The Open Public Health Journal
DOI: 10.2174/0118749445421003251104061253, 2025, 18, e18749445421003
ISSN: 1874-9445
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REVIEW ARTICLE **OPEN ACCESS**

Mapping a Decade of Breast Cancer Research in Morocco: A Bibliometric Analysis (2010–2022)

Fatima-Ezzahra Azzouzi[1,*], Saloua Lamtali[2], Samira Essoli[3,4], Majda Sebbani[1,3,4,5], Mohamed Amine[1,3,4] and Latifa Adarmouch[1,3]

[1]*Bioscience and Health Research Laboratory, Faculty of Medicine and Pharmacy, Cadi Ayyad University (UCA), Marrakesh, Morocco*
[2]*Higher Institute of Nursing Professions and Health techniques-Marrakesh-Morocco*
[3]*Community Medicine and Public Health Department, Faculty of Medicine and pharmacy, Cadi Ayyad University (UCA), Marrakesh, Morocco*
[4]*Clinical Research Department, Mohammed VI University Hospital, Marrakesh, Morocco;*
[5]*Unit of Development and Research in Medical Education (UDREM), Faculty of Medicine, University of Geneva, Geneva, Switzerland*

Abstract:

Purpose: This study aimed to describe the state of breast cancer research based on PubMed data over the past twelve years (from 2010 to 2022) in Morocco.

Methods: To conduct this bibliometric study, we began by implementing a selection strategy through a "search equation". We specified the time filter "between 2010 and 2022," which enabled us to select a sample of all available articles on PubMed written by Moroccan authors and focused on breast cancer in women. The sample included 506 articles of various types. We performed data processing and statistical analysis using SPSS 21 and Excel 2016.

Results: A total of 256 publications met our inclusion criteria, indicating an increasing trend in breast cancer scientific production, with a majority of Moroccan affiliations (90.2%). Of the publications, 37% were case reports, and 82.8% had no funding. Doctors of medicine were the most productive (46.5%), and 89.5% of the publications came from academic institutions, with 93.4% from public institutions. In our study, 64.5% of the publications were the result of national collaborations, compared to 28.1% involving international collaborations. Notably, only a small percentage (16%) of the studies received international funding, primarily from high-income countries (53.7%). Finally, most journals were located in the United Kingdom and the United States, with all journals requiring English-written articles and only three accepting French-written articles. All journals were indexed in Web of Science and Scopus in 94.7%.

Conclusion: Breast cancer research in Morocco requires an enabling environment, quality education for health professionals, and enhanced collaboration.

Keywords: Breast cancer, bibliometric analysis, morocco, research.

*Address correspondence to this author at the Bioscience and Health Research Laboratory, Faculty of Medicine and pharmacy, Cadi Ayyad University (UCA), Marrakesh, Morocco; E-mail: fatimaezzahraazzouzi@gmail.com

Cite as: Azzouzi F, Lamtali S, Essoli S, Sebbani M, Amine M, Adarmouch L. Mapping a Decade of Breast Cancer Research in Morocco: A Bibliometric Analysis (2010–2022). Open Public Health J, 2025; 18: e18749445421003.
http://dx.doi.org/10.2174/0118749445421003251104061253

Received: June 28, 2025
Revised: August 07, 2025
Accepted: August 15, 2025
Published: November 12, 2025

1. INTRODUCTION

Scientific production is a key indicator of a country's development [1, 2]. Cancer research is among the most active fields of biomedical research in the most similar countries. However, little empirical quantitative evidence is available to guide decisions on the orientation of specific research fields or the allocation of research resources [3]. Indeed, breast cancer research, along with care missions, teaching, and prevention, is the most appropriate scientific expression to improve prevention, screening, care, and other services for patients [4]. In general, research on breast cancer faces complex constraints, which require appropriate means and structures, with combined efforts of several disciplines and dynamic links between several research teams: hospitals, universities, and others.

Breast cancer research also aims to produce knowledge to better understand female cancer in its specificity and diversity in the national context, notably its risk factors, genetics, modes of care, and social repercussions [4, 5]. Breast cancer represents the first female cancer in the world [6-8], with an estimated 1.67 million new cases diagnosed in 2012 and 522,000 deaths per year [9]. In Morocco, its incidence is constantly increasing, making it currently the most frequent cancer in women. It is responsible for 36.4 new cases per 100,000 inhabitants per year according to the cancer registry of the greater Casablanca region and 43.4 new cases per 100,000 inhabitants according to the cancer registry of Rabat [10, 11]. It is also the most common cancer in women [12]. Each year, 2.3 million new cases are diagnosed, and more than 670,000 women die from the disease [13].

Compared to other countries [14, 15], Morocco's scientific production on oncology declined significantly between 1979 and 2009 [16, 17]. Notably, Morocco lacks a national journal that specializes in this topic. Furthermore, the number of scientific publications on breast cancer remains significantly lower than that of other Arab countries; research productivity in Egypt is higher, with a total of 582 publications (35.10%) [1].

To our knowledge, no study has evaluated scientific productivity in the field of breast cancer in women in Morocco. We aimed to perform a bibliometric analysis of articles on breast cancer during the period 2010-2022 in order to quantify research activity in Morocco through bibliometric indicators of measurement.

2. METHODS

We conducted a bibliometric analysis including scientific publications (editorials, case reports, case series, original articles, systematic reviews, and meta-analyses) dealing with breast cancer in women published on PubMed during the period 2010-2022 with at least one author affiliated to Moroccan institution. We excluded articles that dealt with male breast cancer, as well as retracted and unfound articles.

We launched a search using the PubMed search engine with the keywords: breast neoplasm, its inclinations, and Morocco, as well as the cities with faculties of medicine and pharmacy (Marrakech, Casablanca, Rabat, Fez, Oujda, Agadir, Tangier). We selected the scientific publications between 2010 and 2022; two authors evaluated the titles of the articles, abstracts, and full texts, and then we selected the articles according to the inclusion criteria already mentioned.

We collected data from articles indexed on PubMed about breast cancer in women between 2010 and 2022, using a data sheet that was compiled throughout 2023. This data sheet contained bibliometric indicators related firstly to the article (title of the article, DOI, PMID, year of publication, year of the study, and type of publication). Secondly, the data sheet focused on the author, including the first author’s country of affiliation, the total number of authors, the order of Moroccan affiliation, the number of Moroccan authors, the institution of the first Moroccan author, the professional grade of the first Moroccan author, international and national collaborations, and H-index. Thirdly, the data sheet included bibliometric indicators that are specific to the study, such as the study’s access, type theme, study population, sample size, study architecture, language, number of citations, and funding resources. Finally, bibliometric indicators related to the publishing journal were included (Country and language of publication, indexing, scientific journal rankings—Scimago, research field, payment or free access to the scientific journal, acceptance rate, and open access).

We analyzed the data using the Statistical Package for the Social Sciences (SPSS, version 21). We used descriptive statistics (percentages and frequencies) to describe the state of breast cancer research at the Moroccan level, and performed bivariate analysis using the chi-square test to identify the associated factors to international collaboration. The confidence interval was set at 95%, and a p-value of <0.05 was considered significant.

3. RESULTS

In total, we found 506 scientific publications that met the inclusion criteria. A total of 79 of them were out of time, or none of the authors are affiliated with a Moroccan institution. Next, we eliminated an additional 96 scientific publications due to their retraction, inaccessibility, association with male breast cancer, or lack of a primary focus on breast cancer. Only 256 scientific publications made the final cut (Fig. **1**).

3.1. Moroccan Scientific Production on Breast Cancer in Women

We can distinguish two phases of evolution. First, between 2010 and 2015, the annual scientific production on breast cancer was relatively low, with a total of 78 publications over six years. Between 2016 and 2022, the annual scientific output experienced significant improvement, resulting in a total of 178 publications over the five-year period. We recorded a total of 256 publications over twelve years (Fig. **2**).

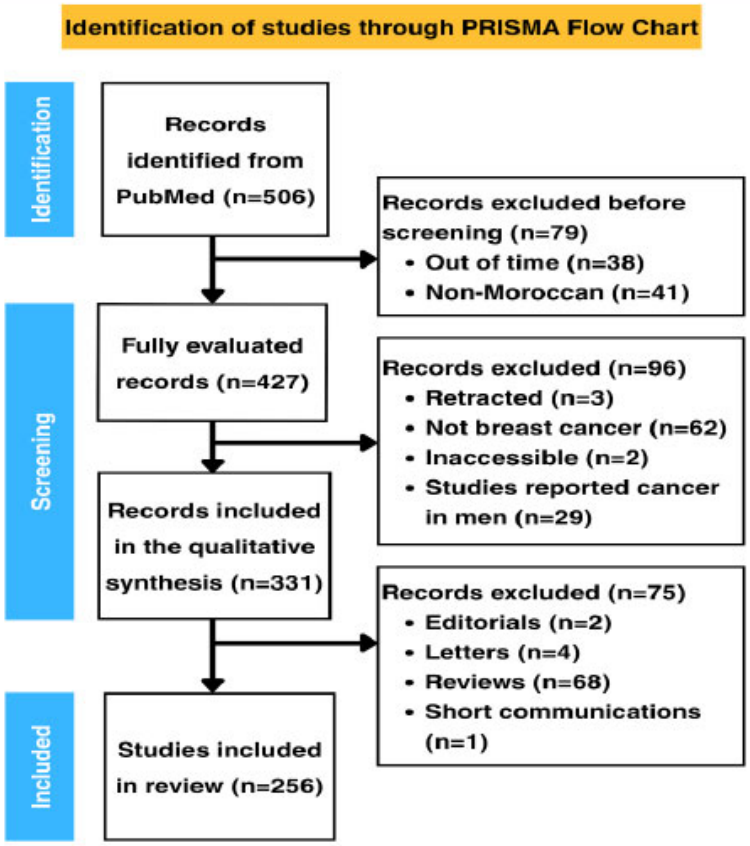

Fig. (1). Flowchart of scientific publications identified from a PubMed database search.

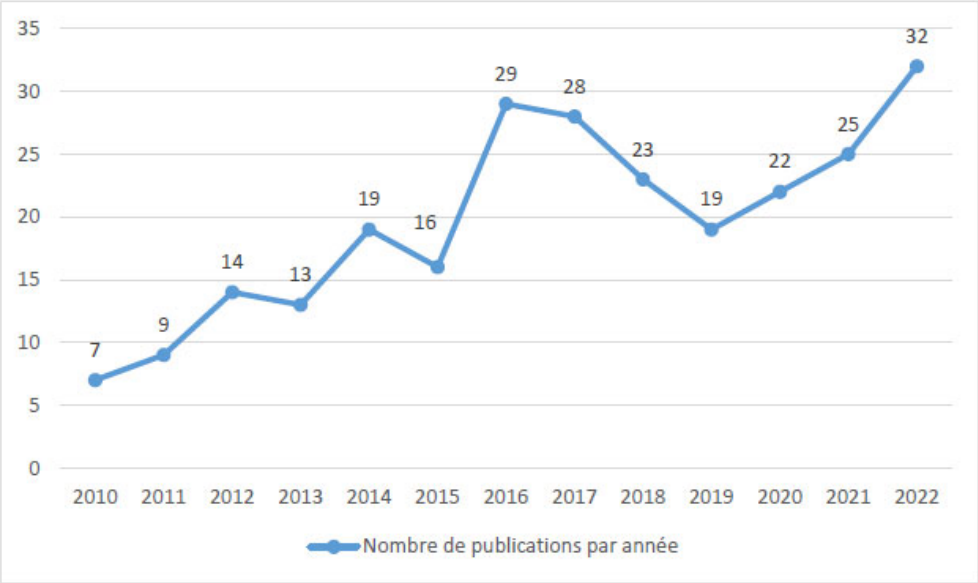

Fig. (2). Evolution of scientific production on breast cancer in women between 2010 and 2022.

3.2. The Authors of Scientific Production on Breast Cancer in Women in Morocco

In 90.2% of the cases, the first author's affiliation was primarily Moroccan, with Rabat ranking as the top city at 32.4%. The first authors were medical doctors (46.5%) and university professors (32%). The public sector (93.4%) was the most active compared to the private sector (3.9%) (Table 1).

Table 1. The bibliometric indicators related to the authors of scientific production on breast cancer in Morocco.

-	Frequencies (n)	Percentages (%)
Affiliation of the First Author		
- Moroccan	**231**	**90.2**
- Non-Moroccan	**25**	**9.8**
Country of Affiliation of the Non-Moroccan First Author		
- United States	05	20.0
- France	04	16.0
- Turkey	03	12.0
- Saudi Arabia	03	12.0
- Spain	02	08.0
- United Kingdom	02	08.0
- Mali	02	08.0
- Burkina Faso	01	4.0
- Egypt	01	4.0
- Allemande	01	4.0
- Portugal	01	4.0
City of Affiliation of the 1st Author Affiliated with Morocco		
- Rabat	83	32.4
- Casablanca	49	19.1
- Fez	45	17.6
- Oujda	26	10.2
- Marrakesh	20	07.8
- Tanger	08	03.1
- Mohammedia	04	01.6
- Settat	04	01.6
- Other	17	06.6
Professional grade of the first Moroccan author		
- Medical doctor	119	46.5
- Professor	82	32.0
- PhD	54	21.1
- Master	01	0.4
Research Institution		
- University	229	89.5
- Non-university	27	10.5
Sector of Research Establishment		
- Public	239	93.4
- Private	10	3.9
- Mixed	7	2.7
The Institution of the First Moroccan Author		
- University Hospital Center	80	31.3
- Faculty of Sciences	65	25.4
- Faculty of Medicine and Pharmacy	40	15.6
- National Institute of Oncology	33	12.9
- Other	38	14.8
Affiliation of the Last Author		
- Moroccan	217	84.8
- Non-Moroccan	39	15.2

3.3. The Study Designs Associated With Scientific Production on Breast Cancer in Women in Morocco

The most frequently conducted studies by authors were case reports, accounting for 73.3%, followed by case series at 16.5%, cross-sectional studies at 22.0%, case-control studies at 12.0%, and longitudinal studies at 7.5%. Cohort studies, clinical trials at 1.5%, and systematic reviews and meta-analyses at 0.5% were the least represented.

Non-epidemiological studies, including molecular, chemical, cost-of-illness, dosimetric, and informatics studies, accounted for a small percentage of research on breast cancer (21.8%). The majority of studies (82.8%) focused on human subjects, while a smaller portion examined biopsies, tissues, genes, bacteria, or proteins. Most studies were openly accessible (69.1%), and the vast majority (84%) were published in English.

National collaborations were more prevalent (64.5%) compared to international collaborations (28.1%), with a notable lack of funding in 82.8% of cases and only a small percentage (16%) of studies funded by international sources (53.7%, “high-income countries”) (Table **2**).

3.4. Scientific Journals Associated with Breast Cancer Research in Moroccan Women

Most journals were based in the United Kingdom and the United States, each accounting for 26.3% of the total. All journals required articles to be written in English, with only three accepting submissions in French (Fig. **3**). The majority of journals (94.7%) were indexed in Web of Science and Scopus. Most journals focused on medicine (89.5%) and were subscription-based (89.5%), while a significant proportion were open-access (73.7%) (Table **3**).

Table 2. Bibliometric indicators related to scientific studies on breast cancer in Morocco.

-	Frequency (n)	Percentage (%)
Type of Studies		
- Epidemiological	200	78.1
- Non-epidemiological	56	21.9
Types of Epidemiological Study		
- Case reports	74	37.0
- Case series	33	16.5
- Cross-sectional	44	22.0
- Longitudinal	15	07.5
- Case-control	24	12.0
- Cohort	3	01.5
- Clinical trials	3	01.5
- Systematic reviews	1	0.50
- Meta-analyses	1	0.50
- Qualitative	2	1.0
Other Types of Studies		
- Molecular	47	81.0
- Chemical	5	08.6
- Cost of illness study	2	03.4
- Dosimetric	1	01.7
- Informatics	1	01.7
Research themes		
- Medicine	180	70.3
- Biochemistry	46	18.0
- Genetics	29	11.3
- Physics	1	0.4
Study Architecture		
- Monocentric	190	74.2
- Multicentric	66	25.8
Study Population		
- Human	212	82.8
- Tissues	40	15.6
- Genes	2	8
- Bacteria	1	0.4
- Proteins	1	0.4
Publication Model		
- Open access	177	69.1
- Closed Access	79	30.9

(Table 2) contd.....

-	Frequency (n)	Percentage (%)
Language		
- English	215	84
- French	41	16
National Collaboration		
- Yes	165	64.5
- No	91	35.5
International Collaboration		
- Yes	72	28.1
- No	184	71.9
Funding		
- Yes	41	16
- No	212	82.8
Source of Funding		
- National	19	46.3
- International	22	53.7
Type of Funding Source		
- HIC	18	81.8
- MIC	4	18.2

HIC: High-income-country; **MIC:** Middle-income country.

Table 3. Bibliometric indicators related to 19 scientific journals.

	Frequency (n)	Percentage (%)
Language of Publication		
- English	19	100
- French	03	15.8
Indexing		
- Scopus	18	94.7
- PubMed	19	100
- Web of sciences	19	100
Scientific Journal Rankings - Scimago		
- Q1	02	11.1
- Q2	09	50.0
- Q3	07	38.9
Research Field		
- Medicine	17	89.5
- Biology	07	36.8
- Biochemistry	08	42.1
Paid		
- Yes	17	89.5
- No	02	10.5
Acceptance Rate		
- 0-19.9	02	10.5
- 20-39.9	06	31.6
- 40-59.9	03	15.8
- 60-79.9	02	10.5
- >80%	04	21.1
Open Access		
- Yes	14	73.7
- No	05	26.3

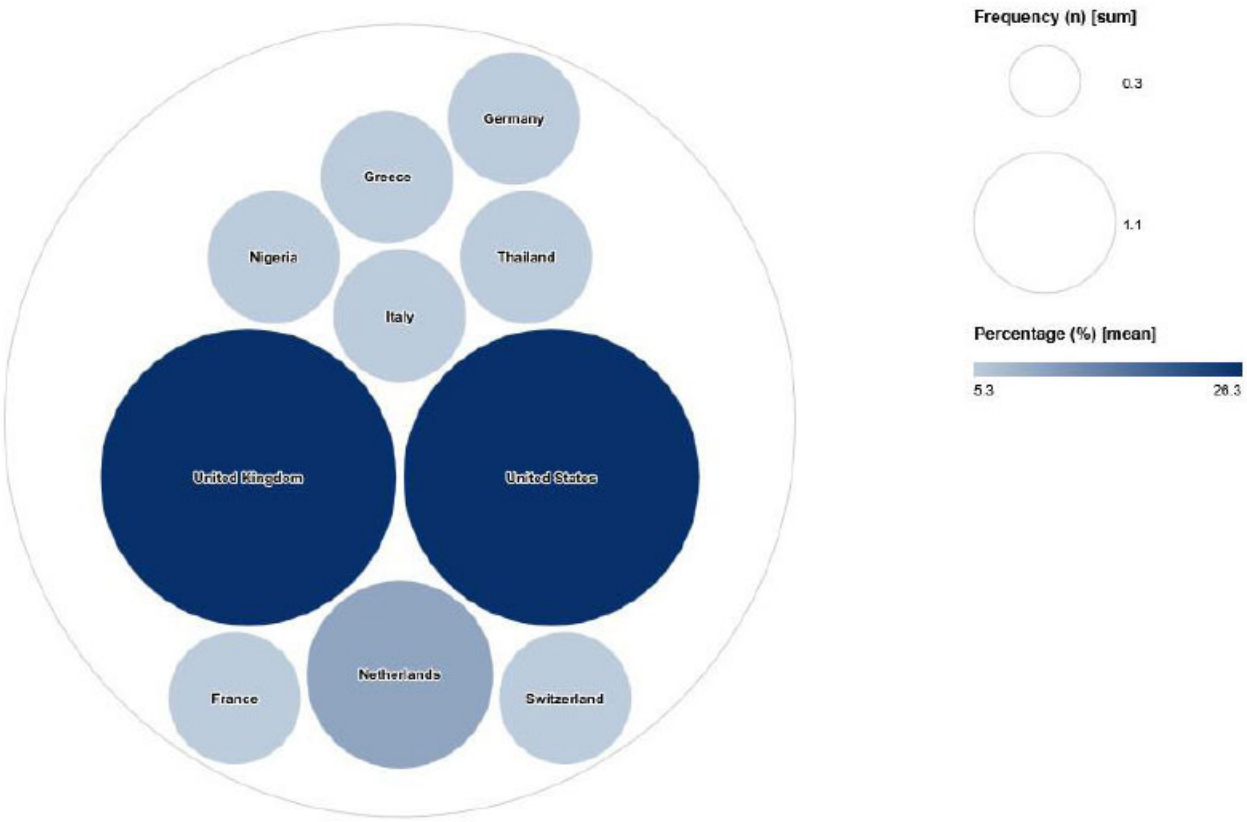

Fig. (3). Distribution of publications by country.

3.5. Main Bibliometric Indicators Related to Breast Cancer Research in Morocco

The bivariate analysis enables us to compare the most important bibliometric indicators related to breast cancer research in Morocco. It shows that having funding ($p < 0.001$), an article published in closed access ($p = 0.016$), a multicenter design ($p < 0.001$), an English-written article, and a high H-index of the first author ($p < 0.001$) were all linked to international collaboration (Table **4**).

4. DISCUSSION

In this study, we evaluated research activity on breast cancer in Morocco. We used the PubMed database to explore research activities [18, 19]. To our knowledge, this is the first updated bibliometric study aimed at describing the state of breast cancer research activity in the Moroccan context. We identified only one similar national bibliometric study covering the period 1979–2009 [16]. However, while researchers have previously examined the productivity of global breast cancer research, they did not specifically focus on the Arab region [20].

Our study reveals that Morocco published 256 studies on breast cancer between 2010 and 2022. This finding provides important information for future analyses and for health policymakers [21, 22]. Despite the valuable contributions of Arabs to medicine throughout history, other studies have shown that most Arab countries neglected breast cancer research during the 1980s [23]. Reports indicate that medical research activity in the Arab world still lags behind that of non-Arab countries in the region, such as Turkey and Iran [24, 25].

In fact, many Arab countries with strong economies, such as Bahrain, consider breast cancer research activity to be low, with only 7% of studies conducted on the disease. However, in Egypt and Saudi Arabia, this activity has experienced strong growth. The weakness of breast cancer research in some Arab countries is a multifaceted problem [25-27].

A study published in 2015 listed publications on “breast cancer” in the ISI Web of Science database to assess the quantity and quality of research from Arab countries. This study analyzed only original research and review articles. Research productivity was evaluated by examining the number of publications and their evolution over time, journal names, citation analysis, the top 10 contributing institutions, and each country’s overall contribution to breast cancer research. The study identified a total of 1,658 original research and review articles from Arab countries [1].

Table 4. Comparison of the main bibliometric indicators related to breast cancer research in Morocco.

International Collaboration			*p* value
-	n(%)	n(%)	
Funding			<0.001
- Yes	27 (65.9)	14(34.1)	
- No	43(20.9)	168(79.6)	
Article Published			0.016
- Open Access	42 (23.9)	134(76.1)	
- Closed Access	30(38.0)	49(62.0)	
Architecture			<0.001
- Monocentric	27 (14.3)	162(85.7)	
- Multicentric	45(68.2)	21(31.8)	
Language			<0.001
- English	71(33.2)	143 (66.8)	
- French	1(2.4)	40 (97.6)	
First Author's Rank			0.012
- Professor	20 (24.4)	82 (75.6)	
- Medical doctor	28 (23.5)	91 (76.5)	
- Phd/Master	24 (44.4)	30 (55.6)	
Number of Citations			0.196
	62±18.42	140±6.84	
H-index			<0.001
	6.6±08.0	2.1±04.4	

Our findings revealed two distinct phases in Moroccan breast cancer scientific production. Between 2010 and 2015, annual research output was relatively low, totaling 78 publications over six years. From 2016 to 2022, annual output increased significantly, with 178 publications over five years. Overall, we recorded a total of 256 publications over the twelve-year period.

This significant increase in Moroccan breast cancer research is partly attributed to the launch of the 1st National Plan for Cancer Prevention and Control (PNPCC, 2010–2019) [28], which was implemented through an effective partnership between the Lalla Salma Association for Cancer Control and the Ministry of Health. As part of the national plan, measure 30 aimed to strengthen research on cancer prevention, including: (a) basic research into prevention; (b) studies on the incidence, mortality, and prevalence of specific cancer types; (c) research to identify and quantify risk factors; (d) operational research on the cost-effectiveness of preventive actions; (e) studies in behavioral sciences and socio-anthropology; and (f) research on familial cancers [28].

Additionally, the establishment of regional oncology centers within university hospitals sought to implement “measure 47,” which focuses on providing specialized care, training, and advanced research activities [28]. The expansion of public university research institutions in Morocco has particularly contributed to the increase in scientific output. These institutions, including university hospitals (89 studies), faculties of science (65 studies), faculties of medicine and pharmacy (40 studies), and national oncology institutes (33 studies), have collectively published 229 studies.

Moreover, private academic and non-academic institutions are increasingly contributing to breast cancer research in Morocco. Comparatively, Egypt shows the highest research productivity among Arab countries, with a total of 582 publications (35.10%), primarily from public academic institutions, especially Cairo University, which accounts for 149 publications [1]. In contrast, the lower scientific output in other Arab countries is largely due to inadequate research infrastructure in many cancer control institutions [25].

The analysis of the main bibliometric indicators related to scientific production on breast cancer in Morocco revealed that international collaboration plays a crucial role in breast cancer research in Morocco between 2010 and 2022. This includes factors, such as funding, access to publications, study architecture, language of publication, first author's grade, number of citations, and H-index, all of which are statistically significant. Consequently, the main factors associated with international collaboration were the presence of funding (p<0.001), closed access publication (p=0.016), multicentric design (p <0.001), articles written in English, and the first author's high H-index (p<0.001). This result suggests that Moroccan researchers with a high H-index play a central role in establishing international collaborations. Their academic visibility and scientific recognition—often earned through previous high-impact publications—facilitate the development of cooperative networks beyond national borders. This observation aligns with the findings of Wagner and Leydesdorff [29] and Gazni *et al* [30], who emphasize that highly cited researchers act as strategic nodes in global research networks, particularly in oncology. Therefore, promoting career development and

research training could indirectly support the integration of Moroccan research into larger-scale international projects.

Similarly, Sweileh *et al*. [1] have noted that Arab researchers collaborate with non-Arab researchers, especially those from the United States (305; 18.40%), in breast cancer research and production. Other studies show that the United States, Germany, and China are the most active and specialized countries in terms of publications related to breast cancer [31]. Moroccan authors target the bibliometric indicators of 19 “Open Access” journals, and 73.7% are indexed in databases, such as Web of Science, Scopus, and PubMed. Of these indexed journals, 50% have an SJR (Scientific Journal Rankings) of Q2. However, Sweileh *et al*. [1] reported that the Web of Science does not index the majority of the 10 scientific journals in which Arab authors published their breast cancer studies.

Our research revealed that only 16% of the studies received funding. Of these, 46.3% benefited from national funding, primarily from the 'Lalla Salma Foundation for Cancer Prevention and Treatment,' the only Moroccan association recognized as a public utility. Meanwhile, 53.7% of the funding came from international collaborations, of which 81.8% originated from high-income countries. This highlights that international collaboration is one of the key mechanisms to improve research funding on breast cancer in our context.

Similarly, the government funded part of the breast cancer research activity in Egypt and Saudi Arabia [25]. In 2020, a study at the National University of Seoul in the Republic of Korea showed that diversifying national funding sources, especially government ones, fosters research projects on intricate subjects, even at the molecular level [32]. Indeed, the promotion of diverse national funding sources impacts the scope of research projects [33].

Morocco's institutional framework significantly influences the availability of research funding for breast cancer, with government policies and universities playing a central role. Since 2010, the Moroccan government has implemented a National Plan for Cancer Prevention and Control, which provides financial support for basic cancer care services, including breast cancer. This plan highlights the government's commitment to combating cancer through structured national strategies [34]. Moroccan universities also play a crucial role within this framework, as their contribution to socio-economic development is increasingly recognized through research activities, including cancer research [35] [36].

The modesty of government and non-government funding, as well as poor cooperation between industry and academia, are hindrances to productivity in scientific research [32]. Arab governments should consider these factors if they wish to improve the status of their scientific research [37] [18]. This study has several strengths, including its comprehensive nature; to our knowledge, it is the first study to evaluate scientific production in breast cancer in Morocco from 2010 to 2022. However, it presents some limitations, in particular the lack of similar studies on scientific production in breast cancer from 2010 to 2022 in Morocco, making it difficult to compare our results with the literature. We also acknowledge that our research was limited to the PubMed database, which may have led us to overlook other publications indexed in different databases.

CONCLUSION

This bibliometric analysis demonstrated that there are limited research contributions on breast cancer in women in Morocco. Case reports and case series on breast cancer in women largely dominate this topic, providing a preliminary description of scientific productivity. Scientific research publications on breast cancer in women in Morocco are insufficient. This paper constitutes the first study conducted at the national and regional level over the previous twelve years, “2010 to 2022”. Indeed, breast cancer research in Morocco holds promising potential but remains hindered by a lack of funding, insufficient training, and limited collaboration. To enhance the quality and visibility of scientific output, it is essential to strengthen researchers' capacities, promote evidence-based studies, and encourage both national and international partnerships through structured projects and scientific exchange platforms [38, 39]. This will undoubtedly enhance future research outcomes in this field. A re-evaluation of the literature published on breast cancer research in women in Morocco is planned for the coming years [40].

CONTRIBUTIONS TO THE LITERATURE

- There are limited research contributions on breast cancer in women in Morocco.
- It is the first study to evaluate scientific production in breast cancer in Morocco from 2010 to 2022.
- This study will improve future research results in the field of breast cancer research, and in turn improve global and national health.
- It contributes to the development of prevention strategies by scientists, and to the discovery of new therapeutic approaches or new practices.
- This study will encourage systematic investment in research capacity and infrastructure, to conduct locally relevant research and apply the results to strengthen their health systems.

AUTHORS' CONTRIBUTIONS

FA carried out conceptualization, methodology, investigation, formal analysis, writing – original draft preparation, review & editing. LA participated in conceptualization, methodology, review & editing of the manuscript. SL participated in the methodology, review & editing of the manuscript. SE participated in the methodology and investigation. MS and MA participated in supervision. All authors reviewed and approved the submitted version.

CONSENT FOR PUBLICATION

Not applicable.

STANDARD OF REPORTING

PRISMA guidelines were followed.

FUNDING

None.

CONFLICT OF INTERESTS

The authors declare that they have no competing interests.

ACKNOWLEDGEMENTS

Declared none.

SUPPLEMENTARY MATERIAL

PRISMA checklist is available as supplementary material on the publisher's website along with the published article.

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