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ORIGINAL ARTICLE / ARAŞTIRMA YAZISI

Obstetrics and Gynecology / Kadın Hastalıkları ve Doğum

Bibliometric Analysis of Joint Publications on Human Papilloma Virus Vaccine and Cervical Cancer

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ABSTRACT

Purpose: In this study, it is aimed to reveal the output, trends and important developments of researches globally by bibliometric analysis of joint publications on Human Papilloma Virus (HPV) vaccine and cervical cancer.

Methods: It is a bibliometric visualized study using the Web of Science (WoS) database. A search query was made with keywords. As a result of the search, 158 out of 923 articles were excluded because they did not meet the specified criteria. 771 articles were analyzed. VOSviewer 1.6.12 was used to visualize bibliometric analyzes and network analysis was performed. Calculated values were presented as frequency (n) and percentage (%).

Results: It was found that the most common publications on HPV vaccine and cervical cancer were in 2021 (n=94). In the countries with the highest number of research articles, the USA is in the first place with 281 research articles, followed by the UK and Australia. Our country, Turkey, had 16 publications in this field. The first magazine "Vaccine" and "PLOS one" published about 11% of its articles. The three most frequently used keywords were "cervical cancer", "human papillomavirus" and "HPV".

Conclusion: In recent years, the number of studies focusing on HPV vaccine and cervical cancer has increased. It is seen that developed countries have done the most studies on the subject. To improve the global output of research in this area, it would be beneficial to establish strong research cooperation between developing and developed countries.

Keywords: cervical cancer, HPV vaccine, HPV, bibliometric analysis

Şule ÖZDEMİR
Kübra ŞAHİN

Human Papilloma Virüs Aşısı ve Serviks Kanseri Konularında Yapılan Ortak Yayınların Bibliyometrik Analizi

ÖZET

Amaç: Bu çalışmada Human Papilloma Virus (HPV) aşısı ve serviks kanseri konularında yapılan ortak yayınların bibliyometrik analizini yaparak küresel olarak araştırmaların çıktısını, eğilimlerini ve önemli gelişmeleri ortaya çıkarmak amaçlanmıştır.

Yöntemler: Web of Science (WoS) veritabanı kullanılarak bibliyometrik görselleştirilmiş bir çalışmadır. Anahtar kelimelerle arama sorgusu yapıldı. Arama sonucunda 923 makaleden 158'i belirlenen kritere uymadığından çıkarıldı. 771 makale analiz edildi. Bibliyometrik analizlerin görselleştirilmesi için VOSviewer 1.6.12 kullanıldı ve ağ analizi yapıldı. Hesaplanan değerler frekans (n) ve yüzde (%) olarak sunuldu.

Bulgular: HPV aşısı ve serviks kanseri konularında yapılan ortak yayınların en fazla 2021 yılında (n=94) olduğu bulundu. En fazla araştırma makalesine sahip ülkelerde, ilk sırada 281 araştırma makalesi ile ABD yer almakta olup İngiltere ve Avustralya'nın takip ettiği saptandı. Ülkemiz Türkiye'nin bu alanda 16 yayını bulunmaktaydı. Makalelerinin yaklaşık %11'ini ilk "*Vaccine*" and "*PLOS one*" dergisi yayınlamıştı. En sık kullanılan 3 anahtar kelime "*cervical cancer*", "*human papillomavirus*" ve "*HPV*" idi.

Sonuç: Son yıllarda HPV aşısı ve serviks kanseri üzerine odaklanan çalışmaların sayısı artmıştır. Konu üzerine en çok çalışmayı gelişmiş ülkelerin yaptığı görülmektedir. Bu alanda yapılacak araştırmaların küresel çıktısını iyileştirmek için gelişmekte olan ülkelerde ve gelişmiş ülkeler arasında güçlü araştırma işbirliği kurulması fayda sağlayacaktır.

Anahtar Kelimeler: sevikal kanser, HPV aşısı, HPV, bibliyometrik analiz

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Human papillomavirus (HPV) infection is the most common sexually transmitted disease in young and sexually active populations in developed countries. It is estimated that there are approximately 30 million new cases of genital HPV every year in the world (1). It is known that 70% of sexually active women and men will be infected with at least one HPV type throughout their lives, especially in the first 5 years of sexual activity. HPV is accepted as the most important factor for cervical cancer (2). Cervical cancer is the second most common type of cancer after breast cancer in women. It constitutes 3.6% of female cancers in developed countries and 15% in underdeveloped countries (3). According to the data of the World Health Organization (WHO), a total of 604,000 women worldwide were diagnosed with cervical cancer in 2020, and 342,000 women die from this disease annually (4). There are more than 200 subtypes of HPV and 15 subtypes are classified as oncogenic. An estimated 72% of cervical cancers globally are associated with these subtypes HPV 16 and HPV 18, and another 17% of cervical cancers are caused by HPV types 31, 33, 45, 52 and 58 (5, 6).

As a result of the increase in information about HPV and molecular and technological developments, studies on the agents of cervical cancer have progressed until the emergence of HPV vaccines. First in 2006 and 2007, these vaccines were included in the vaccination programs of most developed countries. There are three vaccines currently in use on the market. Quadrivalent vaccine (6, 11, 16, 18 types) in 2006, bivalent vaccine (16, 18 types) in 2007, and nonavalent (non-valent) vaccine (6, 11, 16, 18, 31, 33, 45, 52, 58 types) are licensed (7). It is recommended by WHO (8), that vaccination programs should target adolescent girls aged 9 to 14 years. It is also stated that these vaccines, if administered before sexual intercourse, provide protection against high-risk HPV type 16-18, which is responsible for approximately 70% of cervical cancer cases, and other cancers affecting the vulva, vagina, penis, anus and oral cavity (9). WHO launched the "Cervical Cancer Elimination Programme" in its global call on 17 November 2020. In order to eradicate cervical cancer from countries under this program, it is aimed to achieve and maintain an incidence rate of less than four per 100,000 women in all countries. To achieve this goal; 90% of girls should be fully vaccinated with HPV vaccine by age 15, 70% of women should be vaccinated by age 35 and screened again using high-performance testing by age 45, 90% of women with pre-cancer and 90% of women with invasive cancer should be treated (10).

The increasing medical literature on HPV vaccine and cervical cancer also allows for the publication of many current reports and a bibliometric study on the subject. Bibliometric analysis; it is defined as the quantitative analysis of scientific documents or publications by evaluating different bibliometric features (subject, year, contributing institution, keywords used, sources used, number of authors of works, citations, self-citations, etc.) (11,12). In addition, bibliometric analyzes; it provides a statistical and visible approach to examining trends, patterns, and biases in scientific studies, as well as providing a macroscopic view of research output in an individual academic discipline (13).

Therefore, in this study, it is aimed to reveal the output, trends and important developments of researches globally by bibliometric analysis of joint publications on HPV vaccine and cervical cancer.

MATERIAL and METHODS

Study Design and Search Strategy

Our research is a bibliometric visualized study using the Web of Science (WoS) database hosted by Clarivate Analytics, which offers a comprehensive search engine. WoS database is widely used in bibliometric studies. WoS was preferred because it covers many journals in the field of science and social sciences and provides basic information about other bibliometric indexes (14).

Search in WoS, publication year (1991–2021), document type (article), language (English), WoS index (Science Citation Index-Expanded (SCI-E)" "Social Sciences Citation Index (SSCI)", "Emerging Sources Citation Index (ESCI)). The online search was done on August 16, 2022.

The keywords used in the research were created from the literature and searched by subject area. The subject area (topic) searches for title, abstract, author, keywords and Key Words Plus. The search query is "Papillomavirus Vaccination" OR "Human "Papillomavirus Vaccination" OR "Human Papilloma Virus Vaccination" OR "Papillomavirus Vaccine" OR "Human Papillomavirus Vaccine" OR "Human Cancer Papilloma Virus Vaccine" OR "HPV Vaccine" and the title tab "Cervical Cancer" (title) OR "Cervical Intraepithelial Neoplasia" (title) was done.

Data Download and Extraction

The full records of 923 articles that met the search criteria were downloaded and the contents of the articles saved in a Microsoft Excel spreadsheet (Microsoft Corporation, Redmond, WA, USA) were reviewed. As a result of the review, research articles with title, abstract, introduction, materials and methods, findings, discussion and conclusion

sections were included in the study. These research articles were defined as "original article, original paper, research article, research paper, article, major article". Article content includes comments, short reports, letters, editorials, reports, case presentations, case series, etc. Since 152 publications did not meet the specified criteria, 6 publications were published in 2022, they were excluded from the data records. In this context, analyzes were made on 771 research articles.

Data Analysis and Interpretation

Microsoft Excel 2019 for Windows, VOSviewer 1.6.12 was used in the analysis of the obtained data. Calculated values were presented as frequency (n) and percentage (%). The required charts were created using Microsoft Excel 2019. Exported to VOSviewer for visualization of bibliometric analyzes and network analysis was performed. VOSviewer is a freely available and widely used tool for visualization mapping (15). Also, data were plotted for co-authoring countries and co-occurrence keywords visualization mapping using VOSviewer software.

RESULTS

The descriptive features of the research articles whose bibliometric analysis was performed within the scope of the study are shown in Table 1, and the distribution in the number of publications by years was shown in Figure 1. It was found that the most publications on the research topic were in 2021 year (n=94), 2020 and 2019 years (n=74).

It was determined that the authors with the highest number of research articles in the field of our study were Mona Saraiya and Jane J. Kim, and the author with the highest H index was Suzanne M. Garland. Table 2 shows in detail the characteristics of the authors who have at least 10 research articles in the field determined within the scope of the research.

Table 1. Descriptive features of research articles

Time range	1992-2021
Number of articles	771
Number of journals	287
Number of institutions	1463
Number of countries	110
Number of sources	15990
Keyword	1094
Number of authors	3816
Number of single-author publications	15
Number of publications per author	0.202
Number of authors per publication	4.95

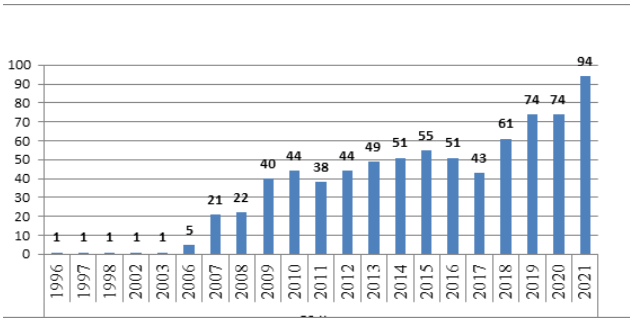

Figure 1. *Distribution of the number of research articles by years*

When the journals in which research articles were published were examined, it was seen that the journal "Vaccine" took the first place, followed by the journal "PLOS One". It was determined that the "International journal of cancerprevention", which had the highest impact factor with 7,316, was in the third place. The characteristics of the journals that published at least 15 articles were shown in Table 3 in detail.

When the countries with the highest number of research articles in the determined field are examined, the USA is in the first place with 281 research articles, followed by England and Australia. Our country, Turkey, had 16 publications in this field. The publication and citation numbers of the first 10 countries were shown in Table 4.

The number of publications of the countries and their cooperation with each other were visualized in Figure 2. In this way, there were 46 countries with at least 5 publications from 110 countries. As a result of the network analysis, three clusters were formed. The red cluster consisted of 18 countries such as France, Belgium, Spain, Sweden, Netherlands, Germany, Denmark and Italy. The country with the most publications in this cluster is France with 54 articles. It was found that it cooperated with the USA at most (20 times), for a total of 154 times. It was found that it cooperated with the USA at most (20 times), for a total of 154 times. Spain was second in this cluster with 38 articles. He collaborated with the USA at most (19 times), for a total of 132 times. The green cluster consisted of 15 countries such as the USA, England, Canada, People's Republic of China, Australia, India, Turkey, Norway. The country with the most publications in this cluster was the USA with 281 articles. It has collaborated with the UK at most (21 times), 251 times in total. England was in the second place in this cluster with 68 articles. It has collaborated with the USA the most (21 times), for a total of 163 times. The blue cluster consisted of 12 countries such as Malaysia, Brazil, Taiwan, South Korea, Thailand, and Portugal. The most collaborating country in this cluster was Brazil with 16 publications, 48 times.

Table 2. Characteristics of authors who have at least 10 research articles in the field determined within the scope of the research

Author	H index	Number of articles n(%)	Number of citations*	Institution	Country
Mona Saraiya	46	20 (2.59)	1510	CDC	USA
Jane J. Kim	41	20 (2.59)	950	Harvard University	USA
Karen Canfell	37	19 (2.46)	1040	University of Sydney	Australia
Megan A. Smith	25	11 (1.42)	902	University of Sydney	Australia
Kate T. Simms	17	10 (1.29)	838	University of Sydney	Australia
Emily A. Burger	20	10 (1.29)	634	Harvard University	USA
Suzanne M. Garland	65	10 (1.29)	194	University of Melbourne	Australia
Yutaka Ueda	34	10 (1.29)	97	Osaka University	Japan
Asami Yagi	12	10 (1.29)	97	Osaka University	Japan

**The number of citations belongs to the number of publications of the author in this field.*

Table 3. Characteristics of journals that have published at least 15 research articles in the specified field

Name of the journal	Number of articles n(%)	Impact factor	Q rank	Publisher's address
Vaccine	54 (0,07)	3.641	Q3	Elsevier Sci Ltd., the Boulevard, Langford Lane, Kidlington, Oxford OX 51 GB, Oxon, England
PLOS one	32 (0,04)	3.24	Q2	Public Library Science, 1160 Battery Street, STE 100, San Francisco, CA 94111
International journal of cancer	23 (0,03)	7,316	Q1	3.24 (3.788) Q2 Public Library Science, 1160 Battery Street, STE 100, San Francisco, CA 94111
Asianpacific journal of cancer prevention	23 (0,03)	ESCI index		Korean Soc Cancer Prevention , 502, Bldg C, Advanced Inst Convergence Technology-Aict, 145 Gwanggyo-Ro, Yeongtong-Gu, Suwon, South Korea, 16229
BMC public health	17 (0,02)	4,135	Q2	BMC, Campus, 4 CrinanSt, London, England, N1 9xw
Journal of cancer education	15 (0,02)	1,771	Q3	Springer, One New York Plaza, Suite 4600, New York, United States, Ny, 10004

Table 4. Characteristics of the 10 countries with the highest number of research articles in the specified field

Number	Country	Number of articles n(%)	Total Number of Citations
1	USA	281 (36.4)	8152
2	England	68 (8.8)	2771
3	Australia	63 (8.2)	2479
4	Chinese	56 (7.3)	973
5	France	54 (7.0)	4003
6	Canada	54 (7.0)	1729
7	Spain	38 (4.9)	3028
8	Belgium	38 (4.9)	2391
9	India	36 (4.7)	458
10	Japan	32 (4.2)	485

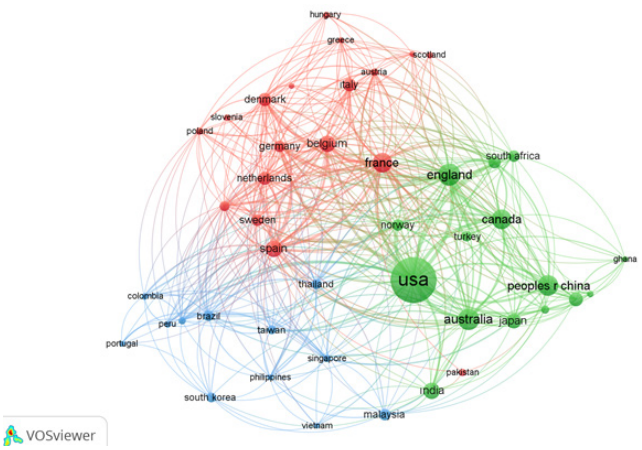

Figure 2. *Co-authorship network analysis of countries (n=46)*

The temporal variation of the publications of the countries by years is shown in Figure 3. It was seen that articles by countries such as China, Japan, India, Denmark, and Greece were published in recent years.

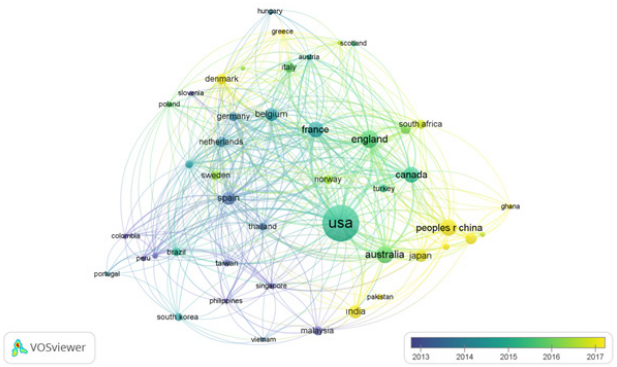

Figure 3. *The temporal variation of the publication dates of research articles by countries (n=46)*

As a result of the analysis, it was found that a total of 1094 keywords were used. The co-occurrence network analysis of keywords used 5 or more times was shown in Figure 4. The most frequently used keywords were "cervical cancer (361 times)", "human papillomavirus (167 times)" and "HPV (107 times)". When the network analysis of the co-occurrence of the keywords was examined, it was seen that four clusters were formed. It was found that there are 24 keywords in the first cluster (red). These keywords were like "cervical cancer", "human papillomavirus", "HPV", "vaccination", "screening", "prevention", "vaccine", "pap smear", "cost-effectiveness". The theme that emerged as a result of the keywords used in this cluster was named "cervical cancer, HPV and HPV vaccine relationship". The second cluster (green) consisted of 21 keywords such as "HPV vaccine", "HPV vaccination", "cervical cancer screening", "knowledge", "awereness", "attitude". The theme that emerged as a result of the keywords used in this cluster was called "knowledge, attitude and awareness towards cervical cancer screening and HPV vaccine". The third cluster (blue) consisted of 14 keywords such as "cancer screening", "papilloma virus vaccines", "mortality", "health education", "primary prevention". The theme that emerged as a result of the keywords used in this cluster was called "cervical cancer primary prevention and death". The fourth cluster consisted of 11 keywords such as "human papillomavirus (HPV)", "cervical intraepithelial neoplasia", "epidemiology", "prevalence", "genotype". The theme that emerged as a result of the keywords used in this cluster was called "cervical cancer and epidemiology of HPV".

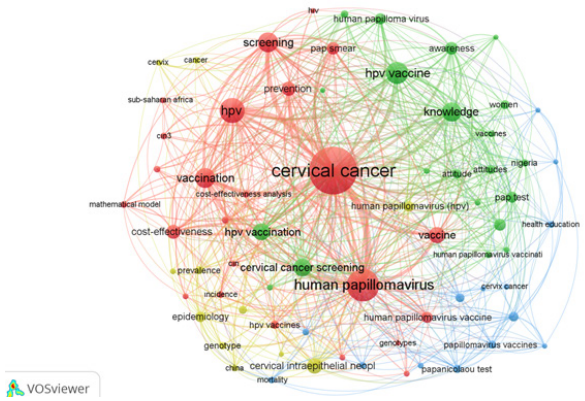

Figure 4. *Network analysis of the co-occurrence of keywords used in the determined area*

DISCUSSION

Our article is important as it is the first study in which bibliometric analysis of joint publications on HPV vaccine and cervical cancer was performed according to the WoS database, as far as we researched. Bibliometric analyzes provide comprehensive historical information about scientific publications by analyzing the structure of publications in a particular research area and show the productivity of countries, authors and organizations (16).

With the discovery of the HPV vaccine, animal experiments investigating protection against cervical cancer were started and the first publications focused on this subject were found in 1991 (17). In the bibliometric analysis, in which only the HPV vaccine was investigated in the literature, it was found that there was an average of 28% increase in the number of publications per year between 2001 and 2018. It has been shown that the rate of increase in publications reached 150%, especially between 2006 and 2007(18). It is thought that this increase is due to the inclusion of HPV vaccine in the vaccination program in developed countries in those years. As a result of our study, it is seen that the joint publications on HPV vaccine and cervical cancer have increased especially since 2018 and the most publications were in 2021. We thought the possible reason for this was the WHO (10) global call for a cervical cancer elimination program in 2020. The increase in HPV vaccine administration and cervical cancer screening may have contributed to the increase in joint publications in 2021.

The journals "Vaccine" and "PLOS one" published approximately 11% of their joint articles on HPV vaccine and cervical cancer. It shows that the "Vaccine" journal is the area of expertise and scope of the journal, which attracts the authors to publish in the journal, especially in the fields related to the HPV vaccine.

In the joint publications on HPV vaccine and cervical cancer, it is seen that the USA has the highest number of publications and there is a significant difference with other countries. In a study examining medical scientific publications, the country with the highest number of publications between 1995 and 2015 was found to be USA with 4.19 million publications, while China was the second country with 0.91 million publications (19). Similar to this result in our study, it is seen that the country with the most publications in the field we researched is the USA. The presence of a large number of clinical and research centers in the USA may have allowed further research on this subject. Similar to our study, in the bibliometric research on the anthrax vaccine, the highest number of publications was published by the USA, followed by the UK (20). The fact that there is more publication in the USA on vaccines suggests that it may be due to the fact that the USA allocates a significant budget to research and development in almost every research area. It is reported that the National Institutes of Health in the USA received an award of 30 billion dollars for medical research in 2014 (21). Some researchers in African countries and developing countries work on their own or independently instead of collaborating with developed countries (22). This may be one of the reasons why these countries produce fewer articles compared to other parts of the world. Another possible explanation for the fewer publications on the subject from other countries is the difficulties faced by authors from less wealthy countries in promoting and publishing their work. When the citation and related author were examined in our study, the dominant country was the USA again. In the results of the network visualization of the co-authorship relationship between the countries or organizations we found in our study, it was found that the countries that cooperated most with the USA on the subject were England, France and Spain. Therefore, researchers in countries with a burden of disease should seek to collaborate with researchers from leading countries such as the USA and the UK.

Keywords in an article indicate relevant and important points in the article (23). These points help represent potential trends in future research (24). It is important to easily scan the frequency and distribution of keywords in the article using bibliometric analysis to highlight the relevant points in research. According to our results, the 3 most frequently used keywords in joint articles on HPV vaccine and cervical cancer were "cervical cancer", "human papillomavirus" and "HPV". In the themes that emerged in line with the keywords, the subjects of cervical cancer and HPV and HPV vaccine relationship, knowledge, attitude and awareness towards cervical cancer screening and HPV vaccine, cervical cancer primary prevention and death, cervical cancer and HPV epidemiology were studied. As a result, it is seen that different areas related to the subject are mentioned. In addition to these, we believe that it would be beneficial to the literature to conduct more studies on hesitancy in HPV vaccine application.

Limitations

Our analyzes are based on articles in the WoS database. The remaining databases other than WoS, such as Pubmed, Scopus, and Google Scholar, were not included as they are technically non-mergeable. The database is still open and some data (number of citations) in the research may be updated continuously.

CONCLUSION

These findings are of interest to researchers and policy makers by conducting bibliometric analysis of co-published articles on HPV vaccine and cervical cancer. In recent years, the number of studies focusing on HPV vaccine and cervical cancer has increased. It was seen that most of the studies were done in developed countries. It is noteworthy that the country that is the leader in the most cited country, responsible author country, international cooperation and leading institutions is the USA. In order to improve the global output of research in this field, it will be beneficial to establish strong research cooperation between researchers and institutes in underdeveloped and developing countries and developed countries.

DECLARATIONS

Funding

The authors declared that this study received no financial support.

Conflicts of Interest

No conflict of interest was declared by the authors.

Ethics Approval

This study does not require ethics committee approval, as no data was obtained from any living thing during the

research process. A public, searchable Web of Science (WoS) database was used for research data.

Availability of Data and Material

Not applicable.

Authors' Contributions

All authors contributed to the design and implementation of the research, to the analysis of the results and to the writing of the manuscript.

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