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Continued Use of Retracted Publications: Implications for Information Systems and Scientific Publishing

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Abstract. Reports on the preliminary results of an empirical study of post-retraction citations of biomedical research literature. Retractions of biomedical publications have a serious impact on research enterprise and public health. Retractions to correct literature and alert readers are actions by the journals based on evidence of serious flaws or errors or upon the request of the authors. The process of retraction could take a few weeks or years after publication. The purpose of this study is to investigate how retracted peer-reviewed journal articles were cited post-retraction. Post-retraction citing articles are those published two years after the retraction year. The dataset includes 961 post-retraction citing articles that cited one or more of 77 retracted articles. The 77 retracted articles were also recommended by experts in a literature recommendation database (Faculty Opinions). The findings show that a higher percentage of the continued use of the retracted articles made no mention of the retraction or invalid results in these articles. Retracted articles and their retraction notices need to be open access; entities involved in publishing and providing literature resources must practice diligence in ensuring the validity of scientific literature.

Keywords: Biomedical research literature, Expert recommendation, Retraction impact, Citation behavior, Scientific publishing.

1 Introduction

Scientific and engineering (S&E) literature grew nearly 4% per year from 2008 to 2018; publications in biomedical and health care fields counted for 36% of the world 2,555,959 S&E publications [1]. However, retractions of journal articles due to research misconduct or serious errors also grew in these fields. For example, retractions of publication in neurology increased from 16.9% in 2010 to 56% for 2016-2020 [2]. The impact of retractions goes beyond the article itself being labeled. The continued use of the retracted publications as if they were valid not only change the results of meta-analyses articles but also mislead researchers who follow these retracted articles. [3] More seriously, medical professionals who use these invalid results may endanger their patients. [4] The lack of effective methods in preventing retracted invalid publi-

cations from use has been pointed out more than 20 years ago: "Methods currently in place to remove invalid literature from use appear to be grossly inadequate." (p. 1423) [5] Although since 2009, the COPE Retraction guidelines (https://publicationethics.org/), has provided advice on how to handle retractions, journals retract invalid articles differently. This study aims to shed light on how the retracted articles were cited after retractions:

1. Did the post-retraction citing articles acknowledge the retraction?
2. Did the post-retraction citing articles identify flaws or invalid results?
3. How did the post-retraction citing articles cite the retracted articles? In other words, did the authors make a cursory citing or a substantial referencing?
4. What are the characteristics of post-retraction citing articles?

2 Methods and Dataset

Faculty Opinions is a literature recommendation database to help scientists find important publications recommended by experts (faculty members or FMs) in biology and medicine (https://facultyopinions.com/). Currently, there are 188,732 journal articles recommended by one FM to as many as 22 FMs. Wang and Su [6] investigated 232 recommended articles that were stamped with an editorial note of retraction or correction. Journals retracted or corrected these articles because of serious errors, fraud, unreliable or unreproducible results. They found that the number of post-retraction citations counted for 17% of the total citations; out of 487 post-retraction citations to five highly cited articles, only 12 acknowledged the article's retraction.

For this study, we searched Faculty Opinions and found 237 recommended articles with an editorial note of being retracted. These articles were published between 2001 and 2021. To focus on citations made to the articles after they were retracted, we define post-retraction citations as two years after the retraction year. To allow at least a 5-year citation window, the final dataset includes 77 recommended articles that were retracted in 2013 or before.

Web of Science was searched for citing articles published two years after the article's retraction. To access the full text of the citing article to examine if the retraction was acknowledged and how the article was cited, the search results were limited to the research and review articles (either open access or accessible to us).

The final dataset for this poster paper includes 961 post-retraction citing articles that are accessible as OA articles or through PubMed PMID. These articles cited 77 retracted articles published in 38 journals, of which 11 journals had two or more retracted articles (Table 1) The 27 journals with one retracted article include *British Journal of Anaesthesia*; *British Journal of Ophthalmology*; *Cancer Cell*; *Chest*; *Clinical Cancer Research*; *Cognition*; *Developmental Cell*; *Diabetes*; *European Journal of Anaesthesiology*; *European Journal of Immunology*; *Gut*; *Hepatology; Intensive Care Medicine*; *Jama-Journal of the American Medical Association; Journal of Experimental Medicine*; *Journal of Immunology*; *Lancet*; *Molecular and Cellular Biology*; *Molecular Cell*; *Molecular Endocrinology*; *Nature Chemical Biology*; *Nature Immu-*

nology; *Nature Methods*; *New England Journal of Medicine*; *Plant Physiology*; *PLOS ONE*; *PLoS Pathogens*.

Table 1. Journals had two or more retracted articles.

Journal	Total	Retracted Dates
Nature	10	03/06/2008 – 11/07/2013
Science	9	01/23/2004 – 10/11/2013
Cell	8	07/09/2010 – 02/14/2013
Proceedings of the National Academy	4	02/16/2010 – 08/21/2012
Anesthesia and Analgesia	3	08/01/2010 – 05/01/2011
Blood	3	03/05/2009 – 02/16/2012
Journal of Biological Chemistry	3	01/04/2008 – 01/11/2013
Journal of Neuroscience	3	06/22/2011 – 12/11/2013
Nature Medicine	3	01/07/2011 – 12/05/2013
Immunity	2	05/16/2008 – 05/25/2012
Journal of Cell Biology	2	02/04/2013 – 10/28/2013

3 Results

3.1 Acknowledging Retraction

Of the 961 post-retraction citing articles, only 90 (9.37%) clearly mentioned retraction, 829 (86.26%) cited without mentioning retraction or flaws, 23 (2.39%) debunked the article without mentioning retraction, 13 (1.35%) noted retraction in references, and 6 (0.61%) expressed concerns or commented vaguely about retraction or cited the retraction notice.

3.2 Identifying Flaws or Invalid Results

Very few articles identified issues about or expressed concerns with the retracted articles. When such discussion was made, the texts tended to leave out the words "retracted" or "retraction." For example, the citing papers noted:
"..... remains controversial ....."
"Controversial studies by [citing the retracted article] ....."
"..... contamination ....."
"..... was not substantiated ....."
"..... proved wrong ....."
"..... the role of [citing the retracted paper] was not substantiated ....."
"..... earlier studies [citing the retracted paper(s)] showed ....., however later studies show ....." [making the contrast to indicate the results have been invalidated]

Without explicitly mentioning "retraction," post-retraction citing authors may use "disproved", "incorrect conclusion," to debunk the issues. They may also cite the retraction notice or the follow-up paper that addressed the retracted paper by the retraction author(s).

3.3 Post-retraction Citing (Cursory vs. Substantial)

Of the 961 citing articles, 79.19% (761) cited a retracted article only once; 14.88% (143) cited a retracted article twice; 3.43% (33) cited a retracted article three times; 2.39% (23) cited a retracted article between 4 and 6 times; only one article cited 13 times. Further analysis focused on where and how these retracted articles were cited (Table 2).

Table 2. Where and how the retracted articles were cited.

Where & How		**Frequency**	**Percentage**
Section	Introduction	246	25.60%
	Body	659	68.57%
	Introduction & Body	50	5.20%
	Conclusion	5	0.52%
	Supplement	1	0.10%
Cited once individually	Introduction	71	21.26%
	Body	263	78.74%
Cited more than once in the paper (not co-cited)	Introduction	14	10.22%
	Body	92	67.15%
	Both	31	22.63%

In co-citing including the retracted article, we found that co-citing two articles counted 294 times; three and four articles counted 252 times; five, six, and seven articles counted 104 times; eight and more counted 48 times. The most co-cited cases including 93 articles using the $^{n1\text{-}n2}$ in-text reference style. The sections of these co-citing are mostly in the body of the articles (Table 3).

Table 3**.** Retracted articles co-cited.

Co-cited with	Introduction	Body	Conclusion	Introduction & Body
1 article	56	146	2	14
2 or 3 articles	65	134	1	14
4, 5, or 6 articles	34	50		8
7 and more articles	8	8		5

3.4 Characteristics of Citing Articles

Of the 77 retracted articles, the articles that received the most post-retraction citations are listed in Table 4.

Table 4. The retracted articles' post-retraction citing (top cited).

Article (Date retracted)	Cited times	Citing Years
10.1016/S0140-6736(11)61590-0, *Lancet* (4/12/2014)	272	2016 – 2021
10.1056/*NEJM*oa1103944 (10/31/2913)	38	2015 – 2021
10.1073/pnas.0901206106, *Proceedings of National Academy of Science* (8/21/2012)	37	2014 – 2021
10.1371/journal.ppat.0020025, *PLOS Pathogens* (9/18/2012)	33	2014 – 2020
10.1126/*science*.1188635 (7/26/2013)	23	2015 – 2021
10.1126/*science*.1173438 (10/11/2013)	*23*	2015 – 2020
10.1038/nm.2209, *Nature Medicine* (7/7/2011)	*20*	2013 -2021
10.1038/nature08456, *Nature* (6/14/2012)	*19*	2014 -2020
10.1038/nature03356, *Nature* (3/3/2011)	*19*	2013 -2021
10.1038/nm.2077, *Nature Medicine* (12/5/2013)	*18*	2015 -2021

Of special interest in Table 4 is the Top-1 *Lancet* (4/12/2014) article that was published on 11/14/2011, followed by a notice of "Expression of Concern" on 4/12/2014, and officially retracted on 3/16/2019. Fig. 1 shows how this article was cited after the "Expression of Concern" and then retraction.

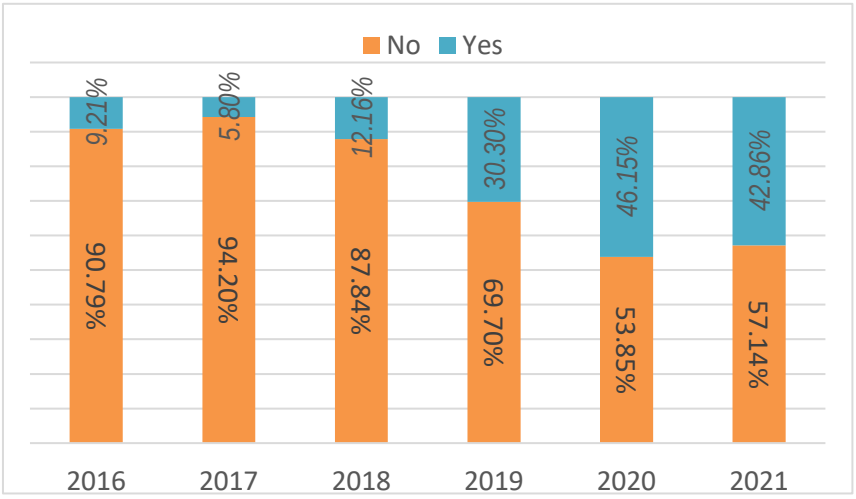

Fig. 1. Mentioning retraction or reasons of retraction by 272 post-retraction citing articles of the *Lancet* article (Table 4: doi: 10.1016/S0140-6736(11)61590-0)

The 961 found post-retraction citing articles were published in 520 journals. The 90 articles that acknowledged the retraction of the cited articles were published between two and 14 years after the articles' retractions in 69 journals. The remaining 829 post-retraction citing articles that cited without acknowledging the retraction were published in 456 journals. The 23 citing articles debunked the retracted articles were published in 23 journals. The 13 articles with references noted retraction were published in 13 journals.

The number of authors of the citing articles are plotted in Fig. 2. This is a long tail distribution. The number of co-authors might not affect if the distribution if the retraction status was acknowledged by the post-retraction citing papers.

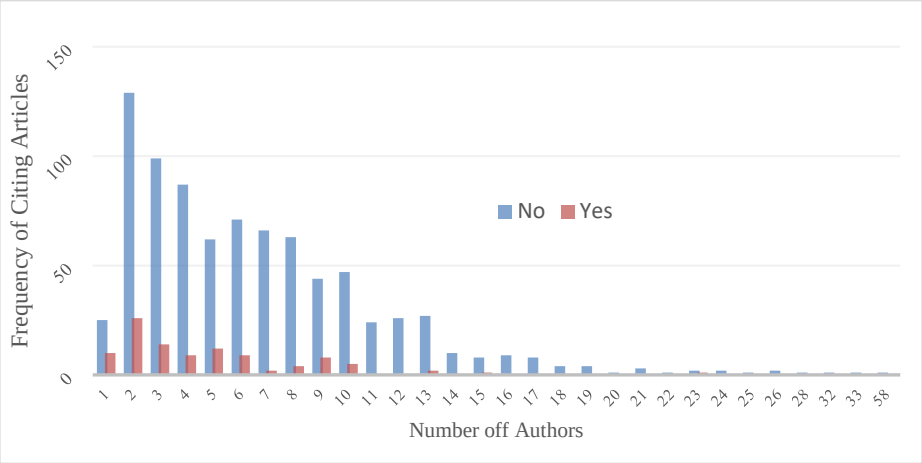

Fig. 2. Number of authors in post-retraction citing articles that retraction status was mentioned (Yes or No)

The top ten journals that published the articles that cited the retracted articles with or without acknowledging the retraction are in Table 5 as two lists. There are five journals (marked with *) that made both lists. The efforts of authors, reviewers, and editors might have contributed to flagging the invalid literature during the publishing process.

4 Discussion

This study collected data from citing articles retrieved from Web of Science to investigate if the post-retraction citing articles cited or referenced the retracted articles appropriately. It is a serious problem that this invalid literature continues to influence scientific research and medical practices. Some retractions took a very long time. The notice of concerns or retractions tend to be missed by citing authors. The data show that the percentage of citing articles that do not mention the issues of the retracted articles after their retractions is still high; these articles are published in a wide range

of journals. The post-retraction citing articles of the *Lancet* article that do not mention the issues is still more than 50% (Table 4 and Fig. 1).

When authors made implicit mentioning of retraction or debunked, it is possible that researchers are sensitive about using the word "retraction." In a few cases, retracted articles were removed from the references but remained in the citing texts.

Cursory citing is reflected in co-citing without substantiating individual articles. We found some passing notes co-listed more than 20 articles, and as many as 84 and 93 articles using n1-n2 referencing style in one sentence. Another finding was that authors aggregated references as one entry. For example, the article (doi:10.1002/adfm.201705134) has listed under the citation numbered 8 three different papers by different authors in different years, one of which was a retracted article, but no mentioning of the retraction. This article has many aggregated reference entries, one of which grouped four different papers. It is unclear how citation indexing databases treat these grouped articles. Bibliographic databases such as Web of Science and PubMed tagged some of the retracted papers, other databases such as researchgate.com and GoogleScholar either do not tag the retracted articles or have multiple entries of the same article harvested from different sources, relying on the sources' tagging, thus some retrieved entries of the same retracted article do not have retraction flagged.

5 Conclusions

A high percentage of the post-retraction citating articles published in a wide range of journals failed to mention the retraction or the issues/reasons for retraction. It is a serious problem that the invalid literature continues to be used as valid scientific results in research or medical practices. Although retracted articles need to remain accessible after retraction, effective measures must be developed to avoid the further use of invalid results. All related entities need to practice diligence. Journal publishers should make retracted articles and retraction notice open access, which is not the case for many none-OA journals. The authors must recheck what they have cited before finalizing the paper for publishing. How to cite retracted articles appropriately should be addressed in reference styles manuals. Information literacy education needs to teach users how to identify retracted literature. Journals need to implement automatic reference checking to notify authors and reviewers on retracted articles being used in the manuscripts under consideration. Databases need to update entries to ensure retracted articles are indexed and searchable. Literature recommendation systems should provide personalized service beyond suggesting publications and flagging retracted articles because it is possible to alert the users about the retraction of the articles they have accessed or downloaded. Reporting guidelines [7] can help avoid certain errors to ensure research results are replicable. For information literacy training, issues related to retractions of scientific publications should be addressed.

Table 5. Journals published post-retraction citing articles (Top 10)

Journal	Articles
Retraction Not Mentioned	
PLOS ONE[*]	39
Circulation Research	33
Scientific Reports[*]	31
International Journal of Molecular Sciences[*]	17
Frontiers in Immunology	16
Oncotarget	16
Stem Cells International[*]	15
Journal of Cellular and Molecular Medicine[*]	9
Stem Cell Research & Therapy	9
Stem Cells Translational Medicine	9
Retraction Cited or in Reference; OR Debunked	
Cochrane Database of Systematic Reviews	5
PLOS ONE[*]	4
Emerging Microbes & Infections	3
International Journal of Molecular Sciences[*]	3
Journal of Translational Medicine	3
Clinical Microbiology Reviews	2
Frontiers in Cardiovascular Medicine	2
Journal of Cellular and Molecular Medicine[*]	2
Scientific Reports[*]	2
Stem Cells International[*]	2

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