



# Systematic Review on Financial Implications of Molybdenum Based Orthopaedic Implants

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## Abstract

Molybdenum is one of the most used metals for orthopaedic implants. The review analysis had been conducted to understand the active authors, organizations, journals, and countries involved in the research domain of “Toxicity of Molybdenum based orthopaedic implants”. All published articles related to “Toxicity of Molybdenum based orthopaedic implants” from “Scopus”, were analyzed using the Meta Analysis to develop analysis tables and visualization maps. This article had set the objective to consolidate the scientific literature regarding “Toxicity of Molybdenum based orthopaedic implants” and also to find out the trends related to the same. Journal of Plant Nutrition, Toxicological Sciences and Ecotoxicology and Environmental Safety were the leading journals. The most active country was the United States of America. The leading organization engaged in the research regarding Molybdenum orthopaedic implants was the Chinese Academy of Sciences, China. The most active authors who had made valuable contributions related to Molybdenum orthopaedic implants were Zhang C. and Hussain S with the highest publication, citations and co-authorship links.

**Keywords:** Molybdenum-implants, Orthopaedic, Toxicity, engineering, Review analysis, Meta Analysis

## 1. Introduction

An engineered medical device to replace a missing or damaged biological structure is known as an implant. Different types of metals and materials are used to create implants (Priyanka *et al.*, 2014). Various types of implants had been used in modern medicine and include dental implants (Bhola *et al.*, 2010) dental crown (Er and Unsaldi, 2013) sensory implants, neurological implants, cardiovascular implants, orthopaedic implants (Er and Unsaldi, 2013), contraceptive implants, and cosmetic implants. Molybdenum alloys-based implant materials are having high corrosion resistance to body fluids, excellent mechanical properties, and biocompatibility (Kumar *et al.*, 1985).



Orthopaedic implants are often used subjected to wear and corrosion (Weightman, Zarek and Bingold, 1969)(Gregory and Ozcan, 1980) and ultimately lead to poor performance, pain, and wastage of money. The other major issues associated with orthopaedic implants based on Molybdenum are the hypersensitivity (allergy) and toxicity of the metal(Kręcis, Kieć-Świerczyńska and Chomiczewska-Skóra, 2012)(Kręcis, Kieć-Świerczyńska and Bąkowicz-Mitura, 2006)(Symeonides, Paschaloglou and Papageorgiou, 1973) and other complications like loosening and tissue necrosis (Evans and Thomas, 1986).The Implants based on Molybdenum disrupts DNA replication dynamics in neuronal cells. Material engineering and surface engineering can play a significant role in improving the performance and life of Molybdenum orthopaedic implants, along with measures for reducing toxicity and hypersensitivity of the metal(Torok *et al.*, 1995).

This review analysis will be a useful platform for future researchers by realizing the top researchers, organizations, and countries involved in research regarding allergy of Molybdenum - implants. This article is arranged into four sections. The first section is the introduction, followed by the discussion of the methodology by which the research was conducted. The third section deals with results and discussion. The fourth section deals with the conclusion. The following research objectives and research questions were framed for conducting review analysis systematically.

### 1.1 Research Objectives

- a) To consolidate the literature regarding the toxicity of Molybdenum based orthopaedic implants
- b) To find out the trends related to research in the toxicity of Molybdenum based orthopaedic implants

### 1.2 Research Questions

- a) Who are the active researchers working on the toxicity of Molybdenum based orthopaedic implants?
- b) Which are the main organizations and countries working on the toxicity of Molybdenum based orthopaedic implants?
- c) Which are the main journals for the toxicity of Molybdenum based orthopaedic implants?

## 2. Research Methodology

Scopus files had been used for this article. For the article selection, the Boolean used was TITLE-ABS-KEY(Molybdenum Toxicity). All the tables in this paper were created by using Microsoft Excel and Meta Analysis. Grammarly was used for spelling and grammar checks. Mendeley was



used for article review and citation. This paper had been inspired by review analysis in its presentation style, analysis, and methodology from the works.

### 3. Results and discussion

#### 3.1 Results

This first round of search produced an outcome of 749 documents, in nine languages, out of which 724 documents were in English. The classification of document categories is shown in Table 1. For improving the quality of the analysis, we had selected only the peer-reviewed articles and all other documents had not been considered. Thus after using filters “Article” and “English” the second round search produced an outcome of 607 English articles (both open access and others) and had been used to conduct review analysis and visualization using Meta Analysis. The English research articles in this domain since 1965 had been shown in Table1. Co-authorship analysis of top authors had been shown in Table1. For a better presentation of the analysis, the parameters used were the minimum number of documents of an author as four and the minimum number of citations of authors as one. This combination plotted the map of 19 authors, in nine clusters. The overlay visualization map of co-authorship analysis plotted in Table1, points out the major researchers with their strong co-authorship linkages and clusters involved. The citation analysis of top authors had been shown in table 1, along with co-authorship links. For the citation analysis, the parameters used were the minimum number of documents of an author as one and the minimum citations of an author as one.

Table 1: Highlights of most active authors

Description	Authors	Documents	Citations	Average citations per documents	Link strength
Authors with the highest publication and co-authorship links	Zhang C.	13	210	16.1	86
Authors with the highest citations	Hussain S.	4	957	239.3	24

In Co-occurrence analysis, we had used all keyword analyses, by keeping the minimum number of occurrences of a keyword as 40. This combination plotted the map of 33 thresholds, in three clusters. The overlay visualization of co-occurrence analysis of keywords has been shown in Table2. The leading organizations engaged in research on “Toxicity of Molybdenum orthopaedic implants” had been found out by the volume of publications and citation analysis, the parameters used are the minimum number of documents of an organization as one and the minimum number of citations of organizations as one. The leading organization in the research regarding “Toxicity of Molybdenum orthopaedic implants”, with the highest number of publications and citations, was the Chinese Academy of Sciences (Refer to table 2).



Table 2: Highlights of the most active organization

Organizations	Country	Documents	Citations	Average Citations per document
Chinese Academy of Sciences	China	19	723	38

Co-authorship analysis of the countries engaged in the research on “Toxicity of Molybdenum orthopaedic implants” had been shown in Table3. The overlay visualization map of co-authorship analysis plotted in Table3, points out the main countries with their strong co-authorship linkages and clusters involved. The citation analysis of top countries had been shown in table 3, along with co-authorship links. For the citation analysis, the parameters used were the minimum number of documents of a country as one and the minimum citations of the country as one.

Table 3: Highlights of Active Countries

Description	Country	Documents	Citations	Link strength
The country with the highest publication, citations, and co-authorship links	United States of America	155	6374	67

The most active country in this research domain was the United States of America, with the highest number of publications, and citations.

Link analysis and citation analysis were used to identify the most active journal in this research domain. We have taken the parameters of the minimum number of documents of a journal as one and the minimum number of citations of a journal as one for the link analysis and citation analysis. Highlights of the most active and relevant journals related to “Toxicity of Molybdenum orthopaedic implants” are shown in table 4. Table 4 shows the journal activity of this research domain through parameters of publication volume, citations, and co-authorship linkages.

Table 4: Analysis of journal activity

Description	Journal details	Documents	Citations	Average citations per documents



Journal with the highest publications	Journal of Plant Nutrition	22	521	17
Journal with highest citations	Toxicological Sciences	1	940	6
Journal with the highest links	Ecotoxicology and Environmental Safety	14	233	35

From the above discussion regarding the review patterns in the research regarding the toxicity of Molybdenum orthopaedic implants, this research had observed a gradual increase in research interest regarding the toxicity of Molybdenum orthopaedic implants from the starting of the millennium, and the momentum is going on positively. This points out the relevance and potential of this research domain (Refer to Table 2). The most active authors in this research domain were Zhang C. and Hussain S. with the highest publication, citations and co-authorship links (Refer to table 1). The overlay analysis of top countries researching the toxicity of Molybdenum orthopaedic implants indicates that the United States of America was the leading country relating to the highest number of publications, citations, and co-authorship links (Refer to Table 5). The top journals of this research domain were identified as the Journal of Plant Nutrition, Toxicological Sciences and Ecotoxicology and Environmental Safety. From these wide sources of information, researchers can focus on top journals where they can identify the most relevant and highly cited articles regarding the toxicity of Molybdenum orthopaedic implants.

#### 4. Conclusion

Toxicity of Molybdenum orthopaedic implants was an interesting research domain and the most active journals related to this research domain were the Journal of Plant Nutrition, Toxicological Sciences and Ecotoxicology and Environmental Safety. The most active country was the United States of America. The leading organization engaged in the research regarding Molybdenum orthopaedic implants was the Chinese Academy of Sciences, China. The most active authors who had made valuable contributions related to Molybdenum orthopaedic implants were Zhang C. and Hussain S with the highest publication, citations and co-authorship links. This research domain offers a new avenue for researchers and future research can be on innovations in toxicity of Molybdenum orthopaedic implants.

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