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ORIGINAL ARTICLE

Integrity of Clinical Neuroradiological Research

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Abstract

Purpose It is unclear if undesired practices such as scientific fraud, publication bias, and honorary authorship are present in neuroradiology. Therefore, the objective was to explore the integrity of clinical neuroradiological research using a survey method.

Methods Corresponding authors who published in one of four top clinical neuroradiology journals were invited to complete a survey about integrity in clinical neuroradiology research.

Results A total of 232 corresponding authors participated in our survey. Confidence in the integrity of published scientific work in clinical neuroradiology (0–10 point scale) was rated as a median score of 8 (range 3–10). In linear regression analysis, respondents from Asia had significantly higher confidence (beta coefficient of 0.569, 95% confidence interval, CI: 0.049–1.088, $P = 0.032$). Of the respondents 8 (3.4%) reported to have committed scientific fraud in the past 5 years, whereas 66 respondents (28.4%) reported to have witnessed or suspected scientific fraud by anyone from their department in the past 5 years. A total of 192 respondents (82.8%) thought that a study with positive results is more likely to be accepted by a journal than a similar study with negative results and 96 respondents (41.4%) had an honorary author on any of their publications in the past 5 years.

Conclusion Experts in the field have overall high confidence in published clinical neuroradiology research; however, scientific integrity concerns are not negligible, publication bias is a problem and honorary authorship is common. The findings from this survey may help to increase awareness and vigilance among anyone involved in clinical neuroradiological research.

Keywords Radiology · Neurology · Scientific misconduct · Fraud · Ethics

Introduction

Scientific research constitutes the basis of modern healthcare. It is pivotal that research is performed in an honest way and that reliable and representative data are published, because failure to do so may compromise the scientific medical literature and ultimately be harmful to patients; however, a recent meta-analysis about research in general (including medical research) estimated that the prevalences of scientific misconduct (defined as falsification, fabrication or plagiarism) and questionable research practices among researchers were 2.9% and 12.5%, respectively [1]. Furthermore, this meta-analysis estimated that 15.5% and 39.7% of researchers witnessed others who had committed scientific misconduct or questionable research practices, respectively [1]. These data give cause for concern about the overall reliability of scientific publications. Neuroradiology is one of the longstanding subspecialties in radiology [2] with its own societies [3–5] and subspecialty journals [6]. To our knowledge, it is unclear if undesired practices, such as scientific fraud, publication bias, and honorary authorship are present in neuroradiology. Therefore, the objective of the study was to explore the integrity of clinical neuroradiological research using a survey method.

Data, Material and/or Code Availability Data are available from the authors upon reasonable request.

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Material and Methods

Data Acquisition

This study was approved by the institutional review board of University Medical Center Groningen. Corresponding authors who published in *Clinical Neuroradiology, American Journal of Neuroradiology, Journal of Neuroradiology*, or *Neuroradiology* (these are the four top clinical neuroradiology journals according to impact factor [6]) between January 2017 and September 2022 were invited by email to participate in the survey. Corresponding authors from the authors' circle of acquaintances were excluded. The survey was composed by two radiologists (University Medical Center Groningen), both with >6 years of experience in clinical radiology and both with >15 years of research experience. The survey consisted of 11 multiple choice questions and one open field to leave any narrative comments (see appendix) and was made available to the invited authors through a weblink created with Qualtrics software (Qualtrics, Provo, UT, USA). Reminder emails were sent 2, 4, 6 and 8 weeks after the initial email.

Data Analysis

Linear regression analysis was used to determine the association between the categorical variables age, continent, academic degree, academic position and research experience of the respondent vs. confidence of the respondent in the integrity of published scientific work in clinical neuroradiology (the latter rated on a scale from 0 to 10). For each nominal variable, the category with the largest number was selected as the reference group. *P*-values less than 0.05 were considered statistically significant. Other analyses were performed using descriptive statistics. Narrative comments by the respondents were qualitatively interpreted. The Statistical Package for the Social Sciences version 26 (SPSS, Chicago, IL, USA) was used for statistical analyses.

Results

Characteristics of Respondents

In total, 2853 unique corresponding authors with valid email addresses were contacted of whom 232 participated in our survey (8.1% response rate). Characteristics of respondents are displayed in Table 1. Most respondents were aged 35–54 years (61.6%), male (75.9%), from the USA (22.8%), had a medical doctor degree (84.1%), were full professor (30.6%) and had more than 10 years of research experience (68.5%).

Table 1 Characteristics of 232 respondents who participated in this survey

Age distribution	25–34 years	*n* = 32 (13.8%)
	35–44 years	*n* = 75 (32.3%)
	45–54 years	*n* = 68 (29.3%)
	55–64 years	*n* = 45 (19.4%)
	>65 years	*n* = 12 (5.2%)
Gender	Male	*n* = 176 (75.9%)
	Female	*n* = 55 (23.7%)
	Other	*n* = 1 (0.4%)
Country	USA	*n* = 53 (22.8%)
	France	*n* = 21 (9.1%)
	Canada	*n* = 17 (7.3%)
	Germany	*n* = 16 (6.9%)
	Italy	*n* = 14 (6.0%)
	China	*n* = 11 (4.7%)
	India	*n* = 11 (4.7%)
	Japan	*n* = 10 (4.3%)
	Netherlands	*n* = 10 (4.3%)
	Other	*n* = 69 (29.7%)
Academic degree	Medical doctor, with or without other degree	*n* = 195 (84.1%)
	Other degree	*n* = 37 (15.9%)
Academic position	Full professor	*n* = 71 (30.6%)
	Associate professor	*n* = 46 (19.8%)
	Assistant professor	*n* = 39 (16.8%)
	Instructor/lecturer	*n* = 20 (8.6%)
	Other	*n* = 20 (8.6%)
	None	*n* = 19 (8.2%)
	Fellow or resident	*n* = 17 (7.3%)
Research experience	<5 years	*n* = 18 (7.8%)
	5–10 years	*n* = 55 (23.7%)
	>10 years	*n* = 159 (68.5%)

Confidence in Scientific Integrity

Confidence in the integrity of published scientific work in clinical neuroradiology was rated a median score of 8 (range 3–10) (Fig. 1). In linear regression analysis, respondents from Asia had significantly higher confidence in the integrity of published scientific work (beta coefficient of 0.569, 95% confidence interval, CI 0.049–1.088, $P = 0.032$). Age, academic degree, academic position, and research experience of the respondent were not significantly associated with confidence in the integrity of published scientific work (*P*-values ≥ 0.159).

Scientific Fraud

Of the respondents 8 (3.4%) reported to have committed scientific fraud in the past 5 years, with duplicate, redundant publication (40%) and plagiarism (40%) being the most commonly reported forms of fraud (Fig. 1). Also,

66 respondents (28.4%) reported to have witnessed or suspected scientific fraud by anyone from their department in the past 5 years, with misleading reporting (31.4%), duplicate, redundant publication (24%), and data manipulation/falsification (18.1%) being the most commonly reported forms of fraud (Fig. 2).

Publication Bias

Of the respondents 192 (82.8%) thought that a study with positive results is more likely to be accepted by a journal than a similar study with negative results, 21 respondents (9.1%) thought that this is not the case, and 19 respondents (8.2%) were indecisive with respect to this issue.

Honorary Authorship

Of the respondents 96 (41.4%) had an author on any of their publications in the past 5 years who actually did not deserve authorship based on the International Committee of Medical Journal Editors (ICMJE) criteria.

Narrative Comments

In the survey 26 respondents provided narrative comments, which are displayed in Table 2. Issues related to scientific integrity that were not directly covered by the multiple choice questions from the survey included concerns related to the peer review system and misappropriation of research data.

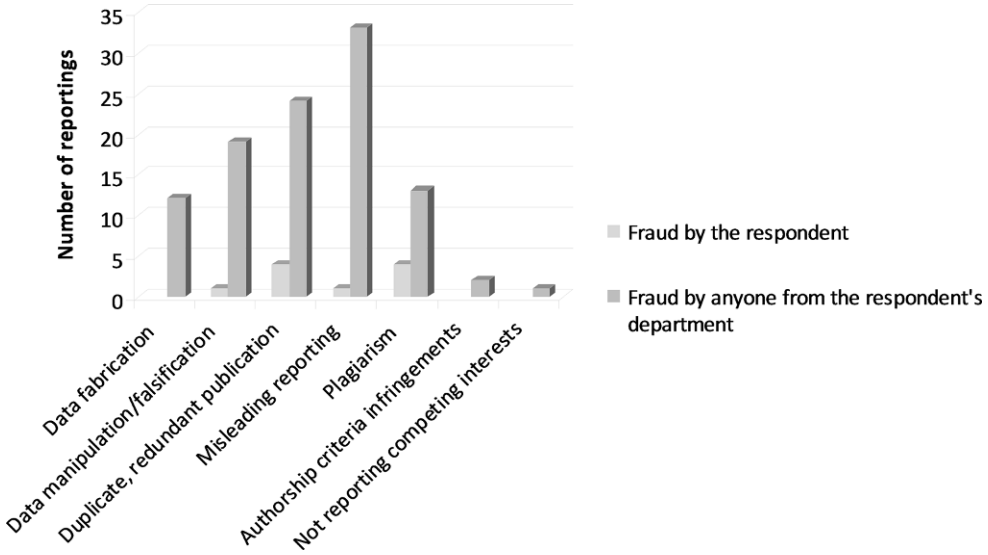

Fig. 1 Types of scientific fraud conducted by the respondent and types of witnessed or suspected scientific fraud by anyone from the respondent's department

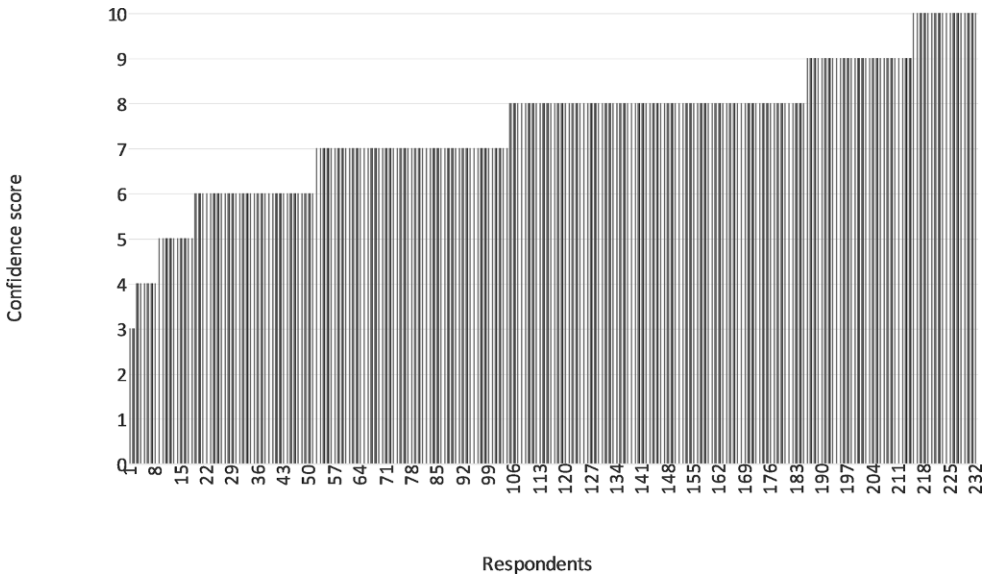

Fig. 2 Distribution of scores by 232 respondents with regard to their overall confidence in the integrity of clinical neuroradiology research (ordered from low to high, on a 0–10 point scale)

Table 2 Narrative comments from 26 respondents (A-Z), subdivided per category (scientific fraud, honorary authorship, peer review system, misappropriation of research data, and other)

Category	Respondent	Narrative comment
Scientific fraud	E	Image manipulation, manipulation by false choice of statistical tests (with favorable results), and … are common
	H	Integrity is highly lab dependent. In general with interdisciplinary teams where data is housed centrally it is difficult to fabricate on the larger scale studies. This remains a challenge we need to be vigilant on
	P	While there is no doubt that scientific fraud/misconduct occurs in *n* neuroradiology and medicine as a whole, …
	V	I believe that there is a high standard of scientific quality in the field of neuroradiology
	X	A lot of data fabrication, manipulation, plagiarism, and duplication is done these days by fake researchers, publishers, and academic institutions for obvious reasons. I know these facts and will not indulge in any of these on my own
	Q	This is an important topic. There is a risk of being overconfident about scientific integrity in our field of research. We must stay vigilant
Honorary authorship	B	Co-authorship is not strictly deserved in many labos
	E	…, and unjustified authorship as well as order of authors are common
	F	Q11—saw it on paper that I was not directly involved in
	G	At least in my country (*Mexico*) the issue of question 11 is a big problem. Senior authors demand authorship regardless of involvement
	L	It is not uncommon to add a co-author for completeness of the research team. For instance, a radiology study with a clinician in the field as co-author makes the paper to appear more scientifically sounds
	M	Most of the co-authors are added for political reasons, …
	N	At least in my field and in my country, the ethical standard is quite high. However, the gift authorship is quite prevailing for several reasons (for someone (with whom the CA or 1st author is close) to get promotion or a gesture of thanking seniors or others)
	O	Universities set the KPI *n* such a manner that giving authorship credits to everyone from a department, irrespective of contribution, is beneficial for the dept in general. Hence a lot of non contributory authors is the norm today
	R	The biggest problem I have witnessed is questionable authorship inclusion. Although probably technically fulfilling ICMJE criteria, the bar for inclusion as author seems to have gotten fairly low
	S	Have seen co-authors who did not contribute added to electronic exhibits more than papers, but usually are section heads/chairs that are inappropriately added
	T	Gift authorship or honorable authorship is decreasing recently but is still being observed in our country (*Korea*)
	Y	Regarding Q11, there have been papers on which I have been a co-author (but not leading) where I have been unconvinced that all of the co-authors had contributed sufficiently to justify inclusion. Of note, I have seen numerous examples where neuroradiologists have NOT been recognised in co-authorship where they have made substantial contributions to work presented. While this is not as formally covered by guidelines, it is effectively misrepresentation of the authors' contributions (i.e. they are being credited for work performed by a non-author)
Peer review system	A	The peer review system is very random. Sometimes I see papers that should have been rewritten or refused. Sometimes, it works well
	J	There are many problems with the so-called peer review. The "peers" and the editors control much that is published, especially if it is political (global warming, woke, COVID, etc.). I have published extensively and have reviewed for over 70 journals so understand the system well. I feel that if an investigator has done the research and if the conclusions are supported by the data presented, it should be published. Reviewers are often much too personal, and unprofessional. Sometimes they are really not the true "peer." Anyway, the system is clearly flawed
	M	…, the main problem is also the reviewer system. The journals do not pay reviewers are not interested in high expertise of the reviewers, on top of that most of the journals charge the authors for publications which is very unethical and makes a paper unlikely to be rejected
	O	Open access journals, even those with reasonable IF, would publish most things, provided the English grammar is acceptable, if they receive their publication fee. The value and message from such manuscripts is highly debatable
	V	As in any other field the fact that reviewers are not openly disclosed is in my view a problem, as reviewers often use their political positions to reject high quality papers. Rejections are frequently not made on the basis of scientific quality and content, but on personal feelings of referees. Generally, neuroradiology would substantially benefit from a more open scientific and educational culture, as in the past the field is driven by some groups and very few influential persons, who are not acting in a very inclusive fashion. It would be beneficial, if a younger, more open and inclusive scientific culture would develop

Table 2 (Continued)

Category	Respondent	Narrative comment
Misappropriation of research data	K	One colleague from another department of our hospital stole research data that we produced to publish it
	U	I am a pediatric neuroradiologist with 20 years experience as attending. I was senior researcher on a manuscript regarding the use of volumetric growth analysis to distinguish benign nodules from tumors. The studied was conceived and designed by myself and by a senior child neurologist who ran the clinical referral center at my institution and who funded the project by providing salary support for a premedical student who trained with me and then did the volumetric measurements putting in an estimated 900 h of work. The medical student was designated as the first author and I as senior author. We started the project in 2017. 3 years into the project I brought in a colleague senior neuroradiologist with little experience in pediatric neuroimaging research (s), and a junior neuroradiologist (j1), to participate in the project as a research experience enhancement for both of them. Following the successful presentation of our data at a national meeting in 2020 by the premed student and designated senior author, the two newer members of the group, s and j1 unbeknownst to me or my colleagues, went rogue, recruited another junior neuroradiologist j2, wrote an unauthorized manuscript and proposed the newest junior neuroradiologist j2 as first author and j1 as senior author and wrote an email threatening to publish the manuscript by the end of the week. The writing of a manuscript based on our data and the new authorship list were completely unauthorized. Perhaps this example does not represent actual fraud as s, j1, and j2 withdrew their proposal when the senior child neurologist threatened to report their actions to the dean of academic affairs, but rather an example of misappropriation of data and misconstrual of authorship assignment, that may be germane to your inquiry, and that compromised multiple trust relationships within our division and between our division and child neurology. I apologize for the long note, if such does not fall into your inquiry
Other	C	Excellent that you work with this!
	D	Thanks and good luck for your investigation
	I	This is important work and the research community will benefit from the results of this survey
	P	..., the bigger concern is likely the deluge of small, insignificant, and/or poorly designed studies that produce non-reproducible results (J. Ioannidis, Why most published research findings are false, PLoS Medicine 2005). These studies at best waste precious time and resources and at worst distract researchers/clinicians from doing more meaningful research that can result in real improvements in health. This problem needs to be studied more closely
	W	This survey really provides no useful information as the instrument being used to detect fraud has not been validated and. if used to produce a result, is fraudulant
	Z	I do not know the ICMJE criteria

Discussion

Our survey among researchers who recently published in a major clinical neuroradiology journal shows that overall confidence in the integrity of clinical neuroradiology research is high, with a median score of 8 on scale of 0–10. The confidence is particularly high among researchers from Asia, which could be related to cultural differences. However, the presence of scientific fraud is not negligible, as 3.4% of respondents admitted having committed scientific fraud themselves and 28.4% witnessed or suspected scientific fraud by anyone from their department in the past 5 years.

Misleading reporting, duplicate, redundant publication, data manipulation/falsification, plagiarism, and data fabrication were the most common types of scientific fraud identified by this survey. Some researchers may become triggered to commit these unethical practices by the "publish or perish" culture [7]. Potential solutions include a change in the reward system for scientific research that should focused more on the quality rather than on the quantity of publications, more training in research ethics for researchers, and higher repercussions for those who commit scientific fraud.

The majority of respondents (82.5%) believe that a study with positive results is more likely to be published than a similar study with negative results. The existence of publication bias was confirmed by a recent meta-analysis that found evidence of widespread prevalence of small study effects in the diagnostic imaging accuracy literature [8]. The undesired phenomenon of publication bias could trigger some researchers to perform scientific fraud, in particular misleading reporting and data manipulation/falsification. Journal editors may play a key role in countering publication bias by accepting a balanced proportion of studies with "positive" and "negative" results.

Honorary or undeserved authorship violates publication ethics and distorts the publication output of both honorary authors and authors that truly deserve authorship. However, a considerable proportion of respondents (41.4%) had an honorary author on any of their publications in the past 5 years. Primarily, honorary authors (who are often section or departmental heads) should refrain from being listed on the author list in case their contributions do not fulfil the ICMJE criteria [9]. In addition, journals may potentially counteract honorary authorship by setting limits to the maximum number of authors and by strictly adhering to ICMJE authorship criteria.

Our study findings largely concur with a recent meta-analysis about research in general (including other medical specialties than medical imaging) that reported 2.9% and 12.5% prevalences of scientific fraud and questionable research practices among researchers, and 15.5% and 39.7% prevalences of witnessed scientific misconduct or questionable research practices by others, respectively [1]. It should be noted, however, that this meta-analysis [1] may not be directly comparable to the current survey due to different methodology and definitions (for instance, the meta-analysis [1] did not give a clear definition of questionable research practices). Our findings in clinical neuroradiology are in line with previous surveys in general radiology and nuclear medicine [10, 11], which used similar methodology and definitions as the current survey. In those previous surveys [10, 11] overall confidence in published research was also high (median scores of 8 out of 10). Furthermore, prevalences of self-committed scientific fraud (4.3% and 5.9%), suspected or witnessed scientific fraud by colleagues (21.3% and 27.4%), publication bias (84.5% and 87.4%), and honorary authorship (39.4% and 40.6%) were comparable to the current survey. Altogether, these findings suggest that scientific misconduct is present to a similar degree throughout the clinical medical imaging literature and that neuroradiology is no exception.

Our study has some limitations. First, the response late of 8.1% can be considered relatively low. However, we received responses from as many as 232 corresponding authors, of which 68.5% had substantial (>10 years) research experience. As such, we believe that our study findings are reliable. Second, our study was based on perceptions from researchers in the field of clinical neuroradiology. Therefore, we could not determine the actual prevalence of scientific fraud. However, this may be difficult if not impossible to determine by any study design. It may be possible that scientific fraud only comes to light during the peer review process or by post-publication retraction [12]. Third, this study only included neuroradiological research in explicit neuroradiological journals. The results might have been different in other clinical or higher impact journals. Fourth, corresponding authors who were surveyed typically have a more senior rank. Perhaps the answers would have been different among more junior researchers who may have a different perception about scientific integrity. Fifth, a few respondents brought up some issues by their narrative comments that were not directly covered by the multiple choice questions from our survey. These issues, including concerns related to the peer review system and misappropriation of research data, remain a topic for further investigation.

In conclusion, experts in the field have overall high confidence in published clinical neuroradiology research. However, scientific integrity concerns are not negligible, publication bias is a problem, and honorary authorship is common. The findings from this survey may help to increase awareness and vigilance among anyone involved in clinical neuroradiological research.

Supplementary Information The online version of this article (https://doi.org/10.1007/s00062-023-01280-4) contains supplementary material, which is available to authorized users.

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Author Contribution All authors fulfil ICMJE criteria: all authors have made 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.

Data, Materials and/or Code availability Data are available from the authors upon reasonable request.

Declarations

Conflict of interest R.M. Kwee, M.T. Almaghrabi and T.C. Kwee declare that they have no competing interests.

Ethical standards All procedures performed in studies involving human participants or on human tissue were in accordance with the ethical standards of the institutional review board of University Medical Center Groningen and with the 1975 Helsinki declaration and its later amendments or comparable ethical standards.

Consent The survey was conducted online using Qualtrics. All responses were anonymised. The participants were made aware that the survey was being conducted for research purposes.

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