

Bibliometric Analysis of the Relationship Between Breast Cancer and Exercise Based on Citespace

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Abstract

This study aims to conduct a bibliometric analysis of the literature on the relationship between breast cancer and exercise using Citespace software, in order to explore the research hotspots, trends, and deficiencies in this field. Relevant literature including keywords such as “breast cancer” and “exercise” was retrieved from the Web of Science database and analyzed using Citespace software for data processing and visualization.

The main conclusions of this study are as follows: In co-occurrence analysis of keywords, researchers mainly focus on the prevention, rehabilitation, and treatment of breast cancer, as well as the effects of different types of exercise on breast cancer. Meanwhile, the co-occurrence patterns of keywords in studies related to exercise and breast cancer indicate an increasing attention to the relationship between breast cancer and exercise, making it gradually one of the hotspots in breast cancer research. The timeline of keywords and burst detection analysis show that researchers have increasingly focused on the relationship between breast cancer and exercise in recent years, with research intensity showing an increasing trend year by year. Furthermore, in recent years, researchers have begun to emphasize the role of exercise in breast cancer rehabilitation, rather than just prevention and treatment. Discipline analysis indicates that research in this field involves multiple disciplinary areas, including medicine, oncology, sports science, nutrition, etc. Additionally, an analysis of papers published by country reveals that the United States leads in research on the relationship between breast cancer and exercise, followed closely by the United Kingdom, China, Canada, Australia, and other countries.

Conclusion: Literature on the relationship between breast cancer and exercise shows a trend of increasing quantity year by year. However, there are still some deficiencies in this field, such as lack of uniform research methods, overly limited research samples, and insufficient rigor in research results. Therefore, further strengthening research on the relationship between breast cancer and exercise is highly necessary.

Keywords: Breast cancer; Physical activity; Bibliometrics; Quality of life; Research trends.

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Introduction

Breast cancer is a common malignant tumor and one of the primary types of cancer among women. Its incidence ranks first among female tumors [1]. The etiology of breast cancer remains incompletely understood, but it is known that the risk factors for female breast cancer are influenced by various factors, including individual genetics, reproductive health history, and lifestyle habits. According to statistics, approximately 2 million people worldwide are diagnosed with breast cancer each year, with around 400,000 unfortunate deaths [2]. Breast cancer not only brings physical and psychological suffering to patients and their families but also imposes a heavy burden on society. Therefore, the prevention and treatment of breast cancer have become important topics in the field of public health.

Treatment methods for breast cancer include surgery, radiotherapy, chemotherapy, endocrine therapy, and targeted therapy, among which these treatments play significant roles in improving the treatment efficacy and survival rate of breast cancer. These include radical mastectomy and breast-conserving surgery. Chemotherapy, radiotherapy, and endocrine therapy are also common treatment methods [3]. In addition, in recent years, targeted therapy has gradually become a new focus of breast cancer treatment by targeting specific molecular targets to inhibit tumor growth and spread [4]. However, there are still many deficiencies and challenges in the treatment of breast cancer, such as recurrence, metastasis, drug resistance, etc. Therefore, exploring other methods for treating breast cancer to improve patients' quality of life and prognosis has become imperative.

A considerable amount of research indicates that exercise plays a positive role in the treatment and rehabilitation of breast cancer [5]. Exercise can enhance patients' physical immunity, alleviate the side effects of chemotherapy and radiotherapy, [6] and also improve patients' mental health. Therefore, exercise, as a rehabilitation adjunctive treatment, is increasingly valued by more and more people.

Currently, research on the relationship between exercise and breast cancer has become one of the hotspots [7]. However, in this field, there are still some unresolved issues. For example, different types, intensities, and durations of exercise have varying effects on the treatment outcomes of breast cancer patients, which need further exploration. Additionally, many studies only focus on the physiological indicators of exercise on patients, while paying insufficient attention to its psychological and social impacts [8]. Therefore, it is necessary to review the research on the relationship between breast cancer and exercise. Despite increasing studies supporting the benefits of exercise in breast cancer treatment, there are still many deficiencies in this field. Firstly, the consistency of research results remains controversial. Although most studies indicate that exercise can reduce the risk of breast cancer recurrence and mortality, there are also a few studies with contradictory results [9]. Secondly, current research on the relationship between exercise and breast cancer primarily focuses on observational studies, lacking high-quality research such as randomized controlled trials. Therefore, further clinical research is needed to determine the effectiveness and safety of exercise as a treatment method. Finally, despite extensive research on the mechanisms of exercise, the current understanding of its detailed mechanisms

remains insufficient, necessitating further basic research to reveal its mechanisms of action. To address these research gaps, this study utilizes bibliometric analysis methods to systematically review and analyze the literature on the relationship between breast cancer and exercise, aiming to provide a deeper understanding and comprehensive evaluation of this field, thereby offering stronger support and guidance for clinical practice and future research.

Research methods

Literature retrieval

We conducted literature retrieval using the Web of Science database and applied Mesh terms for screening. Specifically, we inputted the search terms "Breast Neoplasms" and "physical activity OR exercise OR training" in the advanced search page, and selected article types, languages, and time ranges as limiting conditions for the search. In the Web of Science database, we accessed the advanced search page. In the "Topic" field, we inputted the search term "Breast Neoplasms" and selected "Topic" from the "Add another field" dropdown menu, inputting the search term "physical activity OR exercise OR training." In the "Refine Results" section, we chose "Article," "English," and the core collection, with the search ending on April 12, 2023. We clicked the "Search" button to retrieve the results. In the end, a total of 9223 documents were retrieved. The retrieved documents were selected in full record format and exported as pure text files, choosing the download.txt format sequentially.

Study tool

Citespace is a bibliometric analysis tool that can analyze themes, authors, citation relationships, and other information in the literature, generating visual charts. The software is based on the JAVA system and performs visual analysis of citation networks. It helps us discover relationships between documents, extract keywords, and explore research frontiers. Citespace is mainly based on three network representations: citation network, co-citation network, and collaboration network. These network relationships provide research value.

Research path

In this study, we will use Citespace analysis software to conduct research path analysis of literature in the field of breast cancer promotion through exercise from multiple dimensions.

Keyword co-occurrence analysis is used to determine the key research directions and hot issues in the literature. It is a method based on word frequency and correlation, which can reveal the associations and research topics among keywords in the literature. Through this analysis method, we can understand the research hotspots and trends in the field of exercise promotion for breast cancer, and identify interdisciplinary and important research topics in this field. The keyword timeline chart helps understand the development trends of research hotspots. Using the "Time zone View" feature of Citespace software, we can visualize the retrieved literature on a timeline. In the visualization, the size and color of nodes represent the influence and citation count of articles, while the connections between nodes represent their citation relationships. By analyzing changes in nodes and connections, we can understand the research focus and trends

in the field. The “Burst Detection” feature of Citespace software helps identify keywords or topics that appear frequently during a certain period, which are considered research hotspots or bursts in the field.

National co-publication analysis

National co-publication analysis is used to understand the research trends and contributions of different countries and regions globally in this field. It is an analysis method based on the correlation between countries and literature, which can reveal the research contributions and collaboration situations of different countries and regions in this field. Through this analysis method, we can understand the research hotspots and contributions of different countries and regions in this field, and identify potential partners.

Research dynamics and frontiers exploration

The study explores the research dynamics and frontiers of the field through keyword timeline charts and keyword burst value detection. The keyword timeline chart shows the evolving trends of keywords over time, while keyword burst value detection identifies abnormal fluctuations of keywords in the literature, indicating potential research hotspots. Through these two analysis methods, we can understand the research dynamics, frontiers, and future directions of the field.

Interdisciplinary co-occurrence analysis

Interdisciplinary co-occurrence analysis is used to reveal the interdisciplinary and research hotspots in the field of exercise promotion for breast cancer. It is a method based on the keywords in the literature and the classification system of disciplines, which can reveal the associations and research topics among different disciplines.

By analyzing paths such as keyword co-occurrence, national co-publication, keyword timeline charts, keyword burst value detection, and interdisciplinary co-occurrence, researchers can obtain more comprehensive and in-depth research results.

Research results

Research status/hotspots

Through statistical analysis of the results of bibliometric analysis, we can identify the research status and hotspots in this field. Firstly, in terms of keyword co-occurrence analysis, we found that keywords such as “physical activity,” “exercise,” “breast cancer,” “survival,” and “quality of life” appear frequently and have high centrality, indicating their importance and influence in this field. Secondly, in the analysis of keyword frequency, we observed that “breast cancer,” “physical activity,” “exercise,” “survival,” and “quality of life” are frequently occurring keywords, indicating high research attention in these research directions. Combining the results of these two aspects of analysis, we can conclude that the main focus of research in this field is the relationship between exercise and breast cancer, particularly the impact of exercise on the quality of life and survival rate of breast cancer patients.

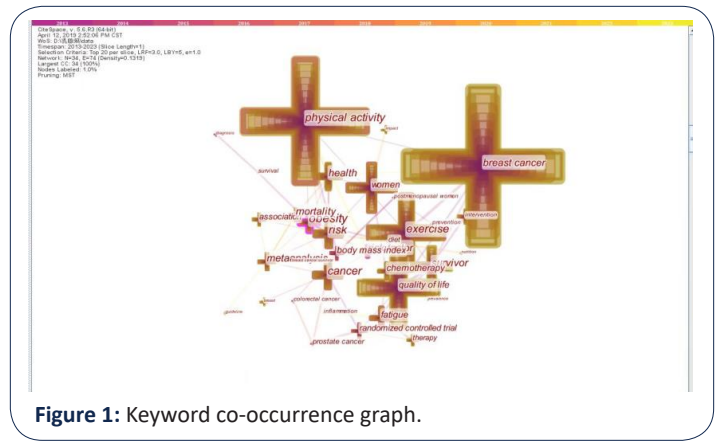


Figure 1: Keyword co-occurrence graph.

Research trends

In terms of research trends, we utilized CiteSpace software to analyze the research trends in this field using keyword timeline graphs and keyword burst detection. From the keyword timeline graph, we observed that the focus of research in this field is continuously evolving. Looking at recent trends, the key research areas are primarily concentrated on keywords such as “physical activity,” “exercise,” “quality of life,” and “survival,” indicating that the current research emphasis is mainly on the quality of life and survival rate of breast cancer patients. Additionally, through the analysis of keyword burst detection, we identified emerging research directions such as “physical exercise interventions” and “breast cancer screening.” These research directions demonstrate high research frontier and potential, warranting attention and further investigation.

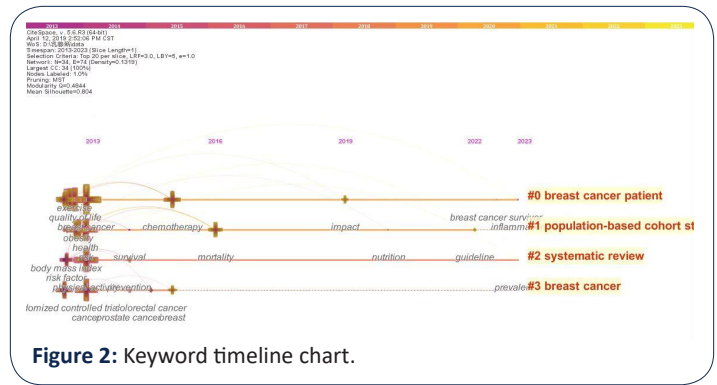


Figure 2: Keyword timeline chart.

Interdisciplinary collaboration

In terms of interdisciplinary collaboration, we utilized the “Discipline Distribution” view and “Discipline Overlap” view of CiteSpace software to analyze the disciplinary distribution and interdisciplinary overlap in this field. From the perspective of disciplinary distribution, this field mainly involves biomedical science, public health, and sports science, as shown in Figure 4. It can be observed that research in the field of exercise and breast cancer primarily concentrates in disciplines such as oncology, public health, sports medicine, and physiology, reflecting the interdisciplinary nature of research in the field of exercise and breast cancer, which necessitates collaboration and communication among different disciplines.

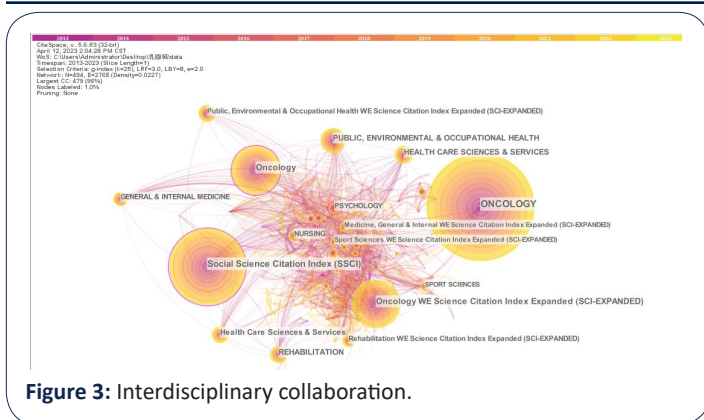


Figure 3: Interdisciplinary collaboration.

Country publication co-occurrence analysis

Country publication co-occurrence analysis can reflect the research activity and collaboration among different countries in a particular field. In this paper, we utilized the “Country Co-citation” feature of Citespace software to conduct the country publication co-occurrence analysis.

Taking the research of this paper as an example, the “Country Co-citation” feature enables us to obtain the country publication co-occurrence network in the field of exercise and breast cancer, as depicted in (Figure 5). It can be observed that countries such as the United States, China, the United Kingdom, and Canada are leading in research on exercise and breast cancer. Furthermore, collaboration among these countries is relatively frequent, reflecting the international nature of research in the field of exercise and breast cancer, which necessitates collaboration and communication among different countries.

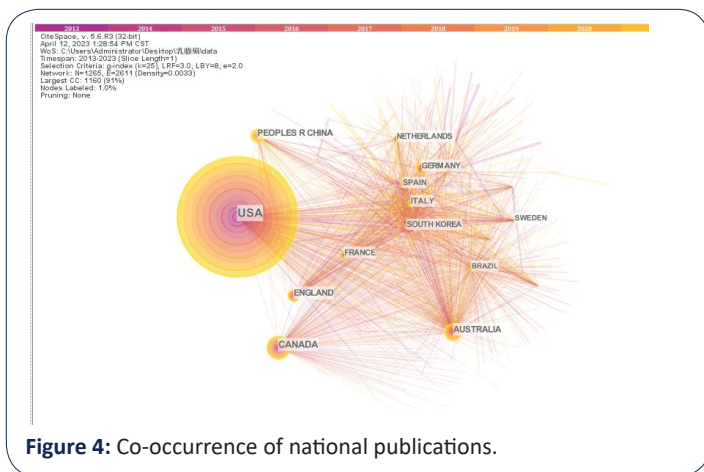


Figure 4: Co-occurrence of national publications.

Discussion

The relationship between exercise and breast cancer

Breast cancer is one of the most common malignant tumors in women, with a complex etiology and pathogenesis [10]. In recent years, numerous studies have indicated that exercise can reduce the risk of breast cancer in women and play a significant role in the treatment and recovery of breast cancer [11].

The preventive effects of exercise on breast cancer have been confirmed by multiple studies. Exercise can reduce the risk of breast cancer through various mechanisms, such as regulating hormone levels, decreasing fat content, and enhancing immunity

[12]. These mechanisms collectively work to lower the probability of women developing breast cancer. A study published in the “Cancer Prevention Research” journal found that engaging in approximately 2.5 hours of moderate-intensity aerobic exercise per week can decrease the risk of developing breast cancer by 20% to 30% [13]. Exercise not only lowers the risk of breast cancer recurrence but also improves patient survival rates [14]. Research indicates that engaging in 150 minutes of moderate-intensity exercise per week can reduce the risk of breast cancer recurrence by about 40% [15]. Additionally, exercise can enhance the physical fitness of patients, alleviate fatigue, and promote recovery. For instance, a study found that 150 minutes of aerobic exercise per week significantly increased patients’ quality of life scores and improved their mental health [16].

A large body of research indicates that exercise has a positive impact on the prevention and treatment of breast cancer, involving various mechanisms [17]. Regulating hormone levels: High estrogen levels are a significant risk factor for breast cancer, and exercise can reduce estrogen levels in the body, thus lowering the risk of developing breast cancer [18]. Additionally, exercise can lower the risk of breast cancer by regulating the endocrine system. Long-term exercise or physical activity can decrease estrogen levels in the body. Estrogen, a sex hormone, has been associated with an increased risk of breast cancer when present in excess. Exercise can reduce the production of estrogen by the ovaries and increase the excretion of bile acids, thereby lowering estrogen levels in the blood [19]. Exercise also promotes the decline of ovarian function, further reducing estrogen production. Reducing fat content: Obesity is one of the risk factors for breast cancer, [20] and exercise can help reduce body fat content, thus lowering the risk of developing the disease. Enhancing immunity: The function of the immune system is closely related to the occurrence and prognosis of breast cancer [21]. Exercise can enhance immune function, elevate the body’s immune level, and help resist the occurrence and recurrence of breast cancer. Improving psychological well-being: Breast cancer is a serious disease that greatly affects patients’ mental health. Exercise can promote the release of neurotransmitters such as dopamine and norepinephrine in the body, thereby improving patients’ psychological status, reducing anxiety, depression, and other negative emotions, and promoting DNA repair. DNA damage is one of the important causes of cancer. Exercise can promote DNA repair and stability, thereby reducing the risk of developing breast cancer. Furthermore, exercise can lower the risk of breast cancer by regulating the endocrine system [22]. Long-term exercise or physical activity can decrease estrogen levels in the body. Estrogen, a sex hormone, has been associated with an increased risk of breast cancer when present in excess [23]. Exercise can reduce the production of estrogen by the ovaries and increase the excretion of bile acids, thereby lowering estrogen levels in the blood. In patients already diagnosed with breast cancer, exercise also demonstrates numerous benefits. Exercise can prevent breast cancer by improving the body’s insulin sensitivity. Insulin resistance is a key feature of obesity and diabetes, both of which are associated with an increased risk of breast cancer. Regular exercise can enhance the body’s sensitivity to insulin, lower insulin levels, and thus reduce the risk of breast cancer: On one hand, exercise can help patients maintain a healthy weight, reduce insulin resistance, and consequently decrease the risk of breast cancer recurrence [24]. On the other

hand, exercise can also improve patients' mental health status, reduce symptoms of depression and anxiety, and enhance their quality of life.

The impact of exercise on quality of life and survival rates of breast cancer survivors

Exercise is considered a critical intervention that can improve the quality of life and survival rates of patients during breast cancer treatment [25]. Treatments such as surgery, radiation, and chemotherapy can impose certain damages and burdens on the body. Exercise can assist breast cancer survivors in improving their physical condition, enhancing fitness and immunity, and reducing post-treatment symptoms like fatigue and muscle atrophy. Moreover, exercise can contribute to weight management, hormone regulation, and aid in lowering the risk of cancer recurrence and mortality. During the treatment process, breast cancer patients often experience negative psychological responses such as anxiety, depression, and insomnia. Exercise promotes balance in the neuroendocrine system, releases pleasure hormones, improves mood, and alleviates psychological discomfort [26]. Additionally, engaging in physical activity can help breast cancer survivors regain confidence, independence, self-worth, and overall quality of life.

Previous studies suggest that engaging in moderate-intensity exercise for over 150 minutes per week significantly reduces the risk of death and improves overall survival rates for breast cancer patients. Disease recurrence is a critical factor influencing survival rates, and regular aerobic exercise has been shown to lower the recurrence rate of breast cancer patients. Around 150 minutes of aerobic exercise per week can notably decrease the risk of recurrence for breast cancer patients. The impact of exercise on survival rates may vary among different subgroups of breast cancer patients [27]. Breast cancer recovery guidelines indicate that moderate aerobic exercise can notably enhance the survival rates of ER+/PR+ subgroup patients, whereas there is no significant survival rate improvement effect for ER-/PR- subgroup patients.

Breast cancer patients often face issues such as physical fatigue and decreased physical strength. Exercise can improve patients' physical function, health status, immunity, endurance, and alleviate symptoms such as fatigue and weakness. Additionally, during breast cancer treatment, patients often experience psychological stress and depression, and exercise can help control and reduce pain felt by breast cancer patients. Exercise stimulates the production of endorphins, a natural pain reliever, which can alleviate chronic pain and improve patient comfort. Furthermore, exercise enhances muscle strength, joint flexibility, helping patients better cope with potential physical discomfort in daily activities. Exercise can improve patients' mental health, help them cope with stress, provide a positive shift in mood, elevate spirits, and further enhance quality of life. Exercise has also been found to improve patients' cognitive function, which is especially important for those patients who may be affected by treatments like chemotherapy [28]. Breast cancer treatment may lead to social isolation and feelings of loneliness, affecting patients' social participation and quality of life. Exercise can promote patients' social activities, increase social participation, and improve overall quality of life. Additionally, breast cancer patients often face sleep issues such as insomnia and excessive sleepiness. Research indicates that ex-

ercise can improve patients' sleep quality and duration, contributing to an overall improvement in patients' quality of life.

Exercise improves quality of life and survival rates of breast cancer patients

Exercise can enhance the social identity of breast cancer patients or improve their quality of life [29]. Exercise is often combined with group activities or community events, providing breast cancer patients with opportunities to interact with peers, share experiences, and strengthen mutual support and understanding. Such social environments can offer positive social feedback, making patients feel they are not alone in facing the challenges of illness, enhancing their social identity. Furthermore, exercise significantly reduces depression and anxiety levels among breast cancer survivors and helps improve sleep quality. Additionally, exercise lowers the risk of breast cancer recurrence and mortality, especially among patients who engage in post-treatment exercise, where the risk of recurrence and mortality decreases noticeably. Moreover, the impact of exercise on survival rates is also related to factors such as the type, intensity, and frequency of exercise. In general, exercise has significant benefits for breast cancer survivors, helping them improve both physical and psychological conditions, enhance quality of life, and reduce the risk of recurrence and mortality. Therefore, breast cancer patients should be encouraged to engage in appropriate exercise during treatment to help them better cope with the disease and improve both quality of life and survival rates.

In conclusion, exercise has a positive impact on the quality of life and survival rates of breast cancer patients. Therefore, breast cancer patients should choose appropriate types and intensities of exercise according to their own conditions, develop suitable exercise plans based on disease symptoms, and follow medical advice to improve quality of life and survival rates.

The impact of interdisciplinary approaches on breast cancer research

Interdisciplinary collaboration refers to cooperation and exchange between different disciplines to explore research methods for interdisciplinary issues. Breast cancer research is a multidisciplinary field involving disciplines such as biomedicine, physiology, psychology, sociology, and epidemiology [30]. In this field, the relationship between exercise as a preventive and rehabilitative measure and breast cancer, particularly its influencing factors and effects, has garnered widespread attention. Citespace software, as a knowledge discovery tool based on scientific literature, can comprehensively explore and analyze research on exercise and breast cancer.

Genomics is an interdisciplinary field involving biology, biochemistry, and computer science, among others [31]. In the context of breast cancer, the application of genomics can help scientists better understand issues such as the etiology and prognosis prediction of breast cancer. In recent years, studies have found a close association between breast cancer occurrence and genetic mutations and chromosomal abnormalities. Through genomic research, scientists can explore issues such as breast cancer susceptibility genes, mutation patterns, and genetic characteristics, providing more accurate bases for breast cancer prevention, diagnosis, and treatment.

Exercise is an interdisciplinary field involving physiology, biochemistry, and sports medicine. In the realm of breast cancer, research has shown that exercise can play a positive role in prevention, treatment, and recovery. Some studies suggest that appropriate exercise can improve patients' quality of life and survival rates, reducing the risk of breast cancer recurrence and death. The impact of exercise on breast cancer involves multiple disciplines, requiring collaboration among experts in exercise science, oncology, epidemiology, and biochemistry, among others.

For instance, the influence of exercise on breast cancer is closely related to factors such as hormone levels, the immune system, and cardiovascular health [32]. Experts in exercise science can explore the mechanisms of exercise in breast cancer prevention and treatment by studying its effects on these factors. Oncologists can investigate the impact of exercise on breast cancer from the perspectives of pathology and molecular biology, as well as the effects of combining exercise with other treatment methods on breast cancer treatment outcomes. Epidemiologists can study the relationship between exercise and breast cancer incidence and mortality from a population perspective, exploring the application value of exercise in breast cancer prevention and treatment. Biochemistry experts can study the molecular mechanisms of exercise on breast cancer cells, further elucidating the principles of exercise in breast cancer treatment.

The relationship between Psychology and Breast Cancer is also an interdisciplinary field involving multiple disciplines. The diagnosis and treatment of breast cancer can have a significant impact on both the physical and psychological well-being of patients. Therefore, mental health is increasingly gaining attention in breast cancer treatment. Psychologists can provide psychological intervention and support for patients by studying aspects of their psychological health and coping mechanisms [33]. Previous research has found a close correlation between the psychological well-being of breast cancer patients and treatment outcomes, as well as survival rates. Mental health experts can assist patients in coping with psychological stress and negative emotions during the treatment process, thereby improving the overall quality of life and survival rates.

Artificial Intelligence (AI) is a cross-disciplinary field involving computer science, mathematics, and statistics, and it has been widely applied in the field of breast cancer. AI can assist doctors in better analyzing data related to breast cancer imaging and pathology, thereby enhancing the accuracy and efficiency of diagnosis and treatment. Through automatic analysis of breast cancer pathology images, AI can help doctors more accurately determine the type and grading of breast cancer, improving diagnostic accuracy and efficiency. Additionally, AI can aid doctors in predicting patient prognosis and treatment responses, providing more accurate guidance for clinical treatment.

Interdisciplinary collaboration has a significant impact on research and treatment in the field of breast cancer [34]. Cooperation and communication between various disciplines can facilitate a deeper and more comprehensive understanding of breast cancer and provide more comprehensive and accurate solutions for prevention, diagnosis, and treatment. In the context of research on exercise and breast cancer, interdisciplinary collaboration is essential for a holistic approach.

Through research on the relationship between exercise and breast cancer, we can not only gain a deeper understanding of the mechanisms of exercise in the prevention and treatment of breast cancer but also provide more comprehensive and personalized treatment plans for patients. Moreover, collaboration between disciplines can foster innovative research and contribute to the development of novel treatment methods, making a greater contribution to the treatment and prevention of breast cancer.

Limitations of the study

The literature data used in this study were sourced from the Web of Science database, which may have omissions or may not include relevant literature from other databases, thus the results may not be comprehensive enough.

The time span of the study ranges from 2000 to 2023, which means that some earlier studies may not have been included. Additionally, due to time constraints, the number of literature selected for this study is limited, which may have some impact on the results.

Since this study mainly adopts quantitative analysis methods, it may not fully reflect qualitative research or other forms of research results.

The relationship between breast cancer and exercise studied in this paper mainly relies on bibliometric analysis methods and cannot be experimentally validated, thus the research results may have certain limitations.

Conclusion

This study conducted a bibliometric analysis of the relationship between breast cancer and exercise using Citespace software. Through co-occurrence analysis of keywords, we identified that exercise, physical activity, breast cancer, tumor, treatment, and intervention are the research hotspots in this field. Analysis of keyword timeline and burst detection revealed that the field has shown a trend towards intervention and treatment in recent years, with keywords such as "traditional Chinese medicine" and "rehabilitation training" exhibiting high burst values. Through co-occurrence analysis of disciplines, we found close connections between breast cancer research and disciplines such as health science, public health, and sports medicine. Analysis of national document co-occurrence indicated that countries such as the United States, the United Kingdom, and China play significant roles in research in this field.

In summary, research on the relationship between exercise and breast cancer has become an important direction in the fields of breast cancer treatment and prevention. Future research could further focus on intervention and treatment strategies, exploring the combined application of traditional therapies such as traditional Chinese medicine and rehabilitation training with exercise. Additionally, in terms of international cooperation and exchange, it is necessary to strengthen collaboration with countries like the United States, the United Kingdom, and others to jointly promote research development in this field.

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