manipulation/falsification as the leading types of scientific fraud, can be considered as reasons for concerns. These scientific integrity concerns are further aggravated by the facts that most respondents indicated that publication bias takes place, and that a substantial proportion of respondents had faced honorary authorship practices. Overall confidence in the scientific integrity of published work in the field of nuclear medicine was generally high, but quite variable when considering the entire pool of survey participants. Interestingly, researchers from Asia had more confidence in the scientific integrity of published work. It can be speculated that Asian researchers generally regard scientific journals as authorative (note that 14 of the 15 general

nuclear medicine journals that were used for the present study are based in Western countries) and therefore trust their publications. However, it should be emphasized that this finding only applies to the respondents who participated in this survey, and that more research is necessary to investigate if this finding can be generalized.

Similar survey studies as the present one have been performed outside the medical imaging field. In a meta-analysis by Fanelli et al. *(8)* that included 18 of such studies, 2.0% of scientists admitted to have fabricated, falsified or modified data or results at least once, and up to 33.7% admitted other questionable research practices. In addition, in surveys asking about the behavior of colleagues, admission rates were 14.1% for falsification, and up to 72.0% for other questionable research practices *(8)*. These percentages are considerably higher than those in the present study. This difference may be explained by the fact that the meta-analysis by Fanelli et al. *(8)* included studies not related to nuclear medicine that were published between 1998 and 2005. Publication bias and honorary authorship practices in nuclear medicine research have also been an unexplored field so far. Related studies in the specialty of radiology reported both phenomena to be widespread *(9-11)*, in line with the results of the present study.

Publication pressure ("publish or perish") and the scramble for research grants have been recognized as important factors that may give rise to fraudulent researches *(12-14)*. This is due to the fact that grants and income, number of publications, publications in high impact journals, and citations of published research, are still regarded as important criteria (either explicit or implicit) for academic appointments and promotions *(15)*. Funding bodies and medical journals are often driven by the desire for positive study results, which may also be detrimental to the scientific climate in which researchers have to operate. Banning scientific fraud and lifting the integrity and trustworthiness of nuclear medicine research and research in general may require a system change taking into account all these different factors.

The present study had some limitations. First, the response rate was 12.4%, and it remains unclear whether this sample was representative of the whole population of nuclear medicine researchers. Second, it can be speculated that corresponding authors frequently also serve as senior authors, as a result of which there may have been underreporting of scientific fraud. Further research is necessary to investigate this speculation. Interestingly, on univariate linear regression researchers aged 55-64 years had significantly more confidence in the integrity of published work, whereas the opposite was true for assistant professors and those with less than 5 years of research experience, which feeds the hypothesis that there are differences in perceptions on this topic between junior and senior researchers. However, these associations did not remain significant on multivariate analysis. Third, only 11 respondents indicated that they committed scientific fraud by themselves, which was too low to investigate which individual factors are associated with performing fraud. Fourth, the results of this study only apply to the past 5 years. Fifth, it remains unclear which publications contained fraudulent data, and to what extent this inflicted patient harm and financial damage.

Conclusion

In conclusion, scientific fraud, publication bias, and honorary authorship appear to be non-negligible practices in nuclear medicine. Overall confidence in the integrity of published work is relatively high, particularly among researchers aged 55-64 years and researchers in Asia.

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Key points

-*Question*: What is the experience of nuclear medicine scientists scientific fraud, publication bias, and honorary authorship practices?

-*Pertinent findings*: In this survey study among 207 nuclear medicine scientists, 3.4% admitted to have committed scientific fraud in the past 5 years, 19.8% reported to have witnessed or to suspect scientific fraud by someone in their department in the past 5 years, 86.0% reported publication bias to be present, and 36.7% had experienced honorary authorship practices.

-*Implications for patient care*: There is considerable room for improvement when it comes to banning scientific fraud and lifting the integrity and trustworthiness of nuclear medicine research, which may be achieved by (cultural and policy) reforms that involve all stakeholders.

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Tables

Table 1. Types of reported scientific fraud.

Type of scientific fraud	**Among survey respondents (n=11)[a]**	**Among departmental co-workers (n=54)[b]**
Data fabrication	2	10
Data manipulation/falsification	4	19
Misleading (e.g. selective) reporting	4	26
Plagiarism	2	16
Duplicate/redundant publication	3	28
Other type of publication fraud	1[c]	3[d]

[a] Three respondents indicated to have committed multiple types of scientific fraud

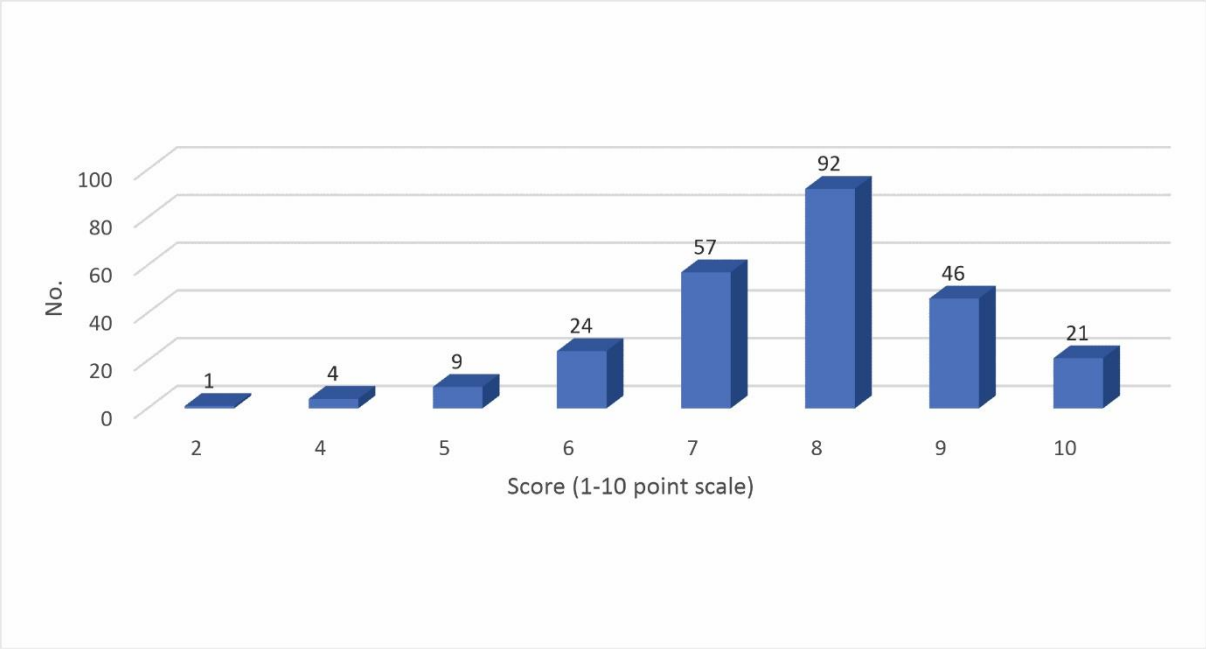
[b] Twenty-eight respondents indicated to have witnessed or suspected multiple types of scientific fraud among departmental co-workers

[c] "Including authors on papers that did not contribute enough to justify this"

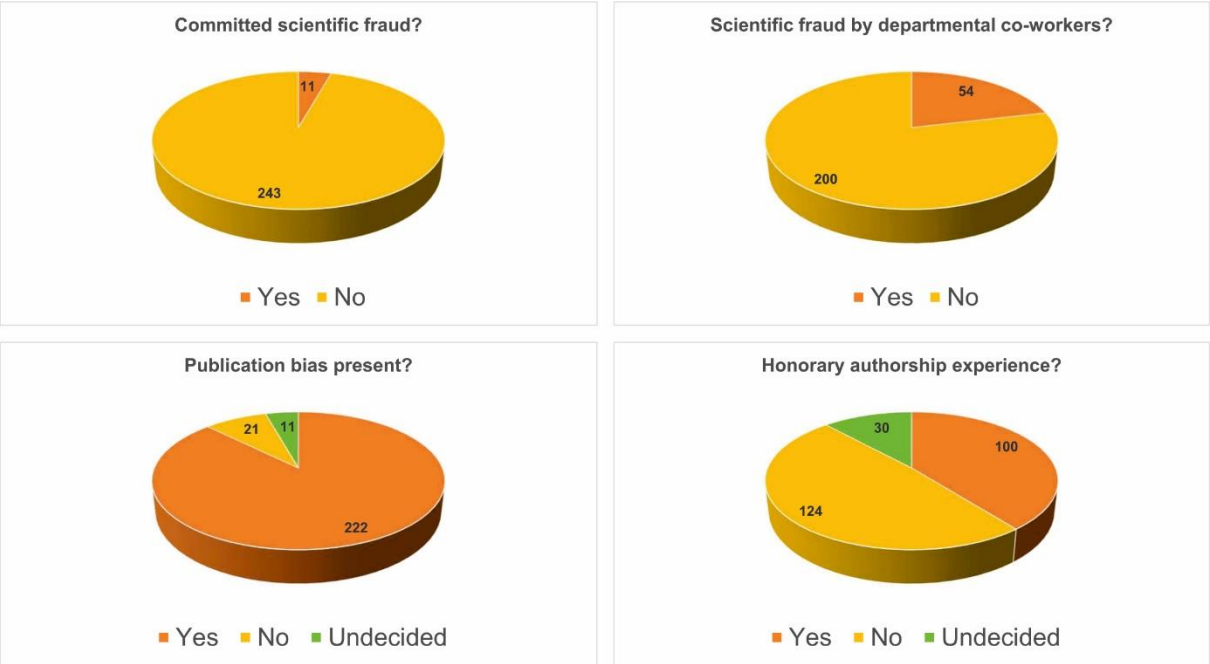
[d] "A doctoral candidate pulled together study plans of others and got a grant with his application. This was noticed and he had to withdraw his application", "Ghost authorship", and "Same as above"

Figures

Figure 1. Distribution of scores assigned by 207 respondents to their overall confidence in the integrity of published work in their scientific field.



Graphical abstract



Supplemental data

Supplemental Table 1. Fifteen general nuclear medicine journals listed in the 2020 Journal Citation Reports *(7)*.

Journal
Journal of Nuclear Medicine
European Journal of Nuclear Medicine and Molecular Imaging
Clinical Nuclear Medicine
Molecular Imaging
Seminars in Nuclear Medicine
Molecular Imaging and Biology
EJNMMI Physics
EJNMMI Research
Annals of Nuclear Medicine
Nuclear Medicine and Biology
Quarterly Journal of Nuclear Medicine and Molecular Imaging
Nuclear Medicine Communications
Nuklearmedizin
Revista Española de Medicina Nuclear e Imagen Molecular
Hellenic Journal of Nuclear Medicine

Supplemental Table 2. Survey questions and possible answer options.

No.	Question	Possible answers
1	How old are you?	<18, 18-24, 25-34, 35-44, 45-54, 55-64, or >65 years old
2	What is your gender?	Male, female, or other
3	In which country do you work?	List of 30 prefilled countries, and option to indicate another country
4	What is your academic degree?	Medical doctor (MD), doctor of philosophy (PhD), master of science (MSc), bachelor of science (BSc), master of public (MPH), and option to indicate another academic degree[a]
5	Which academic position do you hold?	None, fellow/resident, instructor/lecturer, assistant professor, associate professor, full professor, and option to indicate another academic position
6	How many years of research experience do you have?	<5, 5-10, or >10 years
7	Have you committed any of the following in the past 5 years?	Data fabrication, data manipulation/falsification, misleading (e.g. selective) reporting, plagiarism, duplicate/redundant publication, other type of publication fraud (free text field), none of the above[a]
8	Have you witnessed or do you suspect that anyone from your	Data fabrication, data manipulation/falsification, misleading (e.g. selective) reporting, plagiarism, duplicate/redundant publication, other type of

	department committed any of the following in the past 5 years?	publication fraud (free text field), none of the above[a]
9	Do you think that a study with positive results is more likely to be accepted by a journal than a similar study with negative results?	Yes, no, or undecided
10	Please indicate your confidence in the integrity of published work in your scientific field	0-10 point linear scale, with 0 corresponding to no confidence and 10 corresponding to high confidence
11	Is there a co-author on any of your publications in the past 5 years who actually did not deserve this co-authorship based on the International Committee of Medical Journal Editors (ICMJE) criteria?	Yes, no, or undecided
12	Please feel free to add any narrative comments	Free text field

Note:

[a] Multiple answers possible

Supplemental Table 3. Characteristics of the 207 survey respondents.

Variable	Category	Count	Percentage
Age	25-34 years	34	13.4%
	35-44 years	79	31.1%
	45-54 years	62	24.4%
	55-64 years	52	20.5%
	>65 years	27	10.6%
Gender	Male	197	77.6%
	Female	57	22.4%
Country of work[a]	Australia	5	2.0%
	Austria	5	2.0%
	Belgium	15	5.9%
	Brazil	6	2.4%
	Canada	3	1.2%
	Chile	3	1.2%
	China	8	3.2%
	Colombia	2	0.8%
	Cyprus	1	0.4%
	Denmark	2	0.8%
	Egypt	1	0.4%
	Finland	1	0.4%
	France	17	6.7%
	Germany	30	11.8%
	India	6	2.4%
	Iran	1	0.4%
	Israel	1	0.4%
	Italy	32	12.6%
	Japan	6	2.4%
	Korea	3	1.2%
	Malaysia	1	0.4%
	Monaco	1	0.4%

	Poland	2	0.8%
	South Africa	1	0.4%
	Spain	13	5.1%
	Sweden	6	2.4%
	Switzerland	4	1.6%
	Taiwan	2	0.8%
	Thailand	1	0.4%
	The Netherlands	17	6.7%
	Turkey	6	2.4%
	United Kingdom	10	3.9%
	United States	42	16.5%
Academic degree	Medical doctor (MD)	153	60.2%
	Other degree(s)	101	39.8%
Academic position	None	20	7.9%
	Fellow/resident	16	6.3%
	Instructor/lecturer	17	6.7%
	Assistant professor	33	13.0%
	Associate professor	51	20.1%
	Full professor	83	32.7%
	Other	34	13.4%
Years of research experience	<5 years	29	11.4%
	5-10 years	44	17.3%
	>10 years	181	71.3%

Supplemental Table 4. Linear regression analysis on the association of several variables with overall confidence in the integrity of published scientific work.

Variable	**Category**	**Univariate analysis**			**Multivariate analysis**		
		β	**95% CI**	***P*-value**	**β**	**95% CI**	***P*-value**
Age[a]	25-34 years (n=34)	-0.326	-0.856 to 0.204	0.227	-0.213	-0.846 to 0.420	0.509
	45-54 years (n=62)	0.388	-0.051 to 0.826	0.083	0.347	-0.120 to 0.814	0.145
	55-64 years (n=52)	0.565	0.103 to 1.026	**0.017**	0.560	-0.007 to 1.127	0.053
	>65 years (n=27)	0.357	-0.219 to 0.934	0.223	0.396	-0.247 to 1.039	0.227
Gender[b]	Female (n=57)	0.159	-0.237 to 0.555	0.429	-	-	-
Continent[c,d]	Asia (n=35)	0.956	0.479 to 1.433	**<0.001**	0.983	0.512 to 1.454	**<0.001**
	North America (n=45)	-0.104	-0.536 to 0.328	0.635	-0.193	-0.631 to 0.244	0.385
	South America (n=12)	0.468	-0.297 to 1.233	0.229	0.614	-0.144 to 1.372	0.112
Academic degree[e]	Other degree(s) than MD (n=101)	0.126	-0.212 to 0.463	0.464	-	-	-
Academic position[f]	None (n=20)	0.198	-0.449 to 0.845	0.547	0.651	-0.056 to 1.359	0.071
	Fellow/resident (n=16)	-0.702	-1.411 to 0.007	0.052	0.201	-0.664 to 1.066	0.648
	Instructor/lecturer (n=17)	-0.364	-1.055 to 0.328	0.301	-0.078	-0.830 to 0.674	0.839

	Assistant professor (n=33)	-0.558	-1.092 to -0.023	**0.041**	-0.174	-0.795 to 0.447	0.582
	Associate professor (n=51)	-0.050	-0.512 to 0.412	0.832	0.064	-0.437 to 0.564	0.802
	Other (n=34)	-0.599	-1.128 to -0.070	**0.027**	-0.263	-0.846 to 0.320	0.375
Years of research experience[g]	<5 years (n=29)	-0.924	-1.439 to -0.409	**<0.001**	-0.662	-1.421 to 0.097	0.087
	5-10 years (n=44)	-0.276	-0.709 to 0.157	0.211	0.056	-0.458 to 0.571	0.829

Abbreviation:

CI: confidence interval

Notes:

[a] 35-44 years (n=79) was used as reference category

[b] Male gender (n=197) was used as reference category

[c] Europe (n=156) was used as reference category

[d] Africa (n=1) and Australia (n=5) were excluded from linear regression analysis

[e] MD degree (n=153) was used as reference category

[f] Full professor (n=83) was used as reference category

[g] >10 years (n=181) was used as reference category

Supplemental Table 5. Narrative comments provided by 17 respondents at the end of the survey.

No.	Comments
1	In my opinion, at least in Nuclear Medicine, metanalysis results are not far more important than "image of the month" or a clinical series of 5 patients with a rare disease.
2	I believe at least 50% (may be more) of what is published in our field is fabricated and misleading. I usually disagree to include people in papers where they just provided tools or fund but I see it happening a lot.
3	It is unlikely that if a author publishes in a peer reviewed high ranked scientific journal writes false things or engages in fraud
4	I am not sure if asking if a co-author on the own publications does deserve co-authorship is the right question. I have seen many publications from other groups were there are many co-authors that do not deserve to be on the paper though.
5	Some papers in the field of emergent therapies (local phase 2, without control arm) present data that are rarely confirmed in RCT. There should be problem in the selection of patients included in the paper, without clear notification about why some patients are excluded. I am not claiming this is fraud though, just presented data better than what they are in real life.
6	The answer to Q10 may vary based on the reputation/peer-review process of the journal.
7	Last 5 yrs is a short period for a long scientific life, especially if one switched to a city hospital. My answers would have been different 20 years ago ;-)
8	The ICMJE criteria are quite strong, and if properly applied, may lead the exclusion of people who carried out (real) technical work while senior PI will always claim authorship for (more or less real) intellectual contribution. I recently adopted the CREDIT taxonomy and which I use to transparently report the contributions of all co-authors.
9	It is a common rule to add some co-authors from your department or hospital in articles....

10	It is obvious the field is being flooded with numerous un-scientific papers which are either inherently incorrect or intentionally misleading. EJNMMI is a cesspool for these. I don't know what to do about these but I vigorously agree they must be stopped!
11	I am aware of a case where an individual that clearly deserved coauthorship has not been named author on publication
12	10 years ago it happened that co-authors were listed whose contribution was not in full agreement with the ICMJE but in the last 5 years I never observed such inadequate co-authorship
13	Would help to define integrity in q10. I think willful misconduct is 1 thing, accidental misconduct is another thing, and poor science is a third thing. Many articles are being published with poor science but for the sake of this questionnaire I still considered them with integrity though you could argue that these paper lack integrity.
14	Journals should be open to publish studies with negative results and studies that are trying to reproduce previous work. The goal of journals to always be the first to report leads to lack of scrutiny and risk of data fabrication/manipulation.
15	The scientific world and its journals have gradually become much more money dependent, bought and in fact often corrupt, so that access to major clinical (non-radiological, non-nuclear) journals is close to impossible, unless we as nuclear medicine (or radiological) specialists are part of a major and influental clinially based work group or are supported by pharma in a way that can pave access to the highly esteemed journals, the scientific and impartial varnish of which is often crackled. In additon, open access sounds as a good idea, but soon only authors/instititions, who are willing to pay for that will get their manuscripts accepted, almost no matter how good they are.
16	Unclear about what is purpose of the questionnaire.

17	15 years ago, a colleague (well known, now deceased) published my work, which has been agreed that it could not be published a year before, because there were not enough data to conclude with a statistically significant analysis. He sent me the published article, without having contacted me to review, and my name, which should have been the first of the author list, was put in antepenultimate.... <remaining part blinded to keep the respondent's identity concealed>
17	Problems may arise from clinical databases that different groups use (with or without knowing from each other) to collect study data and similar publication may arise.
18	While these things do happen, but my experience has been it's on a minuscule level. Scientific medical research is majorly ethical and accurate.
19	Reviewers are often incompetent in study design, statistics, selection bias, exclusion bias... They also tolerated too short series to be conclusive, no validation group for confirmation after proposition of results based on data from one study group, and almost always confusion between correlation and equivalence of methods. Very often no references about previous similar studies using an alternative method or modality.
20	Sometimes it is not possible to know for sure the answers to any of these questions when it concerns someone in one's own department or other collaborating sites.
21	Always difficult to determine if someone contributing patients to a study should be a co author. I tend to err on inclusion on authorship, especially when there are small, but real, contributions to the work which may be viewed as borderline for authorship per ICMJE. It is problematic to exclude someone whose contribution is borderline as they often have a greater opinion of their contribution than others in the author list.
22	PSMA therapy is all the hype. Lots of "beautiful" results...