



## Review article

# Trends in physical activity research for breast cancer - A bibliometric analysis of the past ten years

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## ABSTRACT

**Introduction:** Cancer, particularly breast cancer, is a significant cause of death worldwide, and physical activity has been shown to reduce the risk of developing cancer and improve the prognosis of patients diagnosed with cancer. However, there is a lack of detailed analysis of publications related to physical activity in breast cancer patients, hindering the provision of strong evidence in this area.

**Materials and methods:** The Core Collection database of Web of Science (WoS) was used as the source of the bibliography, with a search conducted on October 16, 2023. The search strategy used the terms "Physical Activity" and "Breast Cancer" or "Lymphedema," identifying articles published between 2012 and 2022. The bibliometric analysis focused on three dimensions, including scientific production and delivery, scientific collaboration, and bibliometric evaluation at the individual level. We performed the data analysis with Bibimetrix, an open-source tool integrated with R that allows a complete analysis of the behavior of the scientific literature.

**Results:** A total of 979 publications related to physical activity or exercise in breast cancer (974 article, 1 data paper, 2 article early access y 2 proceedings paper), with an increasing trend in the number of articles published over the years. The most common research topics included "quality of life", "woman", "survivors", and the impact of physical activity on the risk of cancer recurrence. The United States was the most productive country in this area, and the Journal "Supportive Care in Cancer" was the most common journal to publish on this topic.

**Conclusion:** This bibliometric analysis provides insight into publication trends and common research topics in the area of physical activity and breast cancer. The results can be beneficial in guiding future physical rehabilitation research inquiries and providing information to funding agencies on areas of greatest research opportunities.

## 1. Introduction

Cancer is a leading cause of death and main barrier to life span expectancy worldwide [1]. The World Health Organization (OMS) in 2019 declared cancer as the first or second cause of death in 112 countries around the world, most of them located in Latin America

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(Fig. 1) [2].

Note: The World Health Organization. From (3)

International Agency for Research on Cancer (IARC) estimated a total of 19.3 million new cases and 10 million cancer deaths worldwide by 2020. It is also estimated that half of all cases and 58.3 % of all cancer deaths will occur mainly in Asia where 59.5 % of the world's population resides. Moreover, Europe accounts for 22.8 % of all cancer cases, although it represents only 9.7 % of the world's population and America has an incidence of 20.9 % with a mortality rate of 14.2 % [4]. The top ten kinds of cancer account for >60 % of newly diagnosed cancer cases and >70 % of cancer deaths. Of these, female breast cancer is the most commonly diagnosed cancer (11.7 % of all cases) and has the highest mortality among females, followed closely by lung (11.4 %), colorectal (10.0 %), prostate (7.3 %), and stomach (5.6 %) cancers [4].

In the last years, exercise and physical activity showed their power to decrease the likelihood of developing cancer and improve the prognosis of many patients diagnosed with this disease. In addition, physical activity and exercise increase the perceived quality of life and decrease associated disability [5]. Therefore, growing evidence suggesting that physical activity and exercise have benefits with respect to the risk of cancer onset, recurrence, and mortality rate is evident [6–9].

A minimum of 2.5 h per week of moderate-intensity physical activity has been found to be associated with a 13 % reduction in cancer mortality [10]. This finding is consistent with recommendations from the American College of Sports Medicine (ACSM), which suggests at least 150 min of cardiovascular exercise per week, along with strengthening exercises for large muscle groups performed at least twice a week, as part of a beneficial approach during cancer-related processes [11].

Thus, this kind of intervention is an accepted method by the WHO, the Centers for Disease Control and Prevention (CDC), the American Cancer Society (ACS), and the National Cancer Institute (NCI) for managing and treatment of this disease [12,13] also pointing out that each patient needs a physical activity program based on exercise throughout the cancer care process due to its benefits in physical condition, quality of life and even as a protector. against disability related to cancer treatments and side effects of cancer [14].

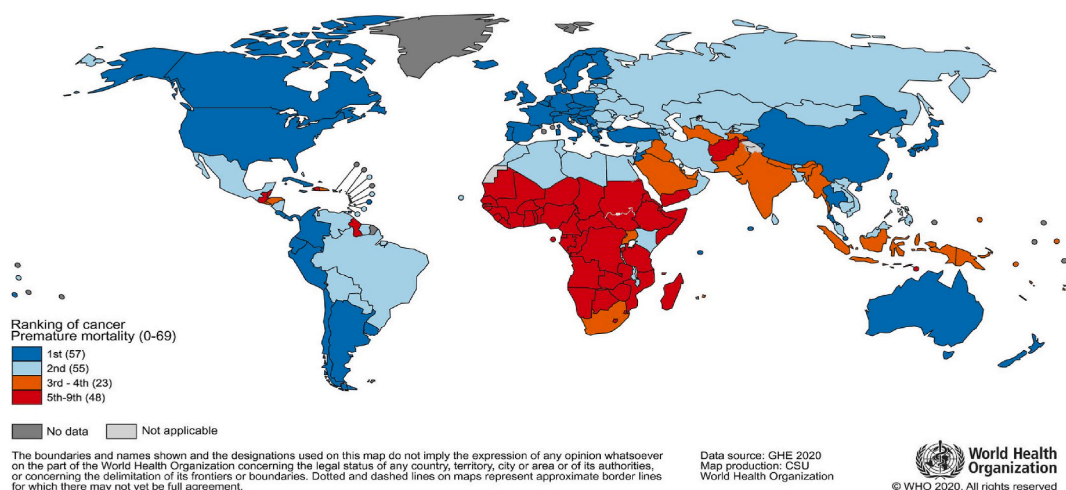
In the last decade, a lack of knowledge has been observed regarding the evolution of publications related to physical activity or exercise in patients diagnosed with breast cancer. It is important to highlight that the evidence and research on the relationship between physical activity and exercise in the context of cancer is not uniform for all types and subtypes of oncological diseases, taking into account the diversity of more than 100 existing cancer types [4]. This diversity has hindered the construction of a solid evidence base in this field and has highlighted the presence of gaps in the scientific literature. Furthermore, the need to point out specific areas that present opportunities to guide future research in the field of physical rehabilitation in cancer patients has been identified.

In this sense, we propose this bibliometric analysis of the literature published in the last decade on the association between physical activity or exercise with breast cancer to identify trends in publication rates and determine the most common research topics in this area. Beyond observing the large volume of publications, this analysis using machine learning methodology provides a more detailed and descriptive view of the published topic areas outside of traditional search methods [15].

## 2. Materials and methods

### 2.1. Design

In this research, a descriptive bibliometric analysis was carried out with the purpose of carrying out a scientific mapping of



Note: The World Health Organization. From (3)

Fig. 1. National Ranking of cancer as a cause of death in Ages <70 Years in 2019.

publications related to physical activity or exercise (PA) and breast cancer (BC). The methods used in this analysis were similar to those used in previous research in the same field [3,16].

## 2.2. Literature source and search strategy

For this bibliometric research, the Web of Science (WoS) Core Collection database was used, and the last updated search was performed on October 16, 2023. As a database, WOS includes more than 12,000 high-impact international publications. academic journals, covering the fields of natural sciences, health sciences, technology, engineering, social sciences, arts and humanities, among others. The WOS Core Collection database allows you to quickly find high-impact articles, discover research areas, and identify developing trends in a given field. These features make WOS a popular database for bibliometric research [17].

The search strategy implemented in the database was designed as follows: the formula was used (TI= ("Breast Cancer" OR "Lymphedema" OR "breast lymphoma" OR "Breast Carcinoma" OR "breast neoplasm")) AND TI= ("Physical Activity" OR "Exercise"). Through this strategy, articles published from 2002 to the current date were identified.

Given the specific focus of this review, a filter was applied to only include articles published in the last 10 years (2012–2022) written in English and Spanish. Furthermore, we restricted our search to the editions of journals indexed in Science Citation Index Expanded (SCI-EXPANDED), Social Sciences Citation Index (SSCI), and Emerging Sources Citation Index (ESCI). This selection ensures the inclusion of high-quality and relevant articles in our review. The data set was downloaded in "BibTex" format and then analyzed in RStudio version 2023.06.2.

To access the complete search strategy, we share the following link: <https://www.webofscience.com/wos/woscc/summary/ce77d85f-a89a-465a-a357-83480dfdb2d7-abbd0ec3/relevance/1>.

## 2.3. Statistical analysis and Visualization

We analyzed three bibliometric dimensions. The dimension of scientific production and dissemination (including the number of articles published per year, journals, countries, citations, and authors). The dimension of scientific collaboration (encompassing national and international collaborative articles, as well as non-collaborative articles) and the dimension of bibliometric evaluation at the individual level, which includes metrics such as Lotka's Law, the h-index, g-index, and m-index.

We performed the data analysis with Bibliometrix, an open-source tool integrated with R that allows a complete analysis of the behavior of the scientific literature [18]. Next, we use descriptive statistics to summarize the analyzed data set, multidimensional scaling techniques, mapping, and data reduction.

We use the Law of Exponential Growth [19,20] to evaluate the annual increase in the number of publications, which will determine the interest in the topic. Additionally, we applied Bradford's Law of Concentration of Science [21,22] to identify the journals most dedicated to the topic and those with the highest citation rates. This analysis will allow us to identify the most prolific and cited journals in this field.

A descriptive analysis of the countries and regions that participated in the co-authorship of the publications was also carried out, highlighting those with high productivity and a large number of citations. This analysis will facilitate the examination of international collaboration and reveal strong social connections, which is indicative of its importance in research in this field. For more details on this analysis, including information on node size, connection strength, scores, and density maps, we invite you to consult the Bibliometrix Manual [18].

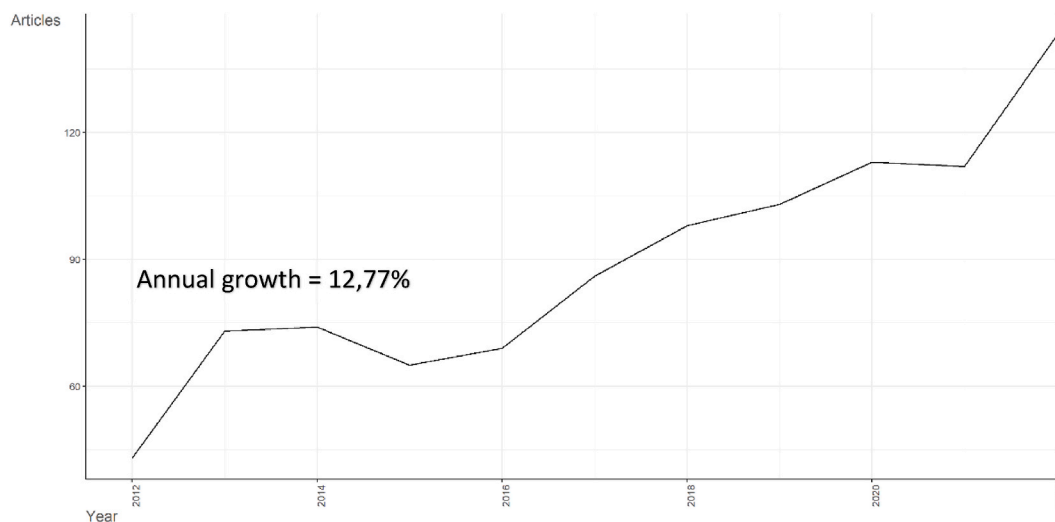


Fig. 2. Annual scientific production.

### 3. Results

The search chain identified a total of 979 publications related to physical activity or exercise in breast cancer (974 articles, 1 data paper, 2 article early access y 2 proceedings paper) published from 2012 to the 2022, 4700 authors, and 1511 keywords. From 2012 to 2022, publications increased by 12.7 % annually, with 2022 being the year of greatest scientific production with 143 papers (Fig. 2).

Fig. 3 shows the countries with the highest number of publications, among them are the United States (appearing 2065 times in the 979 documents), Canada (795 times), Australia (405 times), France (324 times), and Spain (318 times). In Ibero-America, the scientific production of Brazil (152 times), Chile (12 times), Mexico (7 times), and Colombia (8 documents) stands out.

Bradford's Law is a valuable tool in the field of bibliometrics that allows us to identify the most influential and prominent journals in a specific field of research [19]. Bradford's law analysis revealed that the journals that stand out in terms of publication on the topic of study in order of importance are: "Supportive Care in Cancer", "Breast Cancer Research and Treatment," "BMC Cancer," "Psycho-Oncology," "Integrative Cancer Therapies," and "Cancer." the full analysis is found in Table S1 Primary sources according to Bradford's law.

The research institutions with the highest number of publications and makes the main co-institutional scientific collaboration networks (Fig. 4A) include the University of Alberta (with 119 documents), the University British Columbia (with 115 documents), the University of North Carolina (with 95 documents), and University of Calgary (with 88 documents).

Regarding the network of co-authors (Fig. 4B), we found a total of 4700 authors, of which the author with the largest number of articles is Kerry Courneya from the University of Alberta (Canada), with 45 articles. They are followed by Christine Friedenreich from the University of Calgary (Canada), with 28 articles; and Sabiston Catherine from University of Toronto (Canada) with 23 articles. The other authors have less than 20 research articles on the subject. Table S2 lists the productivity of all authors following Lotka's law [23], highlighting that 78.6 % of all authors have only one document written on the subject.

Of the total number of authors found, the 50 most important were selected, to which the H, G and M index was determined, in addition to the number of global citations, evidencing that Courneya KS had a total of 1503 citations, an H index of 21 and an index G of 38, thus considering himself the most prominent author on the topic of study. Table S3 lists the information from the other authors.

In order to avoid bias in the analysis of the keywords resulting from the search criteria used, the "Keywords Plus" were identified. These constitute additional terms or keywords used to improve indexing and facilitate the search for scientific documents in bibliographic databases. The temporal evolution of these keywords in the collected literature was analyzed, as seen in Fig. 5A, revealing a notable increase in bibliographic production over time, with a particular emphasis on quality of life.

This analysis is complemented by the creation of a cloud of the most used keywords, presented in Fig. 5B.

By applying Zipf's law to the constructed metadata matrix, it was possible to determine a total of 50 keywords, with which the word cloud was constructed, taking into account their occurrence. He highlights the keyword "Quality of life" (appearing in 299 documents), followed by "Woman" (present in 281 files) and "Survivors" (mentioned in 245 articles).

Now, when analyzing these keywords over time, it can be seen in Fig. 6 that in the studies of the last two years (2020–2022), the

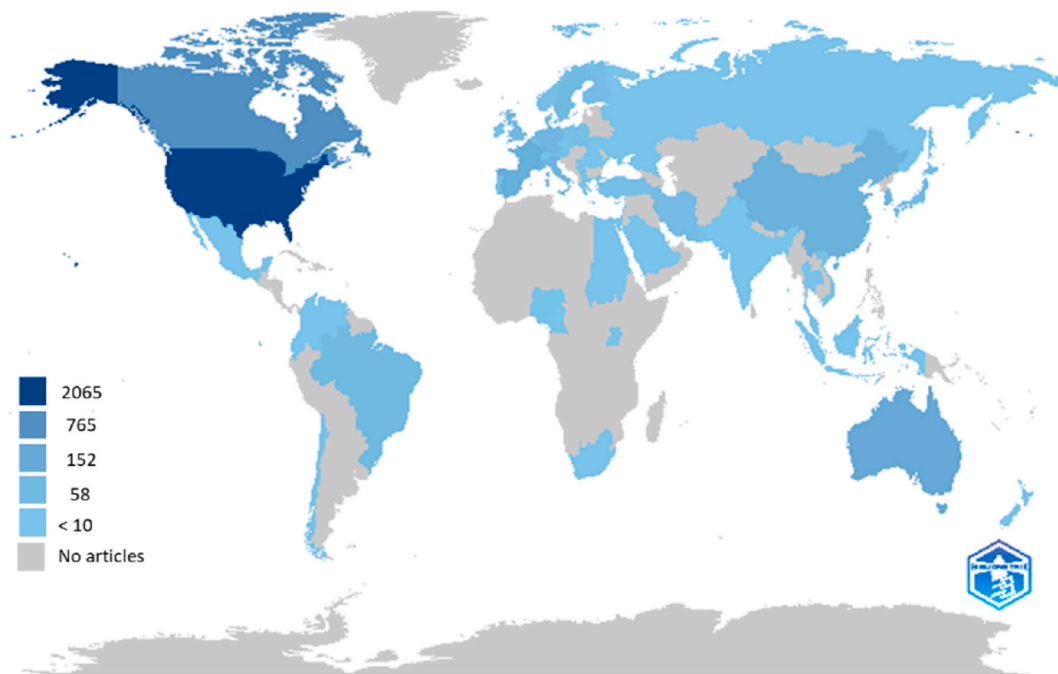


Fig. 3. Countries' scientific production.

(A) Co-institutions network; (B) co-authors network.

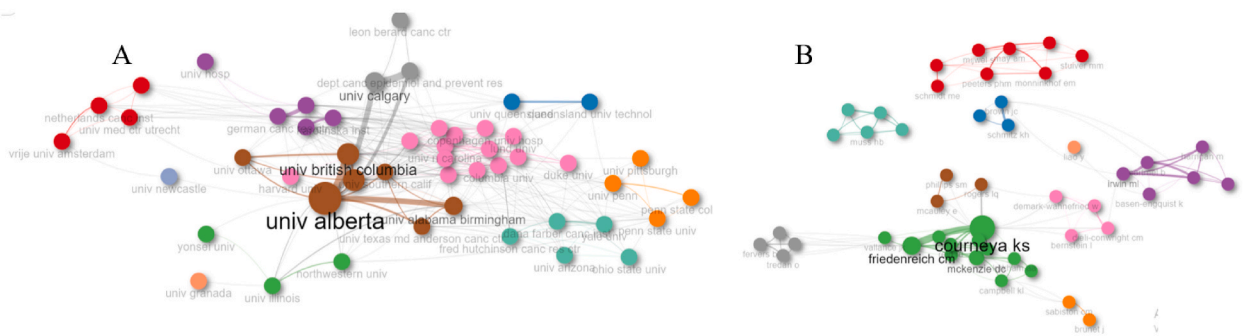
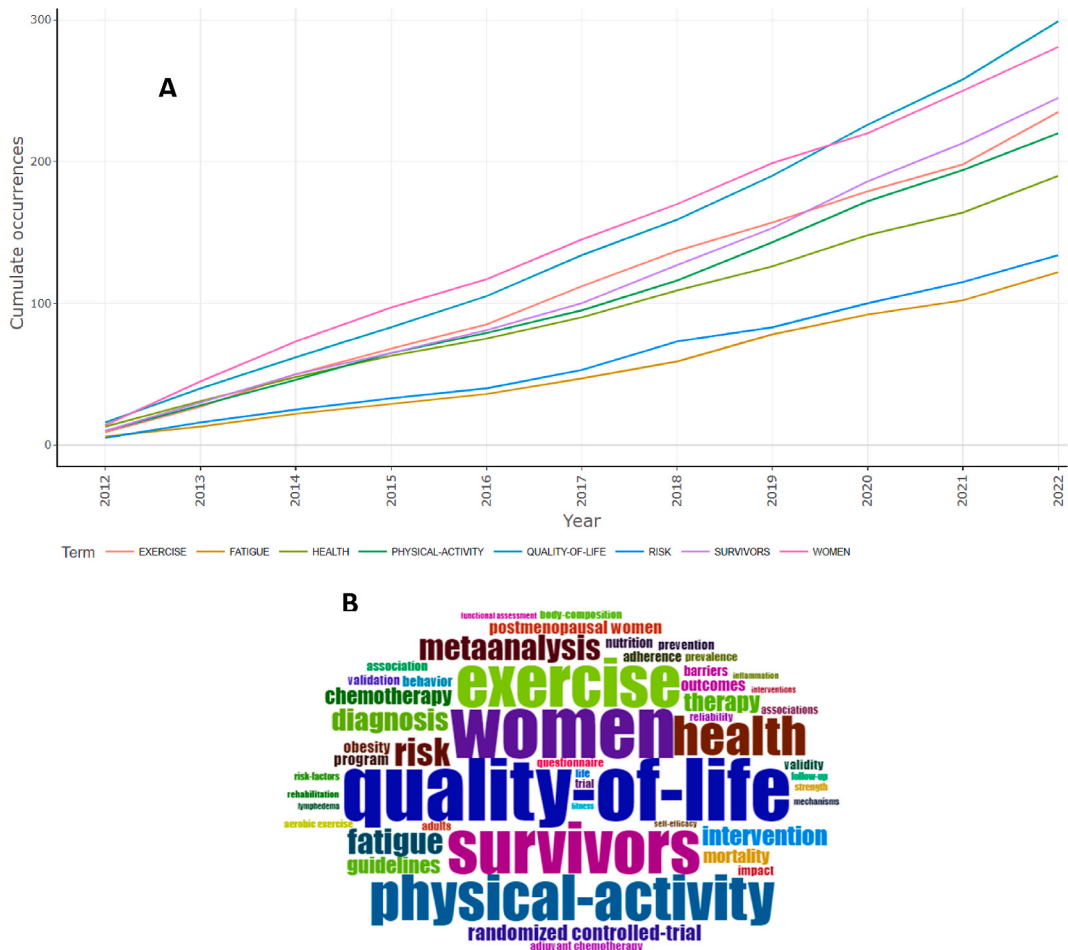


Fig. 4. Collaboration Network (A) Co-institutions network; (B) co-authors network.



A. Keyword trend analysis B. Keyword cloud

Fig. 5. keyword analysis.

focus has been on determining consensus (8 studies), the behavior change (8 studies), inflammation (31 studies), pain (20 studies), risk factors (35 studies), among others. Table S4 provides details on each of the keywords and their behavior over time.

The thematic map of the study issue of this review (Fig. 7) presents 20 clusters of which 3 are classified as "Motor Themes"; 7 as "Basic Themes", 3 as "Emerging or Declining Themes" and 7 as "Niche Themes". To better understand these results it is important to note that centrality (X-axis) measures the strength of the relationship of a specific topic with the development of the whole field of research analyzed; while density (Y-axis) measures the strength among all the keywords describing the research of the topic of study. Therefore, this value can be an indicator of topic development.

Matrix diagram representing the research areas from 2012 to March 2023. Quadrant 1: Niche Themes. quadrant 2: Emerging or declining issues. Quadrant 3: Basic Themes. Quadrant 4: Motor Themes.

Centrality therefore represents the importance of the topic to the research field. It identifies an essential area of study that must be understood by any researcher involved in the research field under analysis. In contrast, density indicates the ability of the issue to predominate over time. Finally, the size of each group shows the proportionality of the number of core documents associated with the issue under study, followed by the sum of their citations.

#### 4. Discussion

This bibliometric study analyzed the properties of 979 scientific articles with the objective of analyzing the literature published in the last decade on the association between physical activity or exercise with breast cancer to identify trends in publication rates and determine the most common research topics. in this area.

Physical activity as a preventive agent in breast cancer was first reported by Frisch et al. [24]. in 1985, since then, several investigations have been published worldwide with a wide range of designs, samples, and evaluation methods to examine the role of physical activity in risk reduction and therapeutic care of the pathology. There are even reports dating back to the first quarter of the 20th century such as Silverstein and Dahlstrom [25] where they found in 86,000 deaths that the probability of dying from cancer (including breast cancer) was inversely related to the amount of muscular work associated with the occupation of the deceased.

However, it is necessary to consider technical and methodological issues related to the nomenclature historically used in the narratives on physical activity, exercise and their relationship to breast cancer. In this regard, there is a marked bias in the scientific literature in treating the concepts of exercise and physical activity as the same in many instances, when by definition they are concepts that, although related, have different scopes and applicability.

At the same time, the complexity and limitations of the variable itself should be highlighted. It should be considered that the type of physical activity may be very diverse (occupational, domestic, or recreational), of different dosages and modalities, and often measured by self-report or without standardized parameters for this purpose. Moreover, in the past, there were no methods of greater reliability and validity that we now consider and take for granted. Therefore, and as other authors point out, it is valid to think that the associations with cancer risk and prognosis have probably been underestimated in the last century, due to random measurement error [26].

Although the evidence available in the high-impact publications reported in this analysis is described since 2010, it is important to mention that there are bibliographic reports on physical activity and cancer in books, lower impact journals, non-indexed journals or alternative databases that It dates back to the 20th century. Due to its nature, the years of publication and language, this type of

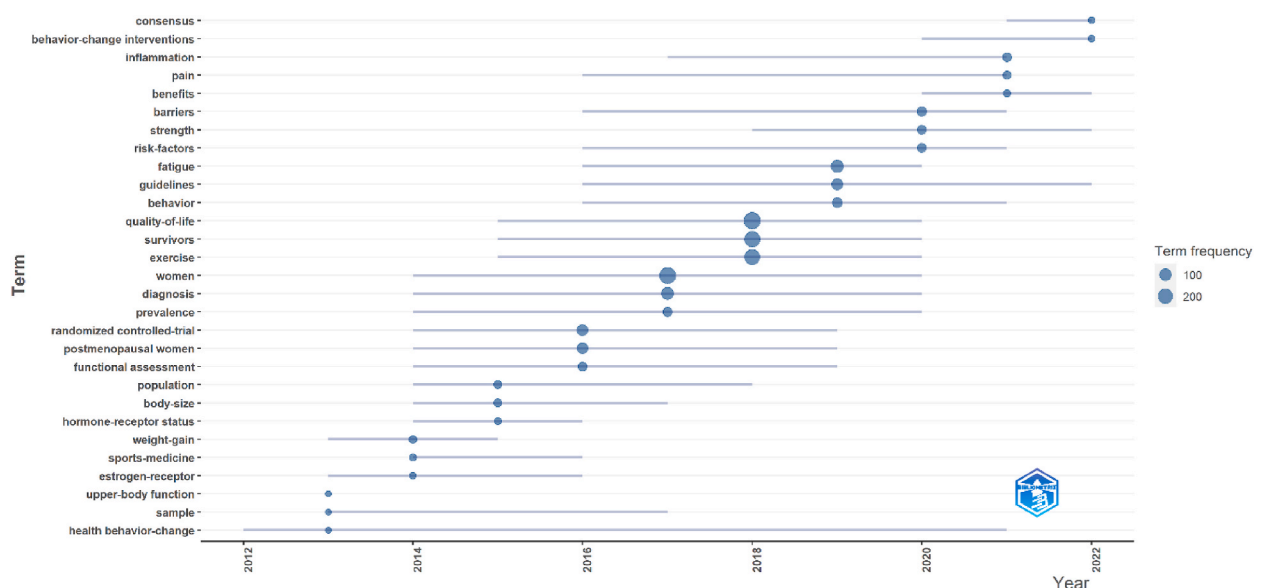


Fig. 6. Trend topics.



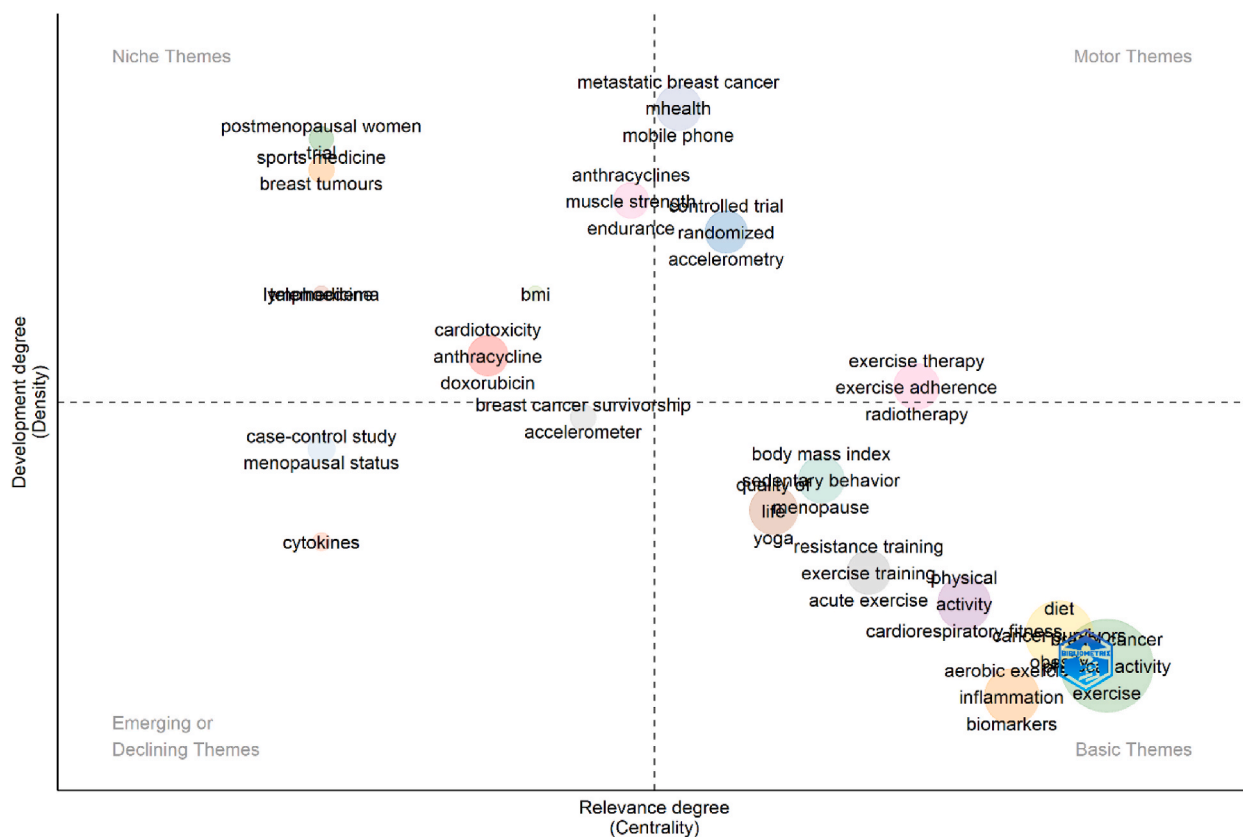


Fig. 7. Thematic map.

literature was not considered in this analysis and may well modify the trends in the results.

Furthermore, it is worth highlighting the marked trend in the origin of most of the publications (North America and Europe); a geolocated monopolization in countries considered developed or first world. This phenomenon could have several meanings. Of course, it could lead to a socioeconomic bias that underlies the disparity of conditions in research and reflects a global structural problem, especially in the case of Latin America, Southeast Asia, Central Asia and Africa, where complex sociopolitical policies and economic conditions may well be intrinsic and hinder research and its scope in these countries. These issues include, but are not limited to, limited institutional funding and organizational support spanning the university and healthcare system (both public and private) and government and regulatory policies that promote and encourage research and publication in quality indexed journals. and high impact. thus, limiting the scope of publications, and with it the transmission and construction of solid and quality knowledge in this area.

Additionally, in this same perspective, mention should also be made to the barrier to publishing for researchers and research groups in developing countries who do not have enough resources to fund their publications. Thus, the business model of the highest-impact scientific journals (which have their publishing houses based in developed countries) generates high fees for the processing and publication of scientific articles that can be unsustainable for research groups, and private or public institutions in developing countries.

Finally, the relationship of inter-institutional cooperation in this document shows a relatively localized trend, which indicates that it is necessary to strengthen inter-institutional and inter-regional cooperation. This also opens up a horizon of opportunity in lines of research that are still poorly explored and have high preventive and therapeutic potential. This is the case of social determinants, health education, and adherence to treatment based on physical activity and exercise, particularly in countries where the impact of breast cancer is evident in the mortality and quality of life of millions of women, as is the case in Latin American countries.

The present study has some limitations inherent to bibliometric research. The data was taken from WoS, so articles indexed in other databases that could have been included in the analysis were lost. Now, the reason for this decision is due to the fact that this database is one of the most used by researchers for bibliometric analysis due to its extensive catalogue, its influence in the scientific field and the complete information it provides for this type of analysis [27]. Finally, regarding the inclusion and exclusion criteria, data cleaning was not taken into account, so it cannot be guaranteed that duplicate articles or articles that did not meet the criteria were eliminated and should be taken into account in future studies of bibliometric analysis.

## 5. Conclusions

According to the development of the bibliometric analysis, there is an increasing global trend of research on physical activity and breast cancer since 2012. The trends in research related to physical activity in breast cancer have their origin mainly in democratic, industrialized, educated, English-speaking countries and white populations in the northern hemisphere of the planet, except for Australia because of its location, and Spain and France because of their language.

The United States is the largest contributor as it appears 2065 times in the 979 publications analyzed. In Latin America, the countries with the greatest appearance in publications are Brazil, Mexico, Colombia and Chile, which in their entirety represent only 2.7 %. Finally, global trends in research specifically involve exercise in women with breast cancer and their quality of life; focusing on survival, pain, risk factors, among others.

## Recommendation

The results showing in this bibliometric analysis, enhance recently developed consensus efforts and will allow researchers to better target their research inquiries to address areas where evidence is lacking to meet the identified needs of the field of study. Furthermore, these results can be beneficial in providing information to funding agencies on areas of greatest research opportunities.

## Data availability statement

The data that support the findings of this study are available from the corresponding author (BEPP), upon reasonable request.

## CRediT authorship contribution statement

**Brayan E. Patiño-Palma:** Writing – review & editing, Writing – original draft, Formal analysis, Data curation, Conceptualization. **Luis López-Montoy:** Writing – review & editing, Writing – original draft, Formal analysis, Data curation, Conceptualization. **Rafael Escamilla-Ugarte:** Writing – review & editing, Writing – original draft, Data curation, Conceptualization. **Alejandro Gómez-Rodas:** Writing – review & editing, Writing – original draft, Formal analysis, Data curation, Conceptualization.

## Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

## Appendix A. Supplementary data

Supplementary data to this article can be found online at <https://doi.org/10.1016/j.heliyon.2023.e22499>.

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