

Bibliometric Analysis of Lead's Effects on the Nervous System

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Abstract:

Lead (Pb) is a heavy metal that is proven to cause various health problems. In its development, research trends on the effects of Pb on the nervous system are still a topic of research. This study aims to identify trends, research focus, and research contributions to understanding the impact of Pb on the nervous system. The method used, namely bibliometric analysis with the help of Publish or Perish (POP) with the keyword Pb on autism and VOS Viewer software and Scopus database. Keyword analysis was conducted on 131 documents from 2013-2024. The results concluded that there are 4 keywords, namely child, lead, effect, and metal and have a great opportunity for future research. This analysis also found that the article entitled "Mechanisms of lead and manganese neurotoxicity" was the most cited article, with 153 citations.

Keywords: Autism, Bibliometrics, Lead, Nervous System

Introduction

Lead (Pb) is one of the heavy metals that exist naturally in the environment or due to the process of activities of living things in the environment, especially human activities. Natural processes such as rock weathering and volcanic activity, and some human activities such as the use of Pb-based paints, the use of cosmetics, basic materials for children's toys, and the use of motor vehicle fuels are known to cause Pb to enter the environment.¹ Pb can accumulate in soil, water, or air which can enter humans through various pathways. Santoso et al.² research mentioned that Pb accumulated in bob fish found in the waters of Banjarmasin's Barito River. Pb bioaccumulation can cause various health effects. Pb that accumulates in the bones can cause changes in the bone criticality index, a decrease in the degree of bone mineralization and others.³ Research by Yuliana et al.⁴ mentioned that Pb can cause kidney damage in experimental animals. Pb can also cause health problems, especially for vulnerable age groups, including children.⁵

Children are one of the most vulnerable age groups because their organ systems are still growing and developing towards maturation. This makes the excretion and detoxification system of toxic compounds and elements still not perfect. Research by Mitra et al.⁶ states that the bioaccumulation of Pb in the body is at risk of causing toxic effects in children compared to adults. Some of the toxic effects of Pb include growth disorders, decreased intelligence, and hearing. Several other studies have also concluded that exposure to Pb in children will cause damage to the nervous system which can lead to abnormal behavior, decreased speech, and emotional disturbances.

Lead (Pb) is a non-biodegradable metal that occurs naturally in the environment and is found in relatively low amounts. Pb will turn toxic to the human body when exposed in

amounts greater than the optimal amount.⁶ Pb exposure in humans is mostly from daily life such as the use of Pb-based paints. In addition, the use of everyday items, such as jewellery, children's toys, and cosmetics also causes humans to be exposed to high amounts of Pb. Environmental pollution of the soil due to industrial activities can also have a harmful effect on humans.¹

The pathomechanism of damage to the nervous system in children due to Pb exposure is still unclear. Brifa et al.⁷ stated that the neurotoxic effect of Pb through its activity is very similar to calcium (Ca). This causes Pb to inhibit Ca in maintaining the homeostasis process in the nervous system. Another known pathomechanism is the effect of Pb which is able to bring up protein kinase C prematurely, thus triggering disruption of the formation and function of small blood vessels in the brain. The neurotoxic effects of Pb are also known through its activity in triggering damage to the blood brain barrier. This results in unnecessary molecules, ions and water entering the brain freely, resulting in cerebral oedema that ends in Pb-induced encephalopathy.

Research on the effects of Pb on children's nervous system is one of the topics of considerable interest especially in several branches of science, such as environmental science, environmental health, public health, toxicology, pharmacology, pharmacy, biochemistry, and molecular biology. Although the neurotoxic effects of Pb in children have been of less concern, some problems due to it still exist in recent years. Therefore, the direction of research on the neurotoxic effects of Pb on children is very important to better understand the pathomechanisms of Pb in triggering growth, development, and nervous system damage in children.

Bibliometric analysis is a research method that uses quantitative and statistical analysis

to describe the distribution pattern of research through publications on certain topics, fields, institutions, or countries. Currently, the use of bibliometric analysis is quite popular because it is based on web applications, free, and quite easy to use. This analysis has been widely used in the fields of science, engineering, medicine/health, and other fields. The use of this analysis in the field of medicine/health is done to explain a certain topic that has been researched or used as a basis for conducting further research. For example, Luo et al.⁸ reviewed research related to health technology from 1990-2020 using this analysis. Fitriyati and Al Husna⁹ also used this analysis to see the direction of research in the field of Obstetrics and Gynaecology in 2016-2020. On the other hand, the use of this analysis to assess the direction of research on the neurotoxic effects of Pb in children has not been widely done. Based on this, this study was conducted to assess the effects of Pb on the nervous system in children using bibliometric analysis.

Research Method

This research is a literature review in the form of bibliometric analysis.¹⁰ This analysis is a free web-based application. This analysis is used to review and analyse the core of a research or author and its relationship by attaching all publications related to a particular topic. The publications studied can be in the form of original articles, book chapters, reviews, and conference articles through mathematical and statistical analysis. This analysis method produces quantitative data that is accurate and objective in measuring the impact of an article on knowledge.¹¹

The next step of bibliometric analysis is to analyse using the VOS Viewer application. VOS Viewer is a free web-based application developed to create an overview of bibliometric analysis.¹² The version used in this research is 1.6.20. The image that will be

displayed are circles that will represent several parameters, including articles, authors, keywords, countries, and so on. These circles will have a certain diameter, colour, and distance between points. The higher the number of articles, citations, and frequency of occurrence, the larger the diameter of the circle. Circles of the same colour indicate the same cluster. In addition, the line and line distance between 2 circles indicate the relationship and proximity or similarity between the subject terms.¹³

The final step in this analysis is descriptive analysis. Descriptive analysis was conducted using VOS Viewer and Microsoft Excel 2019 for Windows 11. VOS Viewer analysis allows for analysis of collaboration between authors or researchers and institutions. In addition, using the VOS Viewer application also allows for analysis based on keywords created by the authors. Both analyses were made based on the mapping visualized through this application. Descriptive analysis was also carried out using general statistics on the Microsoft Excel program in 2019 for Windows 11. This application was used for descriptive analysis on several indicators, including document growth trends, scientific fields, and productivity levels of authors and institutions.¹² Descriptive analysis was carried out using general statistics in the Microsoft Excel program for several indicators such as document growth trends, scientific fields and author productivity levels.

Results and Discussion

The results of the search on publication trends from the Scopus database on the effects of Pb on the nervous system from 2013-2023 using the PoP application are presented in Figure 1. Based on Figure 1, it can be seen that the publication trend on the topic of the effects of Pb on the nervous system varies greatly each year, but in general it has increased every year. The most publications are in 2023, which is 25 documents. This

shows that research on the effects of Pb on the nervous system is increasingly being carried out, resulting in considerable opportunities for research in the future.

Publications made about the effects of Pb on the nervous system on the Scopus database found as many as 131 articles published by 81 scientific journals, with details as shown in Figure 2. In Figure 2, it can be seen that in general, articles about the effects of Pb on the nervous system are more in the form of articles (83.2%) published in scientific journals. According to Habibi et al.¹⁴ publications have several purposes, including (a) dissemination of research results, which can be utilized by the public for the development of science and technology (b) publications can be used as personal branding and the existence of expertise in certain fields

of science (c) building collaborations and networks with other researchers to strengthen expertise in the field of science.

Based on the intended journal, 4 scientific journals with the most documents were obtained. This is presented in table 1.

In table 1, the journal Environmental Research (Scopus Q1) has 10 documents. Environmental Research is a multidisciplinary journal that publishes high-quality and new information. This journal has global relevance and can be applied in various environmental disciplines, and explains the application of the environment in a real-world context. The wide scope of the environment allows researchers to publish their research results in the Environmental Research journal.

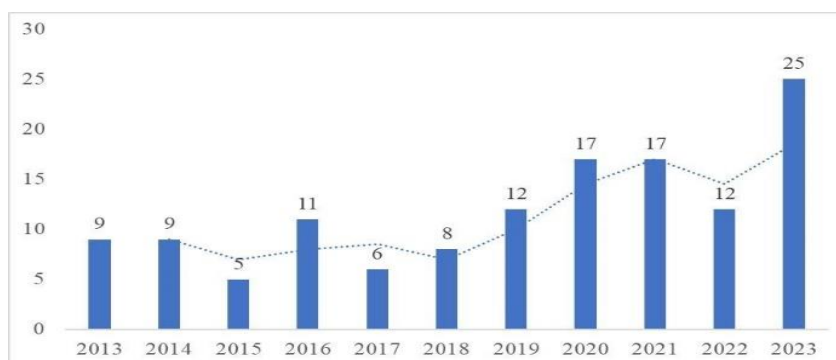


Figure 1 Publication trends on the effects of Pb on the nervous system from the Scopus database using the PoP application

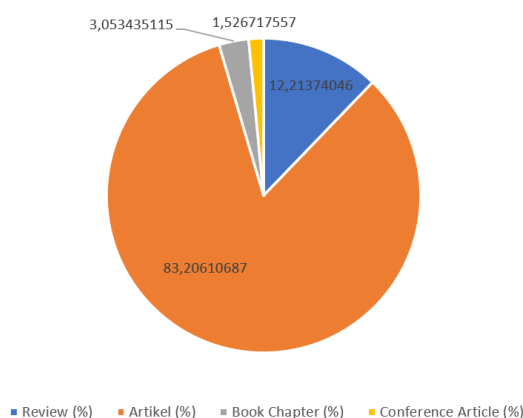


Figure 2 Types of publications on the effects of Pb on the nervous system

Table 1 Number of documents published by several scientific journals on the topic of the effects of Pb on the nervous system

Journal Name	Number of Documents
Environmental Research	10
Environmental Science and Pollution Research	8
Neurotoxicology	6
International Journal of Environmental Research and Public Health	5

Table 2 Number of documents published by several scientific journals on the topic of the effects of Pb on the nervous system

Author	Title	Citation
A.P. Neal	Mechanism of lead and manganese neurotoxicity	153
C. Freire	Prenatal co-exposure to neurotoxic metals and neurodevelopment in preschool children: The Environment and Childhood (INMA) Project	99
H. Bjermo	Lead, mercury, and cadmium in blood and their relation to diet among Swedish adults	94
J. Smolders	Characteristics of differentiated CD8 and CD4 T cells present in the human brain	78
R.G Lucchini	Neurofunctional dopaminergic impairment in elderly after lifetime exposure to manganese	74
K. Raj	Metals associated neurodegeneration in Parkinson’s disease: Insight into physiological, pathological mechanism and management	69
D. Ramirez Ortega	Cognitive impairment induced by lead exposure during lifespan: Mechanism of lead neurotoxicity	67
V.M. Andrade	Lead, arsenic, and manganese metal exposures: Focus on biomarkers of effect	62

On the other hand, the journal Environmental Science and Pollution Research (ESPR) is also among the journals where many documents on the effects of Pb on the central nervous system are found. This journal accepts published articles from the international community in all fields of Environmental Science with an emphasis on chemical compounds. This allows the chemical aspects of Pb and its effects to be published in this journal. The results of this study can also explain the authors and the number of citations related to this topic. The results of this study are presented in full in table 2.

The article entitled "Mechanisms of lead and manganese neurotoxicity" has 153 citations. The article has explained in detail the mechanisms of Mn and Pb that cause toxic effects on the nervous system. The study has explained the mechanism of absorption of Pb and Mn from absorption in the intestine to distribution to various organs including its ability to penetrate the brain barrier. The detailed explanation in the article allows the article to be referred to by other researchers as reference material.

Network Overview and Overlay of Publications on the Effects of Pb on the Nervous System

The analysis conducted with the VOS Viewer application produces an overview of the relationship between the development of research on the effects of Pb on the nervous system. Based on the results of the VOS Viewer analysis, it can be seen that there are 2a clusters, namely red and green clusters. As seen in Figure 2a, the first cluster in red consists of 2 subjects, namely lead and effect. Then the second cluster which is green also

consists of 2a subjects, namely child and metal.

In Figure 2b, the yellow colour indicates current research. The more yellow, the more recent the research. Figure 2b also shows that the most recent studies used the keyword metal. The results of this analysis show that the keywords child, lead, effect, and metal are connected in a line, which means that various studies related to metals have been researched in the range 2013-2024.



Figure 2 (a) Network Overview of Publications on the Effects of Pb on the Nervous System; (b) Overlay of Publications on the Neurotoxic Effects of Pb

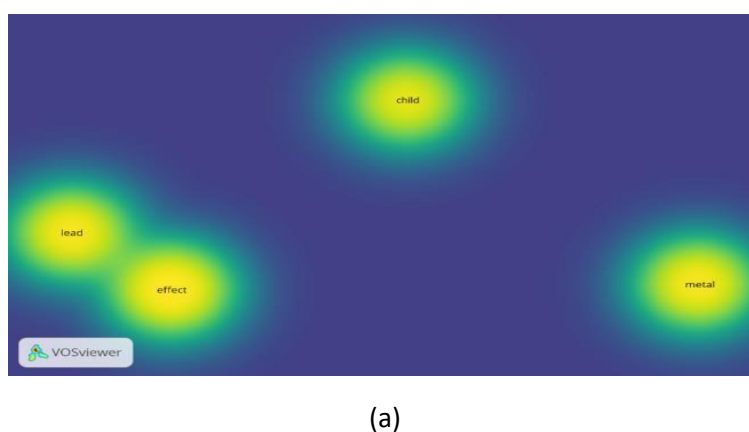


Figure 3 Overview of Density Visualization of Publications on the Neurotoxic Effects of Pb

Overview of Density Visualization of Publications on the Effects of Pb on the Nervous System

To find out the depth of a publication, a density visualization is used, which can be seen in Figure 3. In addition, Figure 3 can also explain the existence of future research

opportunities and is closely related to the novelty aspect on the topics of child, Pb, effect, and metal.

The brightest yellow colour indicates that the topic is frequently researched. Meanwhile, the lightest yellow colour indicates that the topic is rarely researched. Thus, it is concluded that research on the effects of Pb on the nervous system with the subjects of child, lead, effect, and metal has not been done much. This means that the opportunity to conduct research on the topic is still very large.

Conclusions

Based on the results of bibliometric analysis using VOS viewer and the Scopus database, it can be concluded that the trend of publications on the effects of Pb on the nervous system continues to increase, from 9 documents in 2013 to 25 documents in 2023. The number of publications in 2023 is 25 documents and is the largest number of documents. The results of the VOS Viewer analysis also show that research on the effects of Pb on the nervous system with the subjects of child, lead, effect, and metal has a great opportunity for research in the future. In addition, through this analysis it was found that the article entitled "Mechanisms of lead and manganese neurotoxicity" was the most cited article, with 153 citations.

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