[HP#137]

Application of Artificial Intelligence to Toxicological Assessment of Plant: A Bibliometric Analysis and Future Research Plans

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ABSTRACT

Artificial intelligence (AI) has been gaining attention in health science with extensive application in the toxicological assessment of plants in several studies published on this topic. However, there is a dire need for bibliometric analysis of publications to chart research topic direction proposed advances for future research. A bibliometric analysis explores core articles on the toxicological assessment of plants and identifies any unsolved issues regarding the use of AI in the discovery of toxicity of plants used in pharmacological research. Articles published from January 2008 to December 2023 were retrieved from Scopus for bibliometric analysis. The study finds that there was an annual increase in the number of published articles with a drastic increase between 2019 and 2023. Ultimately, the study included 77 research articles in the bibliometric analysis. The articles that are related to the application of AI in drug toxicity assessment are categorized into four main clusters: AI application cluster, drug development, toxicity prediction model, and assessment of the outcome from drug adverse events. "artificial intelligence" has the highest frequency keyword, followed by "drug toxicity", human, machine learning, and drug discovery. The United States of America (USA) had the highest, followed by China and India in the order of 29, 11, and 8 respectively while the United Kingdom had only 4 articles. This study suggests dire trend towards toxicity prediction in drug discovery and development. However, few of the trials have suggested precise conclusions about the potential of AI in toxicity prediction for drug discovery and development.

Keywords: Bibliometric analysis; Artificial Intelligence (AI); Drug toxicity, Toxicological assessment

1 Introduction

Due to the possible challenges of human biases in toxicological assessment in the plant, there rises a dire need in recent times for artificial intelligence to predict possible toxicity and to ascertain off-target outcomes in the pharmacological research workflow. However, there are issues with the threshold of Toxicological Concern (TTC) established to ascertain the level of chemical exposure between standard chemical toxicity data, and below thresholds which can cause risk to human health(1,2). Recent attention has been focused on developing the threshold of toxicological concern (TTC) for evaluating the risk of low-level substances in the diet. This has led to the recognition of the importance of artificial intelligence techniques in identifying risky substances and conducting comprehensive risk assessments. As a result, there is a need for rapid and accurate toxicological assessment of plants and substances used in pharmaceutical products to enhance medicine production and safeguard human

DOI: 10.21467/abstracts.155 ISBN: 978-81-961472-9-7 (eBook)

health(3,4). The foundation of artificial intelligence applies to the recognition of images in substance and have developed today into the identification and recognition of medical substances in plants and animals to aid the process of difficult decision making especially in the toxicological assessment of plant for pharmaceutical products(5,6). Considering the advanced research application of AI in medical sciences, big data in machine learning applications have significantly extended to pharmacological research such as toxicological assessment of plants for drug manufacturing. Recent evidence has suggested that AI capacity can result in specific and accurate diagnose of genotoxic impurities in extractable(7). Global health issues have triggered efforts towards the application of AI in toxicological assessment to derive a “toxic load” value and relationship which will be representative of all sets of exposure conditions predicted to produce a chosen Specified Level of Toxicity (SLOT). The "toxic load" can serve as a foundation for assessing the risk associated with major hazards. While studies have explored the use of AI in toxicological assessment for plants, limited information exists on datasets since AI algorithms typically require extensive data for effective learning and analysis. Through bibliometric analysis and descriptive narrative, this study examines existing literature on the application of AI in the toxicological assessment of plants for drug manufacturing. In the post-COVID-19 era, there is a need for accurate and sustainable AI-based toxicological assessment of plants to support current pharmacological research. However, the use of AI, particularly in determining plant toxicity as a "black box," remains understudied, and the future direction of AI in toxicological assessment for the coming decade is still uncertain.

2 Materials and Methods

Articles published from 2008 to 2023 were screened by two authors of the research team in the SCOPUS core collection database for bibliometric analysis. The study search employed the strategy of the PICO framework. P— population/problem refers to the preclinical toxicity testing of new compounds on animals for the drug development process. In—intervention, our study comprised various AI methods and machine-learning technologies. C—comparison indicated the difference between AI assistance and physical administration of a substance to the animal. O—outcome, which outlined the results of the physiological effects of AI on the toxicological assessment of plants. The search strategy was based on information from previous studies and experts’ opinions. We used the related and specific keywords related to toxicological assessment (“toxicological assessment / toxicological assessment”, “plant toxicity”, “plant toxicity testing”, and “administration of plant substance in an animal”. AI technologies (“artificial intelligence”, “AI”, “machine learning”, and plant substance in animals (“drug toxicity”, “toxicological assessment”) in SCOPUS publication. We downloaded publications from the bibliometric analysis and extracted the dataset on the publication details such as; authors, and titles. This study analyzed articles using standard

ISBN: 978-81-961472-9-7
Series: AIJR Abstracts
DOI: 10.21467/abstracts.155

weight attributes and total link strength attributes. The analysis focused on original articles written in English, while non-English documents and non-original articles were excluded. The SCOPUS core collection database and VOSviewer were employed to describe and visualize co-occurrence networks, citation patterns, and keyword searches. High-frequency keywords were defined as those occurring more than five times, and clustering algorithms were used according to established guidelines.

3 Result: Publications output

The articles analyzed in this research are from the Scopus core database between 2008 and 2023. Out of the 82 chosen articles, 2 non – English written and 5 non–research papers were excluded based on the selection criteria. Thus, bringing the number of articles assessed to 75 publications (Figure 1).

3.1 Growth trend of publications

The number of publications in the field of AI and toxicological assessment research has shown steady growth from 2014 to 2020, with a significant increase observed between 2021 and 2022. A total of 228 articles were published before 2021, while 306 articles were published in the two years of 2021-2022, indicating a substantial surge in research output. The analysis encompassed contributions from 74 countries, with the United States leading with 249 publications, followed by China (127), India (93), and the United Kingdom (76). Keyword searches identified 1415 keywords, with 27 high-frequency keywords meeting the inclusion criteria for analysis based on their occurrence. The number of publications and bibliometric analysis are shown in Figure 1 to Figure 5.

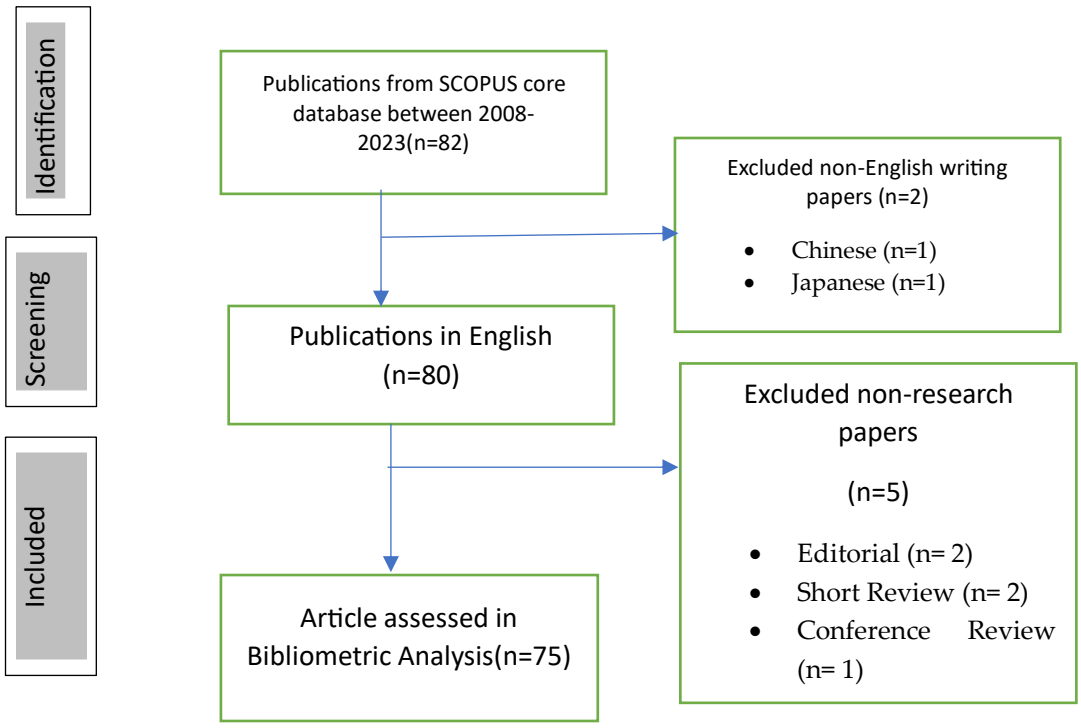

Figure 1: *Flow Diagram of the article selection process: SCOPUS*

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Series: AIJR Abstracts
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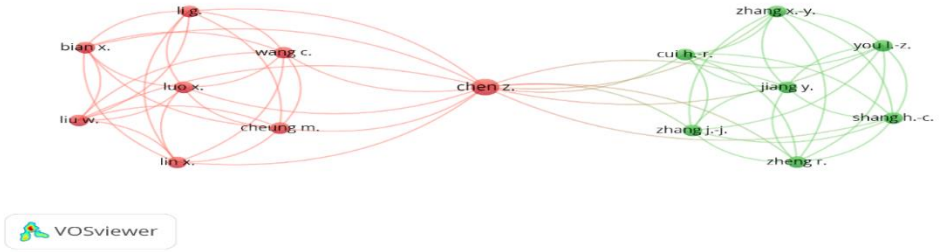

Figure 2: *Co-authorship and full counting*

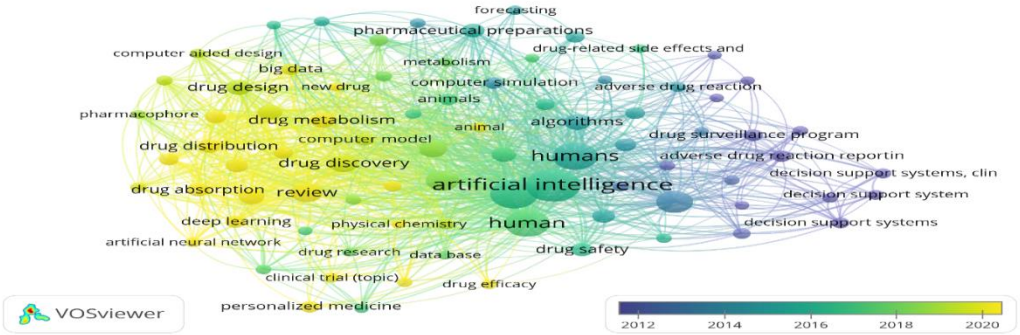

Figure 3: *Keywords Co-occurrence with Full counting method*

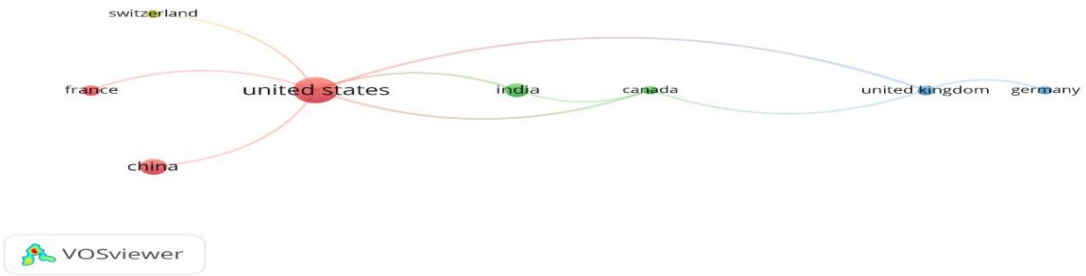

Figure 4: *Co-authorship by Countries with the full counting method*

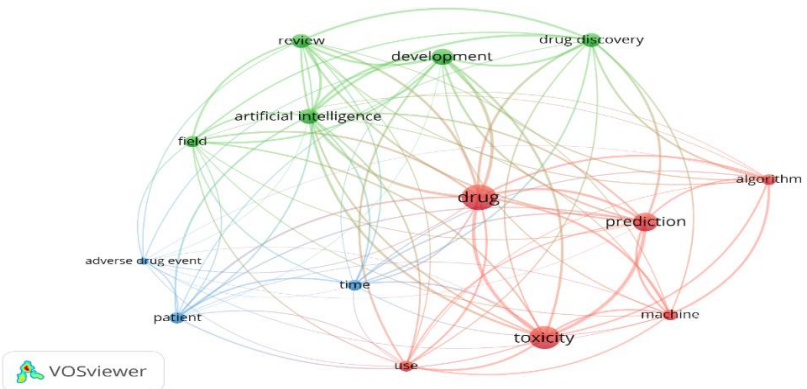

Figure 5: *Kinds of Research Cluster*

ISBN: 978-81-961472-9-7
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4 Conclusion

This study identified four main clusters in articles related to the application of AI in drug toxicity: AI application, drug development, toxicity prediction model, and assessment of outcomes from drug adverse events. The most frequent keywords were "Artificial Intelligence" and "drug toxicity," with notable keywords including human, machine learning, and drug discovery. The United States had the highest frequency of articles, followed by China and India, indicating the potential of AI in drug development research and the need for increased cooperative policy support and funding in the post-COVID-19 era.

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ISBN: 978-81-961472-9-7

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