Mushroom toxicity in academic literature: Holistic analysis of the global publications on mushroom poisoning between 1975 and 2019

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Abstract

Background and objective: Mushroom poisoning is one of the global public health problems. In our study, we aimed to analyze bibliometric and scientometric analysis of mushroom poisoning between 1975 and 2019.

Methods: All data used in the present study were retrieved from Web of Science databases titled Web of Science Core Collection, Russian Science Citation Index, SciELO Citation Index and Korean Journal Database.

Results: A total of 3508 documents were yielded from our preliminary WoS database search. The most productive year was 2018 with 239 documents. The most common documents types were original article, case report, reviews and meeting abstract. United States of America (USA) was the leading country with 667 documents followed by China, Japan and France. All countries in top ten contributor countries list were developed but only Turkey and Poland were developing according to UN criteria. Publications were produced from nearly all regions of the world except for some countries in Africa. Chinese University of Hong Kong (China) was the most contributor institution with 80 documents. Clinical Toxicology was detected to be the most productive source title. Total number of citations was 62,452 times and an average citation per item was 17.8 times. Citations increased gradually, and the peak year was 2019 with 6034 citations.

Conclusion: Findings of our study could help the experts in the fields of toxicology, intensive care and emergency medicine to identify the global research trends and patterns of mushroom toxicity and to offer a basis for future research directions.

Key words: mushroom, mushroom poison, mushroom poisoning, mycetism, bibliometrics, scientometrics, publication trend analysis

Introduction

Mushroom poisoning is one of the global health problems. It is estimated there are more than 5000 mushroom species worldwide. Only 20-25% of mushrooms have been named and 3% of these are poisonous [1,2].

Mushrooms are commonly consumed as food in some countries and regions, while they are treated suspiciously in other countries. Wild mushroom collecting is widespread in Europe (especially Slavic countries and Italy), America and the Far East. However, mushroom collection and consumption is rare in the UK [3,4]. “Mushrooming” is very popular in the USA. In most states, there are societies that organize mushroom-hunting trips emphasizing correct identification and safety. (North American Mycological Association 2017)

It may be difficult to fully and correctly identify mushroom species. Significant morphological variations may occur in the same mushroom species linked to seasons, geographical location and the maturity of the mushroom. Most ingested mushrooms are non-toxic, or are only gastrointestinal irritants and cause mild to moderate degrees of toxic effects [5,6]. In the USA and Europe, nearly all deaths linked to mushroom intoxication belong to the Amanita species (A. phalloides, A.virosa, A. bisporigera) [7,8].

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Ignoring the deliberate consumption of psychoactive mushrooms, the majority of mushroom poisonings are unintended and caused by misidentification of species. Mushroom intoxications due to suicide attempts or criminal actions are very rare events [9,10]. The amount of toxicity varies linked to the age of the mushroom, season, geographical location and the preparation of the mushroom. While one person consuming the same mushroom may show toxicity symptoms, another person may be asymptomatic [7].

A variety of signs and symptoms like gastroenteritis, central nervous system (CNS) disorders and liver failure may occur linked to the toxin contained in poisonous mushrooms [4,11,12]. Though gastroenteritis and CNS disorders are generally temporary, liver failure may be irreversible and deadly without transplantation.

Poisoning due to mushrooms causing gastrointestinal irritation may have mild or moderate degrees of clinical progress, so the majority of these cases are not reported in the literature. However, as gastrointestinal symptoms may occur after intoxication with mushrooms containing amatoxin, it is important to differentiate benign gastroenteritis from life-threatening amatoxin intoxication [13,14].

Bibliometrics is a popular statistical branch to analyze a certain field in the scientific literature by investigating publication trend, contributions of authors, institutions and countries and expectations in academic future [15]. Although there has been an increasing popularity of bibliometric and scientometric researches, to the best of our knowledge this is the first study to analyze literature related to mushroom poisoning.

The first written record of mushroom poisoning is a poem written in the 5th century BC by the Greek poet Euripides about the deaths of a mother and 3 children after eating mushrooms [16]. In our study we aimed to perform bibliometric and scientometric analyses of publications related to mushroom intoxication from 1975 to 2019. This study analyzed the quantitative (global publications output) and qualitative (citation analysis) measures.

Material and methods

All data used in the present study were retrieved from Web of Science databases (WoS) (Thomson Reuters, New York, NY, USA) titled Web of Science Core Collection, Russian Science Citation Index, SciELO Citation Index and Korean Journal Database. We included all materials published between 1975 and 2019. In our search we used the keywords of “mushroom poisoning”, “mushroom toxicity”, “mushroom poisonous”, “mushroom poison”, “mushroom intoxication” and “mycetism”. We generated an info-map to clarify global productivity in this field by using GunnMap source and info-graphics to create bibliometric connection networks by using VosViewer software [17,18].

Results

General features of the literature

A total of 3,508 documents were yielded from our preliminary WoS database search. English was the primary language of the literature (93.13 %) followed by German, French, Spanish and Korean (3.44, 2.30, 1.65 and 1.39, respectively). The most productive year was 2018 with 239 documents (Figure 1). The most common documents types were original article, case report, reviews and meeting abstract (n= 3097, 338, 304 and 303 items, respectively; Table 1). The most searched areas in this field were detected to be toxicology, pharmacology, biochemistry, and microbiology (71.57, 49.45, 49.23 and 44.18%, respectively; Table 2).
Global productivity and performances of the countries

As we investigated the contributions of the countries to the literature we noted that the United States of America (USA) was the leading country with 667 documents followed by China, Japan and France (n=327, 305 and 189 items, respectively, Figure 2). All countries in top ten contributor countries’ list were developed but only Turkey and Poland were developing according to UN criteria [19]. Publications were produced from nearly all regions of the world except for some countries in Africa (Figure 3).

Authors, institutions, journals and academic meetings

Falandysz J, Ferreira ICFR and Kawagishi H were detected to be the most prolific authors in this field (n=67, 58 and 40, respectively; Table 3). Chinese University of Hong Kong (China) was the most contributor institution with 80 documents followed by University of California (USA) and University Of Gdansk (Poland) (n=78 and 74 documents, respectively; Table 4). Clinical Toxicology was detected to be the most productive source title with 127 articles followed by International Journal of Medicinal Mushrooms and Food And Chemical Toxicology (n=96 and 56 items, respectively; Table 5). We noted that the most contributor academic meeting was Annual Meeting of the North American Congress of Clinical Toxicology with 21 abstracts in this field.

Citation analysis of the literature

We measured H-index of the literature as 99. Total number of citations was 62,452 times and an average citation per item was 17.8 times. Citations increased gradually, and the peak year was 2019 with 6034 citations. A review titled “Mushrooms, tumors, and immunity” by Borchers, AT, Stern JS, et al. published in 1999 was the most cited article (369 times totally, Table 6).

Bibliometric network analysis

Detailed keyword analysis of the literature revealed the most used keywords such as “mushroom poisoning”, “mushroom(s)”, “toxicity”, “poisoning” and “Amanita Phalloides”. We created a bibliometric keyword network and we noticed a multi-branched pattern this keywords centered (Figure 4). We generated a cooperation network of the countries and found that the USA was the most collaborative country in the literature (Figure 5).
Table 6: The 10 most cited manuscripts in mushroom poisoning literature

| Article | Author(s) | Journal Name/Year | Total Citation | Average Citations per Year |
|---------|-----------|------------------|---------------|---------------------------|
| Mushrooms, tumors, and immunity | Borchers, AT; Stern, JS; et al. | Proceedings Of The Society For Experimental Biology And Medicine, 1999 | 369 | 16.77 |
| Silymarin: A review of its clinical properties in the management of hepatic disorders | Wellington, K; Jarvis, B | Biodrugs, 2001 | 345 | 17.25 |
| Treatment of amatoxin poisoning: 20-year retrospective analysis | Enjalbert, F; Rapior, S; et al. | Journal Of Toxicology-Clinical Toxicology, 2002 | 239 | 12.58 |
| Hepatotoxicity of botanicals | Stockel, Felix; Egerer, Gerlinde; et al. | Public Health Nutrition, 2000 | 173 | 8.24 |
| A mini-review of chemical composition and nutritional value of edible wild-grown mushroom from China | Wang, Xue-Mei; Zhang, Ji; et al. | Food Chemistry, 2014 | 161 | 23.0 |
| Cytotoxic fungi - an overview | Karlsson-Stiber, C; Persson, H | Toxicon, 2003 | 157 | 8.72 |
| Toxins of Amanita phalloides | Vetter, J | Toxicon, 1998 | 152 | 6.61 |
| Gene family encoding the major toxins of lethal Amanita mushrooms | Hallen, Heather E.; Luo, Hong; et al. | Proceedings Of The National Academy Of Sciences Of The United States Of America, 2007 | 148 | 10.57 |
| Functional properties of edible mushrooms | Chang, R | Nutrition Reviews, 1996 | 148 | 5.92 |
| Kinetics of amatoxins in human poisoning – therapeutic implications | Jaeger A; Jehl F; et al. | Journal Of Toxicology-Clinical Toxicology, 1993 | 123 | 4.39 |

Figure 4 - Keyword network in research field

Figure 5 - Collaborative country network in research field

Discussion

Since the first report that Pritzard proposed the term of “bibliometrics” there have been many bibliometric studies published in the literature [20]. Bibliometrics uses statistical and mathematical methods to measure contributions of researchers, foundations and countries to the literature. To the best of our knowledge, our study is the first bibliometric research in the field of mushroom toxicity.

There are many cases of mushroom poisoning reported each year from regions with excess mushroom consumption. The main causes of mushroom poisoning are insufficient information and misidentification of species. Some species contain dangerous toxins causing a variety of symptoms and syndromes. Not only poisonous mushrooms, some edible mushroom species may contain poisonous compounds. The severity of poisoning is linked to the amount consumed. Correct identification of mushrooms is the basic step to ensure the possibility of successful treatment by preventing poisoning and rapidly identifying poisoning symptoms.

It is important that people know that the toxins in most poisonous mushroom species are resistant to cooking, conserving, freezing and any other processing. As a result, the only way to prevent intoxication is to avoid consuming poisonous species. There is no international guideline for mushroom intoxication cases. Treatment is directed by clinical symptoms and there are no antidotes for the majority of mushroom toxins. Modern intensive care treatments have significantly reduced mushroom mortality and morbidity [21]. Diagnosis of mushroom intoxication should be based on accurate identification of the mushroom, clinical features and laboratory analyses [22].

Mortal mushroom intoxication cases have been reported previously. Additionally, the features of the toxins, syndromes and toxicity mechanisms have not been summarized. As a result, it is very important to review information about mushroom
toxins and deaths. To identify the possible side effects of edible and medical mushrooms and to ensure safe consumption, experimental and clinical research is required.

Due to reasons such as the “return to nature” in recent years and increased demand for organic food, it is stated there may be an increase in mushroom poisonings [4]. According to our study, the highest number of publications was made in the last 3 years, with 2018 the most productive year with 239 documents. Similarly citations increased gradually, and the peak year was 2019 with 6034 citations. Markers of the popularity of this topic are the total of 62452 citations and 17.8 average citations per item.

We have seen that almost all regions of the world have produced publications related to mushroom poisoning, except some parts of Africa. We think this is evidence that mushroom poisoning is a global public health problem.

Findings of our study could help the experts in the fields of toxicology, intensive care and emergency medicine to identify the global research trends and patterns of mushroom toxicity and to offer a basis for future research directions.

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