Journal : *JMMR (Jurnal Medicoeticolegal dan Manajemen Rumah Sakit), 12 (1): 1-13, April 2023*
Website : https://jmmr.umy.ac.id/index.php/jmmr
DOI : https://doi.org/10.18196/jmmr.v12i1.30

Bibliometric Analysis: Antibiotics Compounds as Persistent Origanic Pollutants in Hospital Wastewater

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INDEXING

Keywords:
Antibiotics;
Persistent;
Hospital;
Wastewater;
Bibliometric;

ABSTRACT

Written in English with a single space. Abstract includes a description of the purpose Hospitals produce domestic waste containing medicinal micropollutants, which are persistent and harmful to the environment and living things. Conventional wastewater treatment has not been able to remove persistent organic compounds properly. Bibliometric analysis in this study aims to identify antibiotic compounds as persistent organic pollutants in hospital wastewater. This study aims to obtain the results of the characterization of pharmaceutical product compounds as persistent organic pollutants in hospital domestic wastewater. The method used was qualitative descriptive to describe the bibliometric analysis performance by producing a network visualization of the chosen topic. The bibliometric analysis used Publish or Perish software as a search tool for journal metadata and Vosviewer as software to help find research gaps. This article is a bibliometric analysis using Scopus-indexed journals. The development of Scopus indexed international scientific publications on the topic of antibiotics in hospital wastewater during 2010 - 2022 on Scopus totaling 954 articles published in publications with the subject of environmental science, health, science, pharmacy, and engineering, with the most types of publications being in research articles and review article. Of the 10 articles with the highest citations, they could be grouped into 2 types of articles, 7 of which were research articles and 3 were literature articles reviews.

Kata kunci:
Antibiotik;
Persisten;
Rumah sakit;
Air limbah;
Bibliometrik;

Rumah sakit merupakan salah satu penghasil limbah domestik yang mengandung mikropolutan obat yang bersifat persisten dan berbahaya bagi lingkungan dan makhluk hidup. Pengolahan air limbah konvensional belum mampu menghilangkan senyawa organik yang persisten dengan baik. Analisis bibliometrik pada penelitian ini bertujuan untuk mengidentifikasi keberadaan senyawa antibiotik sebagai pencemar organik yang persisten dalam air limbah rumah sakit. Penelitian ini bertujuan untuk mendapatkan hasil karakterisasi senyawa produk farmasi sebagai bahan pencemar organik yang persisten dalam air limbah domestik rumah sakit. Metode yang digunakan adalah deskriptif kualitatif untuk mendeskripsikan kinerja analisis bibliometrik dengan menghasilkan visualisasi jaringan dari topik yang dipilih. Analisis bibliometrik menggunakan software Publish or Perish sebagai alat pencarian metadata jurnal dan Vosviewer sebagai software untuk membantu menemukan research gap. Artikel ini merupakan analisis bibliometrik dengan menggunakan jurnal terindeks Scopus. Perkembangan publikasi ilmiah internasional terindeks Scopus dengan topik antibiotik dalam air limbah rumah sakit selama tahun 2010 – 2022 di Scopus sebanyak 954 artikel yang diterbitkan dalam publikasi dengan subjek ilmu lingkungan, kesehatan, sains, farmasi dan teknik dengan jenis publikasi terbanyak di berupa artikel penelitian dan artikel review. Dari 10 artikel dengan sitasi tertinggi dapat dikelompokkan menjadi 2 jenis artikel, yaitu 7 artikel penelitian dan 3 artikel literature review.

Article history: Received 2023-01-09; Revised 2023-03-07; Accepted 2023-03-20

INTRODUCTION

The largest use of drugs occurs in China, Brazil, India, Russia and Indonesia. The increasing need for drugs for the community encourages the production of pharmaceutical compounds because research results showed progress, and the discovery of pharmaceutical compounds has provided healing and improved the quality of human health (Chavoshani et

al., 2020). Drugs, especially antibiotics, contained in wastewater treatment plants (WWTPs) and the natural environment have led to the development of antibiotic-resistance genes, which will result in the growth and development of resistant pathogens that have the potential to cause deadly diseases or cause new diseases to emerge (Tiwari et al., 2020). As an institution in the health sector, the hospital has the potential to become a source of antibiotic residue contamination. Patients with bacterial infections will consume antibiotics and can only absorb 30–90% of the total concentration of the antibiotic drug. At the same time, the rest will be excreted again through feces and urine of antibiotic residues. This condition causes the accumulation of antibiotic residues in hospital wastewater treatment plants (WWTP), where most WWTPs in Indonesia still use biological systems. Based on previous research, the WWTP system has not been effective in reducing the presence of antibiotic residues in wastewater (Herawati et al., 2022). Carbon emission from wastewater treatment activities is influenced by the type of biological WWTP system and the level of degradation wastewater. The highest carbon emission of both WWTP resulted from the organic matter removal process, followed by electrical energy consumption and emission from effluent (Setianingsih et al., 2022).

Humans consume medicines and can flow into the environment through sewage, sewage, sewage treatment plants and other channels, causing serious consequences for the ecology of the environment, animals, plants and humans (Zhao et al., 2021). Since the discovery of antibiotics in the 20th century, they have been widely used in human medical treatment to cure infectious diseases caused by bacteria. Prolonged exposure to antibiotics can cause adverse consequences in the human body, causing drug resistance and inducing consistent genetic resistance and resistant bacteria in the environment. Its presence in wastewater can cause groups of bacteria to become resistant. In addition, it can affect the natural development, growth and mobility of various microorganisms, affecting water ecosystems (Thi et al., 2021).

According to the Stockholm Convention, persistent organic pollutants (POPs) consist of three categories: 1) pesticides in the form of Dichloro-diphenyl-trichloroethane (DDT), Aldrin, Endrin, Dieldrin, Chlordane, Heptachlor, Mirex, and Toxaphene; 2) industrial chemicals in the form of Polychlorinated biphenyl (PCB) and Hexachlorobenzene (HCB); and 3) products that are accidentally produced in the form of Polychlorinated dibenzo-p-dioxins (PCDD), Polychlorinated dibenzofurans (PCDF), Hexachlorobenzene (HCB) and Polychlorinated biphenyl (PCB) (President of the Republic of Indonesia, 2009). Some new POP compounds under review by the POP Review Committee are perfluorobutane sulfonate, dechloran plus, and methoxychlor. Emerging pollutants such as some drugs and antibiotics such as norfloxacin, carbamazepine, diclofenac, and ibuprofen are also considered persistent chemicals. Its persistent properties comply with the chemical persistence criteria in water and soil established by the United Nations Environmental Program and Canadian Environmental Protection Agency (Bu et al., 2016).

In recent years, several articles regarding antibiotics in hospital wastewater have been published as research articles and literature reviews with various research methods. However, in Indonesia, no bibliometric analysis has been carried out regarding antibiotic compounds as persistent organic pollutant compounds (POPs) in hospital wastewater from several

scientific publications in Scopus-indexed journals. This bibliometric analysis needs to be done in Indonesia.

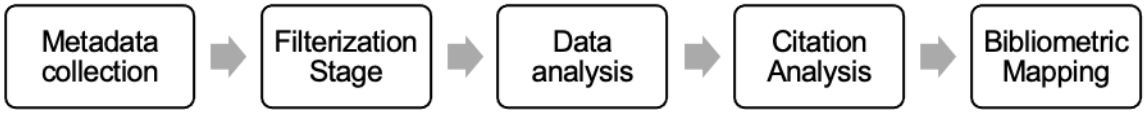
The urgency of this research is due to the increasing population in Indonesia. The number of hospitals and inpatients who consume drugs is also increasing. The persistent release of medicinal micropollutant content into sewers is about ng ~ µg/L continuously flowing into the environment, and wastewater will harm the health of living things and the environment. The novelty raised in this study is bibliometric analysis methods to characterize antibiotic product compounds as persistent organic pollutant compounds in hospital wastewater. This study aimed to determine the development of scientific articles in Scopus-indexed international journals on antibiotics in hospital wastewater from 2010 to 2022. The formulation of the problem in this research is (1) How is the number of developments of Scopus-indexed international scientific publications on the topic of antibiotics in hospital wastewater during the years 2010 - 2022 on Scopus?; (2) What types of publications have the highest citations on the topic of antibiotics in hospital wastewater during 2010 - 2022?; (3) What country statistics resulted in the publication of articles on antibiotics in hospital wastewater during 2010-2022?; (4) What are the characteristics of antibiotics in hospital wastewater based on the bibliometric analysis development map using VOSviewers using keywords?

RESEARCH METHOD

This study is a descriptive design using bibliometric analysis, which began with a search for articles from previous research using scopus.com as the main data provider. Scopus was chosen because it provides international journal data with a high reputation, is informative and has become a reference for several researchers in writing articles and can facilitate data analysis on the number of articles based on the year of publication, author, affiliation, country, type of publication and subject area of publication as well as providing search features and navigation that makes it easier for researchers to understand the information needed precisely and accurately (Herawati et al., 2022).

The scientific article metadata was collected on February 12, 2022, using the keyword "Antibiotic in hospital wastewater" from 2010 to 2020. Furthermore, the resulting article metadata was analyzed for the number of documents based on year of publication, author, affiliation, country, publication type and subject area of publication (Effendy et al., 2021). Then, an evaluation study was conducted using the VOSViewer software to produce a bibliometric map to be interpreted and analyzed for several articles with the highest citations.

The research stages are briefly presented in Picture 1.

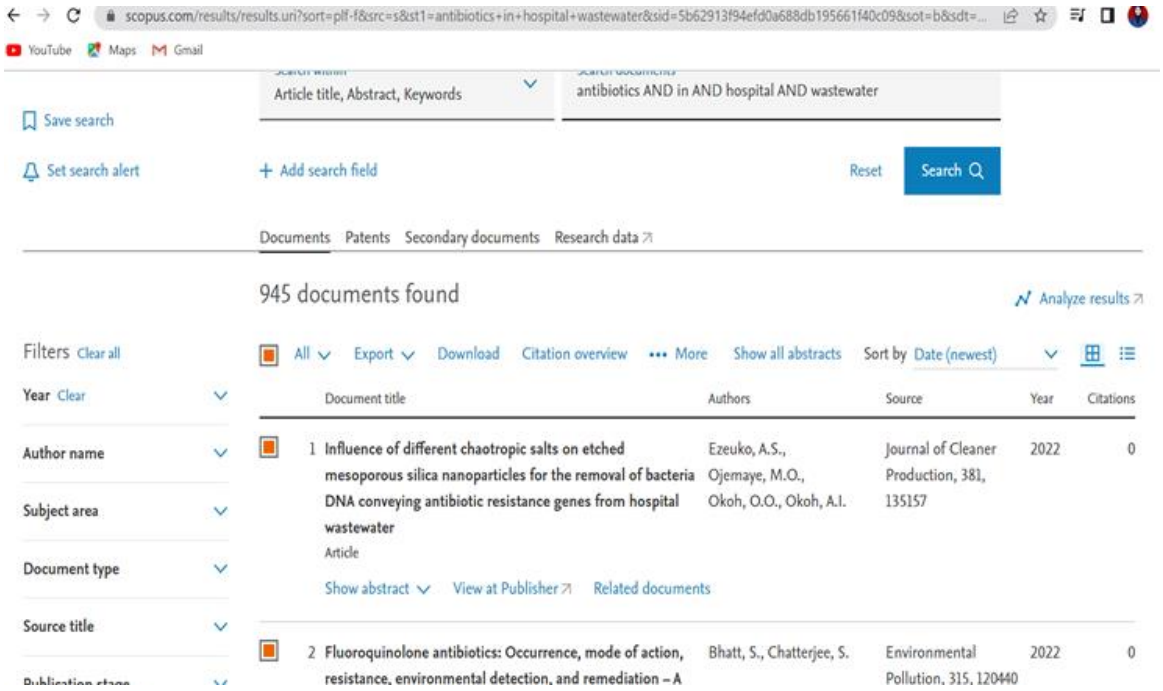


Picture 1. Research stages

RESULT AND DISCUSSION

1. Metadata Collection

Data was collected by searching the scopus.com metadata based on the keyword "antibiotics in hospital wastewater" (antibiotics in hospital wastewater) published in scientific articles from 2010 to 2022. This data search process resulted in 945 documents consisting of several types of Scopus-indexed international journal articles and proceedings. The process of searching for this data is presented in Picture 2.

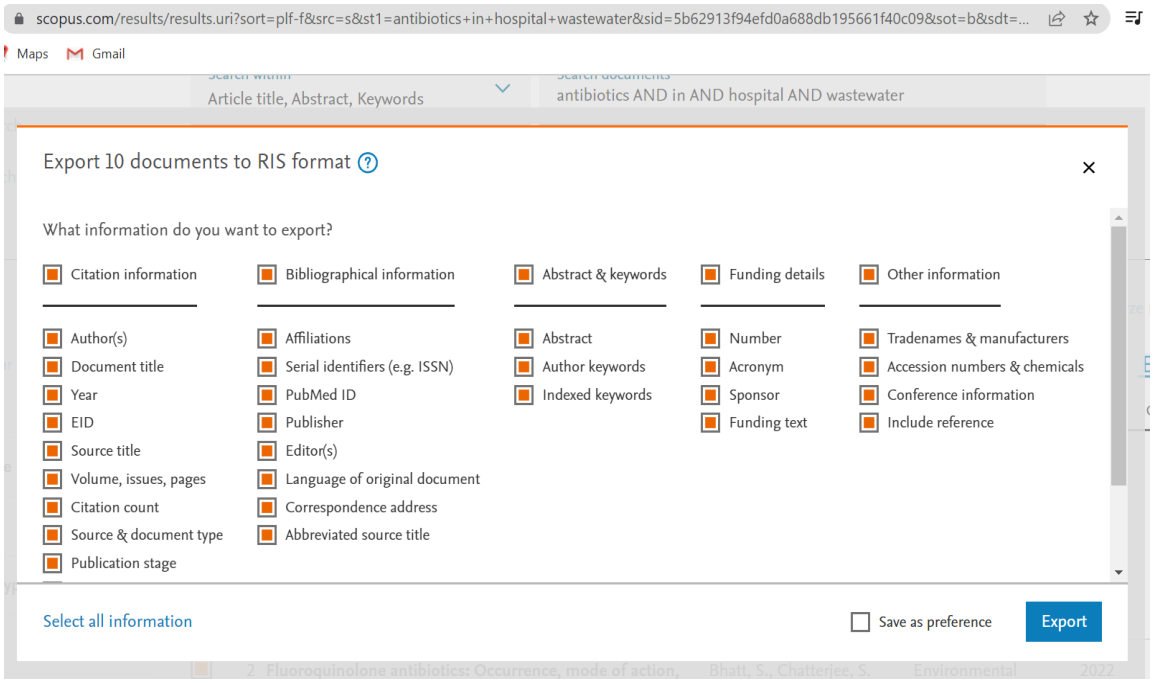


Picture 2. Data search process from Scopus.com

The number of publications related to antibiotics in hospital wastewater in the Scopus database shows that antibiotics in hospital wastewater are a topic of concern in previous studies.

2. Filtration Stage

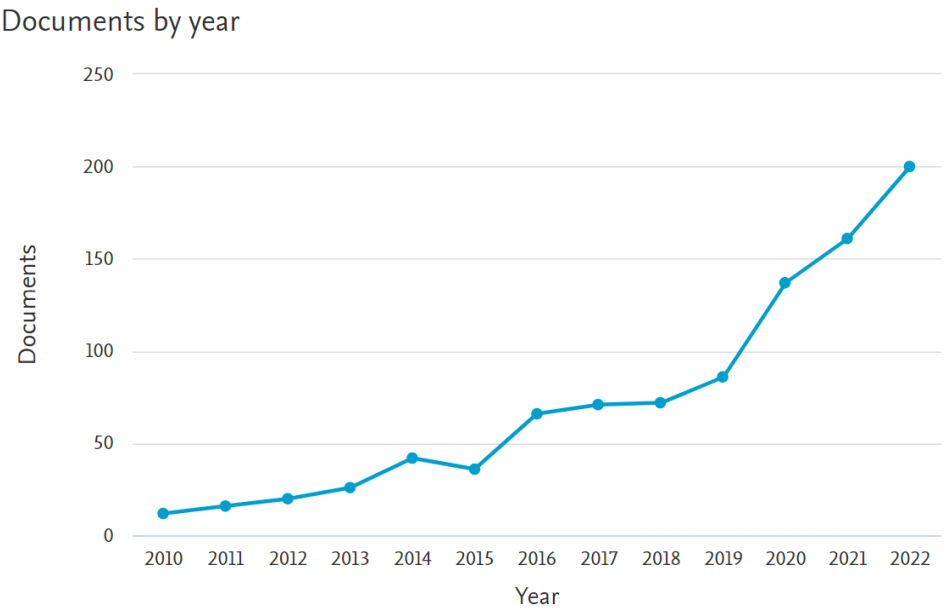
The metadata export was carried out at this stage, produced at the metadata collection stage, which had previously collected 945 scientific articles relevant to antibiotics in hospital wastewater. Before exporting the data, some necessary information was marked, such as citation information, bibliographic information, abstracts and keywords, funding details and other information, which was then exported metadata (metadata documents are stored in RIS).



Picture 3. Selection of the type of information studied in article metadata

3. Data Analysis

At this stage, data analysis was carried out on the number of articles based on the year of publication, author, affiliation, country, type of publication and subject area. Analysis of the number of articles based on the year of publication is presented in Picture 4.

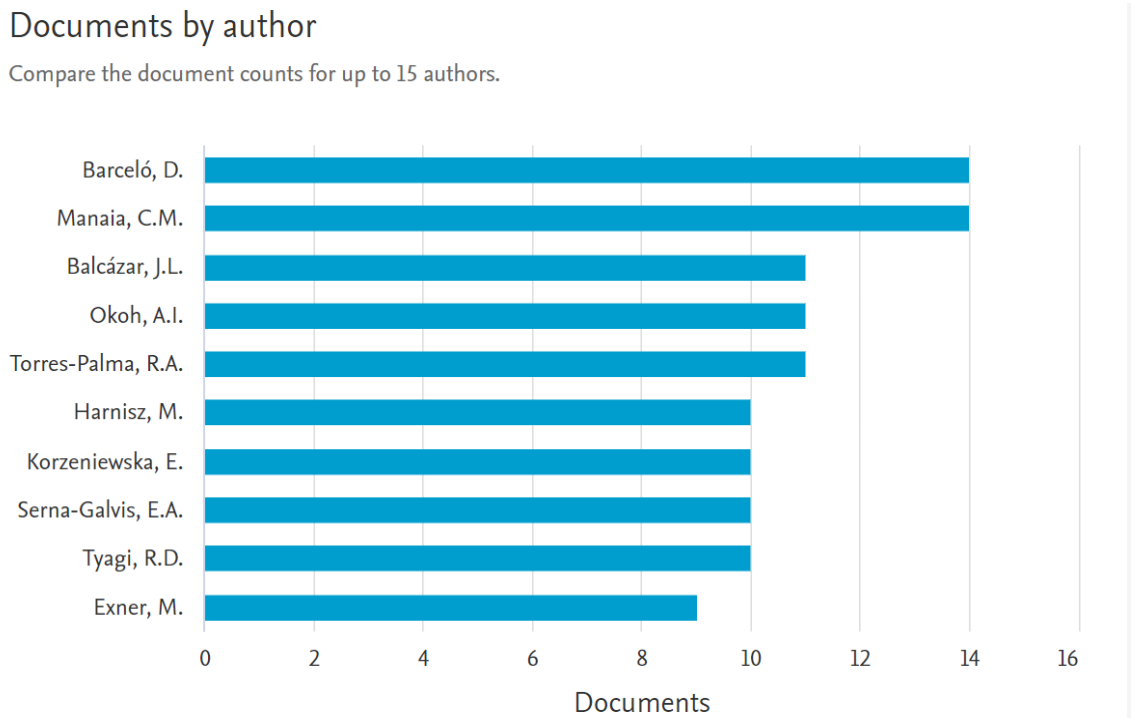


Picture 4. Development of the number of publications during 2010-2022

Picture 4 shows that the number of articles relevant to the topic of antibiotics in hospital wastewater was published in 2010 with 12 articles, 2011 with 16 articles, 2012 with

20 articles, 2013 with 26 articles, 2014 with 42 articles, 2015 with 36 articles, 2016 with 66 articles, 2017 with 71 articles, 2018 with 72 articles, 2019 with 86 articles, 2020 with 137 articles, 2021 with161 articles, and 2022 with 200 articles. The finding shows an increase in publications every year, meaning that this research is still a topic of important concern at the international level (Rinaldi, 2022).

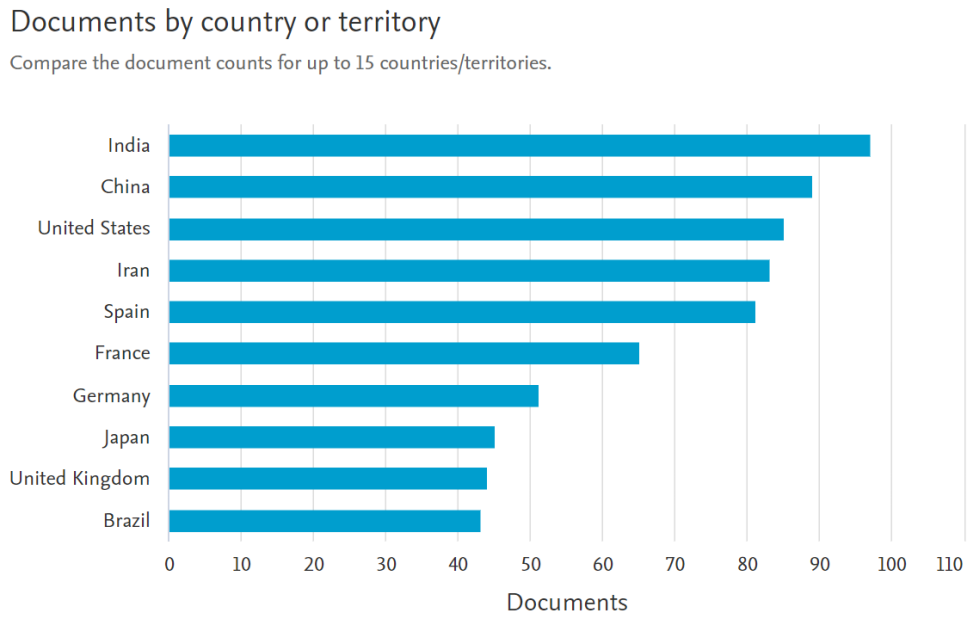
Furthermore, the authors' analysis with the highest number of articles is presented in Picture 5.



Picture 5. Top ten researchers on the topic of hospital wastewater antibiotics

The image above shows Barcelo and Manaia with 14 articles each, followed by Balcazar, Okoh and Torres Palma with 12 each, Harnizs, Korzeiniewska, Serna-Galvis, and Tyagi with 10 articles each, and Exner which has 9 articles relevant to the topic of antibiotics in hospital wastewater. Foreign researchers still dominate interest in researching antibiotics in hospital wastewater.

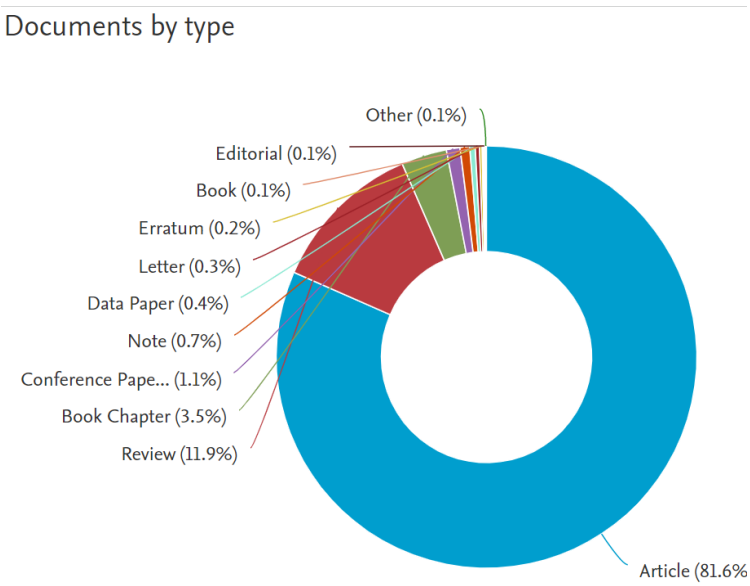
Furthermore, the analysis of countries that produce the highest number of articles is presented in Picture 6.



Picture 6. Top ten countries that produce article publications

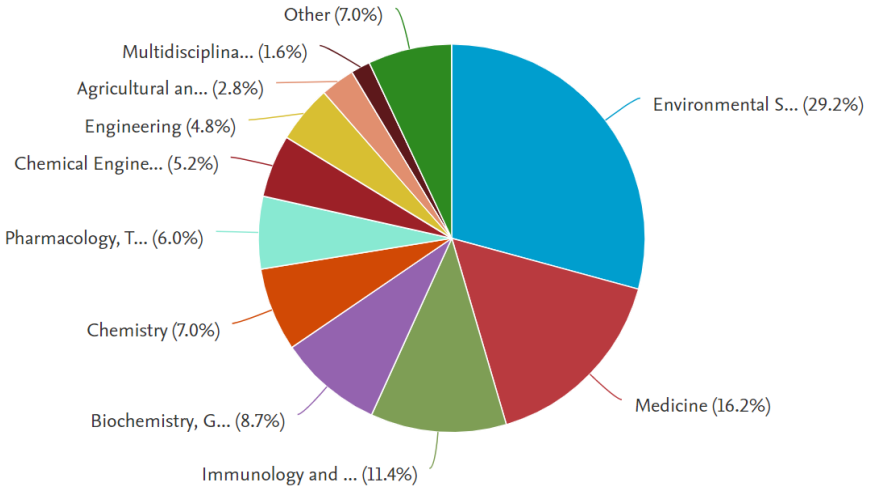
Picture 6 shows the top ten countries that produce the most Scopus-indexed article publications, such as India, China, United States, Iran, Spain, France, Germany, Japan, United Kingdom and Brazil, each of which produces article publications on Scopus that are relevant to the topic of antibiotics in hospital wastewater as many as 97, 89, 85, 83, 81, 65, 51, 45, 44 and 43 articles. Interest in researching antibiotics in hospital wastewater has spread across several parts of the world and is not centered on just one continent. However, there are still far fewer publications from African countries than from other continents, so they do not appear in this top ten analysis (Dewi & Jauhariyah, 2021).

Furthermore, the analysis of most publications is presented in Picture 7.



Picture 7. Top ten types of publications that result in article publications

Picture 7 shows the top ten types of Scopus-indexed publications, such as research articles, review articles, book chapters, conference articles, notes, data papers, letters, erratum, books and editorials, respectively 771, 112, 33, 10, 7, 4, 3, 2, 1 and 1 articles. Most of the publications related to the topic of antibiotics in hospital wastewater are dominated by research articles. Furthermore, publication analysis based on most subject areas is presented in Picture 8.



Picture 8. The subject area of the article publication

Picture 8 shows the highest publication subject area published in several indexed journals distributed in several subject areas. Information obtained in detail includes publications on the subject of environmental science with 504 articles (29.2%), medicine with 280 articles (16.2%), Immunology and toxicology with 196 articles (11.4%), biochemistry, genetics and molecular biology 150 articles (8.7%), chemistry 120 articles (7.0%), Pharmacology, Toxicology and Pharmaceutics 104 articles (6.0%), Chemical Engineering 90 articles (5.2%), Engineering 83 articles (4.8%), Agricultural and Biological Sciences 49 articles (2.8%), Multidisciplinary and others 149 articles (8.6%). The subject areas that dominate the publication of articles on antibiotics in hospital wastewater include environmental science, health, science, pharmacy and engineering.

4. Citation analysis

At this stage, citation rankings were carried out with publish or perish software to map the number of citations of selected articles in the ten highest rankings and Microsoft Excel to display details of the article publication. The appearance of a high h index on articles relevant to antibiotics in hospital wastewater indicated the selection of articles with the highest citation.

After being analyzed using publish or perish software, 10 (ten) articles with the highest citations were obtained compared to other articles. Of the 10 articles with the highest citations, they could be grouped into 2 types of articles, 7 of which were research articles and

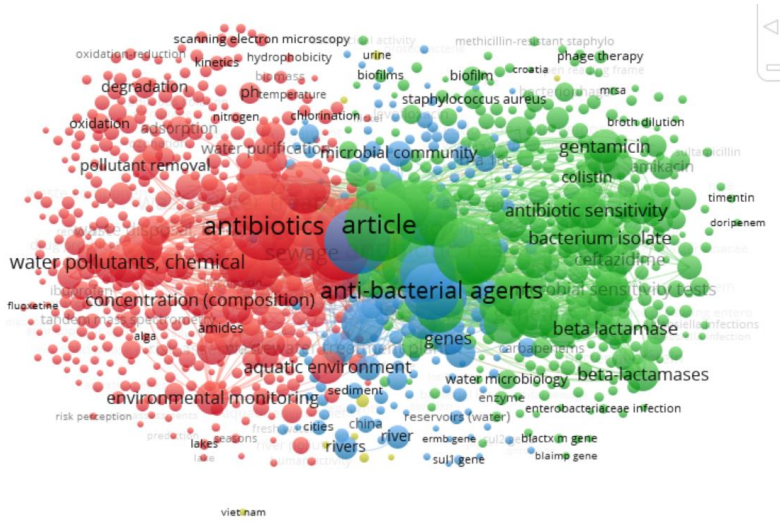
3 were literature articles reviews. Details of the number of citations, article title, year of publication, author's name and source are presented in Table 1.

Table 1. Top ten articles with the highest number of citations

No	Sitasi	Title	Year	Source
1	2403	Comprehensive evaluation of antibiotics emission and fate in the river basins of China: Source analysis, multimedia modeling, and linkage to bacterial resistance	2015	Environmental Science and Technology (Zhang et al., 2015)
2	937	Occurrence of antibiotics and antibiotic resistance genes in hospital and urban wastewaters and their impact on the receiving river	2015	Water Research (Rodriguez-Mozaz et al., 2015)
3	929	Dissemination of NDM-1 positive bacteria in the New Delhi environment and its implications for human health: An environmental point prevalence study	2011	The Lancet Infectious Diseases (Walsh et al., 2011)
4	531	Management options for reducing the release of antibiotics and antibiotic-resistance genes to the environment	2013	Environmental Health Perspectives (Pruden et al., 2013)
5	504	Occurrence, sources, and fate of pharmaceuticals in aquatic environment and soil	2014	Environmental Pollution (Li, 2014)
6	436	Detection and fate of antibiotic-resistant bacteria in wastewater treatment plants: A review	2013	Ecotoxicology and Environmental Safety (Bouki et al., 2013)
7	415	Occurrence and removal of transformation produc of PPCPs and illicit drugs in wastewaters: A review	2015	Science of the Total Environment (Evgenidou et al., 2015)
8	405	Contribution of hospital effluents to the load of pharmaceuticals in urban wastewaters: Identification of ecologically relevant pharmaceuticals	2013	Science of the Total Environment (Santos et al., 2013)
9	405	Hospital effluent: Investigation of the concentrations and distribution of pharmaceuticals and environmental risk assessment	2012	Science of the Total Environment (Verlicchi et al., 2012)
10	402	Antibiotic Pollution in the Environment: A Review	2015	Clean - Soil, Air, Water (Gothwal & Shashidhar, 2015)

5. Bibliometric mapping

The metadata generated in the data collection process was then used to produce a biometric map regarding the publication of international research results related to antibiotics in hospital wastewater using Vosviewers. RIS files are entered into the VOSviewers application for bibliometric analysis based on metadata. The development of Scopus-indexed international article publications from 2010 to 2022 shows the relationship between keywords, as shown in Picture 9.



Picture 9. Bibliometric map of the development of antibiotic research in hospital wastewater (Source: Scopus metadata processed by VOSviewers)

The picture above shows that linking keywords to research on antibiotics in hospital wastewater produces 4 clusters. The red cluster consists of antibiotics, acetonitrile, ammonia, adsorption, algae, amoxicillin, atenolol, azithromycin, bezafibrate, bioaccumulation, biodegradation, biohazard, bioreactor, biomolecule, caffeine, carbamazepine, catalyst, cell, chlorine, citalopram, clarithromycin, cloxacillin, clofibric acid, copper, cosmetics, crustacea, diazepam, dicloxacillin, diethyltoluamide, diphenhydramine, doxycycline, ecotoxicity, emerging contaminants, endocrine disruptor, enrofloxacin, erythromycin, florfenicol, flumequine, fluoroquinolones, fluoxetine, gemfibrozil, hospital wastewater, ketoprofen, lorazepam, losartan, metformin, metoprolol, metronidazole, naproxen, neomycin, norfloxacin, ofloxacin, oxytetracycline, paracetamol, penicillin g, propranolol, roxithromycin, salicylic acid, spectinomycin, sulfadiazine, sulfadimethoxine, sulfadiazine, sulfamerazine, sulfamethoxazole, sulfapyridine, sulfathiazole, tamoxifen, tramadol, trimethoprim, thyroxine, valsartan, venlafaxine. The green cluster consists of Acinetobacter, aeromonas, amikacin, aminoglycoside, ampicillin, aztreonam, bacterial gene, beta-lactams, biofilm, carbapenem, cefalotin, cefazolin, cefepime, cefixime, cefotaxime, cefoxitin, cefpodoxime, ceftazidime, ceftriaxone, cefuroxime, cephalosporin, chloramphenicol, ciprofloxacin, clindamycin, colixin, cotrimoxazole, enzyme, Escherichia coli, fosfomycin, genetic, gentamicin, hospitalization, kanamycin, levofloxacin, meticiline, minocycline, moxifloxacin, nitrofurantoin, oxacillin, piperacillin, quinolones, rifampicin, sultamicillin, tetracycline, ticarcillin, tigecycline, timentin, tobramycin and vancomycin. The blue cluster consists of aminoglycoside, angiotensin receptor antagonist, anti-bacterial agent, antibiotic resistance genes, bacitracin, bacteriology, biodiversity, enterococcus, environmental pollutants, fecal coliform, fluoroquinolones resistance, gammaproteobacteria, genetic elements, health risks, hospital effluents, pathogens, persistence, resistant bacteria, sulfonamides, wastewater effluents. The yellow cluster comprises hospitals, Rio de Janeiro, swine, slaughterhouses, urine, pigs, rural areas, Vietnam, laboratory methods and municipal solid waste.

CONCLUSION

Based on the results and discussion, (1) The development of Scopus-indexed international scientific publications on antibiotics in hospital wastewater during 2010 - 2022 on Scopus as many as 954 articles published in publications with the subject of environmental science, health, science, pharmacy and techniques; (2) The type of publication with the highest citations on antibiotics in hospital wastewater during 2010 - 2022 was review articles in several science and environmental journals. (3) Several countries that produced the highest ranking of articles published on antibiotics in hospital wastewater during 2010-2022 were India, China, United States, Iran, Spain, France, Germany, Japan, United Kingdom and Brazil (4) Characteristics of antibiotics in hospital wastewater based on bibliometric analysis development maps using VOSviewers including amoxicillin, azythromycin, clarithromycin, cloxacillin, dicloxacillin, doxycycline, enrofloxacin, erythromycin, florfenicol, flumequine, fluoroquinolones, fluoxetine, neomycine, norfloxacin, ofloxacin, oxytetracycline, roxithromycin, spectinomycin , sulfadiazine, sulfadimethoxine, sulfadimizine, sulfamerazine, sulfamethoxazole, sulfapyridine, sulfathiazole, trimetrophim, tyloxine, venlafaxine, amikacin, ampicillin, cefalotin, cefazolin, cefepime, cefixime, cefotaxime, cefoxitine, cefpodoxime, ceftazidime, ceftriaxone, cefuroxime, cephalosporin , clindamycin, colixin, c otrimoxazole, enzyme, fosfomycin, gentamicin, kanamycin, levofloxacin, meticiline, minocycline, moxifloxacin, nitrofurantoin, oxacillin, piperacillin, quinolones, rifampicin, sultamicillin, tetracycline, ticarcillin, tigecycline, timentin, tobramycin and vancomycin.

ACKNOWLEDGMENT

The authors would like to thank Universitas Pelita Bangsa for supporting research funds to run fluently.

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