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THE RELATIONSHIP OF BREAST CANCER, BIOMINERALIZATION DISORDERS AND BONE METASTASES: A BIBLIOGRAPHICAL ANALYSIS

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Bone metastases are the most common and hard-to-treat complication of BC. About 70% of patients with metastatic BC have distant bone relapses during the disease. BC always leads to the death of patients within 5-10 years, and this statistic has not changed in the last 2-3 decades. The work aims to carry out a bibliometric analysis of the interrelationships of BC, processes of biomineralization (calcification), and metastases of BC to bone tissue. The authors searched electronic databases such as PubMed, Scopus, Web of Science, and Google Scholar for the period 1973-2023 using key terms such as "breast cancer," "calcification," and "bone metastases." For bibliometric analysis, an online platform for monitoring and analyzing international scientific research using visualization tools and current citation metrics SciVal (Scopus), and a tool for building and visualizing bibliometric networks VOSviewer, were used. The authors used Scopus database bibliometric tools to analyze the year, source, type of study, subject area, and country of the publication. The VOSviewer system from the University of Leiden (<https://www.vosviewer.com/download>) was used to generate and visualize the bibliometric network. We found and examined 103 publications in the Scopus database using the keywords "breast cancer," "calcification," and "bone metastases" for the period 1973-2023. The results of the bibliometric analysis indicate that the number of publications on the specified subject has grown significantly (with small fluctuations) over the past 20 years, indicating scientists' interest in the problem and ways to solve it. The complex relationship between pathological biomineralization, breast cancer, and bone metastases is being actively studied by scientists, mainly from the United States of America, Germany, and Italy. Using the tool for building and visualizing bibliometric networks VOSviewer of publication activity for the period 1973-2023 in the researched topics of BC with calcification, we identified four chronological stages, which include: 1) radiological and biochemical research methods, 2) research on the effectiveness of diagnostics and treatment, including .h pathomorphological assessment of pathology, 3) fundamental studies of bone and mineral metabolism, 4) a practically oriented period of research. We also divided the identified publications into six thematic clusters: 1) application of radiological methods, 2) bone and mineral metabolism in conditions of pathology, 3) clinical diagnosis and prediction of the course of related pathology, 4) biomaterials and nanotechnology, 5) chemotherapy of oncopathology and its consequences, 6) fundamental molecular genetic research.

Key words: breast cancer, calcification, bone metastases, bibliometry, Scopus, VOSviewer.

ЗВ'ЯЗОК РАКУ ГРУДНОЇ ЗАЛОЗИ, ПОРУШЕННЯ БІОМІНЕРАЛІЗАЦІЇ ТА КІСТКОВИХ МЕТАСТАЗІВ: БІБЛІОГРАФІЧНИЙ АНАЛІЗ

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Метастази в кістки є найбільш поширеним та важковиліковним ускладненням РГЗ. Близько у 70% пацієнтів з метастатичним РГЗ спостерігається віддалений кістковий рецидив під час перебігу хвороби. РГЗ маже завжди призводить до загибелі пацієнтів впродовж 5-10 років, при чому ця статистика не змінилася за останні 2-3 десятиліття. Метою роботи є проведення бібліометричного аналізу взаємозв'язків РГЗ, процесів біомінералізації (кальцифікації) та метастазів РГЗ до кісткової тканини. Матеріали і методи. Автори провели пошук інформації в електронних базах даних, таких як PubMed, Scopus, Web of Science та Google Scholar, за період 1973-2023 років за такими ключовими термінами, як «рак грудної залози», «кальцифікація», «кісткові метастази». Для бібліометричного аналізу застосовувалися онлайн-платформа для моніторингу та аналізу міжнародних наукових досліджень з використанням інструментів візуалізації та сучасних метрик цитування SciVal (Scopus) та інструмент для побудови та візуалізації бібліометричних мереж VOSviewer. The authors used Scopus database bibliometric tools to analyze the year, source, type of study, subject area and country of the publishing. The VOSviewer system from the University of Leiden (<https://www.vosviewer.com/download>) was used to generate and visualize bibliometric network. Автори використовували бібліометричні інструменти бази даних Scopus для аналізу року, джерела, типу дослідження, предметної галузі та країни видання. Для генерації та візуалізації бібліометричної мережі використовувалася система VOSviewer Лейденського університету (<https://www.vosviewer.com/download>). Результати. Ми виявили та дослідили 103 публікації у базі даних Scopus за ключовими словами «рак грудної залози», «кальцифікація» та «кісткові метастази» за період 1973-2023 рр. Результати бібліометричного аналізу, свідчать про те, що кількість публікацій на зазначену тематику помітно зростала (з невеликими коливаннями) за останні 20 років, що вказує на інтерес до проблеми та шляхів її вирішення у науковців. Комплексну проблему взаємозв'язків патологічної біомінералізації, раку грудної залози та кісткових метастазів активно вивчають вчені переважно з Сполучених Штатів Америки, Німеччини та Італії. Використавши інструмент для побудови та візуалізації бібліометричних мереж VOSviewer публікаційної активності за період 1973-2023 рр у дослідженні теми РГЗ з кальцифікацією ми виділили 4 хронологічні етапи, які включають: 1) радіологічні та біохімічні методи дослідження, 2) дослідження ефективності діагностики і лікування, в т.ч патоморфологічна оцінка патології, 3) фундаментальні дослідження кісткового та мінерального метаболі-

зму, 4) практично орієнтований період досліджень. Також виявлені публікації ми розподілили на 6 тематичних кластерів: 1) застосування радіологічних методів, 2) кістковий і мінеральний метаболізм в умовах патології, 3) клінічна діагностика та прогнозування перебігу пов'язаної патології, 4) біоматеріали та нанотехнології, 5) хіміотерапії онкопатології та її наслідки, 6) фундаментальні молекулярно-генетичні дослідження.

Ключові слова: рак грудної залози, кальцифікація, кісткові метастази, бібліометрія, Scopus, VOSviewer.

Introduction

Breast cancer is a significant medical and social problem that requires comprehensive study [1, 2]. According to the World Health Organization (WHO), in 2020, 2.3 million women were diagnosed with breast cancer (BC), with 685.000 deaths worldwide [3, 4]. Bone metastases are the most common and hard-to-treat complication of BC [5]. After all, 70% of patients with metastatic BC have distant bone relapses during the disease [6, 7]. BC always leads to the death of patients within 5-10 years, and this statistic has not changed in the last 2-3 decades [8].

Since prostate cancer is second in frequency of bone metastasis after prostate cancer (PC) and is often accompanied by biomineralization phenomena [9], we conducted an in-depth bibliographic analysis of relationships between prostate cancer, processes of biomineralization (calcification), and prostate cancer metastases to bone tissue.

The aim of the research is to carry out a bibliometric analysis of the interrelationships of BC, processes of biomineralization (calcification), and metastases of BC to bone tissue.

Materials and methods

We searched for information on the relationships between BC, biomineralization (calcification) processes, and BC metastases to bone tissue in electronic databases such as PubMed, Scopus, Web of Science, and Google Scholar for the period 1973-2023 using the fol-

lowing key terms: such as "breast cancer," "calcification," "bone metastases." For bibliometric analysis, an online platform for monitoring and analyzing international scientific research using visualization tools and current citation metrics SciVal (Scopus), and a tool for building and visualizing bibliometric networks VOSviewer, were used. We used Scopus database bibliometric tools to analyze the year, source, type of study, subject area, and publishing country. The VOSviewer system from the University of Leiden (<https://www.vosviewer.com/download>) was used to generate and visualize the bibliometric network.

The results of their discussion

Recurrent BC can be of two forms: distant metastases (mainly bones, brain, liver, lungs, and distant lymph nodes) and locoregional recurrence (spread to the chest, chest wall, or regional lymph nodes). In more than 50% of patients with BC, the first place of formation of distant metastases belongs to the bones, followed by the lungs (17%), brain (16%), and liver (6%) [10-13].

We found and examined 103 publications in the Scopus database using the keywords "breast cancer," "calcification," and "bone metastases" for the period 1973-2023. The results of the bibliometric analysis indicate that the number of publications on the specified subject has grown significantly (with slight fluctuations) over the past 20 years, indicating scientists' interest in the problem and ways of solving it (Fig. 1).

Documents by year

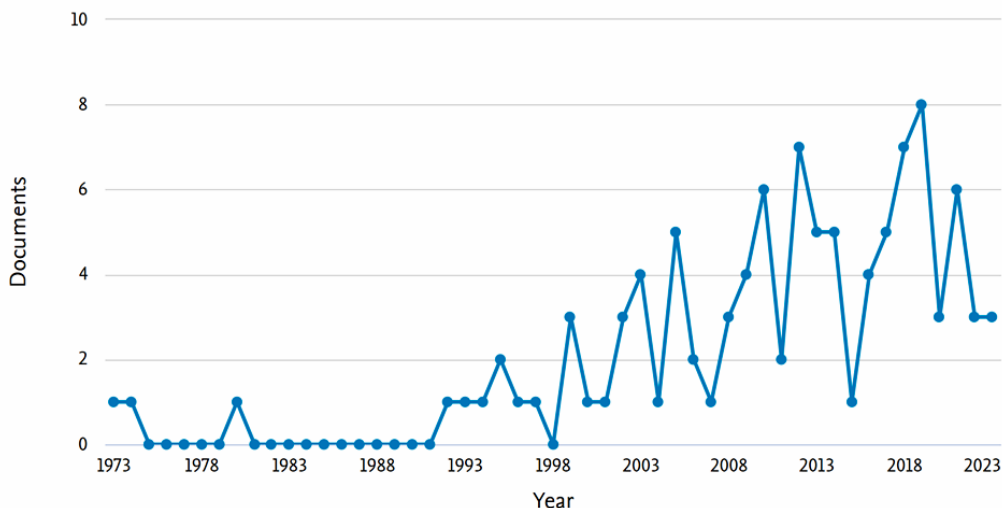


Fig. 1. The result of visualization of the publication chronology for the period 1973-2023 using the tools of bibliometric analysis of the Scopus database

The complex problem of relationships between pathological biomineralization, breast cancer, and bone metastases is actively studied by scientists from the United

States of America, Germany, and Italy (Fig. 2). Scientists from other countries account for less than ten publications per country.

Select year range to analyze: 1973 to 2023 Analyze

Documents by country or territory

Compare the document counts for up to 15 countries/territories.

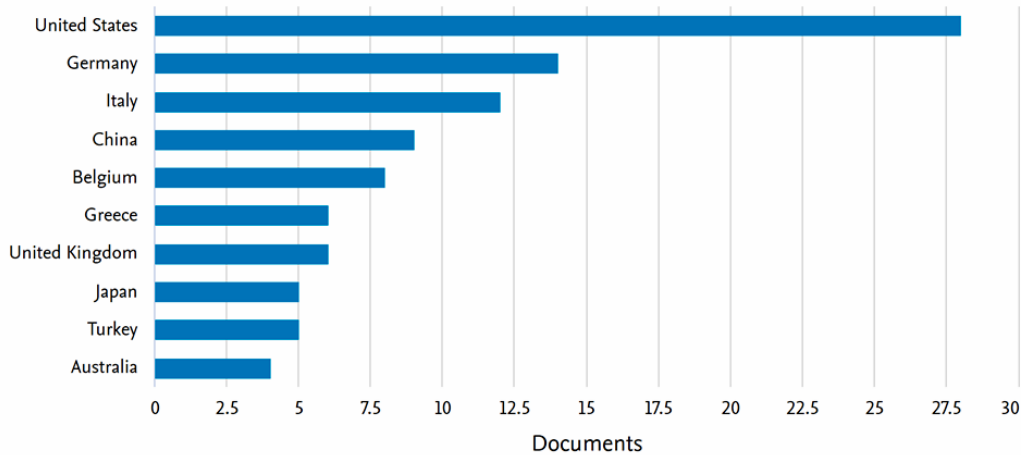


Fig. 2. Distribution of publications by country of origin in the period 1973-2023 according to the Scopus scientometric database

According to the fields of science, it was established that the vast majority belongs to the area of medicine and biochemical and molecular biological sciences (Fig. 3). A somewhat smaller number of works refers to pharmacology, materials science, and engineering, mainly they relate to biomaterials for replacing bone defects after removal of bone metastases [14].

We also used the VOSviewer tool for building and visualizing bibliometric networks to analyze the identified publications by the keywords "breast cancer," "calcification," and "bone metastases." This analysis makes it possible to assess trends and shifts in emphasis in scientific research over the entire 50-year research period.

We could logically expect a change in the publication topic of research from outdated and simple scientific methods to state-of-the-art materials and diagnostic tools. But this expected trend is only partially confirmed. Thus, the earlier works relate to radiographic and biochemical processes of examination and diagnosis. The following periods relate to clinical assessment, treatment, and research of bone tissue metabolism in pathological conditions. The latest works are mostly practically oriented and are devoted to clinical diagnostic procedures and predictive assessments of the course of the pathological process (Fig. 4).

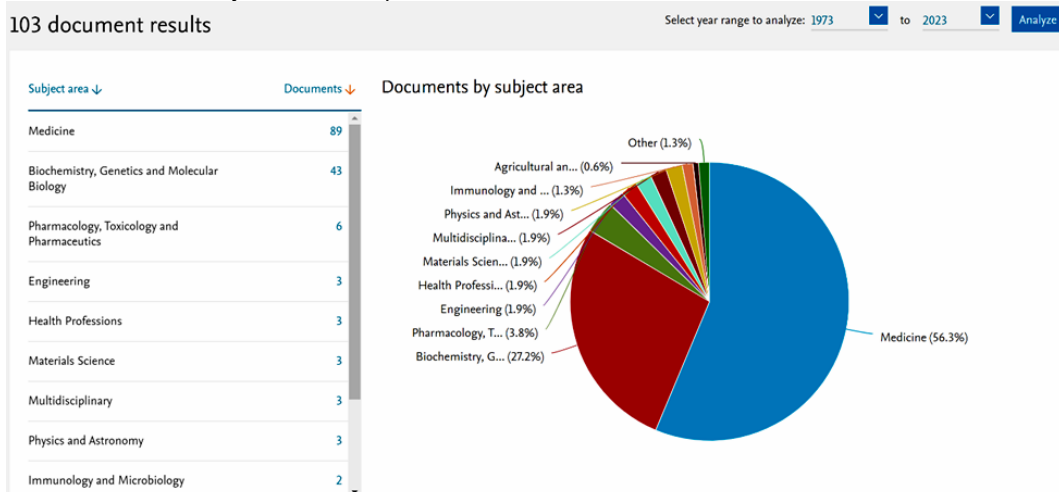


Fig. 3. The result of visualization of the distribution of publications by fields of knowledge using Scopus bibliometric analysis tools.

Thus, we identified four chronological stages, which include: 1) radiological and biochemical methods of research, 2) research on the effectiveness of diagnosis and treatment, including pathomorphological assessment of

pathology, 3) fundamental research on bone and mineral metabolism, 4) a practically oriented period of research.

We have divided the complex problems of BC, bone metastases, and subsequent mineralization disorders into six thematic clusters: 1) application of radiological

methods, 2) bone and mineral metabolism in conditions of pathology, 3) clinical diagnosis and forecasting of the course of related pathology, 4) biomaterials and

nanotechnologies, 5) chemotherapy of oncopathology and its consequences, 6) fundamental molecular genetic research.



Fig. 4. The result of visualization of the patterns of the chronological development of this topic using VOSviewer bibliometric analysis tools

Limitations. This research includes publications only in the Scopus database from 1973 to 01.06.2023.

The study of the relationship between BC, biomineralization disorders, and bone metastases has been of stable and growing interest among scientists in developed countries for a long time.

The results of the analysis of scientific sources of the Scopus database by keywords in the period from 1973 to 01.06.2023 indicate that the number of publications on the specified subject has a tendency to increase over the past 20 years, which means the relevance of the issues and ways of solving them among scientists.

Using the tool for building and visualizing bibliometric networks VOSviewer of publication activity for the period 1973-2023 in the researched topics of BC with calcification, we identified four chronological stages, which include: 1) radiological and biochemical research methods, 2) research on the effectiveness of diagnostics and treatment, including .h pathomorphological assessment of pathology, 3) fundamental studies of bone and mineral metabolism, 4) a practically oriented period of research. We also divided the identified publications into six thematic clusters: 1) application of radiological methods, 2) bone and mineral metabolism in conditions of pathology, 3) clinical diagnosis and prediction of the course of related pathology, 4) biomaterials and nanotechnology, 5) chemotherapy of oncopathology and its consequences, 6) fundamental molecular genetic research.

Conclusions

According to our research results, scientists' most significant interest today is the solution of practically-oriented tasks that improve the quality of diagnosis and treatment of pathology associated with RH and mineral metabolism disorders.

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Конфлікт інтересів:

Автори заявляють про відсутність конфлікту інтересів.

A – концепція та дизайн дослідження; **B** – збір даних; **C** – аналіз та інтерпретація даних; **D** – написання статті; **E** – редагування статті; **F** – остаточне затвердження статті.

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