KⓝE Publishing

Check for updates

Research Article

Bibliometrics Analysis and Thematic Mapping of Global Literature on Human Papillomavirus (HPV)

Meisam Dastani[ID][1]**, Jalal Mardaneh**[ID][1,2]*****, and Reza Ahmadi**[ID][3]

[1]Infectious Diseases Research Center, Gonabad University of Medical Sciences, Gonabad, Iran
[2]Department of Microbiology, School of Medicine, Gonabad University of Medical Sciences, Gonabad, Iran
[3]School of Medicine, Infectious Diseases Research Center, Gonabad University of Medical Sciences, Gonabad, Iran

Corresponding Author: Jalal
Mardaneh; email:
jalalmardaneh@yahoo.com

Editor-in-Chief:
Prof. Nazik Elmalaika Obaid
Seid Ahmed Husain, MD, M.Sc,
MHPE, PhD.

Abstract

Background: Since human papillomavirus (HPV) infection is known as one of the main causes of cervical cancer, medical researchers pay significant attention to this issue2. The current study applies the bibliometric method to identify the trends and advancements of research on HPV worldwide.

Methods: This descriptive study was conducted using a bibliometric approach. All HPV-related scientific publications in the Web of Science database until 2022, August 30 were included in the statistical population. The Bibliometrix package of the R programming language was used to analyze the data.

Results: In the field of HPV, a total of 45,657 scientific publications were retrieved, the majority of which were articles. The countries with the highest publications were the USA (45,954 document), China (9977), and UK (6652). The words "Infection," "Cancer," and "Women" are the most important keywords of scientific publications on HPV. "Cancer," "infection," and "women" are the more developed and essential in HPV subject area. "Protein," "gene-expression," and "human-keratinocytes" are in this quadrant. "DNA," "squamous-cell carcinoma," and "head" keywords are basic themes in the HPV subject area. "Human-papillomavirus vaccination," "knowledge," and "attitude" are in this quadrant.

Conclusion: The study suggests the need to enhance the focus on global and public health aspects within HPV research to encourage greater participation from various countries in international research endeavors.

Keywords: human papillomavirus (HPV), bibliometric, scientific production

🔒 **OPEN ACCESS**

1. Introduction

Infection with human papillomavirus (HPV) is the main cause of cervical cancer [1] and is known as the most common sexually transmitted infection in the world [2]. One of the leading causes of cancer-related deaths in developing nations is cervical cancer, which is mainly (95%) due to the high-risk HPV genotype. HPV has more than 210 genotypes identified so far, which contribute to the development of other types of cancer in humans [3].

HPV constitutes a family of more than 200 interconnected viruses, with some being transmitted through vaginal, anal, or oral intercourse. The transmission of HPV occurs via intimate skin-to-skin contact, letting individuals to contract the virus even in the absence of visible symptoms. Sexually transmitted HPV types are categorized into two groups: low risk and high risk. HPV infections have the potential to lead to specific cancers, including those affecting the cervix, vagina, and vulva in women, the penis in men, and the anus and the back of the throat in both genders. The progression to cancer typically takes years, sometimes even decades, following HPV exposure. Predicting who will develop cancer or other health complications resulting from HPV remains elusive. Individuals with compromised immune systems, such as those with HIV/AIDS, may face challenges in clearing HPV infections, thereby increasing the likelihood of HPV-related health issue2s. Notably, HPV vaccination has demonstrated efficacy in preventing over 90% of cancers caused by HPV, along with pre-cancers affecting the anus, vagina, cervix, and vulva. Regular screening for women aged 21 to 65 years can effectively prevent cervical cancer [4].

Therefore, numerous studies in this area have been carried out following the discovery of the correlation between HPV and cervical cancer [5], which eventually resulted in the establishment of the scientific structure of this subject area.

Research in this field has recently increased dramatically, resulting in the development of HPV vaccinations. These vaccinations were a part of most vaccination programs in developed countries between 2006 and 2007 [6].

As knowledge advances, significant scientific advancements necessitate the collaborative efforts of an expanding number of researchers. By examining the patterns of scientific collaboration, innovation and knowledge production can be comprehended better [7].

Bibliometrics is an approach used to assess scientific studies and is a scientific discipline that analyzes scientific productions and publications quantitatively to objectively and comprehensively evaluate the body of knowledge in a particular field. In addition, bibliometrics allows for the quantitative organization of research groups, including the identification of their research centers [8, 9]. The bibliometric analysis provides an objective, experimental, and unbiased look into a specific topic by rationally and accurately evaluating the contribution of research production and publications for advancing knowledge in that particular field [10]. Drawing scientific maps and visualizing quantitative data is also suggested as an appropriate solution to improve understanding of quantitative data and their connections in a scientific field. A scientific map indicates the relationship between individual or group articles of authors, disciplines, places, and specialties by their physical closeness or relative positions. Drawing the scientific and social structure of researchers in

a field of science provides important details regarding each researcher's position within the body of knowledge in that field and, in a manner, expresses their power [11]. There are numerous methods to draw scientific maps, including word co-occurrence analysis, co-citation, and co-authorship [12].

In different areas of medical science, some investigations have been conducted utilizing bibliometric and scientometric methodologies, such as the following:

● Tuberculosis Research [13];

● Molecular Mechanisms of Exercise on Cancer [14];

● Bacteria-mediated cancer therapy [15];

● Breast Cancer [16, 17]; and

● miRNAs in Cancer [18].

Lin *et al.* (2011) investigated all the HPV-related literature published between 1993 and 2008 using bibliometric and scientific methods [5]. Using social network analysis, Vanni *et al.* (2014) looked into trends of worldwide scientific collaboration in HIV and HPV publications [7]. In a different investigation, Danesh and GhaviDel (2020) performed a co-word analysis of the scientific and intellectual structure and conceptual visualization of this field between 2014 and 2018 [20]. Moreover, Danesh and GhaviDel (2019) analyzed the content of scientific papers in the field of HPV between 2014 and 2018 [19, 20]. Özdemir and Şahin (2023) have also discovered important research trends and advancements at the global level through bibliometric analysis of collaborative publications on the HPV vaccination and cervical cancer between 1991 and 2021 [21].

The present study applied the Bibliometrix tool to conduct a bibliometric analysis of studies on HPV between 1950 and 2022, taking into account the aforementioned cases, the significance of the subject, and the growing number of investigations in this subject area.

2. Methods

Bibliometric techniques were used in this descriptive study. The statistical population of this study was all the scientific publications in the field of HPV indexed in the Web of Science Core Collection (WoSCC) database. On 2022, August 30, the data was obtained by conducting a search on the aforementioned database using the keywords human papilloma virus*, human papillomavirus*, and HPV.

The data extraction was performed with precision by designing a meticulous search strategy and searching within the titles of articles in the WoSCC database to specifically retrieve data related to the HPV virus. This rigorous approach ensured the inclusion of only pertinent and significant studies in the bibliometric analysis, thereby enhancing the credibility of the results.

The Biblioshiny graphical interface tool based on the Bibliometrix package in R programming language was employed to analyze the data. Bibliometrix is a tool for visualizing information in bibliometric analyses based on scientific productions and publications in nations and regions, journals, authors, articles, keywords, and research institutes. This tool can generate several types of scientific maps [9, 22, 23].

It should be noted that KeyWords Plus has been applied to draw conceptual maps in each of the publications.

The thematic map uses the KeyWords Plus field. The KeyWords Plus is associated with Thomson Reuters editorial experts supported by a semi-automated algorithm. KeyWords Plus terms can

capture an article's content with greater depth and variety [24].

In general, the present investigation is structured as follows:

1. Data collection;

2. Data analysis and visualization; and

3. Interpretation

3. Results

A total of 45,657 scientific publications on the HPV subject area were extracted from the WoS database. Figure **1** indicates the annual trend of these publications from 1950 to 2022, August 30 August.

According to the data in Figure **1**, there have been an increasing number of scientific papers conducted on HPV every year, and it is shown that the most significant number of articles were published in 2021. Furthermore, of note, the analyzed scientific publications in 2022 were until 2022 August, 30.

The types of scientific publications in the field of HPV are demonstrated in Figure **2**, with articles accounting for the majority of these publications (27,456 documents).

Figure **3** demonstrates 10 of the most important resources of scientific publications in the HPV subject area and indicates that the Laboratory Investigation, the Modern Pathology, and Vaccine journals with 1040, 993, and 940 documents, respectively, have the highest amount of scientific publications in this scientific field.

Figure **4** illustrates the countries with the highest scientific publications in the HPV subject area.

Moreover, Figure **5** shows the scientific map of the scientific collaboration of participating countries in this field.

Figures 4 and 5 indicate that researchers from the United States, China, and the United Kingdom highly contributed to scientific publications on HPV.

Figure **6** indicates the word cloud of 1000 most important keywords of scientific publications in the HPV subject area, which suggests that the words "Infection," "Cancer," and "Women" are the most important keywords of scientific publications on HPV.

Figure **7** indicates the strategic diagram of the thematic map to demonstrate the significance and development of research topics. Utilizing the walktrap algorithm, thematic maps in HPV research were constructed through cluster analysis. This process involved identifying prevalent keywords and subsequently categorizing them into four distinct groups based on their centrality and density:

● Basic Themes: Encompassing keywords of general relevance in the research field.

● Niche Themes: Including keywords that are peripherally related but less explored.

● Motor Themes: Involving keywords that are central to structuring and evolving the field.

● Emerging Themes: Denoting keywords representing emerging research areas.

Moreover, Figure **7** shows the thematic map based on density (y-axis) and centrality (x-axis). The centrality measures the importance of the selected theme, and density measures the development of the chosen theme.

In Figure **7**, the upper-right quadrant shows the motor themes. They are characterized by both high centrality and density. "Cancer," "infection," and "women" are more developed and essential in HPV subject area. In the upper left quadrant, the niche themes are observed, which are peripheral and specific topics for the research field. "Protein," "gene-expression," and
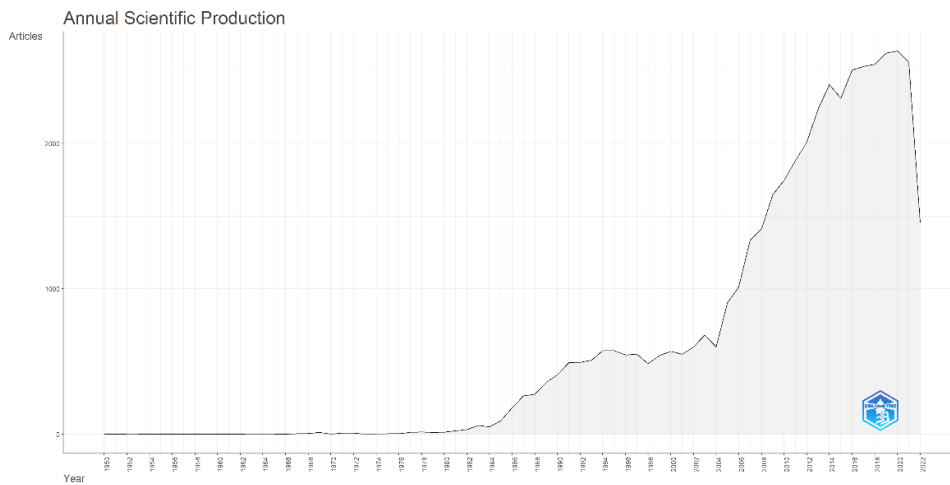
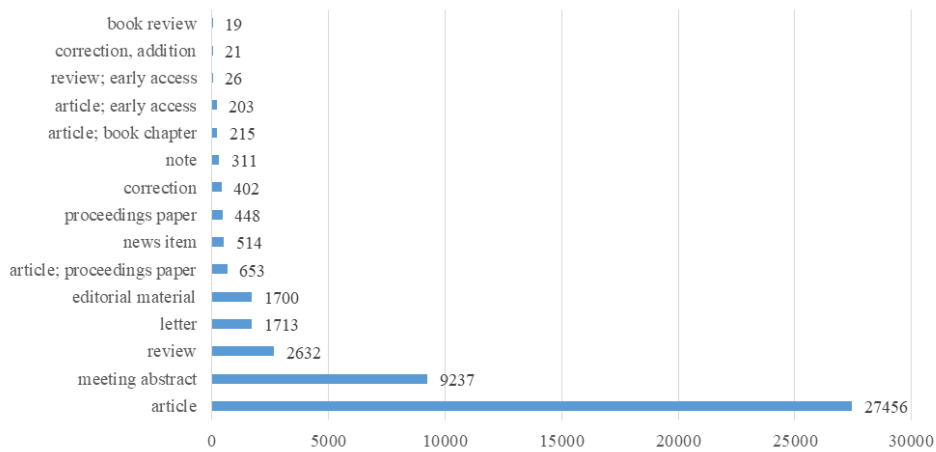**Figure 1**: Annual trend of scientific publications in the HPV subject area.

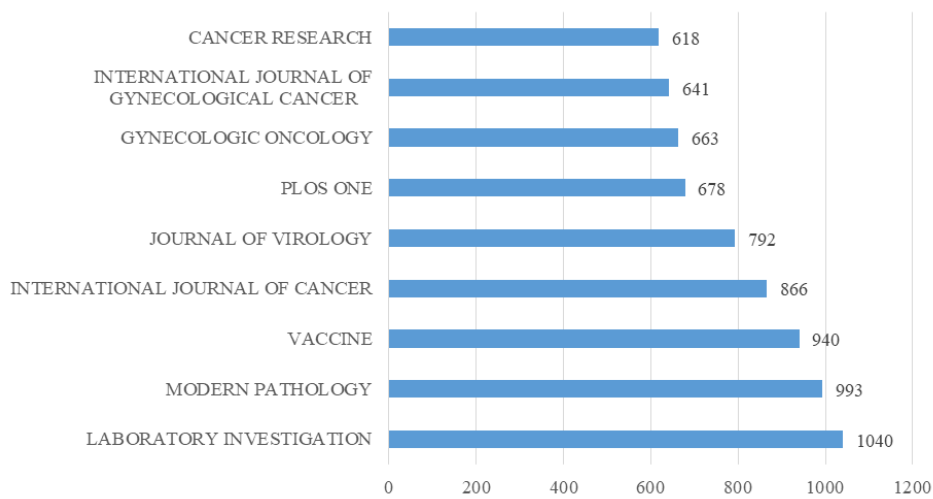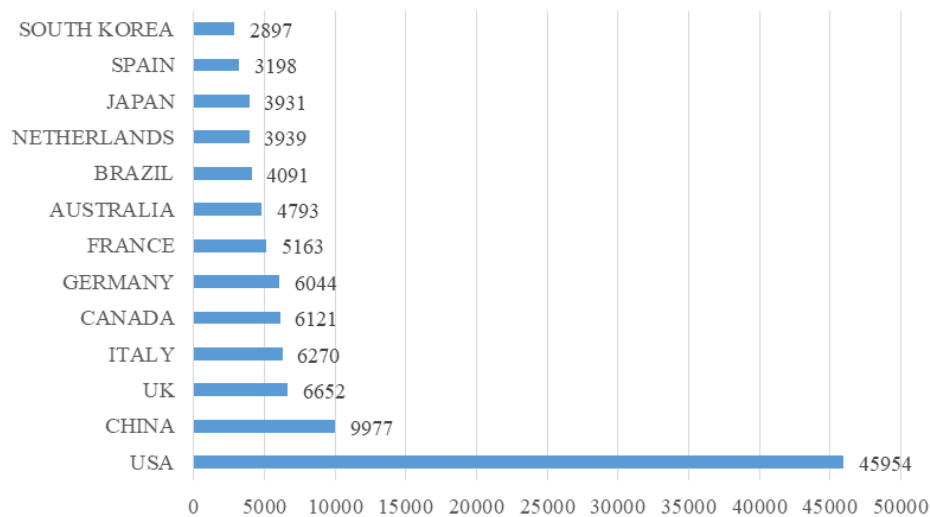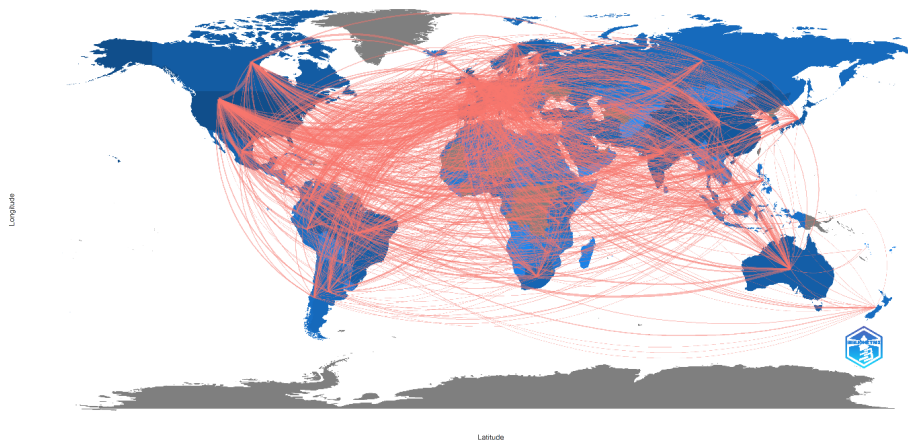**Figure 2**: Types of scientific publications in the HPV subject area.

Figure 3: Most important resources of scientific publications.

"human-keratinocytes" are in this quadrant. The   basic themes are demonstrated in the lower right

Figure 4: Countries with the highest rate of scientific publications in the HPV subject area.

Figure 5: Collaboration map of participating countries in scientific publications in the HPV subject area.

quadrant. These are basic, general, and transversal themes in the research field. "DNA," "squamous-cell carcinoma," and "head" keywords are basic themes in the HPV subject area. Finally, there are emerging, or declining themes in the lower left quadrant. "Human-papillomavirus vaccination," "knowledge," and "attitude" are in this quadrant.

Furthermore, Figure **8** demonstrates the topical evolution trends in the scientific publications of the HPV subject area over time in four time periods 1950–2000, 2001–2010, 2011–2021, and 2022.

The data in Figure **8** indicate that the terms DNA and cervical carcinoma were the most important

in HPV science in the years 1950–2000, and researchers focused on these keywords the most. Also, this figure shows the evolution of keywords in three other time periods. Also, Figure **8** indicates that the word "cancer" is an essential keyword in the HPV subject area, which has been repeated in three time periods and is of great significance. Moreover, the HPV vaccine has also been an important topic recently repeated at a high rate.

Figure 6: Word cloud of the most important keywords of the HPV subject area.

Figure 7: Thematic map based on density (*y*-axis) and centrality (*x*-axis).

4. Discussion

The analysis of scientific models and maps is a suitable method for demonstrating the ever-growing advancement of scientific activities and establishing the intellectual and scientific structure of a subject area. The present study has identified significant and influential aspects of scientific publications in the HPV subject area. The results indicated that scientific publications in this subject area have been growing since 2004. Most of the publications were in the form of articles, meeting abstracts, and reviews. The United States, China, and England had the highest collaboration in HPV publications. Previous investigations have

Figure 8: Topical evolution trends in scientific publications of the HPV subject area.

also pointed to the exponential growth of scientific publications on this subject area [25]. Moreover, a study in 2018 has demonstrated that most scientific publications in medical fields belong to the United States and China [26]. In addition, Vani *et al.* (2014) claimed that high-income countries generally have more scientific collaborations [7]. Further studies on the HPV vaccine have indicated that scientific publications in this field mainly belong to the United States [6, 21].

The results of the thematic map have shown the existing topics in scientific publications on the HPV subject area. Co-word and h-index analyses are employed to create a thematic map. There are four categories in a research area, namely, essential and well-developed themes (Motor themes), highly specialized and peripheral themes (niche themes), emerging or declining themes, and basic themes [27]. Accordingly, the topics "cancer," "infection,"

and "women" are themes in the field of HPV. Moreover, the topics "DNA," "squamous-cell carcinoma," and "head" are the basic themes in the HPV subject area. In addition, "protein," "gene-expression," and "human-keratinocytes" are niche themes. Finally, the topics "human-papillomavirus vaccination," "knowledge," and "attitude" are emerging or declining themes.

In further elaboration of the identified themes, namely "cancer," "infection," and "women" within the context of HPV research, it is imperative to delve into their substantial significance. These themes not only represent critical aspects of HPV studies but also play a pivotal role in advancing our comprehension of the virus and its associated diseases [28]. The theme of "cancer" is of paramount importance as it underscores the link between HPV and various types of cancers. By examining the literature associated with this theme, we can gain insights into the diverse

manifestations and impacts of HPV-induced malignancies. Understanding the intricate relationship between HPV and cancer is crucial for the development of effective preventive and therapeutic strategies [29]. The theme of "infection" provides a foundation for investigating the mechanisms of HPV transmission, host–virus interactions, and the development of infection-related diseases. Analyzing literature related to this theme contributes to a comprehensive understanding of the virology and epidemiology of HPV, aiding in the design of targeted interventions to manage and prevent HPV infections [30].

Furthermore, the theme of "women" is pivotal in recognizing the gender-specific aspects of HPV research. Focusing on literature associated with this theme allows for a nuanced exploration of how HPV affects women, including its impact on reproductive health and the development of cervical cancer. This understanding is instrumental in shaping public health initiatives tailored to the needs of women and enhancing preventive measures [31].

A study conducted by Danesh and Ghavidel in 2019 demonstrated that the topics of "HPV-induced cancers," "vaccination and prevention," and "genital warts" are the major emerging topics of this subject area [19]. In addition, Danesh and Ghavidel in 2020 indicated that "cervical cancer" was the most frequent keyword in scientific HPV publications [20].

Therefore, it can be claimed that the topics "women," "infection," and "cancer" are among the main subjects, showing that the occurrence of infectious cancer caused by HPV in women is of great importance because it is one of several major diseases that cause death in women around the world, and its transmission to other people, especially sexual partners, causes the disease to spread

in the society, and the prevention of the disease among all people, especially women, is one of the main agendas of the World Health Organization (WHO) [32]. Furthermore, topics such as "protein," "gene expression," and "keratinocytes" are part of trivial research topics and are not the main concern of researchers and governments, which is expected since the main challenges currently are attempting to prevent cancers caused by this virus through conducting regular vaccinations and manufacturing more efficient vaccines [33].

Accordingly, the results indicated that research on prevention methods based on vaccine manufacturing and vaccination to stop the spread of the diseases caused by HPV is increasing, and the focus of researchers and related research institutions has been on this virus, aiming to prevent the occurrence of HPV-induced cancer and other complications and deaths. On the other hand, the results revealed that the studies on basic topics, including preliminary information about this virus, are significantly diminishing, which indicates that the general and public knowledge regarding this virus in the world is thorough; there is no need for further studies and research funds regarding this subject, and other imperative and up-to-date issue2s such as vaccination are addressed [34].

Moreover, the thematic evolution diagram has indicated that in the initial emergence of the HPV publications, the topics "DNA" and "cervical carcinoma" were the most important and predominantly used subjects in this scientific field. However, in recent years, the topics "cancer," "vaccination," and "head" have been employed more. Moreover, in this diagram, the historical trend and progress of the research topics related to a scientific field were demonstrated. In addition, the diagram indicates the thematic history and the evolution of these thematics using Keywords Plus [35].

In this regard, Bruel *et al.* (2021) indicated that exclusive research on the HPV vaccine has increased along with the growth in the number of publications [6]. Özdemir and Şahin (2023) demonstrated that the three most frequent keywords in joint articles about the HPV vaccine and cervical cancer were "cervical cancer," "human papillomavirus," and "HPV." Moreover, the topics "cervical cancer" and "HPV," "knowledge," "attitude and awareness towards cervical cancer screening and the HPV vaccine," "preliminary prevention of cervical cancer and death," and "cervical cancer and HPV epidemiology" were identified in joint articles regarding the HPV vaccine and cervical cancer [21].

Furthermore, the results indicated that at the beginning of the history of studying this virus by humans, researchers investigated its DNA and genomic features and the cervical carcinoma caused by it, which demonstrates that it was impossible to deal with this virus without gaining knowledge about its genome, the function of its genes, and the resulting carcinoma. Whereas, in recent studies, researchers around the world have mainly invested in studies regarding the vaccination and cancer caused by this virus. Certainly, with more knowledge regarding this virus, it is totally possible to prevent the diseases caused by it, and the result will be to prevent the occurrence of HPV-induced cancer, reduce the mortality of the infected people, and reduce the healthcare costs caused by these diseases. However, HPV infection can also cause other viral diseases (e.g., HIV) and make individuals susceptible to it [36].

Therefore, it has been indicated that the DNA of the virus and the carcinoma caused by it has been the main topic considered and studied since the many years, which can indicate that the objective of humans had been to thoroughly understand the carcinoma caused by the virus through investigating its genome and the genes that take part in the occurrence of this disease because controlling the disease could lower the costs to the healthcare system of countries and families.

5. Conclusion

The present investigation has demonstrated the growing trend of studies in the HPV subject area and that the developed countries collaborated most in scientific HPV publications. The results have also revealed that the studies in this subject area were commenced from research on the preliminary knowledge, genomic features, and general understanding of this virus, while in recent years, the investigations on vaccine development and prevention have been of great significance. According to the findings, in order to improve the global efficiency of research in this field, it would be helpful to establish a robust research collaboration between researchers and institutions in underdeveloped, developing, and developed countries. Such collaborative endeavors hold the potential to enhance the global efficiency of research in the field, paving the way for informed future directions in both research and the formulation of public healthcare policies targeting HPV. Moreover, the identified trends can guide researchers, policymakers, and public health professionals in formulating evidence-based strategies to address the challenges posed by HPV. Recognizing the collaborative efforts of researchers across developed and developing nations, it is clear that fostering international partnerships is crucial for the comprehensive understanding and effective management of HPV.

Declarations

Ethical Considerations

The study received approval from the Ethics Committee of Gonabad University of Medical ical Sciences under the reference number IR.GMU.REC.1401.025.

Competing Interests

The authors declare no competing interests.

Availability of Data and Material

All data and materials utilized in this study are available upon request from the corresponding author.

Abbreviations and Symbols

HPV: Human papillomavirus

References

[1] Walboomers, J. M., Jacobs, M. V., Manos, M. M., Bosch, F. X., Kummer, J. A., Shah, K. V., Snijders, P. J., Peto, J., Meijer, C. J., & Mu noz, N. (1999). Human papillomavirus is a necessary cause of invasive cervical cancer worldwide. *The Journal of Pathology, 189*(1), 12–19. https://doi.org/10.1002/(SICI)1096-9896(199909)189:1<12::AID-PATH431>3.0.CO;2-F

[2] Chesson, H. W., Dunne, E. F., Hariri, S., & Markowitz, L. E. (2014). The estimated lifetime probability of acquiring human papillomavirus in the United States. *Sexually Transmitted Diseases, 41*(11), 660–664. https://doi.org/10.1097/OLQ.0000000000000193

[3] Mobini Kesheh, M., & Keyvani, H. (2019). The prevalence of HPV genotypes in Iranian population: An update. *Iranian Journal of Pathology, 14*(3), 197–205. https://doi.org/10.30699/IJP.2019.90356.1861

[4] Choi, S., Ismail, A., Pappas-Gogos, G., & Boussios, S. (2023). HPV and cervical cancer: A review of epidemiology and screening uptake in the UK. *Pathogens (Basel, Switzerland), 12*(2), 298. https://doi.org/10.3390/pathogens12020298

[5] Lin, H. W., Yu, T. C., & Ho, Y. S. (2011). A systemic review of human papillomavirus studies: Global publication comparison and research trend analyses from 1993 to 2008. *European Journal of Gynaecological Oncology, 32*(2), 133–140.

[6] Bruel, S., Dutzer, D., Pierre, M., Botelho-Nevers, E., Pozzetto, B., Gagneux-Brunon, A., Chauvin, F., & Frappé, P. (2021). Vaccination for Human Papillomavirus: A historic and bibliometric study. *Human Vaccines & Immunotherapeutics, 17*(4), 934–942. https://doi.org/10.1080/21645515.2020.1805991

[7] Vanni, T., Mesa-Frias, M., Sanchez-Garcia, R., Roesler, R., Schwartsmann, G., Goldani, M. Z., & Foss, A. M. (2014). International scientific collaboration in HIV and HPV: A network analysis. *PLoS One, 9*(3), e93376. https://doi.org/10.1371/journal.pone.0093376

[8] Huang, L., Zhang, Y., Guo, Y., Zhu, D., & Porter, A. L. (2014). Four dimensional Science and Technology planning: A new approach based on bibliometrics and technology roadmapping. *Technological Forecasting and Social Change, 81*, 39–48. https://doi.org/10.1016/j.techfore.2012.09.010

[9] Chen, T., & Gong, X. (2022). Global research trend analysis of *Osmanthus fragrans* based on Bibliometrix.

Mobile Information Systems, *2022*, 4091962. https://doi.org/10.1155/2022/4091962

[10] Yang, L., Sun, T., & Liu, Y. (2017). A bibliometric investigation of flipped classroom research during 2000-2015. *International Journal of Emerging Technologies in Learning, 12*(06), 178–186. https://doi.org/10.3991/ijet.v12i06.7095

[11] Khasseh, A. A., Soosaraei, M., & Fakhar, M. (2016). Cluster analysis and mapping of Iranian researchers in the field of parasitology: With an emphasis on the co-authorship indicators and H index. *Majallah-i Mikrub/Shinasi-i Pizishki-i Iran, 10*(2), 63–74.

[12] Janssens, F., Leta, J., Glänzel, W., & De Moor, B. (2006). Towards mapping library and information science. *Information Processing & Management, 42*(6), 1614–1642. https://doi.org/10.1016/j.ipm.2006.03.025

[13] Dastani, M., Mohammadzadeh, A., Mardaneh, J., & Ahmadi, R. (2022). Topic analysis and mapping of tuberculosis research using text mining and co-word analysis. *Tuberculosis Research and Treatment, 2022*, 8039046. https://doi.org/10.1155/2022/8039046

[14] Zhong, D., Li, Y., Huang, Y., Hong, X., Li, J., & Jin, R. (2022). Molecular mechanisms of exercise on cancer: A bibliometrics study and visualization analysis via CiteSpace. *Frontiers in Molecular Biosciences, 8*, 797902. https://doi.org/10.3389/fmolb.2021.797902

[15] Wang, J., & Maniruzzaman, M. (2022). A global bibliometric and visualized analysis of bacteria-mediated cancer therapy. *Drug Discovery Today, 27*, 103297. https://doi.org/10.1016/j.drudis.2022.05.023

[16] Hao, K. J., Jia, X., Dai, W. T., Huo, Z. M., Zhang, H. Q., Liu, J. W., & Wang, X. B. (2022). Mapping intellectual structures and research hotspots of triple negative breast cancer: A bibliometric analysis. *Frontiers in Oncology, 11*, 689553. https://doi.org/10.3389/fonc.2021.689553

[17] Zhang, Y., Yu, C., Zhao, F., Xu, H., Zhu, C., & Li, Y. (2022). Landscape of artificial intelligence in breast cancer (2000–2021): A bibliometric analysis. *Frontiers in Bioscience (Landmark Edition), 27*(8), 224. https://doi.org/10.31083/j.fbl2708224

[18] Shaw, P., Lokhotiya, K., Kumarasamy, C., Sunil, K., Suresh, D., Shetty, S., Muthukaliannan, G. K., Baxi, S., Mani, R. R., Sivanandy, P., Chandramoorthy, H. C., Gupta, M. M., Samiappan, S., & Jayaraj, R.

(2022). Mapping Research on miRNAs in cancer: A global data analysis and bibliometric profiling analysis. *Pathophysiology, 29*(1), 66–80. https://doi.org/10.3390/pathophysiology29010007

[19] Danesh, F., & Ghavidel, S. (2019). GhaviDel S. Visualizing the clusters and dynamics of HPV research area. *Majallah-i Mikrub/Shinasi-i Pizishki-i Iran, 13*(4), 266–278. https://doi.org/10.30699/ijmm.13.4.266

[20] Danesh, F., & Ghavidel, S. (2020). Visualizing human papillomavirus conceptual network evolution: A global view. *Health Information Management, 16*(6), 301–307.

[21] Özdemir, Ş., & Şahin, K. (2023). Bibliometric analysis of joint publications on human papilloma virus vaccine and cervical cancer. *Acıbadem Üniversitesi Sağlık Bilimleri Dergisi, 14*(1), 61–67. https://doi.org/10.31067/acusaglik.1189152

[22] Aria, M., & Cuccurullo, C. (2017). Bibliometrix: An R-tool for comprehensive science mapping analysis. *Journal of Informetrics, 11*(4), 959–975. https://doi.org/10.1016/j.joi.2017.08.007

[23] Mühl, D. D., & de Oliveira, L. (2022). A bibliometric and thematic approach to agriculture 4.0. *Heliyon, 8*(5), e09369. https://doi.org/10.1016/j.heliyon.2022.e09369

[24] Della Corte, V., Del Gaudio, G., Sepe, F., & Sciarelli, F. (2019). Sustainable tourism in the open innovation realm: A bibliometric analysis. *Sustainability (Basel), 11*(21), 6114. https://doi.org/10.3390/su11216114

[25] Druss, B. G., & Marcus, S. C. (2005). Growth and decentralization of the medical literature: Implications for evidence-based medicine. *Journal of the Medical Library Association: JMLA, 93*(4), 499–501.

[26] Fontelo, P., & Liu, F. (2018). A review of recent publication trends from top publishing countries. *Systematic Reviews, 7*(1), 147. https://doi.org/10.1186/s13643-018-0819-1

[27] Aria, M., Misuraca, M., & Spano, M. (2020). Mapping the evolution of social research and data science on 30 years of Social Indicators Research. *Social Indicators Research, 149*(3), 803–831. https://doi.org/10.1007/s11205-020-02281-3

[28] Kofler, B., Laimer, J., Bruckmoser, E., Steinbichler, T. B., Runge, A., Schartinger, V. H., von Laer, D., & Borena, W. (2020). The role of HPV and non-HPV sexually transmitted infections in patients with oropharyngeal

carcinoma: A case control study. *Cancers (Basel), 12*(5), 1192. https://doi.org/10.3390/cancers12051192

[29] Adegboyega, A., Obielodan, O., Wiggins, A. T., Dignan, M., & Williams, L. B. (2023). Beliefs and knowledge related to human papillomavirus (HPV) vaccine among African Americans and African immigrants young adults. *Cancer Causes & Control, 34*(5), 479–489. https://doi.org/10.1007/s10552-023-01678-y

[30] Roden, R. B. S., & Stern, P. L. (2018). Opportunities and challenges for human papillomavirus vaccination in cancer. *Nature Reviews. Cancer, 18*(4), 240–254. https://doi.org/10.1038/nrc.2018.13

[31] Camara, H., Zhang, Y., Lafferty, L., Vallely, A. J., Guy, R., & Kelly-Hanku, A. (2021). Self-collection for HPV-based cervical screening: A qualitative evidence meta-synthesis. *BMC Public Health, 21*(1), 1503. https://doi.org/10.1186/s12889-021-11554-6

[32] Kombe Kombe, A. J., Li, B., Zahid, A., Mengist, H. M., Bounda, G.-A., Zhou, Y., & Jin, T. (2021). Epidemiology and burden of human papillomavirus and related diseases, molecular pathogenesis, and vaccine evaluation. *Frontiers in Public Health, 8*, 552028. https://doi.org/10.3389/fpubh.2020.552028

[33] Dadar, M., Chakraborty, S., Dhama, K., Prasad, M., Khandia, R., Hassan, S., Munjal, A., Tiwari, R., Karthik,

K., Kumar, D., Iqbal, H. M. N., & Chaicumpa, W. (2018). Advances in designing and developing vaccines, drugs and therapeutic approaches to counter human papilloma virus. *Frontiers in Immunology, 9*, 2478. https://doi.org/10.3389/fimmu.2018.02478

[34] Mo, Y., Ma, J., Zhang, H., Shen, J., Chen, J., Hong, J., Xu, Y., & Qian, C. (2022). Prophylactic and therapeutic HPV vaccines: Current scenario and perspectives. *Frontiers in Cellular and Infection Microbiology, 12*, 909223. https://doi.org/10.3389/fcimb.2022.909223

[35] Nasir, A., Shaukat, K., Hameed, I. A., Luo, S., Alam, T. M., & Iqbal, F. (2020). A bibliometric analysis of corona pandemic in social sciences: A review of influential aspects and conceptual structure. *IEEE Access: Practical Innovations, Open Solutions, 8*, 133377–133402. https://doi.org/10.1109/ACCESS.2020.3008733

[36] Kojic, E. M., & Cu-Uvin, S. (2007). Update: Human papillomavirus infection remains highly prevalent and persistent among HIV-infected individuals. *Current Opinion in Oncology, 19*(5), 464–469. https://doi.org/10.1097/CCO.0b013e3282c8c84c