

## Bibliometric Evaluation of the Relationship between Selenium and Breast Cancer: A Synopsis

Selim ÖĞÜT\*

### Abstract

**Aim:** To discover the relationship between breast cancer and selenium via bibliometric analysis, identify their current status in literature, and investigate the international research activity based on breast cancer and selenium publications.

**Method:** The Web of Science Core Collection (WoS) database was used to retrieve the data. The keywords ("breast cancer") and ("selenium") were utilized in "topic" selection mode for the search. Bibliometric analysis was employed to evaluate the papers, and correlation analysis was performed to identify the associations between the number of publications and citation counts.

**Results:** A total of 731 outputs were produced between 1980 and 2025. The USA was reported as the most productive and most cited country. The most productive journal, publisher, and institution were reported as "Biological Trace Element Research", "Elsevier", and "Harvard University", respectively. The most cited journal was "Cancer Research and Treatment", the most active funding institution was "National Institutes of Health NIH," and "breast cancer" was the most common keyword.

**Conclusion:** The analysis highlights a growing interest in the potential role of selenium in breast cancer prevention, diagnosis, and treatment. The findings also reveal emerging themes and knowledge gaps that warrant further investigation, particularly regarding selenium's biological mechanisms and clinical applications. Overall, this analysis serves as a guide for future research directions and promote evidence-based advancements in breast cancer management related to selenium.

**Keywords:** Bibliometric analysis, breast cancer, cancer research, oncology, selenium.

### Selenyum ile Meme Kanseri Arasındaki İlişkinin Bibliyometrik Değerlendirmesi

#### Öz

**Amaç:** Bu çalışmanın amacı, meme kanseri ile selenyum arasındaki ilişkiyi bibliyometrik analiz yoluyla ortaya koymak, literatürdeki mevcut durumu belirlemek ve meme kanseri ile selenyum konularında yapılan uluslararası araştırma faaliyetlerini incelemektir.

**Yöntem:** Veriler Web of Science Core Collection (WoS) veritabanından elde edildi. Arama için "konu" seçiminde "meme kanseri" ve "selenyum" anahtar kelimeleri kullanıldı. Yayınlar bibliyometrik analiz yöntemiyle değerlendirilmiş, yayın sayısı ile atıf sayısı arasındaki ilişkileri belirlemek amacıyla korelasyon analizi uygulanmıştır.

**Bulgular:** 1980 ile 2025 yılları arasında toplam 731 yayın üretilmiştir. En fazla yayın yapan ve en çok atıf alan ülke Amerika Birleşik Devletleri olmuştur. En üretken dergi "Biological Trace Element Research", en üretken yayınevi "Elsevier" ve en üretken kurum ise "Harvard Üniversitesi" olarak belirlenmiştir. En çok atıf alan dergi "Cancer Research and Treatment" olurken, en aktif fon sağlayan kurum "National Institutes of Health (NIH)" olmuştur. En sık kullanılan anahtar kelime ise "meme kanseri" (breast cancer) olarak tespit edilmiştir.

**Sonuç:** Bu analiz, selenyumun meme kanserinin önlenmesi, tanısı ve tedavisindeki potansiyel rolüne yönelik artan ilgiyi ortaya koymaktadır. Bulgular, selenyumun biyolojik mekanizmaları ve klinik

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\* Asst. Prof. Dr., Bandırma Onyedi Eylül University, Faculty of Medicine, Department of Biophysics, Bandırma, Türkiye.

E-mail: [sogut@bandirma.edu.tr](mailto:sogut@bandirma.edu.tr) [ORCID https://orcid.org/0000-0001-9126-6477](https://orcid.org/0000-0001-9126-6477)

uygulamaları konusunda daha fazla araştırmaya ihtiyaç duyulduğunu ve bu alandaki bilgi boşluklarını göstermektedir. Genel olarak bu çalışma, gelecekteki araştırmalar için yol gösterici bir kaynak olmayı ve meme kanseri yönetiminde selenyumla ilişkili kanıta dayalı gelişmeleri teşvik etmeyi amaçlamaktadır.

**Anahtar Sözcükler:** Bibliyometrik analiz, meme kanseri, kanser araştırmaları, onkoloji, selenyum.

## Introduction

In 2022, approximately 2.3 million women worldwide were diagnosed with breast cancer, leading to nearly 670,000 deaths due to the disease<sup>1</sup>. Although countless factors have been identified that influence the etiology of breast cancer, family history, sex, and age are considered among the most notable. Treatment options vary depending on the type and spread of the cancer. In general, chemotherapy, surgical intervention, targeted drug therapy, anti-hormone therapy, and radiation therapy are preferred<sup>2-4</sup>.

Approximately 5–10% of breast cancers are inherited through genetic mutations passed down from a parent. The most well-known mutations involve the BRCA1 and BRCA2 genes. Genetic predisposition, particularly involving mutations in these two genes, is considered a significant risk factor for malignancies such as breast cancer<sup>5-9</sup>.

Trace elements are known for their beneficial effects on several biological pathways. These minerals play a critical role in cell stabilization, regulation of oxidative stress, complex DNA damage distribution (DDR), and repair mechanisms. Experimental studies have shown that the trace element selenium has significant anticancer properties. Selenium enhances immune response by activating lymphocytes and stimulating the production of immunoglobulins and antibodies<sup>10</sup>. It contributes to the strengthening of the immune system, including cytotoxic lymphocyte activity and natural killer cell function<sup>11</sup>. However, selenium toxicity may adversely affect individuals through excessive supplementation or high dietary levels<sup>12</sup>.

In this context, selenium, a critically important trace element, is regarded as having potential benefits in cancer prevention<sup>13</sup>. Selenium is vital for many cellular processes because it constitutes various selenoproteins that are believed to play protective roles in certain types of cancer<sup>14-15</sup>. The potential role of selenium in reducing cancer risk has been investigated and continues to be explored<sup>16</sup>. Studies have indicated higher serum concentrations of copper and ceruloplasmin protein in various malignancies, including leukemia, breast, cervical, and endometrial cancers. The activation of DNA and RNA polymerase enzymes also depends on copper, which serves as a cofactor for antioxidant enzymes<sup>17</sup>.

Selenium plays a vital role in synthesizing a limited number of selenoproteins involved in antioxidant defense, thyroid hormone metabolism, tumor growth, and cell proliferation<sup>18-19</sup>. While selenium is recognized to play a significant role in apoptotic processes, its effects are not fully understood due to the complexity of these pathways and limited knowledge of selenoproteins. Current evidence suggests that selenium exerts its effects through mechanisms such as caspase activation, protein kinase signaling, reactive oxygen species (ROS) neutralization, and p53 phosphorylation. Increased selenium levels have been shown to induce apoptosis in various neoplastic cells, including liver, colon, and prostate cancer, as well as lymphoma and leukemia.

Additionally, several selenium-containing compounds are widely considered to exhibit chemopreventive and anticancer effects.

A crucial statistical tool for mapping the present level of knowledge in a particular scientific field, spotting possible avenues for future research, and confirming scientific findings is bibliometric analysis<sup>20</sup>. It reflects the practical applicability of handling large volumes of scientific data and its significant contributions to research impact. The development of bibliometric tools such as R and VOSviewer, along with scientific databases like Google Scholar, Scopus, and Web of Science—including their accessibility and usability—have all contributed to this popularity. The interdisciplinary influence of bibliometric methodology, spanning from data science to operational research, also plays a critical role in its widespread adoption<sup>21</sup>.

By employing a bibliometric approach to studies on the relationship between breast cancer and selenium, it is possible to identify general research trends, keywords, and frequently explored themes. Such a study offers researchers the opportunity to evaluate the existing literature more effectively and to guide future investigations.

Recent years have seen a significant increase in interest in bibliometric analysis, resulting in numerous bibliometric performances in a wide range of areas, including medical<sup>22</sup>, health<sup>23</sup>, life<sup>24</sup>, and natural sciences<sup>25</sup>. However, the association between breast cancer and selenium is lacking in literature. The present study aims to reveal the prevailing research trends, key contributing publications, and popular research topics in the context of a bibliometric analysis on the relationship between breast cancer and selenium. Furthermore, it is expected that this research will help identify gaps and directions in the current literature regarding the potential role of selenium in breast cancer treatment, thereby paving the way for future studies.

## **Material and Methods**

The Web of Science Core Collection (WoS) catalogue ([www.webofknowledge.com](http://www.webofknowledge.com)) was used to retrieve the data. To prevent misunderstandings brought on by daily variations in the quantity of publications, the search was initiated and ended on May 26, 2025. The keywords (“breast cancer”) and (“selenium”) were utilized in “topic” selection mode for the search. “Article” was chosen as the only research type, and “English” was the only language. Science Citation Expanded (SCI-E) and Social Science Citation Expanded (SSCI) were selected as WoS indexes; others were excluded. Further, the .txt documents with bibliometric indicators, including Citation Count (WoS Core), Number of Publications (NP), Publication Year, etc., were downloaded from the website.

## **Statistical Analysis**

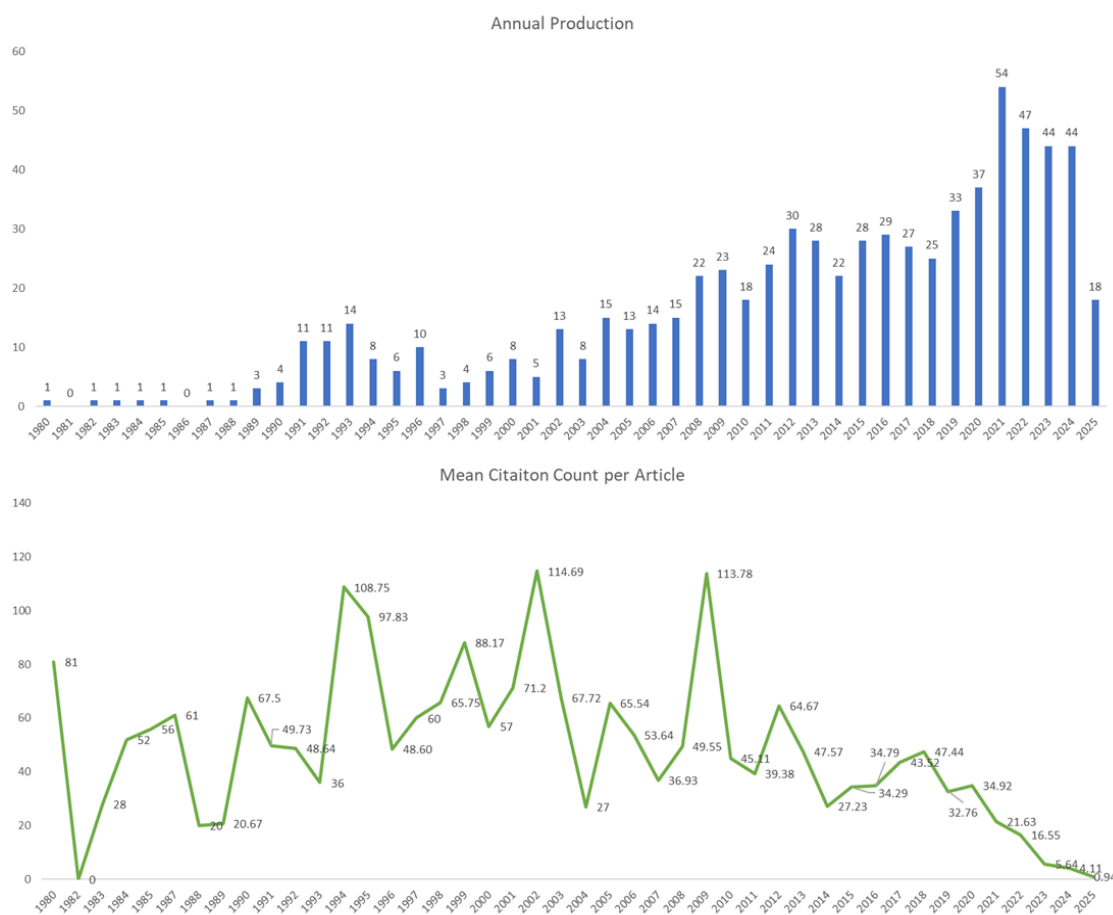
Median, minimum, and maximum values were reported for numerical variables, while frequency (n) and percentage (%) were provided for categorical ones. Income classifications were retrieved from <https://databank.worldbank.org/> website. The Kruskal-Wallis (K-W) test was utilized for group comparisons. Spearman Correlation Coefficients were calculated to determine the associations between bibliometric indicators, namely NP and CC values. Biblioshiny web application of the bibliometrix package ([www.bibliometrix.org](http://www.bibliometrix.org)) were utilized for bibliometric analyses. VOSviewer software (v.1.6.16) was used to obtain graphs for co-authorship analysis and citation

analysis. The R statistical programming language was used for the remaining analyses. Two-sided  $p\text{-value} \leq 0.05$  was taken as statistically significant in all analyses.

## Results

A total of 731 publications that were published between 1980 and 2025 were analyzed in this bibliometric research. The bibliometric papers on breast cancer and selenium showed an increasing mode, with an annual growth rate of 6.63%. The distributions of publications and citations over the years were shown in Figure 1. The peak in NP was noticed in 2021 with 54 outputs. The total number of authors who contributed to these products was 3,746. Bibliometric analyses in BRCA & selenium were published in 731 different sources. From a collaboration perspective, a total of 17 single-authored documents were recorded; additionally, international co-authorships were calculated as 24.9%.

**Figure 1.** Annual production and mean citation count per article distributions on breast cancer and selenium publications



All of the research has been documented in Science Citation Index (SCI)-indexed journals ( $n=731$ , 100%), whereas 6 of them was also indexed in SSCI journals. Oncology ( $n=187$ , 25.581%), Biochemistry & Molecular Biology ( $n=133$ , 18.194%), and Nutrition & Dietetics ( $n=75$ , 10.260%) were listed as top-three WoS categories where the majority of the BRCA & selenium publications were produced.

The research has been published in fundamental scientific fields such as Oncology, Biophysics, Biochemistry, and Molecular Biology, as well as in applied disciplines including Nutrition, Public Health, Internal Medicine, and Pharmacology-Toxicology. This diversity indicates that studies on the relationship between selenium and breast cancer have been addressed from clinical, molecular, epidemiological, and environmental perspectives, thereby reflecting the multidisciplinary approach within the literature.

Basic descriptive statistics for Single Country Publications (SCP), Multi-Country Publications (MCP), total NP and CC were found to be 0.4 [0 - 21], 3 [0 - 128], 3 [1 - 153], and 1 [0 - 25], respectively. NP ( $p=0.178$ ), SCP ( $p=0.086$ ), MCP ( $p=0.439$ ), and CC ( $p=0.101$ ) values were found to be similar across income classifications. Median, minimum, and maximum values were also provided for these bibliometric indicators for each income class (Table 1).

**Table 1.** Group comparison results regarding bibliometric indicators across income classifications

| Variable | Lower-Middle Income | Upper-Middle Income | High Income      | p-value |
|----------|---------------------|---------------------|------------------|---------|
| NP       | 21 [9 - 40]         | 28.5 [18 - 135]     | 13 [9 - 153]     | 0.178   |
| SCP      | 8 [4 - 31]          | 21.5 [15 - 115]     | 10 [3 - 128]     | 0.086   |
| MCP      | 9 [5 - 13]          | 7 [3 - 20]          | 5 [0 - 25]       | 0.439   |
| CC       | 413 [159 - 1496]    | 879.5 [698 - 5019]  | 524 [101 - 9479] | 0.101   |

Further, strong and significant association was found via correlation analysis between NP and CC values for all countries ( $r=0.616$ ;  $p=0.002$ ), while they were calculated as  $r=0.8$ ;  $p=0.2$  for upper-middle,  $r=0.355$   $p=0.193$  for high economic-level countries.

The USA (153 publications), China (135 publications), and India (40 publications) were observed to be in the top-three list regarding the number of scholarly outputs. Similarly, the USA (9479 citations), China (5019 citations), and India (1496 citations) were also placed in the top three in terms of citation counts received. “Biological Trace Element Research” was recorded as the most active journal (42 publications), and “Cancer Research and Treatment” was reported as the most cited source (1086 citations) (Table 2).

**Table 2.** Most active countries, journals, and most cited countries and journals

| Country | NP  | SCP | MCP | Country     | CC   | Source               | CC   | Best Quartile  | Journal   | NP | Best Quartile  |
|---------|-----|-----|-----|-------------|------|----------------------|------|----------------|---|----|----------------|
| USA     | 153 | 128 | 25  | USA         | 9479 | Cancer Res           | 1086 | Q <sub>1</sub> | Biological Trace Element Research                 | 42 | Q <sub>2</sub> |
| China   | 135 | 115 | 20  | China       | 5019 | Biol Trace Elem Res  | 649  | Q <sub>2</sub> | Cancer Epidemiology Biomarkers & Prevention       | 17 | Q <sub>1</sub> |
| India   | 40  | 31  | 9   | India       | 1496 | J Biol Chem          | 499  | Q <sub>2</sub> | Nutrients   | 17 | Q <sub>1</sub> |
| Iran    | 37  | 26  | 11  | Netherlands | 964  | Carcinogenesis       | 459  | Q <sub>2</sub> | Anticancer Research                               | 13 | Q <sub>4</sub> |
| Poland  | 29  | 16  | 13  | Iran        | 944  | Am J Clin Nutr       | 434  | Q <sub>1</sub> | Journal Of Trace Elements In Medicine And Biology | 13 | Q <sub>2</sub> |
| Germany | 22  | 15  | 7   | Brazil      | 815  | Am J Epidemiol       | 404  | Q <sub>1</sub> | Cancer Research                                   | 12 | Q <sub>1</sub> |
| Egypt   | 21  | 8   | 13  | UK          | 746  | Cancer Epidem Biomar | 392  | Q <sub>1</sub> | Breast Cancer Research And Treatment              | 11 | Q <sub>2</sub> |
| Turkey  | 20  | 17  | 3   | Portugal    | 732  | Int J Cancer         | 342  | Q <sub>1</sub> | Nutrition And Cancer-An International Journal     | 11 | Q <sub>3</sub> |
| Canada  | 19  | 14  | 5   | Türkiye     | 698  | Jnci-J Natl Cancer I | 341  | Q <sub>1</sub> | International Journal Of Cancer                   | 10 | Q <sub>1</sub> |
| Korea   | 19  | 17  | 2   | Finland     | 624  | J Nutr               | 314  | Q <sub>2</sub> | Plos One  | 10 | Q <sub>1</sub> |

Current breast cancer and selenium literature has been published by different affiliations over the years. Harvard University (n=37), and National Institutes of Health (NIH) (n=34) were reported as top contributors. National Institutes of Health (NIH) (n=91), United States Department of Health Human Services (n=91), National Natural Science Foundation of China (NSFC) (n=73) formed the top-three list in terms of funding agents, and “Elsevier” (163 publications) was the most active publisher (Table 3).

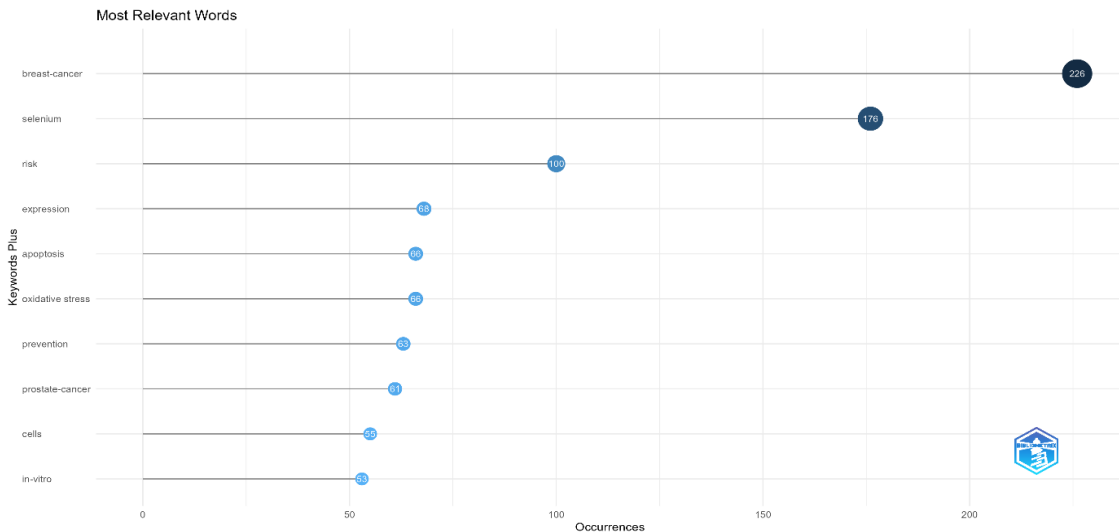
**Table 3.** Most active affiliations, funding agencies and publishers

| Affiliation  | NP | Funding Agencies  | NP | Publisher                  | NP  |
|--|----|---|----|----------------------------|-----|
| Harvard University   | 37 | National Institutes Of Health NIH USA                         | 91 | Elsevier                   | 163 |
| National Institutes Of Health (NIH) - USA                    | 34 | United States Department Of Health Human Services             | 91 | Springer Nature            | 113 |
| Pennsylvania Commonwealth System Of Higher Education (PCSHE) | 34 | National Natural Science Foundation Of China NSFC             | 73 | Wiley                      | 50  |
| Lund University  | 31 | NIH National Cancer Institute NCI                             | 64 | MDPI                       | 44  |
| Tehran University Of Medical Sciences                        | 31 | National Natural Science Foundation Of Guangdong Province     | 15 | Amer Assoc Cancer Research | 37  |
| Sun Yat Sen University                                       | 30 | NIH National Institute Of Environmental Health Sciences NIEHS | 14 | Humana Press Inc           | 30  |

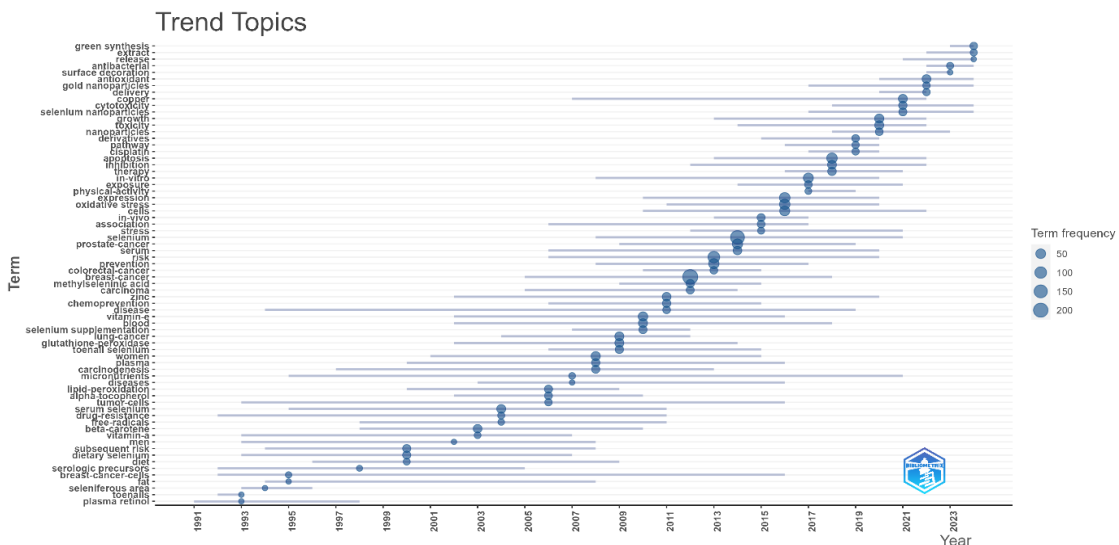
|  |    |  |    |                     |    |
|--|----|--|----|---------------------|----|
| Roswell Park Comprehensive Cancer Center | 28 | Coordenacao De Aperfeicoamento De Pessoal De Nivel Superior Capes  | 12 | Taylor & Francis    | 30 |
| University Of Texas System               | 27 | Conselho Nacional De Desenvolvimento Cientifico E Tecnologico CNPQ | 11 | Oxford Univ Press   | 21 |
| Pennsylvania State University            | 26 | China Postdoctoral Science Foundation                              | 10 | Amer Chemical Soc   | 17 |
| University Of Illinois System            | 23 | European Union EU  | 10 | Royal Soc Chemistry | 17 |

“breast cancer” (n=226), “selenium” (n=176), and “risk” (n=68) were listed as the most commonly utilized keywords (Figure 2a). Further, trend topics from 1991 to 2023 were revealed to be wide-range, as it covers “plasma retinol”, “green synthesis”, “surface decoration.”, “serologic presurcos” etc. (Figure 2b).

**Figure 2a.** Most relevant keywords on BRCA & Selenium research



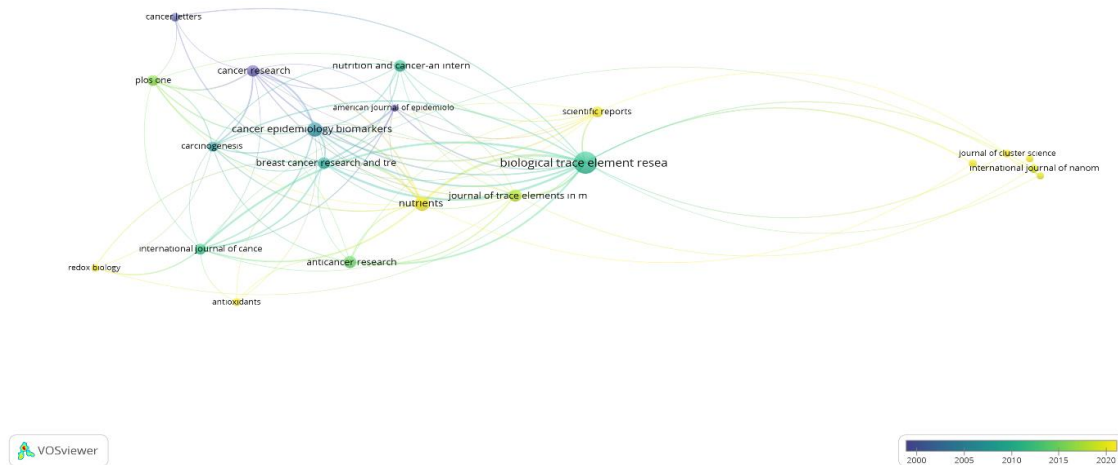
**Figure 2b.** Trend topics on BRCA & Selenium research



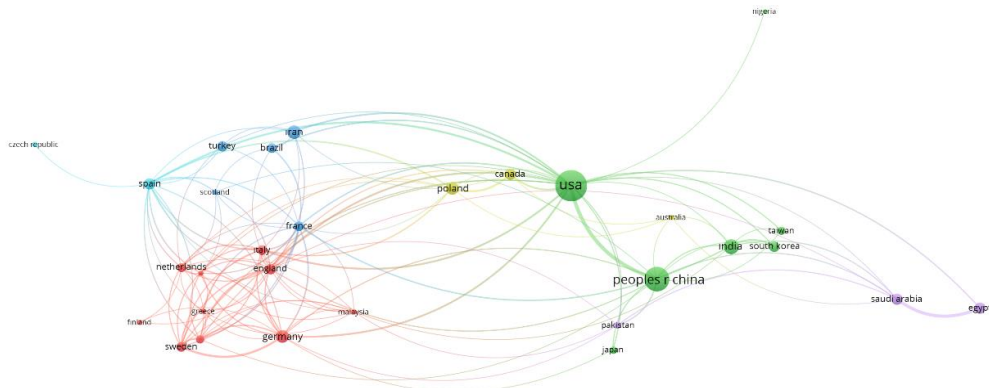


Co-authorship analysis based on countries, and citation analysis based on sources are plotted in Figure 3. The indicator in the figure of citation analysis showed the current number of average citations from dark blue to yellow (Figure 3a). Moreover, a total of 6 clusters were offered by co-authorship analysis based on worldwide partnership (Figure 3b).

**Figure 3a.** Citation analysis based on sources.



**Figure 3b.** Co-authorship analysis based on countries. **Cluster 1 (Red):** Denmark, England, Finland, Germany, Freece, Italy, Malaysia, Netherlands, Norway, Sweden. **Cluster 2 (Green):** India, Japan, Nigeria, China, South Korea, Taiwan, USA. **Cluster 3 (Blue):** Brazil, France, Iran, Scotland, Türkiye. **Cluster 4 (Yellow):** Australia, Canada, Poland. **Cluster 5 (Purple):** Egypt, Pakistan, Saudi Arabia. **Cluster 6 (Light Blue):** Czech Republic, Spain.



## Discussion

The majority of the breast cancer and selenium bibliometric documents were produced in the “Oncology” WoS category. The USA was reported as the most fruitful and most cited country. Further, the most active journal, publisher, and institution were reported as “Biological Trace Element Research”, “Elsevier”, and “Harvard University”, respectively. The most cited journal was “Cancer Research and Treatment”, the most active funding institution was “National Institutes of Health NIH,” and “breast cancer” was listed as the most common keyword.



Up until now, various bibliometric analyses regarding breast cancer have been produced. These studies have evaluated either the association between inflammation and breast cancer<sup>26</sup>, or have summarized crucial information about metastatic breast cancer via scientific reports<sup>27</sup>, or have inspected the targeted therapy for this cancer type<sup>28</sup>. Similarly, several bibliometric research studies on selenium regarding its relationship to thyroid diseases<sup>29</sup>, and its effects on drinking water<sup>30</sup> have been conducted previously. Even though its relationship to several diseases and its effects on the environment and cancer prevention were identified, to date, no research on investigating the association between selenium and breast cancer has been carried out. Therefore, to the best, this current study is thought to be the first one to explore this association.

The USA was reported as the most productive and most cited country on breast cancer and selenium research in this study. This leadership may be credited to investments in cancer research and development, as well as funding opportunities for research personnel, diagnostic supplies, etc., in this country. Moreover, most prolific countries were observed to be prevail across the world, that is, each continent has its productive country regarding breast cancer and selenium studies. This could be the reflection of both the prevalence of breast cancer, and the crucial role on global collaboration of scholarly outputs.

Several limitations could be pointed out for the current bibliometric research. First, since revealing the general framework was the primary goal of the search, self-citations were disregarded. Second, the WoS database was chosen as the primary source; no coverage was given to other databases like SCOPUS, DOAJ, EBSCO, PubMed, etc. Third, the terms "breast cancer" and "selenium" were broad search terms; more focused terms could be employed for further investigation. Some specific keywords were ignored, though, to form a broad structure.

## Conclusion

In conclusion, this bibliometric analysis offers a structured overview of the most current scholarly literature on the association between breast cancer and selenium. The analysis highlights a growing interest in the potential role of selenium in breast cancer prevention, diagnosis, and treatment, as demonstrated by an increasing number of publications over time. Key contributing institutions, sources, funding agencies, and countries were identified, emphasizing the global and multidisciplinary nature of this research area. The findings also reveal emerging themes and knowledge gaps that warrant further investigation, particularly regarding selenium's biological mechanisms and clinical applications. Overall, this analysis serves as a guide for future research directions and promote evidence-based advancements in breast cancer management related to selenium.

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