



Visualization Analysis of HPV Vaccination Research Based on VOSviewer and CiteSpace

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Abstract. This study performed a bibliometric and visualization analysis of HPV vaccination research using VOSviewer and CiteSpace based on the Web of Science Core Collection and CNKI database. A total of 2,114 English and 597 Chinese articles were included. Publication output increased significantly for both languages. Web of Science indexed literature formed an academic community centered on Zimet GD, Brewer NT, and Reiter PL with extensive cross-team collaboration; CNKI indexed Chinese literature centered on Qiao Youlin, Li Jing, and Zhao Fanghui with weaker inter-institutional linkages. The global network is regionally structured, with high-income countries at the core. High-frequency Web of Science indexed literature keywords include human papillomavirus, cervical cancer, knowledge, vaccine hesitancy; CNKI indexed Chinese literature keywords include human papillomavirus, cognition, cervical cancer, influencing factors, willingness to vaccinate. Clusters in both literatures fall into three similar thematic categories. Vaccine hesitancy is the latest frontier of common concern.

Keywords: HPV vaccine; vaccination behavior; bibliometrics

1 Introduction

In 2022, over 1.5 million new HPV-related cancer cases occurred globally¹. HPV vaccines can prevent most of these cancers, and over 140 countries have included them in national immunization programs². However, vaccination coverage remains low, driving increasing research. Using VOSviewer and CiteSpace on WoS and CNKI, this study compared Web of Science indexed literature and CNKI indexed Chinese literature in publication trends, collaboration, hotspots, and frontiers.

2 Data and Methods

Search on March 26, 2026 for 2000-2026. WoSCC Topic: TS=(health belief model OR HBM OR knowledge OR attitude OR intention OR acceptability) AND TS=(HPV vaccine OR human papillomavirus vaccine), Article/Review, English, initial 2,378 records. CNKI Subject: SU=(cognition OR knowledge OR awareness rate OR attitude OR belief OR intention OR vaccination willingness OR acceptability OR acceptance rate OR

vaccination behavior OR influencing factors OR related factors) AND SU=(HPV vaccine OR human papillomavirus vaccine OR HPV OR human papillomavirus vaccine alt.), academic journals, initial 611 records. Duplicates were removed using DOI for WoS records and title/author/year for CNKI records; no duplicates were found. Inclusion: human HPV vaccination studies reporting cognition, attitude, intention, behavior, or influencing factors. Exclusion: editorials, case reports (n<10), virology/therapeutic vaccines only, duplicates, retracted. After independent two-stage screening (titles/abstracts, full texts), 2,114 WoS English and 597 CNKI Chinese articles included.

VOSviewer 1.6.20 built author (≥ 5 docs), institution (≥ 8), country (≥ 5) and keyword (≥ 4 occurrences) networks, with association strength normalization and minimum spanning tree pruning. Author name variants merged by full name/initials, institutions standardized, countries as WoS labels. CiteSpace 6.4.R1 performed keyword clustering and burst detection: time slicing 2000-2026 (1-year slices), g-index (k=25), pathfinder + sliced network pruning, LLR clustering, $\gamma=0.8$, minimum burst duration 1 year. Data cleaning merged singular/plural forms, unified abbreviations, and merged synonyms.

3 Results and Analysis

3.1 Web of Science Indexed Literature

Publication Trends and Collaboration Network Characteristics.

Fig. 1 shows publications rose from 4 (2003) to 220 (2025), accelerating after 2017(2026 data excluded due to incomplete year). Author collaboration (Fig. 2) centers on Zimet GD, Brewer NT, Reiter PL, with extensive cross-team ties. Top institutions(Fig. 3): North Carolina, Indiana, South Florida, Emory; Chinese institutions (CAMS, Sichuan University) also participate globally. Country network (Fig. 4) shows the US is the hub, followed by China, with separate European, African, Middle Eastern clusters.

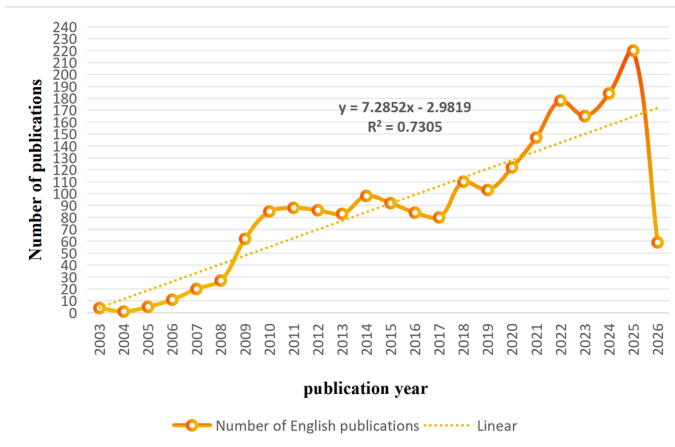


Fig. 1. Annual publication volume of Web of Science indexed literature, 2003 – 2026

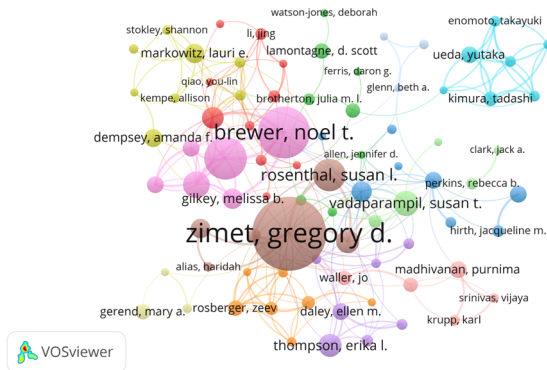


Fig. 2. Author collaboration network in Web of Science indexed literature.

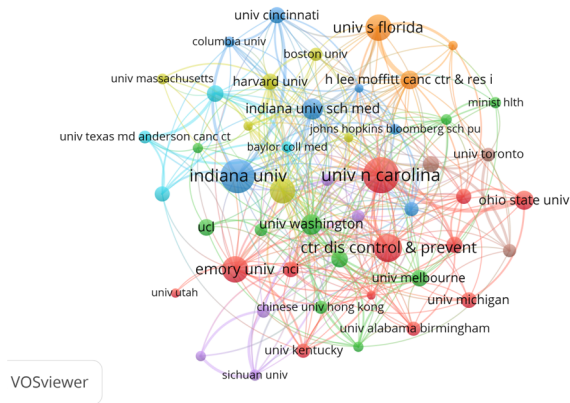


Fig. 3. Institutional collaboration network in Web of Science indexed literature.

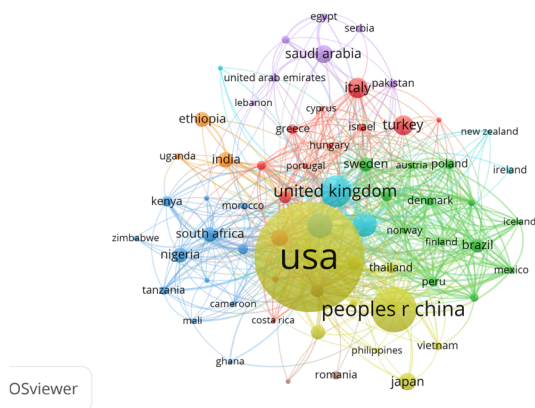


Fig. 4. Country collaboration network in Web of Science indexed literature.

Research Hotspots and Frontier Evolution.

The keyword co-occurrence network shows that high-frequency keywords in Web of Science indexed literature focus on human papillomavirus, cervical cancer, knowledge, and vaccine hesitancy, etc., as shown in Fig. 5.

Combined with Fig. 6, the 11 clusters fall into three categories: (1) HPV vaccine and cancer prevention; (2) burden and distribution of HPV-related diseases; (3) social and behavioral factors (social media, health education, vaccination disparities, behavioral theories).

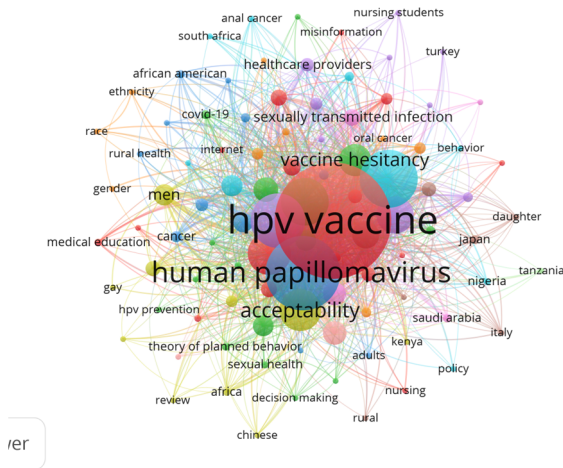


Fig. 5. Keyword co-occurrence network in Web of Science indexed literature.

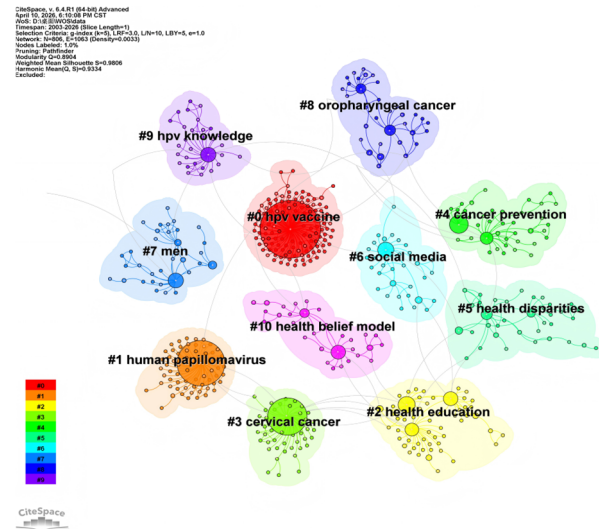


Fig. 6. Keyword clustering map for Web of Science indexed literature.

Table 1 shows keyword burst information. Early bursts (2003-2018) included attitude, sexual behavior, cervical cancer, STI. From 2012, adolescents and knowledge appeared. Health communication from 2019 to 2021 addressed social media misinformation, HPV is among the most affected topics, as vaccine-related misinformation accounts for about 43%³. Health education from 2022 to 2026 then gained sustained attention for improving uptake. Most recently, from 2023 to 2026, vaccine hesitancy and oropharyngeal cancer have emerged, the latter signaling expansion beyond cervical cancer.

Table 1. Keyword burst analysis in Web of Science indexed literature.

Keyword	Burst strength	Start year	End year
attitude	8.18	2003	2016
sexual behavior	3.02	2003	2018
cervical cancer	4.19	2004	2009
sexually transmitted infection	10.36	2005	2015
adolescents	2.97	2012	2015
knowledge	4.62	2017	2018
health communication	7.05	2019	2021
health education	5.22	2022	2026
vaccine hesitancy	10.04	2023	2026
oropharyngeal cancer	4.48	2024	2026

3.2 CNKI Indexed Chinese Literature

Publication Trends and Collaboration Network Characteristics.

Fig. 7 shows the publication trend: first appearing in 2008, peaking at 74 in 2021, then slightly fluctuating. 2026 data excluded due to incomplete year. The author collaboration network (Fig. 8) shows teams centered on Qiao Youlin, Li Jing, Zhao Fanghui, with weak cross-team linkages. The institutional collaboration network (Fig. 9) highlights the School of Public Health at Xinjiang Medical University and the School of Population Medicine and Public Health at CAMS & PUMC.

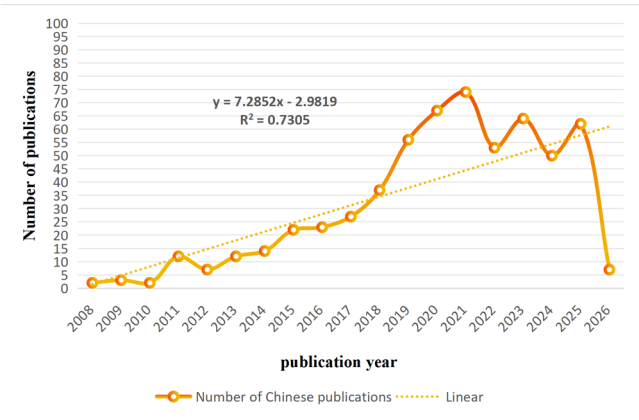


Fig. 7. Annual publication volume of CNKI indexed Chinese literature, 2008 – 2026.

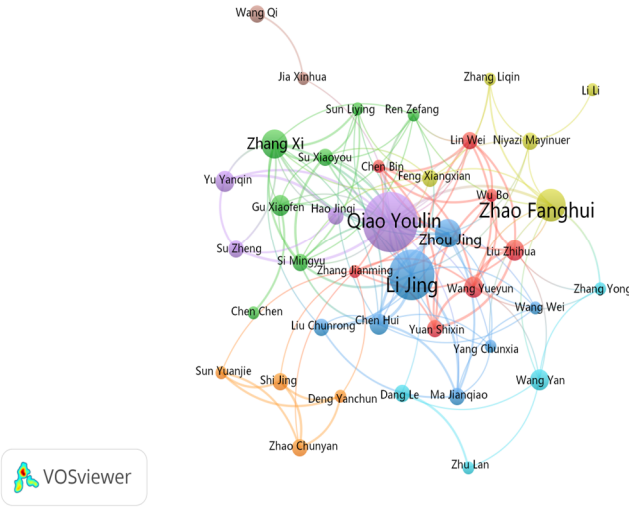


Fig. 8. Author collaboration network in CNKI indexed Chinese literature.

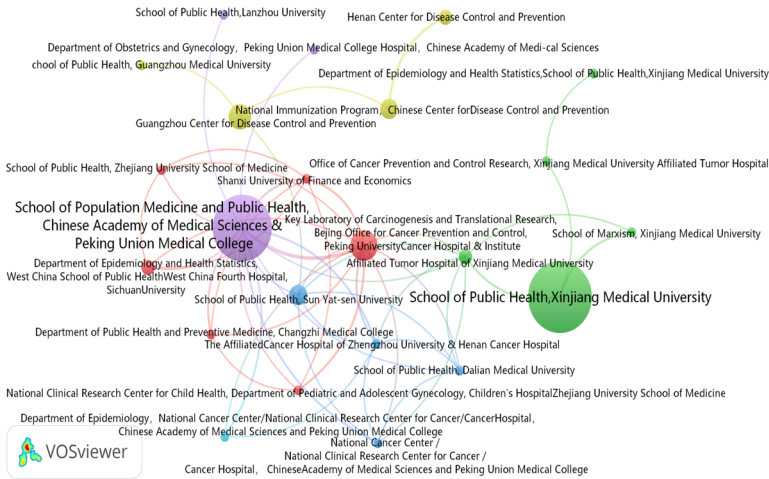


Fig. 9. Institutional collaboration network in CNKI indexed Chinese literature.

Research Hotspots and Frontier Evolution.

In the keyword co-occurrence network of CNKI indexed Chinese literature (Fig. 10), the high-frequency keywords include human papillomavirus, cognition, cervical cancer, influencing factors, willingness to vaccinate, etc.

From Fig. 11, the 10 clusters fall into three categories: (1) HPV infection and cervical cancer epidemiology; (2) cognitive, attitudinal, behavioral factors (knowledge, willingness surveys, health education); (3) specific populations (male groups, parents).

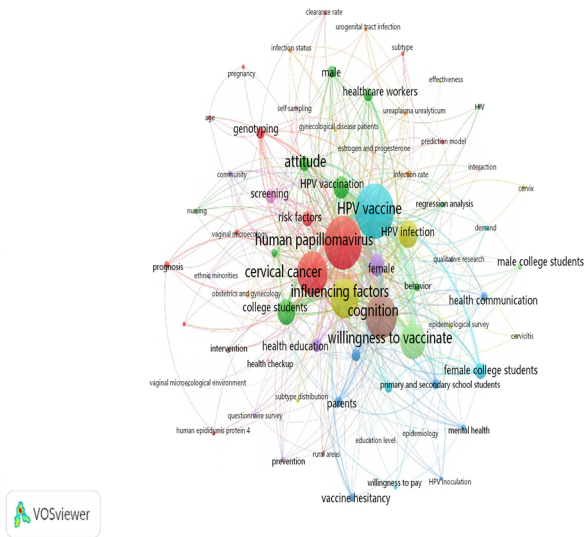


Fig. 10. Keyword co-occurrence network in CNKI indexed Chinese literature.

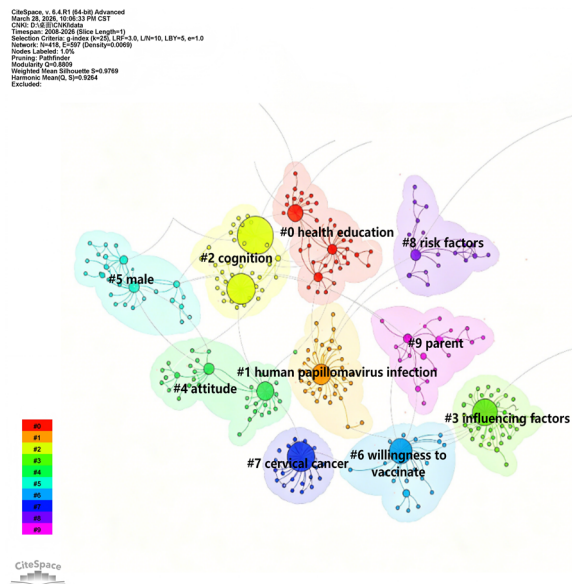


Fig. 11. Keyword clustering map for CNKI indexed Chinese literature.

Table 2 shows keyword burst analysis. From 2009 to 2015, cervical cancer and cognition emerged sequentially, with disease burden and public awareness as early topics. Between 2013 and 2018, attitude and behavior burst successively, extending research from cognition to attitude and behavior. From 2018 to 2023, population-specific

keywords like healthcare workers, female college students, and male college students burst, reflecting a shift to refined population-stratified research. Between 2022 and 2024, health education and health communication emerged sequentially. From 2023 to 2026, vaccine hesitancy emerges, aligning with the international frontier.

Table 2. Keyword burst analysis in CNKI indexed Chinese literature.

Keyword	Burst strength	Start year	End year
cervical cancer	5.45	2009	2015
cognition	1.98	2011	2015
attitude	4.51	2013	2018
behavior	1.56	2014	2018
healthcare workers	2.87	2018	2019
female college students	1.74	2020	2021
male college students	1.79	2022	2023
health education	1.73	2022	2023
health communication	1.99	2023	2024
vaccine hesitancy	2.06	2023	2026

4 Conclusion

Web of Science indexed literature surpasses CNKI indexed Chinese literature in output and growth, which may be partly attributed to the fact that the global HPV vaccine was approved in 2006 while China approved it in 2016. Collaboration networks differ: Web of Science indexed literature is internationally extensive, whereas CNKI indexed Chinese literature remains team-confined, with limited involvement from practice-oriented institutions like disease control centers. High-income countries dominate the global network, and as of 2020 only four countries achieved HPV vaccination targets, with access to vaccination and screening remaining limited in most low- and middle-income countries⁴. This suggests that the global distribution of research capacity may influence not only knowledge production but also real-world vaccine promotion outcomes.

Web of Science indexed literature and CNKI indexed Chinese literature share hotspots but diverge. The presence of "men" in Web of Science indexed literature and "male" in CNKI indexed Chinese literature indicates male vaccination is on the global agenda. Including males could reduce their HPV-related cancer risk and indirectly protect unvaccinated females, supporting gender-neutral policies⁵. Web of Science indexed literature's "health disparities" cluster compares vaccination gaps across populations, studies have identified disparities by insurance, race, age, income, education, and geography⁶. In contrast, CNKI indexed Chinese literature "male" and "parent" clusters focus on willingness of specific populations. This reflects different research approaches. Web of Science indexed literature has an independent "health belief model" cluster, a theory-driven paradigm; CNKI indexed Chinese literature lacks such a label, with most clusters instead focusing on descriptive influencing factors. Burst analysis shows vaccine hesitancy as the latest frontier for both. Although it emerged simultaneously in CNKI indexed Chinese literature, its burst strength is much lower, indicating domestic response is nascent.

In summary, Web of Science indexed literature research is mature; CNKI indexed Chinese literature research is developing rapidly but needs deeper theory application and inter-institutional collaboration. This study only used WoS and CNKI; future studies should include more databases and gray literature. Research focus should shift from describing influencing factors to validating behavioral interventions.

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