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How Do Open and Closed Access Journals Compare in Citations, Altmetrics, and Social Media Engagement for Pesticide Research?

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ABSTRACT

This study analyzes the roles of altmetric and citation scores in open and closed-access pesticide research journals from 2013 to 2023, revealing key insights into impact metrics across publishing models. Traditional citations predominantly favor subscription-based journals, which account for 68.03% of the total citations. In contrast, green open-access journals excel in altmetric scores, primarily driven by social media engagement on platforms such as Mendeley, Twitter, and Facebook. Green open-access documents record the highest cumulative citations (13,143) and altmetric scores (5,768), suggesting greater online visibility and broader social reach. Statistical analysis shows no significant difference between altmetrics and citations, indicating that both metrics contribute complementary perspectives on research impact. Descriptive statistics highlight variations in citation patterns, with open-access journals showing a more concentrated distribution. Toxicology journals, where much pesticide research is published, are predominantly closed access, though citation patterns and altmetric attention vary by journal. Leading journals such as *Ecotoxicology and Environmental Safety* emphasize citations, while *Food and Chemical Toxicology* focuses on altmetrics, underscoring the dual approach to research visibility and impact in pesticide studies. These findings emphasize the evolving role of altmetrics in complementing traditional citations, especially for studies with high public and social relevance.

Keywords: pesticide exposure, toxicology, open access, closed access, subscription, altimetric score

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1. INTRODUCTION

The term *pesticide* encompasses various compounds, including insecticides, fungicides, herbicides, rodenticides, molluscicides, nematicides, plant growth regulators, and various other pesticides (Aktar et al., 2009). Pesticides play a crucial role in advancing agricultural development, but their application can lead to both immediate and prolonged human health risks, as well as significant environmental challenges (Tudi et al., 2022). Therefore, it is essential to research pesticide application methods, exposure pathways, and their impacts on health and the environment. Merely engaging in research is insufficient to mitigate pesticide exposure; effective communication and dissemination strategies are also imperative. Researchers increasingly use blogs, wikis, Twitter, Facebook, LinkedIn, and other social media, along with open access (OA) journals and online repositories, to disseminate their findings (Cho, 2021a). Online reference management software and proficient networks are now significant to research processes that provide insights into the social influence of research beyond conventional citation methods (Azer & Azer, 2019).

Although citation counts are a long-established and reliable metric for measuring the academic influence of a research paper, they do not fully capture the research's wider impact beyond the academic community. Therefore, there is a need for tools that measure the wide-ranging societal impact of research (Cho, 2015; Cho, 2021b). Altmetrics, propelled by social media, offers an alternative by tracking views, downloads, readings, and mentions of an article across various platforms (Kırlangıç et al., 2022). Agriculture is quite essential to satisfy basic human needs and also has economic, social, cultural, and environmental dimensions. Disseminating pesticide research through social media maximizes its societal impact, influences policy decisions, raises public awareness, fosters interdisciplinary collaboration, and enhances communication strategies. This study analyzes the relationship between altmetric scores and citation scores and examines how OA status affects altmetric scores. This section presents the analysis of altmetric and citation scores to explore how open and closed-access (CA) journals impact the visibility and engagement of pesticide research. By evaluating these metrics together, the results highlight key patterns in research dissemination, accessibility, and scholarly influence within the field.

1.1. Overview of Publishing Models

OA is a scholarly publishing model in which research findings and information are made freely available to readers at no cost. In contrast, the subscription-based model requires readers to pay for access to research content. OA journals have different ways of publishing such as gold, hybrid, green, and bronze. In the golden route, the article publishing charge (APC) is paid by the author or their institution and the documents are available to the readers in full text. In the hybrid route, hybrid journals are subscription-based scholarly platforms where authors can pay an APC for OA to specific works, while others remain behind a paywall, requiring readers to pay for full-text access. In green access, authors self-archive their communication and it will be published publically after the embargo period. Publications in bronze OA are freely accessible on publishers' platforms, but do not include a Creative Commons Attribution License. As a result, they may be subject to modifications at any time, potentially limiting their accessibility and reusability (Cho, 2021b).

This study explores the following questions:

1.2. Research Questions

RQ1) What are the altmetric scores of highly cited articles on pesticide exposure?

RQ2) Do the highest altmetric attention scores correlate with the citation numbers of pesticide exposure articles?

RQ3) Does OA status affect the altmetric and citation scores of highly cited articles on pesticide exposure?

RQ4) Which sources exhibit significant concentration in pesticide research literature and impact?

2. LITERATURE REVIEW

Altmetrics capture research impact beyond traditional citations, reflecting public engagement through platforms like Twitter, Facebook, and Mendeley. Although existing literature has examined the relationship between altmetrics, OA, and citations in disciplines including social sciences and medicine, this relationship remains underexplored in pesticide research. This study addresses that gap by examining altmetric scores and citation performance in open and CA journals within pesticide literature, identifying trends, inconsistencies, and evolving dynamics between traditional and altmetric metrics.

2.1. Reviews Based on Highly Cited Articles

Cho (2021b) investigated altmetrics for highly cited

social science papers (638) from Scopus, evaluating correlations with citations and OA status. Altmetric scores of views, readers, blogs, Wikis, and Tweets linked with citations and OA were analyzed using Spearman correlation and Mann-Whitney U Tests. The consequences demonstrated a strong relationship between citations and readership, with OA papers showing higher altmetric engagement. The top 1,000 articles of *Nature* on social media websites and tools are examined by Ouchi et al. (2019) to evaluate and correlate the altmetric score and their bibliometric indicators. In that, 98.9% of articles were incorporated with social media. Mendeley, Wikipedia, and CiteULike are the most altmetric-scored social media sources, and a positive correlation between altmetric score and citation score was also found. Nisha et al. (2022) conducted a bibliometric analysis of the top 100 most cited studies in information science and library science, revealing that most of the top 100 cited research papers (80%) are in paid subscription journals, emphasizing the importance for libraries to maintain these subscriptions for student access to high-quality research. Highly cited articles were primarily from the USA, Canada, and UK, indicating the growing influence of social media in research dissemination. Saberi and Ekhtiyari (2019) examined highly cited documents in the library and information science (LIS) field as identified by Google Scholar, revealing a positive and significant correlation between capture metrics and Google Scholar citations. Similarly, Li and Thelwall (2012) conducted a comparative analysis of 1,397 genomics and genetics articles using Faculty of 1,000 and Mendeley data alongside traditional bibliometric indicators, identifying a significant correlation between citations and Journal Impact Factors.

Previous research on highly cited studies demonstrates a positive correlation between altmetric scores and traditional citations, with OA papers generally achieving greater altmetric presence and visibility.

2.2. Reviews Based on Open Access and Altmetric Score

The impact of OA on altmetrics for LIS research was determined by Cho (2021a), who found a prevalence of Mendeley bookmark readers (63%) and an unreliable comparison of altmetrics in OA papers. Particularly, views, blogs, and tweets display higher sensitivity in OA papers, while Mendeley readers shows a major correlation with citations. Mounce (2015) suggests that OA may offer an altmetric advantage due to increased visibility, noting that seven out of the top ten papers ranked by Altmetric.com in 2012 were OA. Mounce (2015) also points out that while the OA model is relatively well-established, altmetrics are still new and largely unexplored. Bernal (2013) reviews studies on OA and emerging metrics, highlighting that altmetrics provide added value for OA (Poplašen & Grgić, 2017) and that there is a correlation between page views, citations, and social media impact (Priem et al., 2012). It is obvious from the above literature that OA boosts altmetric impact by increasing visibility and engagement across platforms such as Mendeley and social media, strengthening research reach and influence.

2.3. Reviews Based on Pessimistic Correlation between Citation and Altmetric Score

Heydari et al. (2019) analyzed 1,077 highly cited surgery articles and found 62.74% of documents received altmetric scores. Positive correlations were observed between citations and Wikipedia, policy-making documents, CiteUlike, and citation count. A non-significant positive correlation was found with Mendeley readers. Overall, the weak and negative correlation between citation counts and altmetric attention scores indicates that altmetrics serve as a complementary measure rather than a replacement for traditional citations. Azer and Azer (2019) searched for top-cited articles on medical professionalism from the Web of Science database and identified that no correlation was found between citation and altmetric scores for publications before 2007, but for those published in 2007 and after, there was a significant correlation. The overall summary of the literature confirms that altmetrics generally show weak correlations with traditional citations, indicating that they complement rather than replace citations. Positive correlations were noted with platforms such as Wikipedia and policy documents, but with some variations depending on the publication year.

2.4. Reviews Based on Optimistic Correlation between Citation and Altmetric Score

Statistically significant associations were identified for metrics including Twitter, Facebook, research highlights, blogs, mainstream media, and forums. These findings underscore the influence of time in using altmetrics to rank articles and raise questions about the practical utility of altmetrics due to their inconsistent coverage (Thelwall et al., 2013). A study by Mohammadi and Thelwall (2014) examined the correlation between Mendeley readership counts and citations in social sciences and humanities disciplines, and also identified patterns of information flow between scientific fields using Mendeley data, showing

potential for capturing knowledge transfer across disciplines and providing early-stage impact evidence. Thelwall et al. (2023) conducted an evaluation of the UK Research Excellence Framework 2021 and found that altmetrics demonstrated a stronger correlation with research quality and field-normalized Scopus citation counts. Among the various altmetrics, Mendeley readers counts emerged as the most reliable indicator across the majority of assessment units. It was also found that altmetrics are generally stronger indicators of research quality in health and physical sciences and weaker in the arts and humanities.

Former studies show a clear correlation between the number of citations an article receives and its free online availability (Davis & Walters, 2011; Gargouri et al., 2010; Harnad & Brody, 2004; Kurtz et al., 2005; Lawrence, 2001). Very few studies have examined the connection between OA and altmetric scores. It is crucial to avoid applying the same criteria to older and newer articles. As Web 2.0 continues to evolve, the growing number of social media users has increased altmetric scores for earlier publications compared to more recent ones—a trend attributed to the expansion of communication channels rather than differences in publication quality (Adie, 2014). Moreover, scientific publications generally receive higher altmetric scores than those in other fields. Despite existing literature, significant gaps remain in understanding the correlation between altmetrics and citations, particularly in specialized fields such as pesticide research. Most studies focus on broad disciplines like social sciences and medicine, leaving the relationship between OA and altmetric scores within pesticide research underexplored. Inconsistencies across studies regarding the relationship between altmetrics and citations further highlight the need for more focused investigation.

This study addresses these gaps by examining the interplay among altmetrics, citations, and OA in pesticide research, providing new insights into the field. Previous research has shown strong associations between altmetrics and social media activity, with timing playing a crucial role in article rankings. Mendeley readership demonstrates a significant correlation with citation counts, and altmetrics serve as stronger indicators of research quality in health sciences than in the arts. However, few studies have explored the link between OA and altmetrics in specialized areas such as pesticide research. The following sections outline the study's materials, methods, and analytical approaches used to achieve these objectives.

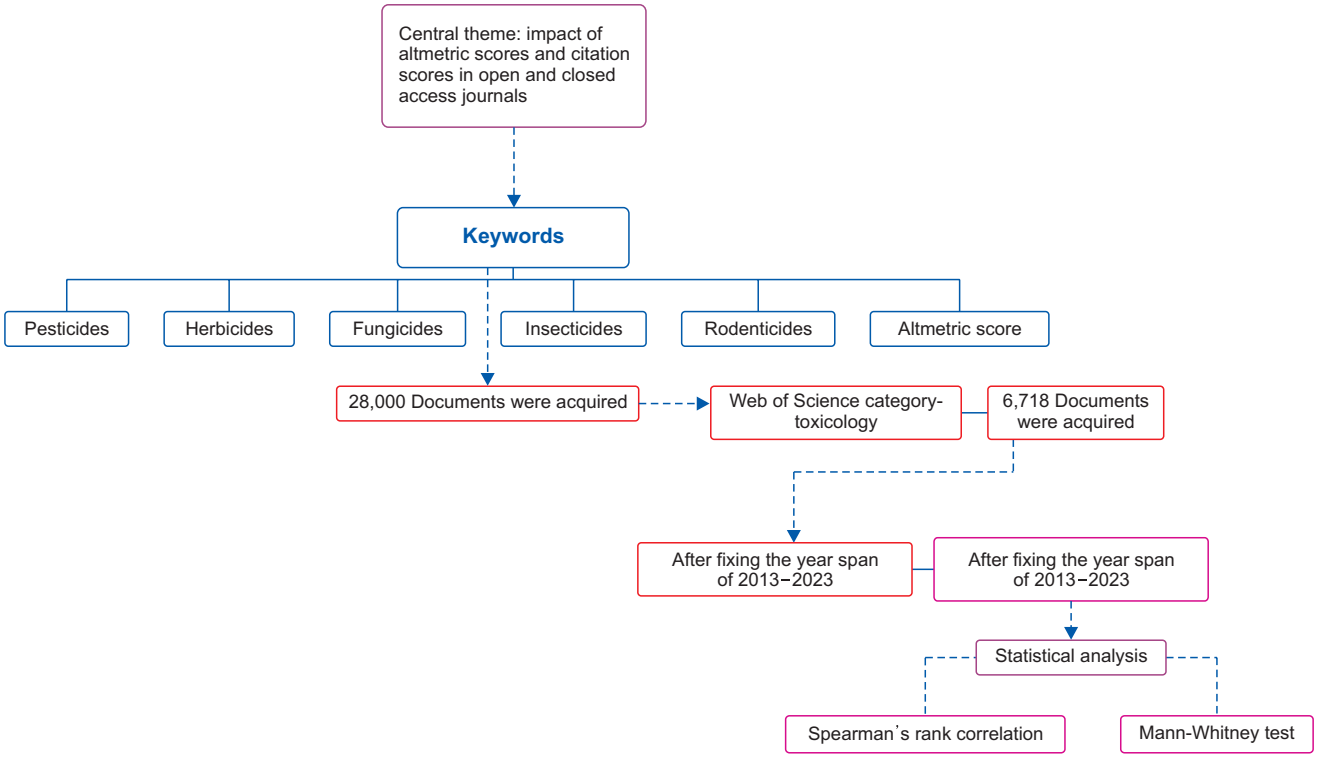

Fig. 1. Data structure of the study.

3. METHODOLOGY

3.1. Materials

To address the research questions, data were retrieved from the Web of Science database, maintained and published by Clarivate Analytics. Although Scopus and Google Scholar also offer citation tracking capabilities, it was essential to limit the search to the Web of Science due to its consistent updates and amendments. On December 20, 2023, data were collected using the keywords 'Pesticides,' 'Herbicides,' 'Fungicides,' 'Rodenticides,' 'Insecticides,' and 'Altmetric Score' in the basic search query. This initial query yielded 28,000 documents. To refine the results, the Web of Science category 'Toxicology' was applied, narrowing the dataset to 6,718 documents. Further filtering was performed by restricting the publication years to 2013-2023 to focus on recent developments in traditional citation scores and social media metrics within the pesticide research literature. Ultimately, 3,291 documents were selected for analysis (Fig. 1).

3.2. Methods

The citation and statistical analyses were conducted using Bibexcel software (2017 ver; Olle Persson, Leuven, Belgium), while the altmetric scores were obtained from the *Journal of Altmetrics* (https://www.journalofaltmetrics.org) by utilizing the DOIs of all 3,291 documents, resulting in altmetric scores for 1,961 documents. To determine the association between citation scores, altmetric scores, and OA status, Spearman's rank correlation analysis was performed using IBM SPSS Statistics 26 (IBM Corp., Armonk, NY, USA). Furthermore, the Mann-Whitney U Test was utilized to determine whether OA articles received a significantly higher number of citations and altmetric scores compared to CA articles (Fig. 2).

4. RESULTS

Integrating altmetric and citation scores enables researchers to gauge both societal impact and academic significance in pesticide research, providing a more nuanced understanding of broader implications and practical applications. This dual analysis enhances the formal demonstration of research significance.

Integrating altmetric and citation scores enables researchers to gauge both societal impact and academic significance in pesticide research, providing a more nuanced understanding of broader implications and practical applications. This dual analysis enhances the formal demonstration of research significance. Table 1 presents data encompassing 3,291 documents spanning the period of 2013-2023, contributed by 104 journals. Remarkably, 79.82% of the documents are articles, 11.39% are meeting abstracts, and 5.40% are reviews. Document types other than this account are less than 2% of the total publications.

4.1. Traditional Citation

A substantial portion of documents (68.03%) is published in subscription or CA journals, contrasting with 31.97% exclusively in OA journals. Within OA, prevalence is observed in green access (603 documents, 13,143 citations), followed by hybrid access (170 documents, 3,123 citations), gold access (158 documents, 2,488 citations), and bronze access (121 documents, 2,150 citations). Research focus is especially concentrated in subscription-based journals with green OA being the preferred choice

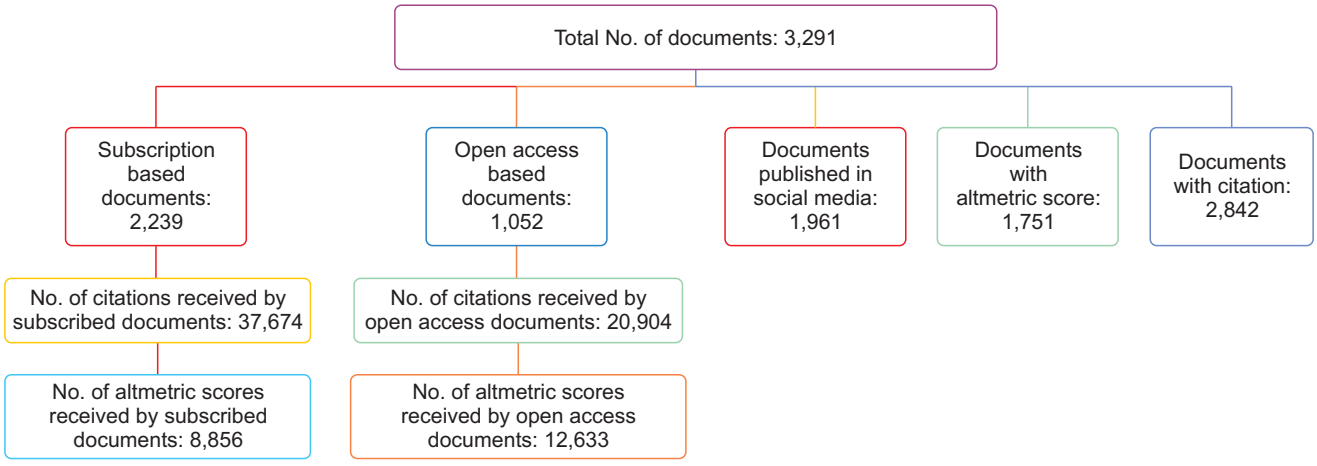

Fig. 2. Overview of collected data: Key information visualization.

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Table 1. Overview of document types and characteristics (2013-2023)

Description	Result
Total no. of documents	3,291
Time span	2013-2023
Sources (journals, books, etc.)	104
Annual growth rate (%)	-18.1
Document average age	5.41
Document type	
Article	2,627 (79.82%)
Meeting abstract	375 (11.39%)
Review	178 (5.40%)
Letter	45 (1.36%)
Correction	29 (0.88%)
Editorial material	29 (0.88%)
News item	5 (0.15%)
Retraction	3 (0.09%)
Status	
Subscription based documents	2,239
Open access documents	1,052
Documents media published in social	1,961
Documents with altmetric scores	1,751
Documents with citation	2,842
No. of citations received by open access documents	20,904
No. of citations received by subscribed documents	37,674
No. of altmetric scores received by open access documents	12,633
No. of altmetric scores received by subscribed documents	8,856

for its absence of article publication charges, and the highest citation was received in the post-embargo period. The cumulative citation count across 3,291 documents stands at 58,578, with the majority of citations occurring in 2013, accounting for 11,049 citations. Publications in recent years are yet to be cited. Subscription journals led with 37,674 citations, while OA journals received 20,904 citations. Traditional citation scores indicate 2,842 cited documents, where most of the documents are articles and 449 meeting abstract documents are uncited.

4.2. Altmetric Score

Among the 3,291 documents, 1,961 have been integrated into social media, predominantly comprising articles and chapters. Of these, 1,751 documents have received altmetric scores, while 210 are pending evaluation. OA journals have garnered the highest altmetric scores, totaling 12,633 from 782 documents, with green access leading at 5,768 scores from 226 documents. Gold access follows with 3,599 scores (221 documents), hybrid access with 2,834 scores (195 documents), and bronze access with 432 scores (100 documents), reflecting fewer publications engaging with social media. Subscription-based journals received 8,856 altmetric scores from 1,179 documents.

Table 2 presents descriptive statistics for traditional citations received by pesticide research literature, categorizing documents into subscribed and OA. Subscribed documents show a publication range of 24 to 274, with a mean of 203.55 (standard deviation [SD]=66.21) representing a moderate level of variability around the average, while OA documents range from 25 to 155 publications, with a mean of 95.64 (SD=37.22) representing more concentrated distribution around the average. For subscribed documents citation, citations range from 45 to 8,125, with a mean of 3,424.91 (SD=2,331.53) indicating a wider variability in citation counts. OA citation documents have citations ranging from 53 to 3,122, with a mean of 1,900.36 (SD=925.67) designating a more concentrated distribution

Table 2. Descriptive statistics of traditional citation scores

Nature of access	Total no. of documents	No. of documents	Minimum	Maximum	Mean	Standard deviation
Subscribed documents	3,291	2,239	24	274	203.55	66.21
Open access documents	3,291	1,052	25	155	95.64	37.22
Subscribed documents citation	3,291	2,239	45	8,125	3,424.91	2,331.53
Open access citation	3,291	1,052	53	3,122	1,900.36	925.67

of citation values around the mean. These statistics reveal differences in citation patterns, indicating varying degrees of attention from researchers and reflecting diverse levels of impact, influence, or recognition within the academic community. In contrast, lower dispersion suggests a more consistent level of citation across the publications.

Table 3 outlines altmetric scores for a dataset of 1,961 documents, which has various dimensions of online attention. Mendeley readers mean scores (51.97, SD=71.448) display the highest number of times a research document has been saved or 'read' by users, followed by Dimensions citations (27.38, SD=43.660). The number of citation count of 22.92 was less than Mendeley readers and Dimensions citations, but higher than news, blog, Twitter, and Facebook mentions. While analyzing the SD counts, Facebook (89.324) obtains varying level of attention from researchers, followed by Twitter mention (87.214), Mendeley readers (71.448), and Dimensions citations (43.660). While citation is a significant metric for traditional scholarly impact, the altmetric scores, representing online attention and engagement, divulge that on average, documents may obtain more attention on platforms such as Facebook, Mendeley, Dimensions citations, and Twitter compared to traditional scholarly citations.

Levene's test was conducted to evaluate the assumption of equal variances between OA and CA journals. A *p*-value of 0.102, which exceeds the typical significance threshold of 0.05, indicates that there is no significant difference in variance between the two groups. The t-test was subsequently applied to assess whether a significant difference exists in mean citation counts between OA and CA journals. The negative t-test value indicates that the mean citation count for OA journals is lower than that of CA journals. However, despite both the Levene's test and t-test showing *p*-values below 0.05—implying statistical significance—the observed difference in mean citations did not translate into a significant variation in citation rates between OA and CA journals. The 95% confidence intervals provide a range within which the true difference in means likely falls, underscoring the importance of cautious interpretation (Table 4).

A Spearman's rank correlation analysis was conducted to examine the relationship between citations and altmetric scores across various sources, including news, blogs, Twitter, Facebook, Mendeley readers, Dimensions citations, and total citations (Table 5). The results showed that blog mentions had a weak positive correlation with traditional citations, while Dimensions citations, Mendeley readers, and Facebook mentions demonstrated strong correlations above 40%. Twitter mentions had the highest

Table 3. Descriptive statistics of altmetric scores

Altmetric scores	Total no. of documents	No. of altmetric scored documents	Minimum	Maximum	Mean	Standard deviation
News mentions	1,961	1,751	0	203	0.65	5.496
Blog mentions	1,961	1,751	0	54	0.19	1.580
Twitter mentions	1,961	1,751	0	3,083	7.93	87.214
Facebook mentions	1,961	1,751	0	3,196	3.79	89.324
Mendeley readers	1,961	1,751	0	1,336	51.97	71.448
Dimensions citations	1,961	1,751	0	821	27.38	43.660
Citations	1,961	1,751	0	708	22.92	36.299

Table 4. Difference in number of citations in open access and subscribed access articles - independent samples test

Total citations	Levene's test for equality of variances		t-test for equality of means						
	F	Sig.	t	df	Sig. (2-tailed)	Mean difference	Standard error difference	95% Confidence interval of the difference	
								Lower	Upper
Equal variances assumed	2.68	0.102	-2.7	3,289	0.007	-3.044	1.127	-5.255	-0.834

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Table 5. Correlation between altmetric scores and citation

		News mentions	Blog mentions	Twitter mentions	Facebook mentions	Mendeley readers	Dimensions citations	Citations
News mentions	Pearson correlation	1	0.794	0.696	0.039	0.355	0.332	0.314
	Sig. (2-tailed)		0.000	0.000	0.083	0.000	0.000	0.000
	n	1,961	1,961	1,961	1,961	1,961	1,961	1,961
Blog mentions	Pearson correlation	0.794	1	0.679	0.132	0.248	0.209	0.210
	Sig. (2-tailed)	0.000		0.000	0.000	0.000	0.000	0.000
	n	1,961	1,961	1,961	1,961	1,961	1,961	1,961
Twitter mentions	Pearson correlation	0.696	0.679	1	0.264	0.157	0.111	0.099
	Sig. (2-tailed)	0.000	0.000		0.000	0.000	0.000	0.000
	n	1,961	1,961	1,961	1,961	1,961	1,961	1,961
Facebook mentions	Pearson correlation	0.039	0.132	0.264	1	0.079	0.064	0.064
	Sig. (2-tailed)	0.083	0.000	0.000		0.000	0.005	0.004
	n	1,961	1,961	1,961	1,961	1,961	1,961	1,961
Mendeley readers	Pearson correlation	0.355	0.248	0.157	0.079	1	0.940	0.504
	Sig. (2-tailed)	0.000	0.000	0.000	0.000		0.000	0.000
	n	1,961	1,961	1,961	1,961	1,961	1,961	1,961
Dimensions citations	Pearson correlation	0.332	0.209	0.111	0.064	0.940	1	0.499
	Sig. (2-tailed)	0.000	0.000	0.000	0.005	0.000		0.000
	n	1,961	1,961	1,961	1,961	1,961	1,961	1,961
Citations	Pearson correlation	0.314	0.210	0.099	0.064	0.504	0.499	1
	Sig. (2-tailed)	0.000	0.000	0.000	0.004	0.000	0.000	
	n	1,961	1,961	1,961	1,961	1,961	1,961	1,961

Table 6. Mann-Whitney U Test statistics for altmetric scores and citation

	News mentions	Blog mentions	Twitter mentions	Facebook mention	Mendeley readers	Dimensions citations	Citation
Mann-Whitney U	426,746.500	434,309.500	383,213.500	439,557.500	428,577.000	455,421.500	414,101.000
Z	-5.175	-4.746	-6.469	-3.132	-2.640	-0.454	-3.820
Asymp. Sig. (2-tailed)	0.000	0.000	0.000	0.002	0.008	0.650	0.000

correlation with citations at 99%, suggesting that researchers may bookmark these works for future reference.

New mentions were highly correlated with all social media sources except Facebook (0.03). Blog mentions showed weak correlations with most social media sources, except for strong correlations with news (79%) and Twitter (67%). Twitter had weak associations with Facebook, Mendeley, and Dimensions citations but was more closely linked with blogs (69%) and news (67%). Facebook exhibited minimal connections to news, blogs, and Twitter but had strong correlations with Mendeley and Dimensions citations. Mendeley readers were highly correlated with Dimensions citations (94%) but weakly correlated with other sources. Similarly, Dimensions citations had strong associations with Mendeley and Facebook but weaker correlations with other mentions.

The determination of statistically significant differences between altmetric scores and citations is verified

through the Mann-Whitney U Test, as depicted in Table 6. The results reveal significant differences found in altmetric scores and citations, except for Dimensions citations (0.650), which is evidenced by *p*-values less than the predictable significance level of 0.05. Negative Z-scores suggest that the altmetric scores are generally lower than the citations. The Mann-Whitney U Test results emphasize prominent divisions in the relationship between altmetric scores and citations across distinct categories.

Table 7 summarizes the differences in altmetrics and citations between CA (subscription-based) and OA journals across various categories. CA articles outperformed OA articles in news mentions, with a higher average rank (951.96 vs. 1,024.79) and total performance (1,122,356.50 vs. 801,384.50). A similar trend was observed for blog mentions, where CA articles also had a higher average rank (958.37 vs. 1,015.12) and total performance (1,129,919.50 vs. 793,821.50). However, OA articles performed better in Twitter mentions, with a higher sum rank despite a lower mean rank (915.03). For overall citations, OA articles had a higher average rank (1,040.96 vs. 941.23) but lower total performance (814,030.00 vs. 1,109,711.00), suggesting greater visibility and impact for OA publications. Lower values for both metrics generally reflect better performance, emphasizing the increased reach of OA articles within scholarly and online communities.

Table 8 provides a comprehensive assessment of publication metrics for diverse toxicology journals, enabling a thorough comparison of their performance in terms of visibility, impact, and accessibility. Notably, the top 10 journals exhibit significant contributions from the Netherlands and the USA, both recognized as leading exporters of agricultural products. Among these, the journal *Ecotoxicology and Environmental Safety*, based in the USA, emerges as the foremost contributor, marked by extensive

Table 7. Open access differences in altmetrics and citations

NOA of AS and citation		n	Mean rank	Sum of ranks
News mentions	Closed	1,179	951.96	1,122,356.50
	Open access	782	1,024.79	801,384.50
	Total	1,961		
Blog mentions	Closed	1,179	958.37	1,129,919.50
	Open access	782	1,015.12	793,821.50
	Total	1,961		
Twitter mentions	Closed	1,179	915.03	1,078,823.50
	Open access	782	1,080.46	844,917.50
	Total	1,961		
Facebook mentions	Closed	1,179	962.82	1,135,167.50
	Open access	782	1,008.41	788,573.50
	Total	1,961		
Mendeley readers	Closed	1,179	953.51	1,124,187.00
	Open access	782	1,022.45	799,554.00
	Total	1,961		
Dimensions citations	Closed	1,179	976.28	1,151,031.50
	Open access	782	988.12	772,709.50
	Total	1,961		
Citation	Closed	1,179	941.23	1,109,711.00
	Open access	782	1,040.96	814,030.00
	Total	1,961		

NOA, number of open access; AS, altmetric score.

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Table 8. Top 10 highly cited journals and their impact through citation and altmetric scores

Journals (country)	Open access	Closed	Total doc	TC	Open access-doc	Closed- doc	Total doc	Total AS	Impact factor (H-Index)
Ecotoxicology and Environmental Safety (USA)	161 (2,648)	221 (6,558)	382	9,206	134 (531)	160 (355)	294	886	7.129 (161)
Environmental Toxicology and Chemistry (USA)	88 (1,634)	175 (3,152)	263	4,786	78 (627)	152 (1,194)	230	1821	4.218 (186)
Aquatic Toxicology (Netherlands)	44 (810)	99 (2,436)	143	3,246	35 (94)	67 (324)	102	418	4.964 (156)
Ecotoxicology (Netherlands)	33 (611)	135 (2,316)	168	2,927	26 (242)	110 (478)	136	720	2.935 (101)
Food And Chemical Toxicology (UK)	39 (673)	77 (1,766)	116	2,439	33 (781)	43 (1,763)	76	2,544	5.572 (192)
Environmental Toxicology and Pharmacology (Netherlands)	11 (234)	82 (1,684)	93	1,918	7 (104)	45 (574)	52	678	5.785 (97)
Bulletin of Environmental Contamination and Toxicology (USA)	18 (297)	148 (1,330)	166	1,627	14 (81)	102 (196)	116	277	2.807 (80)
Food Additives and Contaminants Part A-Chemistry Analysis Control Exposure & Risk Assessment (UK)	12 (128)	88 (1,408)	100	1,536	7 (9)	40 (66)	47	75	3.549 (57)
Toxicology Letters (Netherlands)	13 (144)	286 (1,378)	299	1,522	5 (18)	30 (640)	35	658	4.372 (158)
Clinical Toxicology (UK)	18 (177)	80 (181)	98	358	16 (145)	19 (90)	35	235	3.738 (103)

TC, total citation; AS, altmetric score.

citations and a notable H-Index (161). Despite its prominence, the journal predominantly publishes under CA, showcasing a robust Impact Factor of 7.129. However, it is observed that this journal has a limited focus on social media engagement. Conversely, the UK-based *Food and Chemical Toxicology* stands out with the highest altmetric score of 2,544, complemented by substantial H-Index values (192) and a commendable Impact Factor of 5.572. The journal's prominence on social media is remarkable, evident through a significant altmetric score, and its contributions, though predominantly in CA journals, receive the highest citations (1,766). An overarching observation is that these impactful works are predominantly featured in subscription-based journals, indicating widespread subscription among various institutions. This information is invaluable for researchers, institutions, and readers keen on understanding the influence and reach of these journals within the field of toxicology.

Table 9 unveils a curated list of the top 10 research articles concerning the impact of pesticides on human health. The most cited article, "Pesticides and human chronic diseases: Evidence, mechanisms, and perspectives," authored by S. Mostafalou and published in the journal *Toxicology and Applied Pharmacology* in 2013, has garnered the highest citation count of 708. Despite its citation success, the article has a relatively modest altmetric score of 251, suggesting untapped potential for greater social media visibility and impact are highlighted in bold letters. A pattern emerges where top articles, primarily published in the journal *Toxicology*, receive comparatively lower altmetric scores. This indicates an opportunity for these impactful research works to enhance their visibility and societal impact by leveraging social media platforms. Such efforts could contribute to increased awareness and engagement

Table 9. Top 10 highly cited articles and their altmetric scores

Rank	Title (type of access)	Source	First author	Year	AS	Citation
1	Pesticides and human chronic diseases: Evidences, mechanisms, and perspectives (closed access)	*Toxicology and Applied Pharmacology*	Sara Mostafalou	2013	251	708
2	Heavy metals and pesticides toxicity in agricultural soil and plants: Ecological risks and human health implications (open access)	*Toxics*	Ahmed Alengebawy	2021	245	419
3	Toxic effects of pesticide mixtures at a molecular level: Their relevance to human health (closed access)	*Toxicology*	Antonio F. Hernandez	2013	10	375
4	Pesticides: An update of human exposure and toxicity (closed access)	*Archives of Toxicology*	Sara Mostafalou	2017	64	370
5	Impact of glyphosate and glyphosate-based herbicides on the freshwater environment (closed access)	*Journal of Applied Toxicology*	Robert Annett	2014	38	319
6	Neurodevelopmental disorders and prenatal residential proximity to agricultural pesticides: The CHARGE study (open access)	*Environmental Health Perspectives*	Janie F. Shelton	2014	426	315
7	Persistent organochlorinated pesticides and mechanisms of their toxicity (closed access)	*Toxicology*	Ezra J. Mrema	2013	4	303
8	Effects of neonicotinoid pesticide exposure on human health: A systematic review (open access)	*Environmental Health Perspectives*	Andria M. Cimino	2017	187	276
9	Hazardous effects of chemical pesticides on human health-cancer and other associated disorders (open access)	*Environmental Toxicology and Pharmacology*	Akash Sabarwal	2018	63	263
10	Ethoxylated adjuvants of glyphosate-based herbicides are active principles of human cell toxicity (closed access)	*Toxicology*	Robin Mesnage	2013	128	252

Top 3 high altmetric score received articles, and their scores are as follows: Pesticides and human chronic diseases: Neuro developmental disorders and prenatal residential proximity to agricultural pesticides: The CHARGE study (open access, 426); Pesticides and human chronic diseases: Evidences, mechanisms, and perspectives (closed access, 251); Heavy metals and pesticides toxicity in agricultural soil and plants: Ecological risks and human health implications (open access, 245).
AS, altmetric score.

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Table 10. Top 10 highest altmetric scored articles and their citations

Rank	Title	Source	First Author	Year	Citation	AS
1	Exposure to glyphosate-based herbicides and risk for non-Hodgkin lymphoma: A meta-analysis and supporting evidence	*Mutation Research/ Reviews in Mutation Research*	L. Zhang	2019	156	2,928
2	Refined assessment and perspectives on the cumulative risk resulting from the dietary exposure to pesticide residues in the Danish population	*Food and Chemical Toxicology*	Olaf Larsson Martin	2018	12	1,307
3	Cytotoxicity on human cells of Cry1Ab and Cry1Ac Bt insecticidal toxins alone or with a glyphosate-based herbicide	*Journal of Applied Toxicology*	Robin Mesnage	2013	40	659
4	Neurodevelopmental disorders and prenatal residential proximity to agricultural pesticides: The CHARGE study	*Environmental Health Perspectives*	Janie F. Shelton	2014	315	426
5	An acute exposure to glyphosate-based herbicide alters aromatase levels in testis and sperm nuclear quality	*Environmental Toxicology and Pharmacology*	E. Cassault-Meyer	2014	73	425
6	Occupational exposure to pesticides and consequences on male semen and fertility: A review	*Toxicology letters*	O. Mehrpour	2014	149	413
7	Mechanisms underlying the neurotoxicity induced by glyphosate-based herbicide in immature rat hippocampus: Involvement of glutamate excitotoxicity	*Toxicology*	Diane Cattani	2014	151	361
8	Pesticides and human chronic diseases: Evidences, mechanisms, and perspectives	*Toxicology and Applied Pharmacology*	Sara Mostafalou	2013	708	251
9	Heavy metals and pesticides toxicity in agricultural soil and plants: Ecological risks and human health implications	*Toxics*	Ahmed Alengebawy	2021	419	245
10	Carbamate insecticides target human melatonin receptors	*Chemical Research in Toxicology*	M. Popovska-Gorevski	2017	36	226

AS, altmetric score.

among both researchers and non-academic audiences. These findings offer valuable insights into the performance and characteristics of leading toxicology journals, as well as the potential for maximizing the societal impact of influential research articles on pesticide-related human health impacts.

Table 10 represents the top articles that received more altmetric scores. The article "Exposure to glyphosate-based herbicides and risk for non-Hodgkin lymphoma: A meta-analysis and supporting evidence," published in 2019, received the highest altmetric score of 2,928 with the least citation number of 156. This suggests that the article's amalgamation in social media has created more impact than in traditional citation within the short period. The article "Heavy metals and pesticides toxicity in agricultural soil and plants: Ecological risks and human health implications," which was published in the recent year 2021, received more citations and received a moderate altmetric score specifying the quality of work. It can be merged into social media to get more visibility. Most journals specializing in toxicology-related subject areas occupy top-ranking positions. The highest altmetric-scored articles are recently published in the years 2018 to 2023, with a mere number of citations showing the dominance of social media against traditional citation.

5. DISCUSSION

The altmetric scores of highly cited articles are generally moderate, indicating the need for greater incorporation of these articles across various social media platforms. Currently, most of the articles are primarily associated with Mendeley readers and Dimensions citations. However, if these articles were more widely shared on platforms such as Facebook, Twitter, and blogs, they could potentially achieve higher altmetric scores, increasing their visibility and amplifying their impact on society (Heydari et al., 2019). For instance, the most-cited article, "Pesticides and

human chronic diseases: Evidence, mechanisms, and perspectives" by S. Mostafalou, published in *Toxicology and Applied Pharmacology* in 2013, has received 708 citations. However, its altmetric score is 251, with approximately 200 of these derived from Mendeley and Dimensions. These results suggest that while altmetrics, particularly on platforms like Mendeley, Dimensions, and Twitter, can indicate academic influence, there are clear distinctions between the engagement measured by altmetrics and traditional academic citations. Altmetric scores may reflect public interest and early-stage impact, but they are not a direct replacement for citation metrics in evaluating research impact. The findings emphasize that researchers need to strategically engage with a broader range of social media platforms to enhance both societal and academic visibility.

The analysis reveals nuanced differences between OA and CA journals in terms of citations and altmetric impact. While CA journals outperform OA journals in citations, OA journals gain greater visibility and impact on platforms like Twitter. The nature of OA content may facilitate its dissemination, particularly in online and social media spaces, even if this does not always result in higher citation counts. These findings highlight the complexity of measuring scholarly impact and suggest that different access models may influence distinct dimensions of academic visibility and engagement.

The study also notes that the highest altmetric articles are from toxicology journals and those published between 2018 and 2023, demonstrating the increasing influence of social media over traditional citation methods. Out of 3,291 total documents, only 60% (1,691) are featured on social media, with 71% of OA documents having non-zero altmetric scores, compared to 88.3% for CA documents. Further analysis reveals that OA articles generally perform better in altmetric scores, but show no significant difference in citation rates compared to CA articles. Moreover, the study finds that 30% of highly cited documents are not featured on social media, while the remaining 70% with higher altmetric scores are prominently present on platforms such as Twitter, Mendeley, and Dimensions. The comparison of altmetric and citation scores between OA and CA journals, with a p-value of 0.102, indicates no significant evidence to reject the assumption of equal variances. However, the negative t-test value of less than 0.05 suggests a meaningful difference between open and CA journals, consistent with previous research (Nisha et al., 2022). In inference, integrating traditional and non-traditional metrics provides a more comprehensive view of an article's impact. As new methods and trends evolve, they increasingly shape scholarly communication and must be monitored to effectively assess research significance.

The findings indicate that while there is no significant difference in citation rates between OA and CA journals, there is a noticeable distinction in their altmetric performance. OA articles tend to have a greater impact on social media platforms, potentially leading to higher visibility and wider dissemination among researchers and the general public. However, CA journals often exhibit better performance in traditional citation metrics. This highlights the emerging trend of social media outpacing traditional citations in terms of immediate visibility, particularly for newer research. Researchers and institutions may need to strategically utilize social media to maximize the reach and societal impact of their work.

6. CONCLUSION

The findings demonstrate a clear distinction between the performance of OA and CA journals in terms of citations and altmetric scores. While OA articles tend to perform better on social media platforms, CA journals still dominate in traditional citation metrics, especially within institutional and academic circles. For toxicology journals, the analysis highlights the opportunity for leveraging social media to enhance the visibility and societal impact of impactful research articles, especially those related to human health and pesticide exposure. Researchers and journals should consider utilizing altmetric data to expand their audience reach and foster greater engagement across diverse platforms. This integrated approach, combining both traditional citation analysis and altmetric evaluation, offers a more holistic understanding of the influence and visibility of research in the scholarly community and beyond.

7. LIMITATIONS

The data were exclusively retrieved from the Web of Science database for the period 2013-2023 and were specifically filtered using the Web of Science category 'Toxicology.' These limitations should be considered in future research, and subsequent studies may expand the scope by including additional databases and categories to provide a more comprehensive analysis.

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CONFLICTS OF INTEREST

No potential conflict of interest relevant to this article was reported.

REFERENCES

Adie, E. (2014). *Attention! A study of open access vs non-open access articles*. https://www.altmetric.com/blog/attention-a-study-of-open-access-vs-non-open-access-articles/

Aktar, M. W., Sengupta, D., & Chowdhury, A. (2009). Impact of pesticides use in agriculture: Their benefits and hazards. *Interdisciplinary Toxicology*, 2(1), 1-12. https://doi.org/10.2478/v10102-009-0001-7

Azer, S. A., & Azer, S. (2019). Top-cited articles in medical professionalism: A bibliometric analysis versus altmetric scores. *British Medical Journal Open*, 9(7), e029433. https://doi.org/10.1136/bmjopen-2019-029433

Bernal, I. (2013). Open access and the changing landscape of research impact indicators: New roles for repositories. *Publications*, 1(2), 56-77.

Cho, J. (2015). A study about scholarly impact measurement through altmetrics. *Journal of Korean Library and Information Science Society*, 46(1), 65-81. https://doi.org/10.16981/kliss.46.1.201503.65

Cho, J. (2021a). Altmetrics analysis of highly cited academic papers in the field of library and information science. *Scientometrics*, 126(9), 7623-7635. https://doi.org/10.1007/s11192-021-04084-w

Cho, J. (2021b). Altmetrics of highly cited research papers in social science. *Serials Review*, 47(1), 17-27. https://doi.org/10.1080/00987913.2021.1882652

Davis, P. M., & Walters, W. H. (2011). The impact of free access to the scientific literature: A review of recent research. *Journal of the Medical Library Association*, 99(3), 208-217. https://doi.org/10.3163/1536-5050.99.3.008

Gargouri, Y., Hajjem, C., Larivière, V., Gingras, Y., Carr, L., Brody, T., & Harnad, S. (2010). Self-selected or mandated, open access increases citation impact for higher quality research. *PLoS One*, 5(10), e13636. https://doi.org/10.1371/journal.pone.0013636

Harnad, S., & Brody, T. (2004). Comparing the impact of open access (OA) vs. non-oa articles in the same journals. *D-Lib Magazine*, 10(6). http://www.dlib.org/dlib/june04/harnad/06harnad.html

Heydari, S., Shekofteh, M., & Kazerani, M. (2019). Relationship between altmetrics and citations: A study on the highly cited research papers. *DESIDOC Journal of Library & Information Technology*, 39(4), 169-174. https://www.proquest.com/openview/3139001d7c9d8253fbf31757e8f39b1d/1?pq-origsite=gscholar&cbl=2028807

Kırlangıç, M. M., Sahin, E., Sahin, M. E., Kütük, S., Halıcı, B. N. A., & Ak, M. (2022). Evaluation of altmetric analysis scores of the top 100 articles on polycystic ovary syndrome published in the last 10 years. *Cureus*, 14(12), e32903. https://doi.org/10.7759/cureus.32903

Kurtz, M. J., Eichhorn, G., Accomazzi, A., Grant, C., Demleitner, M., Henneken, E., & Murray, S. S. (2005). The effect of use and access on citations. *Information Processing & Management*, 41(6), 1395-1402. https://doi.org/10.1016/j.ipm.2005.03.010

Lawrence, S. (2001). Free online availability substantially increases a paper's impact. *Nature*, 411(6837), 521. https://doi.org/10.1038/35079151

Li, X., & Thelwall, M. (2012). *F1000, Mendeley and traditional bibliometric indicators*. Paper presented at 17th International Conference on Science and Technology Indicators, Montréal, QC, Canada.

Mohammadi, E., & Thelwall, M. (2014). Mendeley readership altmetrics for the social sciences and humanities: Research evaluation and knowledge flows. *Journal of the Association for Information Science and Technology*, 65(8), 1627-1638. https://doi.org/10.1002/asi.23071

Mounce, R. (2015). Dark research: Information content in many modern research papers is not easily discoverable online. *PeerJ Preprints*, e773v771. https://doi.org/10.7287/peerj.preprints.773v1

Nisha, F., Kumar, S., Awasthi, S., & Tripathi, M. (2022). Top 100 cited papers in information and library science: A brief analysis. *Journal of Scientometric Research*, 11(3), 371-383. https://doi.org/10.5530/jscires.11.3.40

Ouchi, A., Saberi, M. K., Ansari, N., Hashempour, L., & Isfandyari-Moghaddam, A. (2019). Do altmetrics correlate with

citations? A study based on the 1,000 most-cited articles. *Information Discovery and Delivery*, 47(4), 192-202. https://doi.org/10.1108/IDD-07-2019-0050

Poplašen, L. M., & Grgić, I. H. (2017). Altmetric and bibliometric scores: Does open access matter? *Qualitative and Quantitative Methods in Libraries,* 5(2), 451-460. http://www.qqml.net/index.php/qqml/article/view/331

Priem, J., Piwowar, H. A., & Hemminger, B. M. (2012). Altmetrics in the wild: Using social media to explore scholarly impact. *arXiv*, 1203.4745v1201. https://doi.org/10.48550/arXiv.1203.4745

Saberi, M. K., & Ekhtiyari, F. (2019). Usage, captures, mentions, social media and citations of LIS highly cited papers: An altmetrics study. *Performance Measurement and Metrics*, 20(1), 37-47. https://doi.org/10.1108/PMM-10-2018-0025

Thelwall, M., Haustein, S., Larivière, V., & Sugimoto, C. R. (2013). Do altmetrics work? Twitter and ten other social web services. *PLoS One*, 8(5), e64841. https://doi.org/10.1371/journal.pone.0064841

Thelwall, M., Kousha, K., Abdoli, M., Stuart, E., Makita, M., Wilson, P., & Levitt, J. (2023). Do altmetric scores reflect article quality? Evidence from the UK Research Excellence Framework 2021. *Journal of the Association for Information Science and Technology*, 74(5), 582-593. https://doi.org/10.1002/asi.24751

Tudi, M., Li, H., Li, H., Wang, L., Lyu, J., Yang, L., Tong, S., Yu, Q. J., Ruan, H. D., Atabila, A., Phung, D. T., Sadler, R., & Connell, D. (2022). Exposure routes and health risks associated with pesticide application. *Toxics*, 10(6), 335. https://doi.org/10.3390/toxics10060335