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Original Article

Cervical cancer screening in vulnerable women: a bibliometric study

Rastreamento do câncer de colo do útero em mulheres vulneráveis: um estudo bibliométrico

Rastreo del cáncer de cuello uterino en mujeres vulnerables: estudio bibliométrico

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ABSTRACT

Objective: To investigate scientific production on vulnerability in cervical cancer screening through bibliometric indicators. **Method:** A bibliometric study with quantitative approach, based on documentary analysis conducted in the MEDLINE/PubMed, Scopus, and Web of Science databases, using search strategies in English, Portuguese, and Spanish. Data collection was carried out from December 2024 to February 2025. The analysis was performed using the Bibliometrix package via the Biblioshiny interface in R software version 4.4.2. **Results:** The final sample comprised a total of 1,118 articles. A growth in scientific production was observed from 2010, peaking in 2024. Among the studies, the United States presented the highest number of publications, followed by China, Brazil, and India. The most productive journal was the U.S.-based *PLOS ONE*. The most frequent keywords were "cervical cancer," "screening," "HPV," and "vulnerable populations." **Conclusion:** Scientific production on vulnerability in cervical cancer screening has shown significant growth in recent decades; however, it remains concentrated in high-income countries. Challenges related to internationalization of science in countries such as Brazil and approaches incorporating social and territorial dimensions were also identified.

DESCRIPTORS:
Cervical Neoplasms; Screening Programs; Developing Countries; Health Vulnerability; Bibliometrics.

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RESUMO

Objetivo: Investigar a produção científica sobre vulnerabilidade no rastreamento do câncer do colo do útero, por meio de indicadores bibliométricos. **Método:** Estudo bibliométrico de abordagem quantitativa, com análise documental nas bases MEDLINE/PubMed, Scopus *e Web of Science,* nos idiomas inglês, português e espanhol. A coleta foi realizada de dezembro de 2024 a fevereiro de 2025. A análise foi conduzida com o pacote *Bibliometrix,* via interface *Biblioshiny* do software R versão 4.4.2. **Resultados:** Compuseram a amostra 1.118 artigos. Observou-se o crescimento da produção científica a partir de 2010, com pico em 2024, entre os estudos, os Estados Unidos apresentaram o maior número de publicações, seguidos por China, Brasil e Índia. O periódico com maior produtividade foi o Estadunidense *Plos One*. As palavras-chave mais frequentes foram "*cervical cancer*", "*screening*", "HPV" e "*vulnerable populations*". **Conclusão:** A produção sobre vulnerabilidade no rastreamento do câncer do colo do útero apresentou um significativo crescimento nas últimas décadas, contudo, permanece concentrada em países de alta renda. Identificam-se também desafios na internacionalização da ciência em países como Brasil e em abordagens que contemplem dimensões sociais e territoriais.

DESCRITORES:
Neoplasias do Colo do Útero; Programas de Rastreamento; Países em Desenvolvimento; Vulnerabilidade em Saúde; Bibliometria.

RESUMEN

Objetivo: Investigar la producción científica sobre la vulnerabilidad en el tamizaje del cáncer de cuello uterino, mediante indicadores bibliométricos. **Método:** Estudio bibliométrico con enfoque cuantitativo, basado en análisis documental en las bases de datos MEDLINE/PubMed, Scopus y *Web of Science*, utilizando estrategias de búsqueda en inglés, portugués y español. La recolección de datos se realizó entre diciembre de 2024 y febrero de 2025. El análisis fue realizado con el paquete *Bibliometrix*, a través de la interfaz *Biblioshiny* del *software* R versión 4.4.2. **Resultados:** La muestra final estuvo compuesta por 1.118 artículos. Se observó un crecimiento en la producción científica a partir de 2010, con un pico en 2024. Entre los estudios, Estados Unidos presentó el mayor número de publicaciones, seguido de China, Brasil e India. La revista más productiva fue la estadounidense *PLOS ONE*. Las palabras clave más frecuentes fueron "cervical cancer", "screening", "HPV" y "vulnerable populations". **Conclusión:** La producción científica sobre vulnerabilidad en el tamizaje del cáncer de cuello uterino ha crecido significativamente en las últimas décadas; sin embargo, sigue concentrada en países de altos ingresos. También se identifican desafíos relacionados con la internacionalización de la ciencia en países como Brasil y con la adopción de enfoques que incluyan dimensiones sociales y territoriales.

DESCRIPTORES:
Neoplasias del Cuello Uterino; Programas de Tamizaje; Países en Desarrollo; Vulnerabilidad en Salud; Bibliometría.

INTRODUCTION

Cervical cancer (CC) is the fourth most common malignant neoplasm among women worldwide[1]. Its etiology is strongly associated with persistent infection by oncogenic types of human papillomavirus (HPV), transmitted predominantly through sexual contact. Other factors, such as genetic predisposition, immunosuppression, smoking, and prolonged use of oral contraceptives, also contribute to disease development[2].

When detected early, CC has high cure rates. In this context, screening tests constitute an essential strategy for early detection, especially in low- and middle-income countries (LMICs), where incidence and mortality rates are higher[1]. In these regions, investment in CC control policies is heterogeneous and marked by multiple dimensions of vulnerability. This can be understood in three interdependent spheres: individual, related to factors such as low income, lower education, and risky sexual behaviors; social, associated with unemployment and discrimination; and programmatic, linked to insufficient access to preventive examinations, which affects people's exposure to diseases and compromises their well-being[3-4].

Moreover, cultural and ethnic vulnerabilities highlight that indigenous women and other minorities face structural, social, and cultural barriers that hinder access to health services. These obstacles contribute to higher incidence and mortality in these populations. Globally, indigenous women show greater susceptibility to CC compared to non-indigenous women. In Latin America and the Caribbean, for example, they represent approximately 10% of the total population, although the true magnitude of CC impact in these groups remains poorly understood due to scarce data[5-7].

Despite technological advances and global guidelines for CC elimination, LMICs continue to present high incidence and mortality rates, reflecting failures in prevention and screening programs[1,4]. Although reviews and bibliometric analyses exist on CC, gaps remain in the literature regarding vulnerabilities, especially concerning specific populations such as indigenous women, LGBTQIA+ women, and other historically marginalized groups. Thus, this study is justified by the need to investigate the characteristics of scientific production on vulnerability in CC screening based on the following question: "What is the profile of scientific publications on vulnerability in cervical cancer screening?".

OBJECTIVE

To investigate scientific production on vulnerability in cervical cancer screening through bibliometric indicators such as publication year, journals, authors, countries, and terms, presenting a scientific overview on the theme in the health field.

METHODOLOGY

Study design

This is a bibliometric study with a quantitative approach, based on documentary analysis and guided by the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) flowchart, chosen for its wide international use ensuring transparency, standardization, and rigor in conducting systematic reviews and bibliometric studies[8] .

Bibliometrics is a statistical technique intended to measure production and dissemination of scientific knowledge across different fields, including nursing. This approach relies on classical

bibliometric laws, notably: Lotka's Law, which evaluates author productivity; Bradford's Law, which identifies the most relevant journals within a thematic area; and Zipf's Law, which examines frequency and distribution of keywords used in scientific publications[9-10].

Study locus

The study was conducted at the Graduate Nursing Program (PPGENF) of the Federal University of Pará (UFPA), in the capital city Belém, Pará State - PA, from September 2024 to March 2025.

Population and sample

The initial sample comprised 1,618 articles: 727 from WoSCC, 869 from Scopus, and 22 from PubMed. After removing duplicates using R software version 4.4.2 in 2024, a total of 1,118 unique articles composed the corpus of the bibliometric analysis[11].

Inclusion and exclusion criteria

Inclusion criteria were peer-reviewed publications; paid access articles evaluated if available via the CAPES Portal; full-text articles published in Portuguese, English, or Spanish; and those addressing vulnerability in cervical cancer screening directly. Excluded were editorials, pre-print articles, letters to the editor, dissertations, theses, and publications not directly related to the central research theme.

Study protocol

The study followed this design: (1) September – defining research objective; (2) formulation of guiding question based on PICo strategy; (3) October – identification of DeCS/MeSH descriptors; (4) November – combination of keywords and database selection; (5) December, January, February 2025 – searches in MEDLINE via PubMed, Scopus, and Web of Science (WoS); (6) March – export and standardization of collected data; and (7) analysis of results using Bibliometrix package via Biblioshiny interface in R software.

The definition of the research intent (step 1) was motivated by the need to obtain a global overview on the topic, aiming to support a master's dissertation in the *Programa de Pós-graduação em Enfermagem* (PPGENF) of the Federal University of Pará (UFPA), entitled "Invisible Marajoara women and bodies vulnerable to cervical cancer: a mixed methods study." This focus is justified by the scarcity of Brazilian studies that comprehensively address this phenomenon.

The research question formulation (step 2) was guided by the PICo strategy, recommended for constructing research questions in health for its ability to organize essential elements of the investigated problem[12]. In this study, the PICo acronym was defined as: P (Population) – cervical neoplasms; I (Interest) – vulnerability; Co (Context) – developing countries. Based on this framework, the guiding

question was established: “What is the profile of scientific publications on vulnerability in cervical cancer screening?”.

The identification of descriptors (step 3) and combination of keywords (step 4) were carried out through coordination between Health Science Descriptors (DeCS), Medical Subject Headings (MeSH), and Emtree (linked to Embase Index) with support from a librarian expert in search strategies. Boolean operators AND and OR were used, enabling the construction of robust, adaptation-specific strategies for each database. Searches were structured in Portuguese, Spanish and English, resulting in the strategies shown in Table 1.

Table 1. Search strategy. September 2024 - March 2025, Belém, PA, Brazil.

Database	Search strategy
Medline/ PubMed	("Uterine Cervical Neoplasms OR "uterine cervical neoplasm* OR "cervix neoplasm*OR "cervical neoplasm* OR "Cancer of Cervix OR "Cervix Cancer" OR "uterine cervical cancer*" OR "cervical cancer* OR (("Cervix Uteri OR "Cervix OR "Cervixes OR "Cervical OR "Ectocervix OR "Endocervix" OR "Endocervical) AND ("Neoplasms OR "neoplasm*" OR "tumor* OR "neoplasia* OR "cancer*"OR "malignan* OR "Early Detection of Cancer" OR "Mass Screening OR "screening* OR "Early Detection" OR "Early Diagnosis OR "prevention OR "Papanicolaou Test OR "Papanicolaou OR "Pap Test OR "Pap Smear" AND ("vulnerab*OR "Social Vulnerability)
Scopus	("Cervical Neoplasm*" OR "Cervix Neoplasm*" OR "Cancer of Cervix" OR "Cervix Cancer" OR "Uterine Cervical Cancer*" OR "Cervical Cancer*" OR ((Cervix OR Cervixes OR Cervical OR Ectocervix OR Endocervix OR Endocervical) AND (Neoplasm* OR Tumor* OR Neoplasia* OR Cancer* OR Malignan* OR Screening* OR "Early Detection" OR "Early Diagnosis" OR prevention OR Papanicolaou OR "Pap Test" OR "Pap Smear")))END(vulnerab*)
Web of Science	("Cervical Neoplasm*" OR "Cervix Neoplasm*" OR "Cancer of Cervix" OR "Cervix Cancer" OR "Uterine Cervical Cancer*" OR "Cervical Cancer*" OR ((Cervix OR Cervixes OR Cervical OR Ectocervix OR Endocervix OR Endocervical) AND (Neoplasm* OR Tumor* OR Neoplasia* OR Cancer* OR Malignan* OR Screening* OR "Early Detection" OR "Early Diagnosis" OR prevention OR Papanicolaou OR "Pap Test" OR "Pap Smear"))) AND (vulnerab*)

In step 5, searches in databases were carried out via remote access to content available through the Portal of Journals of the *Coordenação de Aperfeiçoamento de Pessoal de Nível Superior* (CAPES), via Federated Academic Community (*Comunidade Acadêmica Federada*, CAFe), available to UFPA. No time limit was set on the search strategy, as the study covered publications from the earliest records about the theme in 1949 through 2025, enabling historical and contemporary mapping of scientific production.

Analysis of the results and statistics

In step 6, files were exported and converted to BibTeX format, widely used for description and organization of bibliographic references, as well as to PubMed format, to enable bibliometric analysis compatible with R environment, version 4.4.2 from 2024[11, 13].

Step 7 consisted of a new removal of duplicates from the consolidated file, followed by data analysis through the Bibliometrix package using its graphical interface Biblioshiny. This tool enables practical, interactive, and low-cost data exploration, in addition to allowing customization of analytical parameters, which contributed to higher accuracy and depth of the performed analyses[11].

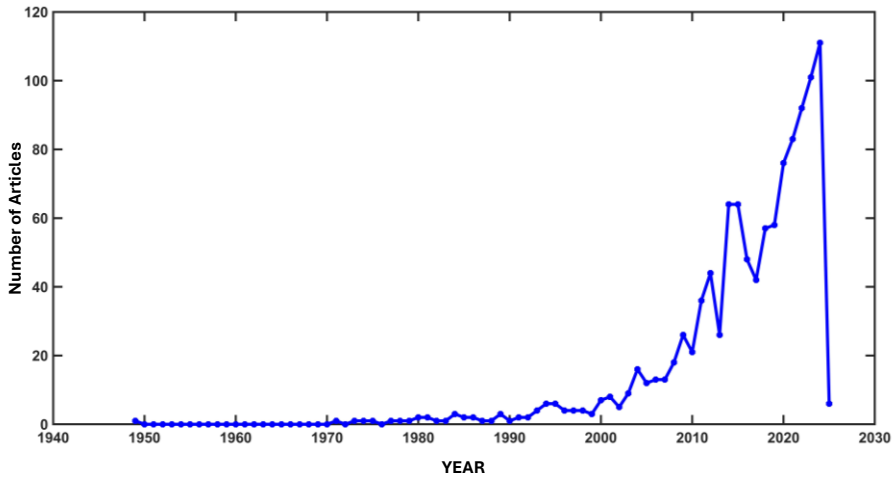
Ethical aspects

This research was not submitted for evaluation by the Research Ethics Committee involving Human Beings (CEP) because it is a study based exclusively on secondary data available in the public domain.

RESULTS

A total of 1,118 unique articles composed the corpus of bibliometric analysis. In relation to the evolution of scientific production on the theme, the analyzed studies spanned the period from 1949 to 2025, allowing a broad and historical overview of literature related to vulnerability in cervical cancer screening, as shown in Figure 1.

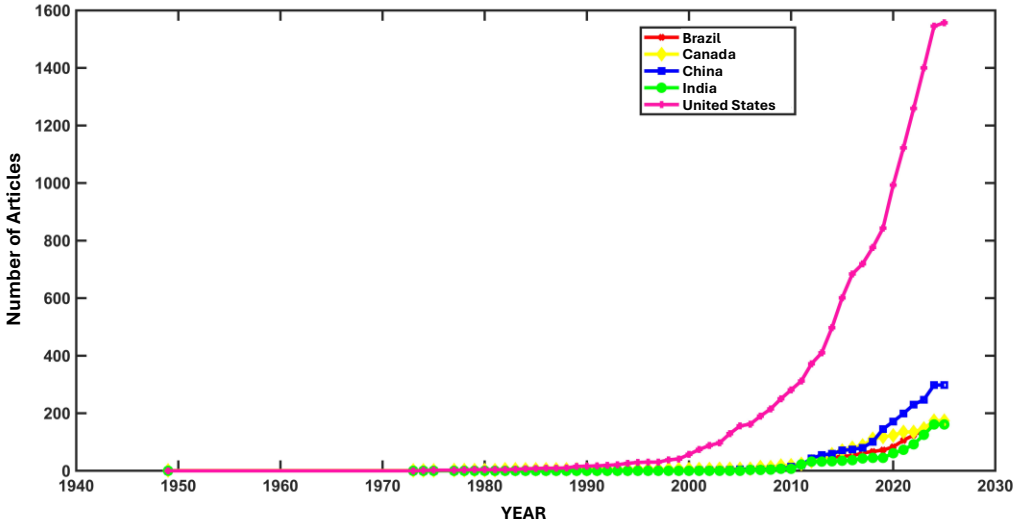
Figure 1. Annual evolution of scientific production on vulnerability in cervical cancer screening (1949–2025). September 2024 - March 2025. Belém (PA), Brazil.



Between 1949 and 1971, the number of publications was extremely low or even nonexistent, characterizing a period of stagnation in the theme's visibility within scientific literature. From the 1990s, a gradual resurgence of academic interest is noted, with modest but continuous growth in the annual number of publications. This increase became more significant in the last two decades, especially from 2010 onward, reaching its peak in 2024 with 111 publications. After this year, a decline is observed until February 2025, when the last search in databases was performed.

At the international level, the United States of America leads distinctly since 1949, showing continuous growth from 2010 and surpassing 1,500 articles in 2024. India ranks second, followed by China, which, although showing expressive advances since 2010, still grows at a slower pace than the USA. Brazil and Canada also present growth trends, albeit on more modest scales compared to major global powers, as illustrated in Figure 2.

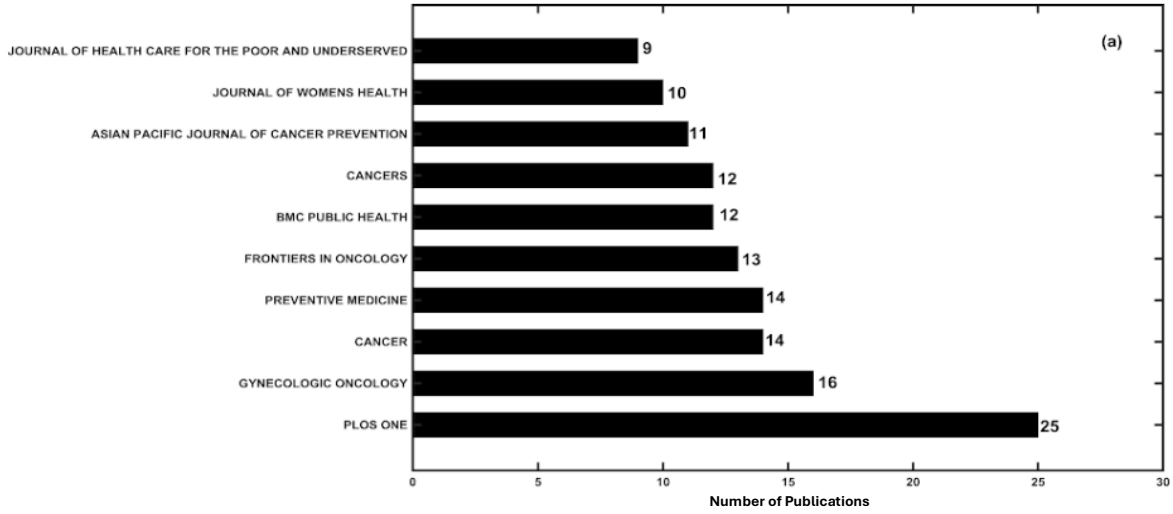
Figure 2. Distribution of scientific production by country on vulnerability in cervical cancer screening (1949–2025). September 2024 - March 2025. Belém (PA), Brazil.



There is predominance of specific countries, with North America standing out where the USA and Canada consolidate as centers of great scientific relevance. Asia, mainly represented by India and China, also stands out with high publication volumes. Following this, South America is noted, with Brazil as the main highlight in the region.

Bradford's Law establishes the relationship between the most relevant journals within a knowledge area, allowing identification of those concentrating the largest volume of publications on a given topic[11], as illustrated in Figure 3.

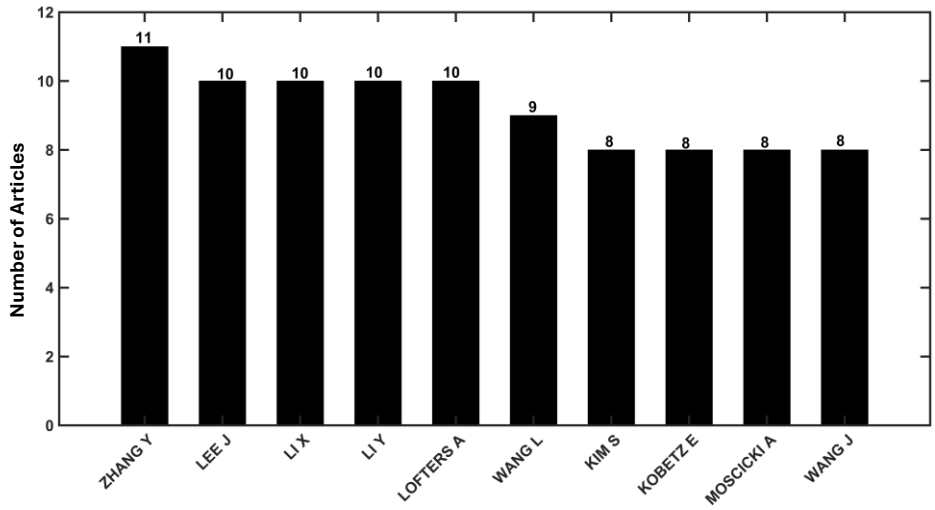
Figure 3. Bradford's Law and distribution of journals (1949-2025). September 2024 - March 2025. Belém (PA), Brazil.



Based on Bradford's Law, the ten most productive journals were identified. At the top of the ranking is the American journal PLOS ONE, with 25 publications. Next is the Chinese journal Gynecologic Oncology, with 16 articles. The journals Cancer and Preventive Medicine appear with 14 publications each, while Frontiers in Oncology ranks fifth, with 13 articles.

Lotka's Law highlighted the ten most productive authors on the analyzed topic, revealing a significant concentration of scientific production among a few researchers. Among them, Zhang Y. stood out with 11 publications, followed by Lee J., Li X., and Lofters A., each with 10 articles, and Wang L., with 9 publications. Other authors appeared with 8 articles, reinforcing the pattern of unequal productivity distribution, as predicted by the law and shown in Figure 4.

Figure 4. Lotka's Law and author productivity (1949-2025). September 2024 - March 2025. Belém, PA, Brazil.



Zipf's Law was applied to identify the most recurrent terms in keywords of analyzed articles. The most frequent term was "cervical cancer," present in 118 publications, followed by "cancer" (68), "screening" (55), "HPV" (54), and "human papillomavirus" (49). Other relevant terms include "cancer screening" (47), "cervical cancer screening" (35), "prevention" (33), and "vulnerable populations" (28). These keywords reflect the research focus on early detection, prevention, and vulnerabilities associated with cervical cancer.

DISCUSSION

This study demonstrated a significant increase in scientific production on cervical cancer (CC) screening, predominantly from high-income countries, with strong concentration of authors and journals, and less attention to socially vulnerable groups such as indigenous and LGBTQIA+ populations.

The first publications on vulnerability in CC screening date back to 1949, reflecting the beginning of scientific concerns about health inequalities among women. However, the following decades saw a prolonged stagnation in scientific production, with more consistent growth only resuming from the 1990s. This trend coincides with the consolidation of public policies focused on women's health and the expansion of the vulnerability concept in collective health[4,14].

Historical analysis shows that advances in screening policies and adoption of new diagnostic technologies directly relate to publication growth. The United States stands out as the country with the largest scientific output on the topic, attributed to a well-structured research system, high investment in science and technology, and a strong presence of high-impact journals based in the country. Moreover, the prevalence of English as the international standard for scientific dissemination reinforces the centrality of U.S. production[15,6].

India and China also stand out, albeit with distinct dynamics. India shows relevant and growing production, aligned with its emergence as a science and technology power. China intensified its presence in international literature especially from 2010 onward, driven by governmental incentives to research. However, English predominance in publications reveals a strategic focus on global reach[17].

Brazil ranks third in publication number, but its output is mainly national, with low international collaboration, suggesting some scientific community isolation. This partly reflects successive budget cuts in science and technology, deterioration of public universities, and devaluation of scientific research under recent governments. Such factors directly impact Brazil's ability to integrate into collaborative networks and enhance international visibility[18-19].

Another pertinent point is Ayres' vulnerability concept, comprising three interdependent dimensions: individual, social, and programmatic. Together, they allow comprehensive analysis of conditions determining exposure and response capacity to health damages. However, this study's results show international literature on CC screening predominantly favors the biomedical dimension, relegating social and programmatic dimensions to secondary status. This analytical asymmetry perpetuates a reductionist approach, limiting critical understanding of multiple vulnerabilities affecting specific populations and thus restricting the scope of response strategies.

Author productivity analysis revealed concentration in few individuals, confirming Lotka's Law that few researchers concentrate most publications on a topic. Though expected, this highlights the need to encourage new researchers' training to decentralize scientific production. Furthermore, key author hubs are in developed countries with high science investment[20].

Concentration of authors and journals in certain countries also relates to increasing adoption of lean healthcare or lean production (LP) in health, emphasizing management, quality, and efficiency in care processes, strongly incentivized by governments and institutions, especially in the USA[21]. Regarding

journals, Bradford's Law helped identify those concentrating most publications, highlighting PLOS ONE. The predominance of international open-access journals emphasizes open science as a strategy to democratize knowledge access, especially in low- and middle-income countries[21].

International collaborations are relevant too. Most high-producing countries show high levels of international co-authorship (Multiple Country Publication, MCP), evidencing consolidated collaboration networks. However, countries such as Brazil and South Korea maintain mostly domestic research, potentially limiting global visibility and impact. MCP ratio is thus an important indicator guiding science internationalization policies[22-23].

Zipf's Law application on keywords showed concentration on terms like "cervical cancer," "screening," "HPV" and "vulnerability," reflecting the biomedical and social focus on screening aspects. However, low frequency of terms related to specific vulnerable groups such as indigenous peoples, *quilombolas*, and LGBTQIA+ individuals reveals important thematic gaps. For example, in Guatemala, nearly half the population is indigenous, and cervical cancer accounts for the second leading cause of death among women[24-25].

Study limitations

It is important to highlight limitations due to scarce research applied to realities of most affected countries and populations, compromising effectiveness of global goals to reduce CC.

Contributions to nursing, health, or public policy

This study offers important contributions by bibliometrically analyzing scientific production related to cervical cancer screening in vulnerable women. Mapping trends, gaps, and research focuses aids understanding challenges faced by populations in accessing early diagnosis and continuous care. Results underscore expanding screening services, reinforce evidence-based practices sensitive to sociocultural and territorial specificities, and strengthen nursing professionals' roles in health education, welcoming, and promoting screening adherence.

Moreover, the concentration of scientific production in central countries expresses the coloniality of knowledge phenomenon, as discussed by collective health and southern epistemologies authors. This reinforces the need to increase representation of peripheral populations and strengthen knowledge production models considering local and territorial contexts.

CONCLUSION

The bibliometric analysis allowed a broad overview of scientific production on vulnerability in CC screening, showing advances in recent decades. Most publications are concentrated in high-income countries, notably the USA, contrasting with higher disease incidence and mortality in low- and middle-income countries.

Nationally isolated production dominates in countries like Brazil, indicating low engagement in international collaborations, which can limit scientific reach and impact. There is also emphasis on biomedical approaches, with fewer studies addressing social, cultural, and territorial vulnerability dimensions, which, when mentioned, are superficially analyzed without critical depth.

These findings highlight the need to promote more equitable and representative science valuing specific contexts most affected by cervical cancer. This study contributes to guiding future research, public policies, and health practices prioritizing tackling inequalities in prevention, early diagnosis, and treatment of cervical cancer in vulnerable contexts.

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