Retracted Publications in the Biomedical Literature from 2012-2018: An Overview

Tao Wang (✉ 591698226@qq.com)

Department of Emergency and Intensive Care Unit, Hainan Hospital of Chinese PLA General Hospital, Sanya, Hainan 572013, China

Qin-Rui Xing

Department of Emergency and Intensive Care Unit, Hainan Hospital of Chinese PLA General Hospital, Sanya, Hainan 572013, China

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Abstract

Background: The number of retracted publications in biomedical literature has increased dramatically in recent years. Many of these retractions are due to a faked review process and a large percentage of the retractions come from Chinese authors. The purpose of the current study was to determine the characteristics of retracted articles from 2012 to 2018 using the Medline database.

Methods: The Medline database was searched to identify retracted publications from the year 2012 through 2017. Reasons for retraction were collected through PubMed, the Google search engine, and journal websites. Relevant data was collected for each retracted article and included the time from publication to retraction, the study type, the journal impact factor, and the institute of origin. Trends in characteristics related to retraction were determined.

Results: Data from 4,043 retracted studies were included in the analysis. The most common reasons for retraction were fraud/suspected fraud (993), error (911), plagiarism (554), duplicate publication (547), and invalid peer review (384). The largest number of retracted articles was from China. Other countries with a large number of retractions were USA, Japan, India, Iran, Korea, Germany, and Italy. A faked review process, was responsible for a large number of retractions from China and Iran and from several journals.

Conclusions: Misconduct, including fraud/suspected fraud, duplicate publication, and plagiarism, was the major cause for publication retraction. A faked review process caused the largest number of retractions in some countries. China has become the top country of origin for retracted publications.

Introduction

Publication retraction, a method of self-correction to maintain integrity, has recently caught world-wide attention (Wager, et al. 2009). The number of retracted publications has increased dramatically in the past several years. Before 2012, there were approximately 2,000 retracted articles in the PubMed database (Fang et al. 2012). However, there are now over 5,600 retractions listed in PubMed. Several reasons have been proposed to explain this increase. First, awareness of misconduct has increased. For example, Retraction Watch (a blog that reports on retractions of scientific papers), which was launched in 2010 (Oransky 2013) and *PubPeer*, (a website that allows for post-publication peer review), which was founded in 2012, have attracted the attention of many academics and has led to the retraction of several articles (Ferguson 2015). Second, the development of specific detection systems and guidelines concerning misconduct allegations has prompted exposure of flawed articles. Tools for detecting plagiarism, duplicate publications and image manipulation have been established (Hiltner 2018; Oransky 2012a). Third, the absolute number of publications has increased dramatically. While, the USA remains the leader in scientific publications, the number of publications from Chinese authors has greatly increased in the last several years and is approaching the level of the USA (Cheng and Ren 2016; Karen et al. 2017). Other small countries, such as Iran, are also producing more papers than previously (Karen et al. 2017). In recent years, mega-journals such as *Plos One*, *Scientific Reports*, and *Medicine*, which publish more articles than traditional journals have become more prevalent, and these journals accept articles based on technical merit, rather than perceived importance (Björk 2015).

Error was the leading cause of retracted publications from 1988 to 2008, accounting for 28% of all retractions (Wager and Williams 2011). However, fraud/suspected fraud was responsible for 43.4% of retractions in Medline prior to 2012 (Fang et al. 2012). Of all retracted articles in the biomedical, medical and clinical sciences reported by Retraction Watch between 2013 and 2015, 47% were due to misconduct (including fabrication/falsification, image manipulation, and faked data/results) (Ribeiro and Vasconcelos 2018). In the last several years, a new form of misconduct, faked review process, has led to lots of retractions from publishers such as SAGE, Springer, BioMed Central, Elsevier, Informa, and LWW (Qi et al. 2016; Wang et al. 2018). There were 107 articles retracted from the journal *Tumor Biology* in one day due to a compromised review process (McCook 2017a). Countries such as the USA, Germany, and Japan produce the largest number of retractions due to fraud/suspected fraud, while plagiarism and duplicate publications are the leading causes for retractions from China and India (Fang et al. 2012). In recent years, the number of retracted publications from China has increased (Ribeiro and Vasconcelos 2018; Chen et al. 2018). There were 825 retracted publications listed in PubMed prior to May of 2017 from Chinese authors (Chen et al. 2018). Cited reasons for these retractions include plagiarism, errors, duplicate publication, faked peer review process, authorship disputes, and fraud/suspected fraud (Chen et al. 2018). Chinese authors contribute approximately one third of the retracted articles published in open access journals (Wang et al. 2018). Notably, some authors have retracted many articles. For example, the Japanese author, Yoshitaka Fujii, has retracted almost 200 publications since 2012 (Amarcus 2012), the Korean author, Hyung-In Moon has retracted approximately 30 publications due to compromised review processes (Oransky 2012b), and Joachim Boldt from Germany who had 88 articles retracted in 2011 still had at least seven retractions after 2012 (Palus 2015).

The current paper presents a comprehensive analysis of the characteristics of retracted publications in the biomedical literature from 2012 to 2018.

Methods

On January 18, 2018, the Medline database, accessed through the Web of Science, was searched for retracted publications from 2012 to 2018. The search terms were publication year (1950–2018) and "RETRACTED PUBLICATION". Retraction notices were also searched through publication year (2012–2018) and "RETRACTION OF PUBLICATION". The results were merged and saved to an Excel (Microsoft Corporation, Redmond, WA, USA) spreadsheet. Redundant articles were excluded by checking information from each individual article. Only publications retracted after 2012 were included, without limitation of publication year. The study flow chart is shown in Figure 1.

Information on the article's authors and institutions, country of origin, first author, journal name, year of publication, and year of retraction was collected. The time interval between publication and retraction was calculated according to the date on which each article was first available. The PubMed database, journal websites, and Google were used to search for retraction notices and reasons for retraction. Two authors independently analyzed retraction notices. Discrepancies were resolved through discussion. Cause of retraction was classified as fraud/suspected fraud, error, plagiarism, duplicate publication, authorship dispute, faked peer review process, unknown, and others (10). The number of citations of retracted publications was gathered from the Web of Science. Journal impact factors were based on the 2015 edition of Journal Citation Reports Science Edition. Journals without an impact factor were assigned a value of 0.

Data analyses were conducted using SPSS 18 software. Data are presented as mean $\pm$ standard deviation (SD), number, and percentage. Chi-square tests were used to compare categorical variables. Differences in parametric data between two groups was calculated using Student's *t* tests. Spearman's rank correlation tests were performed to evaluate the association between groups. Statistical significance was set at $p < 0.05$.

Results

As shown in Figure 1, most retracted articles could be detected by searching "Retracted Publication" or "Retraction of Publication" in Medline. However, there were 102 (2.5%) retracted articles without a corresponding retraction notice and 13.8% of retractions were found only through searching "Retraction of Publication" (Figure 1). There were 4,043 retracted papers listed on Medline included in this study, with a one-year maximum of 804 in 2016 (Figure 2).

Causes

There were 4,203 causes for retractions listed, with the most common reasons being fraud/suspected fraud, errors, plagiarism, duplicate publication, and a faked review process (Figure 2). The causes of 354 retracted publications were unclear. Causes for retractions varied over years (Figure 2) and a faked review process caused the largest number of retractions since 2015. The interval between publication and retraction was longer when retraction was due to fraud/suspected fraud and error than other causes (Table 1).

Country of Origin

China ($n = 1,010$), the USA ($n = 849$), Japan ($n = 350$), India ($n = 269$), Iran ($n = 154$), Korea ($n = 139$), Germany ($n = 123$), the UK (121), and Italy ($n = 118$) contributed the most retractions. Retractions from China have been dramatically increasing over the last several years and have surpassed the number of retractions from the USA since 2015 (Figure 3). Reasons for retraction varied by country of origin ($p < 0.001$) (Figure 5). Error and fraud/suspected fraud were the main causes for retraction in the USA, Japan, Canada, and Spain, while a faked review process was the main reason for retraction in China, Iran and Korea. Duplicate publication and plagiarism were responsible for many retractions from China, Iran, Korea, India, and Italy (Figure 5).

Journals

Most retracted articles were published in journals listed in the Science Citation Index (SCI; $n = 3,503$) and had an average impact factor of 3.98 (SD = 5.55). Impact factor was significantly correlated with the interval between publication and retraction ($\rho = 0.248$, $p < 0.001$) and with the number of retracted publications due to errors ($\rho = 0.235$, $p < 0.001$) and fraud/suspected fraud ($\rho = 0.211$, $p < 0.001$). Journals with more than 15 retracted articles are listed in Table 2. A large number of retractions from some journals were due to different causes as shown in Table 3. In the USA, Japan, and Canada, many retractions were from journals with a high impact factor; while retractions from China, India and Iran were mostly from journals with an impact factor less than 5 (Figure 6). Most retraced articles published in *Tumour Biology* were from Chinese ($n = 127$) and Iranian ($n = 15$) authors. The USA had more retractions from popular journals such as *Nature* ($n = 10$), *Science* ($n = 9$), and *Cell* ($n = 8$).

Authors with Many Retractions

Some authors had multiple retractions. Fujii Yoshitaka ($n = 148$) and Kato Shigeaki ($n = 32$) from Japan, and Staple Diederik ($n = 28$) from the Netherlands, were responsible for many retracted publications due to fraud. Moon Hyung-In from Korea was responsible for 28 retracted articles due to a faked review process. Some retracted articles were cited numerous times (Table 4). Fraud/suspected fraud were the leading reasons for the most cited retractions.

Discussion

The current study explored the characteristics of retracted articles between 2012 and 2017. Incidences of misconduct, including fraud/suspected fraud, duplicate publication, plagiarism, and a faked review process, were the most frequent causes of retracted publications. A faked review process was found to be the most frequent cause for retraction in some countries and in several journals. In some cases, the interval between publication and retraction was lengthy, and as such, these articles have been widely cited. China has become the leader in the number of retracted publications.

Misconduct was the most frequent cause for retraction, with fraud/suspected fraud as the leading cause. These results are like those from previous studies. Fang et al. (2012) found that 67.4% of retractions in PubMed prior to 2012 were attributed to misconduct, including fraud/suspected fraud (43.4%), duplicate publication (14.2%), and plagiarism (9.8%). Another study investigating retracted publications between 2013 and 2015, found that 63% of all retractions were from biomedical, medicine or clinical science literature and that 47% of retracted articles were due to misconduct (Ribeiro and

Vasconcelos.2018). Error and fraud/suspected fraud were the most frequent reasons for retraction in the USA, Japan, Germany, the UK, and Canada, while plagiarism and duplicate publications were the leading causes for retraction in China, India, and Italy. In addition, the largest number of retractions due to a faked review process came from China, Iran and Korea. The difference in retraction characteristics between countries has been previously reported (Fang et al. 2012; Stretton et al. 2012). For example, it has been suggested that non-English-speaking countries that are relatively new to research and have a low average income, retract more articles due to plagiarism and duplication, while developed countries, with a history of longstanding research, retract more articles due to fraud/suspected fraud (Fang et al. 2012; Stretton et al. 2012).

The current study found that a journal's impact factor was significantly correlated with the number of retracted publications due to errors and fraud/suspected fraud. Moreover, the length of time from publication to retraction was longer when retraction was due to fraud/suspected fraud and when the article was published in a journal with a high impactor, ultimately leading to more citations. These results are consistent with previous studies (Fang et al. 2012.; Wang et al. 2018).

A faked review process led to 9.1% of all retractions. In these cases, authors fabricated a suggested reviewer email address and reviewed their own papers for rapid acceptance (Rees 2015; Hvistendahl 2015). Since 2012, many retractions due to a fabricated peer review have come from authors in China, Iran and Korea (Chen et al. 2018; Wang et al. 2018; Qi et al. 2016). Hyung-in Moon, a South Korean researcher, had 28 articles retracted due to a faked review process in 2012 (Oransky 2012b). Since 2014, Chinese and Iranian authors have contributed a large number of retractions due to a faked review process (Chen et al. 2018; Wang et al. 2018; Qi et al. 2016). It has been argued that in addition to the authors and the editing companies, editors should be held partially responsible for these cases of misconduct (Rees 2015; Hvistendahl 2015; Hindawi Publishing 2015). In recent years, researchers have been overwhelmed by requests to review articles and therefore, it is difficult for journal editors to find qualified reviewers. One recent survey revealed that 52.9% of editors list finding reviewers as the hardest part of their job (Wellington 2018; Goldman 2017). Some editors have reported sending 15 or more requests in order to secure two or more reviewers (Wellington 2018; Goldman 2017).

Tumor Biology has retracted the largest number of articles due to a faked review process, while *Genetics and Molecular Research* has retracted 20 articles due to plagiarism from Chinese authors alone. The current study found that *The Journal of Biological Chemistry* had the largest number of retractions, most of which were due to fraud/suspected fraud. The journal did not provide a reason for many retracted articles. These journals are suffering due to the large number of retractions. For example, Clarivate Analytics will no longer take articles from *Tumor Biology* or *Genetics and Molecular Research* (McCook 2017c). Journals and publishers have recently taken measures to avoid misconduct. For example, some journals will no longer accept author-suggested reviewers (McCook 2018) and new tools have been developed to aid in the selection of reviewers (McCook 2017b; Dadkhah. 2017).

It is not surprising that China has recently surpassed the USA in the number of retracted publications, as Chinese authors now produce the largest number of scientific publications (Tollefson 2018). In addition, there is a great amount of "publish or perish" pressure in China in recent years. Chinese researchers must publish articles in SCI journals to meet graduation requirements, achieve promotions, win awards, and gain funding support (Chen et al. 2014; Jiang et al. 2016; He and Xia 2014; Liao et al. 2015). These incentives have greatly increased scientific misconduct. In addition, the punishment for these misconducts from the Chinese government and institutions is mild (Liao et al. 2015). Retractions from Chinese authors (also from Indian, Iranian and Korean authors) were more often published in journals with a low impact factor compared to authors from the USA, Japan, Germany, and Canada. This may partly be explained by the finding that only a small percentage of articles published in high-quality journals are from these developing countries (Chawla 2018). Iran has dramatically increased the production of scientific articles in the last decade (Chawla 2018) and the current study found that Iranian authors contributed 123 retracted articles, and that most of these retractions were due to peer review fraud.

Consistent with previous studies, the current study found that fraudulent articles can go undetected for many years. An extreme case of this is portrayed by the Japanese anesthesiologist, Yoshitaka Fujii who produced 144 articles that took more than 12 years to be retracted. Fujii's work, most of which were clinical trials, had enrolled patients and co-worked by other authors (Amarcus41 2012; Amarcus41 2013, 24). However, no one pointed out these misconducts in the long periods. Journals or publishers may be reluctant to retract flawed papers. For example, it took four years for *the British Journal of Ophthalmology* to withdraw one of Fujii's articles which had been flagged since 2012 (McCook 2016a). Fraudulent articles published in high impact journals are frequently cited prior to retraction. In these cases, the impact of the fraudulent data can be extensive. For example, Joachim Boldt had published numerous papers claiming the benefits of hydroxyethyl starch for fluid resuscitation (Zarychanski et al. 2013). However, further studies have shown controversial effects of hydroxyethyl starch, some reporting increased mortality and risk of kidney failure (Zarychanski et al. 2013). Recently, it has been reported that hydroxyethyl starch may be taken off the European market (Cohen 2018).

While the current paper reports important data on the characteristics of retracted publications, there are some limitations. First, causes for retractions were determined according to retraction notices. Some journals did not provide details of reasons for retractions. In addition, some notices of retractions were called "unhelpful retraction notices", which might be misleading (Oransky 2015). Second, the Medline database was used for our search of retracted publications, and a previous study (Schmidt 2018) has shown that some retractions may not be well-labelled in the database. Third, fraudulent papers were in publication for many years and as such, some retractions may have been overlooked.

A variety of forms of misconduct were responsible for most retracted articles in the biomedical literature in the past six years. It had been argued that reforming scientific incentive programs may be an effective method to reduce the occurrence of misconduct (Casadevall et al. 2012; Liao et al. 2017). The Chinese government has recently taken measures to prevent misconduct. For example, in 2015, ghostwriting, ghost submissions, ghost revisions, a faked peer review, and false authorship activities were banned by the Chinese government (McCook 2016b). In addition, researchers, journals and

publishers have also implemented systems to prevent misconduct. A research team at Harvard has been developing software to identify misused or manipulated images (Hiltner 2018), journal editors use software such as *iThenticate* to detect plagiarism (Oransky 2012a), and Clarivate Analytics, a preeminent citation database, utilizes the *Publons* tracking system for peer reviewers to combat the problem of faked reviews (McCook 2017b). Other measures, such as rewarding reviewers, peer review training, and a higher level of reviewer vetting (Wellington 2018; Goldman 2017) may help to prevent future peer review fraud.

Conclusion

In this study, we found misconducts were still major causes of retracted publications from 2012 to 2018. China had become the country with most retracted publications. Scientific staff and government should take measures to eliminate the misconducts. It was very important to use appropriate ways to evaluate researcher's work.

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Tables

Table 1. Journal impact factor (IF) and time-to-retraction expressed in months by reason for retraction.

Cause for retraction ^a	Number	IF (SD)	Time-to-retraction (SD)
Authorship Issues	249	2.38 (3.01) *	16.9 (28.5) *
Duplicate Publication	547	2.94 (2.95) *	36.4 (42.8) **
Error	911	5.78 (8.27) *	28.1 (34.5) *
Faked Review	384	2.40 (1.15) *	22.5 (12.6) *
Fraud/Suspected Fraud	993	5.50 (6.04) *	81.0 (59.7) *
Plagiarism	554	2.23 (2.51) *	26.5 (29.1) *
Unknown	354	2.62 (2.71) *	35.6 (43.7) ***
Others	211	3.74 (4.76)	30.4 (38.6) **
Total	4,203	3.98 (5.55)	42.2 (48.4)

*<0.001; **<0.01; ***<0.05
^a Some retractions were due to multiple causes.

Table 2. Journals with the greatest number of retracted articles.

Journal	Impact Factor	Number
<i>The Journal of Biological Chemistry</i>	4.258	170
<i>Tumour Biology</i>	2.926	146
<i>Plos One</i>	3.057	73
<i>Canadian Journal of Anaesthesia</i>	2.139	34
<i>Diagnostic Pathology</i>	1.895	34
<i>PNAS USA*</i>	9.423	33
<i>Molecular Biology Reports</i>	1.698	32
<i>Journal of Pain and Symptom Management</i>	2.649	28
<i>Obstetrics and Gynecology</i>	5.656	27
<i>Anesthesia and Analgesia</i>	3.827	25
<i>Nature</i>	38.138	23
<i>Biochemical and Biophysical Research Communications</i>	2.371	22
<i>Genetics and Molecular Research</i>	0.764	22
<i>Immunopharmacology And Immunotoxicology</i>	1.617	21
<i>Acta Crystallographica. Section E, Structure Reports Online</i>	-	19
<i>European Journal of Medical Research</i>	1.684	19
<i>The Journal of Neuroscience</i>	5.924	19
<i>Brain & Development</i>	1.785	19
<i>Science</i>	34.661	18
<i>The Scientific World Journal</i>	-	18
<i>Diabetes</i>	8.784	17
<i>European Journal of Anaesthesiology</i>	3.634	17
<i>International Journal of Clinical and Experimental Medicine</i>	1.075	17
<i>Journal of The Renin-Angiotensin-Aldosterone System</i>	2.35	17
<i>Biomed Research International</i>	2.134	16
<i>Journal of Cell Science</i>	4.706	16
<i>Journal of Immunology</i>	4.985	16
<i>Journal of Personality and Social Psychology</i>	4.736	16
<i>Journal of The American Chemical Society</i>	13.038	16
<i>Molecular Neurobiology</i>	5.397	16
<i>The Journal of Clinical Investigation</i>	12.575	16
<i>Clinical Cancer Research</i>	8.738	15

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Table 3. Journals with the highest numbers of retracted articles by cause for retraction.

Cause	Journal	Impact Factor	Number
Error	Plos One	3.057	27
	PNAS USA*	9.423	18
	Brain & Development	1.785	18
	Nature	38.138	15
	Journal of Pain and Symptom Management	2.649	27
Other	Obstetrics and Gynecology	5.656	24
	Tumour Biology	2.926	138
Faked Review Process	Diagnostic Pathology	1.895	30
	Molecular Biology Reports	1.698	30
	Immunopharmacology and Immunotoxicology	1.617	20
	European Journal of Medical Research	1.684	17
	Journal of The Renin-Angiotensin-Aldosterone System	2.35	15
	Molecular Neurobiology	5.397	15
	The Journal of Biological Chemistry	4.258	98
Fraud/suspected fraud	Canadian Journal of Anaesthesia	2.139	34
	Plos One	3.057	27
	Anesthesia and Analgesia	3.827	24
	Acta Crystallographica. Section E, Structure Reports Online	-	18
	Genetics and Molecular Research	0.764	20
Plagiarism	The Journal of Biological Chemistry	4.258	54
Unclear			

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Table 4. Most cited retracted articles.

PMID	First Author	Journal	Year Published	Year Retracted	Cause for Retraction	Impact Factor	Times Cited
12609035	Vineet	The Plant journal	2003	2015	fraud	5.468	1,106
9822616	Brigneti	The EMBO journal	1998	2015	fraud	9.643	881
15222900	Jobb	BMC evolutionary biology	2004	2015	error	3.406	843
19524507	Valastyan	Cell	2009	2015	fraud	28.71	640
12176951	Rioufol	Circulation	2002	2012	duplicate	17.202	503
16609730	Urisman	PLoS pathogens	2006	2012	error	7.003	462
19918075	Wenz	PNAS USA*	2009	2016	fraud	9.423	406
1359211	Chandra	Lancet	1992	2016	fraud	44.002	405
12480817	Ushio	Circulation research	2002	2014	fraud	11.551	403
16611728	Ryan	PNAS USA*	2006	2017	fraud	9.423	373

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Figures

Figure 1

Study selection flow diagram.

Figure 2

The number of retractions in Medline by year from 2012 to 2017.

Figure 3

The number of retractions in Medline due to different causes by year.

Figure 4

The number of retractions in Medline from different countries by year.

Figure 5

The proportion of retractions due to different causes by country of origin. Reasons for retraction significantly differed across country of origin ($p < 0.001$).

Figure 6

The proportion of retractions by journal impact factor by country of origin. Impact factor significantly differed across country of origin ($p < 0.001$).