Int. J. Pharm. Investigation, 2026; 16(1):58-65.
https://www.jpionline.org

Review Article

A Systematic Review of Vaccination, Prevention, and Public Health Measures for the Human Papillomavirus Epidemic Among Patients in India

Satya Obbalareddy[1], Anubhav Dubey[2,*], Mamta Kumari[3], Chandan Mukherjee[4], Sanyogita Shahi[5], Sayantan Dutta[6]

[1]Department of Health System Management Studies, JSS Academy of Higher Education and Research, Mysuru, Karnataka, INDIA.
[2]Department of Pharmacology, Maharana Pratap College of Pharmacy, Kanpur, Uttar Pradesh, INDIA.
[3]Department of Pharmacy, Harcourt Butler Technical University, Kanpur, Uttar Pradesh, INDIA.
[4]Department of Life Sciences, School of Biosciences and Technology, Galgotias University, Greater Noida, Uttar Pradesh, INDIA.
[5]Department of Science (Chemistry), Kalinga University, Raipur, Chhattisgarh, INDIA.
[6]Faculty of Pharamceutical Science, Rama University, Kanpur, Uttar Pradesh, INDIA.

ABSTRACT

Nearly 70% of the population will be infected with Human Papillomavirus (HPV) at some point in their lives; in India, 27,526 women are diagnosed with the virus each year, and 79,906 lose their lives to it. Research has linked HPV to several malignancies; among Indian women, cervical cancer is the most common HPV-related malignancy. Cervical cancer is still a major public health concern, especially in LMICs like India, even though there are ways to avoid it, such as HPV vaccination and screening. Adolescents and young adults in India have low vaccine awareness and uptake, according to this study that examines the epidemiology, prevention, and obstacles to HPV vaccination in the country. We systematically reviewed all relevant literature on HPV prevalence, vaccination coverage, and preventive policies in India by searching PubMed, Google Scholar, and Research Gate. Out of 38 papers that were found, 10 were deemed suitable for inclusion in the complete review. HPV prevalence ranged from 14.7% in Iran to 37 percent in India, according to the results. About 14,089 new instances of cervical cancer are reported annually in India, making it the second most frequent malignancy among women. Although the HPV vaccination is available, just 13.7% of women in the age bracket have gotten a shot. Cost, cultural bias, a lack of knowledge, and an inadequate public health infrastructure were some of the obstacles we uncovered. Public education of the dangers of HPV should be a priority in public health policy. Affordable or free HPV vaccinations, immunization programs in schools, and awareness campaigns throughout the country should all be part of this. Reducing cervical cancer incidence and mortality rates would be another major goal of the national immunization program if HPV vaccination were included.

Keywords: HPV, Epidemiology, Vaccination, Prevention, Cervical cancer, India.

Correspondence:
Dr. Anubhav Dubey
Department of Pharmacology, Maharana Pratap College of Pharmacy, Kanpur, Uttar Pradesh-209217, INDIA.
Email: anubhavdwivedi803@gmail.com
ORCID: 0000-0002-9089-4794

Received: 09-05-2025;
Revised: 24-07-2025;
Accepted: 12-09-2025.

INTRODUCTION

Epidemiology of Human Papillomavirus

Human Papillomavirus (HPV) will infect approximately 70% of the population at some point in their lives (Alkalash *et al.*, 2002). The taxonomy of Human Papillomaviruses (HPVs) is summarized in Table 1, showing that they belong to the family *Papillomaviridae*, with genera such as *Alphapapillomavirus*, *Betapapillomavirus*, and others; they are double-stranded circular DNA viruses with a nonenveloped icosahedral capsid (Doorbar *et al.*, 2012). According to the World Health Organization (2023), the most prevalent HPV-related disease is cervical cancer; however, the virus is linked to several other forms of malignancies as well, including anal, penile, head and neck, and cervical cancer. While estimates place the worldwide incidence of HPV infection at 11% to 12%, research conducted in India has shown a prevalence of 2.3% to 36.9%. Screening sexually active women in India who seem to be healthy using PCR-based approaches is a rarity in community-based research. The most important thing people can do to avoid getting HPV is to get vaccinated. In 2006, the FDA approved a vaccine that targets four types of human papillomaviruses: types 16, 18, 6, and 11. These types cause benign anogenital warts and recurrent respiratory papillomatosis (Azuogu *et al.*, 2019). Forms 16 and 18 are responsible for 70% of cervical malignancies. Also authorized in 20093 is a bivalent

OPEN ACCESS

Manuscript TECHNOMEDIA

DOI: 10.5530/ijpi.20260462

Publishing Partner : Manuscript Technomedia. [www.mstechnomedia.com]

vaccination that protects against both HPV types 16 and 18. The best time to get either vaccination is before you start having sexual relations, as HPV infection usually happens around the time you start having sexual relations (Balogum *et al.*, 2022). If healthcare providers could boost HPV vaccination rates among eligible individuals to 80% within the target age range, an extra 53,000 cervical cancer cases might be avoided in the lifetimes of those younger than 12 years old, according to the CDC. The course of vaccinations requires three doses for those who start later, between the ages of 15 and 26. Cervical cancer is still one of the top killers of women worldwide, especially in low- and middle-income countries, even though there have been great strides in both prevention and treatment. Low- and Middle-Income Countries (LMICs) accounted for 90% of the new cases and fatalities in 2020, with an estimated 604,000 new cases and 342,000 deaths worldwide. Figure 1 was shown electron microscopy structure of HPV Virus (Deshmukh *et al.*, 2024). Among female cancers in India, cervical cancer is by far the most common. Around 365.71 million women in India are considered to be at risk for cervical cancer if they are 15 years of age or older. India accounts for over one-third of the world's cervical cancer fatalities, with an estimated 132,000 new cases diagnosed and 74,000 deaths every year (Bernard *et al.,* 2010). One major obstacle to HPV prevention efforts in India is the general public's ignorance of the virus and its vaccines, especially among young people and teenagers. India has one of the worst immunization systems in sub-Saharan Africa, despite the widespread availability of vaccinations. The Indian authorities have approved both HPV vaccinations, putting them on the market. These vaccines have received approval from the US Food and Drug Administration, the European Medicines Agency, and the World Health Organization, and two vaccination programs have already implemented them. The state governments of India, the Indian Council of Medical Research (ICMR), and PATH, a non-profit NGO located in the United States, collaborated on one study that looked at the practicality of immunization programs in schools and communities. The second one was a multicenter clinical study that evaluated the immunogenic effectiveness of two doses of Gardasil given six months apart compared to the standard three doses given at 0, 2, and 6-month intervals. Following media reports linking the vaccination to the deaths of four northern Indian girls, the Union Government halted the research and launched an investigation into the vaccines' safety. The state government assured the ICMR and DCGI that vaccination was not a factor in any of the deaths after investigating and reporting them. To inform public health policy and program development, this study seeks to investigate the frequency and factors influencing HPV awareness and vaccination uptake among young individuals in India (Burdette *et al.*, 2017) classification of HPV was given below in Figure 2 (Das *et al.*, 2019).

METHODOLOGY

To preserve rigor and transparency, this review adhered to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) standards. ResearchGate, Google Scholar, and PubMed were utilized to do a thorough literature search. We employed boolean operators, such as "HPV AND India AND VACCINATION," to locate papers that addressed HPV epidemiology, vaccination, prevention, and ant epidemic strategies in India. Table 2 provides a summary of the important research along with its methods and results. The first search across all three databases returned 38 items. After deleting 10 duplicates, we left 28 items for screening. Out of all the titles and abstracts that were considered, 18 were deemed unsuitable for inclusion in the study due to reasons such as missing full texts or being too broad in scope. For eligibility, the remaining ten papers were reviewed in full. After using the inclusion criteria, which were mostly about HPV epidemiology, vaccination coverage, prevention, and antiepidemic interventions in India, ten publications were found to be very relevant and were included in the final evaluation. We eliminated two articles due to their lack of relevance. We deemed ineligible research without full-text access, studies that did not focus on women, and studies conducted outside of India. On the other hand, observational studies, systematic reviews, and meta-analyses published in English between 2010 and 2024 and only about HPV prevalence, vaccination coverage, and prevention strategies in India were allowed to be included.

RESULTS

As far as public health is concerned, the reviewed literature shows that HPV infection is still a major issue in India, with rates ranging from 14.7 percent in Iran to 37.0 percent in Bengal, which is located east of the country, west of the Arabian Sea, and south of the Indian Ocean. The disparities in prevalence highlight the necessity for well-planned public health initiatives. With around 14,943 new cases identified every year, cervical cancer is the second most frequent malignancy among women aged 15-44 years (Desmukh *et al.*, 2025). Cervical cancer, the most common HPV-related malignancy, is one of numerous malignancies that HPV causes. Despite the high frequency of HPV and cervical cancer, only 16.1% of women in Otukpo, Nigeria, had actually had the necessary screenings. The recorded prevalence of HPV varies among regions, with rates as high as 37% in India and as low as 14.7% in Iran. With HPV 16 being the most frequent serotype, research conducted in India found that 19.5% of women who visited a tertiary hospital tested positive for HPV DNA. An extremely low percentage of teenagers know anything about Human Papillomavirus (HPV) or its immunizations; just 5.2% of students in one research study showed any understanding of HPV, and only 17% knew about the vaccine. Similarly, 65 percent of Nnewi research participants between the ages of 15 and 18 said they were unfamiliar with HPV and its vaccination.

VACCINATION COVERAGE

In 2008, two Human Papillomavirus (HPV) vaccinations were approved for use in India: Cervix, a bivalent vaccine, and Gardasil, a quadrivalent vaccine. With at least a decade of antibody stability, both vaccinations offer around 90% protection against cervical cancer. An Indian-made product called Cervical was introduced to the market in September 2022. In India, private practitioners are the only ones who may provide HPV vaccinations at this time. "HPV vaccination uptake in India is low due to its high cost, misinformation regarding safety and effectiveness, and discouraging cultural perceptions for vaccines," Mehrotra points out. Each dosage of the vaccination will set you back about $36 (or about 3,000 rupees). He goes on to explain that poor knowledge of the necessity for HPV vaccination and the shame surrounding reproductive health concerns in India, particularly those involving sexual organs like the cervix, are examples of these cultural views. The same worries, according to some observers, can reduce screening rates.

CONSIDERATIONS FOR SPECIAL POPULATIONS

While it is advised to have a human papillomavirus vaccine while pregnant, it is not urged that you get a pregnancy test done regularly before getting the vaccine (Donovan *et al.*, 2011). Pregnant women rarely receive vaccines, so any evidence of their accidental administration will be reassuring and safe (Drolet *et al.*, 2019). However, there is a lack of data on this topic (Dubey *et al.*, 2023). Patients and obstetrician-gynecologist experts are encouraged to remain in touch with the manufacturer, www.merckpregnancyregistries.com/gardasil9.html, to record the number of women exposed to the 9-valent HPV vaccination either before or during pregnancy (Dubey *et al.*, 2022). No longer are pregnant women able to enroll in the quadrivalent or bivalent HPV vaccination registries. Stopping the series of immunizations should be done until the pregnancy is over if a patient becomes pregnant while receiving them. You don't have to restart the series (Dubey *et al.*, 2022). The vaccine is recommended for lactating women under 26 who have never been vaccinated. Breastfeeding safety for these mothers and their babies is unaffected by the HPV vaccination, according to studies (Errata *et al.*, 2016). HPV vaccination is not recommended for immunocompromised people with HIV or organ transplants. Nevertheless, immunocompromised patients may experience a weaker immune response (Franceschi *et al.*, 2016). Therefore, we advise adults and adolescents with impaired immune systems, including those under the age of fifteen, to adhere to the three-dose regimen (Kumar *et al.*, 2015). The HPV vaccination should be administered to children with a history of sexual abuse or assault as early as feasible, beginning at 9 years of age, up until the age (Humg *et al.*, 2008).

VACCINE SAFETY

Fortunately, all three HPV vaccinations have been shown to be safe. Over the past decade, the Vaccine Adverse Events Reporting System has recorded no evidence of serious side effects or adverse reactions associated with the HPV vaccine, although over 270 million doses of the vaccine have been administered globally (Jedy *et al.*, 2012). While both the 9-valent and quadrivalent HPV vaccinations were safe to use, the 9-valent vaccine was

Table 1: Taxonomy and structural features of HPV.

Family	*Papillomaviridae*
Genera	*Alphapapillomavirus*
	Betapapillomavirus
	Gammapapillomavirus
	Mupapillomavirus
	Nupapillomavirus
Types of Viruses	Double stranded
Genome	Circular
Structure	Nonenveloped
Capsid	Icosahedral

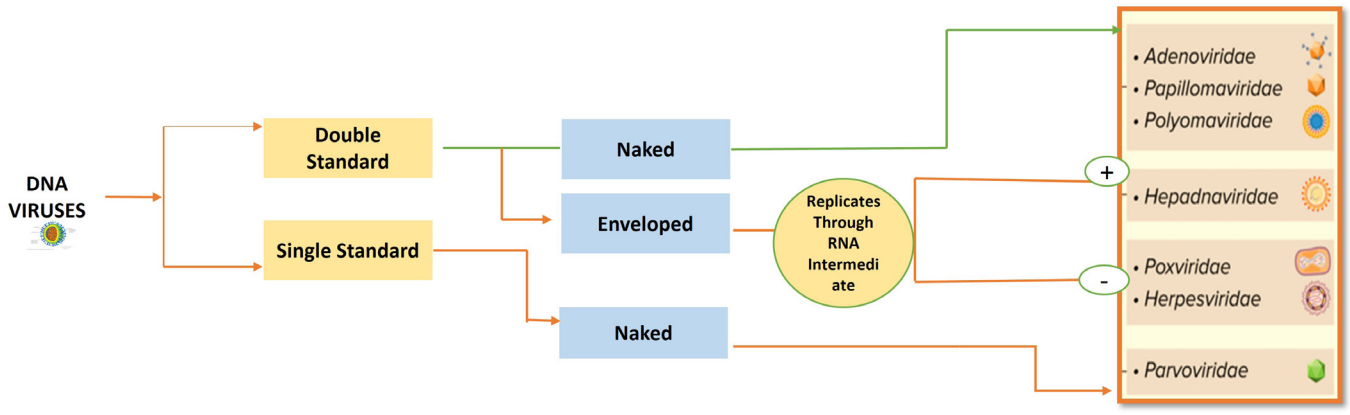

Figure 1: Classification of HPV.

Table 2: Summary of key studies on HPV in India.

Objective	Methodology	Key Findings	Limitations	Reference
Indian cervical cancer rates and the role of HPV vaccine.	Research using a cross-sectional design and data collected via surveys.	HPV prevalence is 26.3%, and cervical cancer is India's second most common malignancy.	Small sample size, possible bias in reporting.	Kaarthigeyan K. *et al.*, 2012
Epidemiology of HPV-related malignancies in India: National Cancer Registry Programmed results.	Quantitative survey of reproductive-age women.	Only 16.1% underwent cervical screening, and 13.7% had at least one immunization.	Only one region was studied.	Ramamoorthy T *et al.*, 2022
Different conformational dynamics in two type-A RNA-binding domains cause double-stranded RNA recognition and binding.	Cross-sectional research was done from 2018 to 2022 among married women aged 18-59 from South Andaman District.	The study found HPV prevalence of 5.9% (95% CI: 3.9-7.9), HR-HPV16 prevalence of 4.1% (95% CI: 2.6-5.5), and HR-HPV18 prevalence of 1.8.	Based on HPV risk factors, this isolated island's women need increased public health awareness and preventive HPV vaccination.	Parvez *et al.*, 2024
HPV screening and cervical cancer in North Indian women.	2700 cervical smear samples were genotyped for HPV prevalence and type specific prevalence using real-time polymerase chain reaction and linear array assay.	HPV was found in 20% of samples. In 50% of HPV-positive samples, several strains were found. Multiple high-risk HPV (HR-HPV) infections were more common in younger women.	Comprehensive cross-cultural research is needed to assist the medical community develop HPV-targeted therapies.	Misra M, *et al.*, 2021
HPV genotype prevalence in Indian women with cervical illness and calculation of HPV vaccines' cervical cancer preventive potential.	In-house developed and standardized nested multiplex PCR (NM-PCR) was performed on 204 cervical biopsy samples from symptomatic women.	Out of 204 samples 188 were treated to HPV-nested PCR. A total of 163 (86.7%) samples were positive for at least one HPV type. Multiple genotypes were discovered in 30% of samples analyzed. HPV-16 (85.3%) was the most commonly detected genotype followed by HPV-18 (13.5%) and HPV-33 (11.0%).	The most common genotype in this investigation was HPV-16 (>85%). Multiple infections in 30% of samples were high compared to national and worldwide references (15-25.4%).	Nagaraja M *et al.*, 2023
A tertiary care hospital in Assam, India, found 14 high-risk human papillomavirus subtypes in cervical cancer screening volunteers by Papanicolaou smear cytology.	A tertiary care hospital in Assam performed cross-sectional research from February 2022 to April 2023. HPV DNA analysis was performed on 100 women aged 23-72 using real-time polymerase chain reaction and Papanicolaou (PAP) smears.	HPV prevalence was 13%, including 10% for HPV 16/18 and 6% for other high-risk variants. HPV 16/18 and other subtypes were detected in 3% of patients.	A longitudinal investigation may shed light on coinfections, the other 12 HPV subtypes, dysplasia, and *in situ* cervical cancer, together with 16/18 HPV subtypes.	Phukan *et al.*, 2025

Objective	Methodology	Key Findings	Limitations	Reference
The prevalence of HPV and the risk of cervical intraepithelial neoplasia in female sex workers in Mumbai, India.	Collaboration with local non-government groups working for FSW health and welfare at sexually transmitted diseases clinics was used to perform a cross-sectional study of 448 FSWs aged 18-50.	FSWs have significant HPV and CIN rates. CIN risk was seven times greater for FSWs with positive HPV DNA tests.	Evidence on the effectiveness of HPV vaccination is lacking	Pahwa *et al.*, 2024
Indian brothel workers' exposure to oncogenic HPV and cervical precancerous tumors.	After verbal informed permission was obtained, all research participants were questioned using a pre-tested questionnaire to ascertain their sociodemographics, risk behavior, and risk perceptions.	Separate testing was performed on a subset (n= 112) of the sample to ascertain the presence and severity of HPV genotypes 16 and 18. 10% (11 out of 12) of the samples had genotype 16, 7% (eight out of twelve) had genotype 18, and 7% (eight out of twelve) had both genotypes.	A key component of an effective intervention program might include HPV vaccination for newly hired sex workers.	Sarkar K, *et al.*,2017
The epidemiology, prevention, present state, and future prospects of cervical cancer in India	With 79,906 deaths, India's maternal mortality rate is still far higher than the world average of 7.1 per 100,000 women, despite improvements elsewhere. Screening for VIA in women between the ages of 30 and 65 is a priority for the National Preventive Health Care System (NPCDCS) and other programs in India.	Health and Wellness Centers and PM-JAY are part of Ayushman Bharat's push for national health insurance. Better cancer care is possible because to programs like Ayushman Bharat and the National Cancer Grid.	Reducing the cervical cancer burden and improving health outcomes for women countrywide can be achieved by eliminating barriers, enhancing access, and promoting teamwork.	Gupta K *et al.*, 2024
Cervical cancer patients in eastern Uttar Pradesh, India, and the prevalence of high-risk HPV types	It ranks second in the country for female-specific cancers. Herpes simplex virus infection is the main precursor. The country's population is still under vaccinated against HPV, the sole preventative strategy now accessible.	This study provides valuable information about the frequency of HPV in cervical cancer patients from eastern Uttar Pradesh, an area that has not been previously studied. It has been shown that a staggering 97.5% of cervical cancer cases are infectious. Related to HPVs. Of them, HPV16 is by far the most common, accounting for 77.8% of instances, while HPV18 follows closely behind at 23.5%.	Based on the results of this study, HPV16 and HPV18 are the most promising candidates for prevention efforts in this area.	Das M *et al.*, 2019

associated with an increased risk of injection site swelling and erythema after each dose, compared to the quadrivalent vaccine. Between 2014 and 2017, records from the Vaccine Adverse Events Reporting System showed that the 9-valent HPV vaccine did not cause any extra or unexpected side effects (keelan *et al.*, 2010). After receiving the quadrivalent HPV vaccination, patients were inoculated with the 9-valent vaccine without any safety issues, according to the available data (Kolatorova *et al.*, 2022).

Figure 2: Scanning electron microscope model of the human papillomavirus.

VACCINE EFFICACY

When given to women who have never been exposed to that specific strain of HPV, human papillomavirus vaccinations are among the most effective preventative measures against cervical cancer. In fact, there is irrefutable evidence that these vaccines are more than 99% effective. Both men and women can benefit from the HPV vaccine's ability to drastically lower the risk of anogenital cancer and genital warts (Moher *et al.*, 2009). Furthermore, there is some evidence that HPV vaccination can reduce the incidence of oropharyngeal cancer. From 2006 to 2014, the prevalence of vaccine-type HPV infection in women aged 14 to 19 years declined by 71% in the US (Moreria *et al.*, 2016). This decline occurred after the introduction of the quadrivalent HPV vaccination. Nations that widely use the HPV vaccination have seen a significant decline in genital warts (Rabiu *et al.*, 2023). The 9-valent HPV vaccine protects against a very large number of HPV diseases, including those caused by genotypes 6, 11, 16, and 18, as well as those caused by genotypes 31, 33, 45, 52, and 58, which together make up up to 96.7% of these diseases. The procedure involves protecting against various kinds of HPV-induced diseases in the genital, vaginal, vulvar, and anal areas. One such preventative vaccination is the HPV vaccine. Research into its potential usefulness in disease prevention is continuing; however, there is no evidence to suggest it might be used as a therapeutic vaccination at this time (Ramamoorthy *et al.*, 2022).

PROBLEMS TO VACCINATION

There has been a lack of HPV vaccination knowledge and uptake in Nigeria since the vaccinations became available in 2006. Concerns regarding safety and a lack of knowledge have made many parents and teenagers hesitant to receive the vaccination(Santin *et al.*,2008). Public health facilities do not have access to the vaccination due to its expensive cost, which makes the situation even worse (Saslow *et al.,* 2020). Although other African nations have achieved strides in HPV vaccination with the help of GAVI, Nigeria is now at the reintroduction stage (Saslow *et al.*,2020). A major obstacle to acceptance is the persistent fear of vaccine safety, especially among parents of adolescent girls The key barriers to vaccination include the following:

Limited Access and High Cost: Vaccine, which cost between N9000 and N15000 per dose, remain unaffordable for many families.

Lack of Awareness: Studies reported that only 5.2% of adolescents have heard of HPV and its vaccine.

Cultural and religious concerns: Misinformation associated with vaccines with infertility has led to parental resistance.

Healthcare System Challenges: Limited vaccine availability in public health facilities and inconsistent policy implementation hinder national immunization efforts.

PREVENTIVE AND ANTI-EPIDEMIC MEASURES

To prevent and control the spread of HPV, the main measures are health education, cytological screening, and vaccination (Sindi *et al.,* 2024). The World Health Organization states that the best way to avoid HPV is to get vaccinated before initiating sexual relations. To diagnose and treat precancerous lesions early, it is vital to undergo regular HPV typing and Pap smear screening. Therapeutic HPV vaccines that target diseased cells are also being developed in addition to preventative vaccinations (Wen *et al.*,2014). Since its release in 2016, the 9-valent HPV vaccination has significantly reduced the prevalence of HPV-related illnesses. Both the CDC and the FDA advise that boys and females between the ages of 12 and 26 have a three-dose HPV vaccine spaced six months apart. Research has demonstrated that immunization at younger ages (between 9 and 11 years old) results in a stronger immune response and offers superior protection against malignancies caused by HPV (Yang *et al.*,2016).

DISCUSSION

India's poor HPV vaccine awareness and uptake demonstrates inadequate public health education and policy execution. Research shows that very few young women are aware of HPV and its vaccinations; in fact, vaccination rates might be as low as 1.5% in certain areas. Developed nations like the US have far higher immunization rates, so the finding is rather surprising. Because

of their critical role in vaccination uptake, parents and caregivers' lack of knowledge about the issue is even more problematic. A combination of government-led vaccination programs, discounted vaccine prices, and extensive public health campaigns is needed to overcome these obstacles. Cons: Due to our reliance solely on online research, we were unable to take into account the regional variations in HPV prevalence in Nigeria. Their small sample sizes may also affect this research's generalizability and accuracy. No studies have followed the same participants from one year to the next to see how immunizations affected them. We highly recommend that researchers in the future do long-term studies to determine how well HPV vaccination programs in Nigeria worked.

CONCLUSION

Although Human Papillomavirus (HPV) is a leading cause of cervical cancer in India, a concerningly low vaccination rate persists owing to institutional, cultural, and economic barriers. Reducing the incidence of HPV-related cancer cases requires incorporating HPV vaccination into the national immunization schedule, introducing extensive health education initiatives in public places, schools, and religious organizations, and subsidizing the costs of vaccines. To safeguard the health of women in India and improve vaccination coverage, drastic steps should be taken to increase public knowledge through awareness programs, parental involvement, and government subsidies.

FUTURE PROSPECTIVES

HPV vaccination should be accelerated and included in the national immunization schedule by the Federal Government of India's Ministry of Health and the National Primary Health Care Development Agency. As a result, young girls will receive the vaccination at no cost or at a significantly reduced cost. Public education campaigns: Robust health promotion initiatives should prioritize HPV, the malignancies it causes, and the importance of immunization. To reach the widest possible audience, these ads should focus on schools, churches, and community organizations. Educating Parents and Caregivers: Kids need their parents and guardians to know why HPV vaccines are so important. Health centers and clinics can provide seminars and workshops and disseminate educational materials to the public to help accomplish this goal. Secondary school enrollment should be contingent upon having received an HPV vaccine as part of school-based immunization programs. As a result, more young females will get the vaccine before they start having sexual relations. Reduced Vaccine Costs: The government, in collaboration with pharmaceutical firms and international organizations, should endeavor to lower the price of HPV vaccines so that they are affordable for low-income families. Data Collection and Analysis: To fully comprehend the challenges associated with HPV vaccination across Nigeria, further data collection and analysis are required. We should continuously monitor and evaluate vaccination programs to identify gaps and improve their execution methods.

ACKNOWLEDGEMENT

The authors are very much grateful to Prof. Vikram Kumar Sahu, principal of Maharana Pratap College of Pharmacy Kanpur for his inspiration and facilities.

CONFLICT OF INTEREST

The authors declare no conflict of interest, financial or otherwise.

ABBREVIATIONS

HPV: Human papillomavirus; **WHO:** World Health Organization; **PCR:** Polymer chain reaction; **FDA:** Food and Drug Administration; **LMICs:** Low- and middle-income countries; **ICMR:** India Council of Medical Research.

REFERENCES

Alkalash, S. H., Alshamrani, F. A., Alhashmi Alamer, E. H., Alrabi, G. M., Almazariqi, F. A., & Shaynawy, H. M. (2022). Parents' knowledge of and attitude toward the human papillomavirus vaccine in the western region of Saudi arabia. Cureus. https://doi, 14(12), Article e32679. https://doi.org/10.7759/cureus.32679

Azuogu, B. N., Umeokonkwo, C. D., Azuogu, V. C., Onwe, O. E., Okedo-Alex, I. N., & Egbuji, C. C. (2019). Appraisal of willingness to vaccinate daughters with human papilloma virus vaccine and cervical cancer screening uptake among mothers of adolescent students in Abakaliki, Nigeria. Nigerian Journal of Clinical Practice, 22(9), 1286-1291. https://doi. https://doi.org/10.4103/njcp.njcp_452_18

Balogun, F. M., & Omotade, O. O. (2022). Facilitators and barriers of healthcare workers' recommendation of HPV vaccine for adolescents in Nigeria: Views through the lens of theoretical domains framework. BMC Health Services Research, 22(1), 824. http ://doi: 10.1186/s12913-022-08224-7. https://doi.org/10.1186/s12913-022-08224-7

Bernard, H.-U., Burk, R. D., Chen, Z., Van Doorslaer, K., zur Hausen, H. Z., & De Villiers, E.-M. (2010). Classification of papillomaviruses (Pvs) based on 189 PV types and proposal of taxonomic amendments. Virology, 401(1), 70-79. https://doi. https://doi.org/10.1016/j.virol.2010.02.002

Burdette, A. M., Webb, N. S., Hill, T. D., & Jokinen-Gordon, H. (2017). Race-specific trends in HPV vaccinations and provider recommendations: Persistent disparities or social progress? Public Health, 142, 167-176. https://doi.org/10.1016/j.puhe.2016.07.009

Das, D., Bristol, M. L., Smith, N. W., James, C. D., Wang, X., Pichierri, P., & Morgan, I. M. (2019). Werner helicase control of human papillomavirus 16 e1-e2 dna replication is regulated by sirt1 deacetylation. mBio, 10(2), Article e00263-19. https://doi. https://doi.org/10.1128/mBio.00263-19

Deshmukh, R., Verma, S., Yaduwanshi, P. S., Dubey, A., & Kumari, M. (2025). Molecular-targeted therapy for precision medicine in gastrointestinal cancer: Advancement in cancer targeting strategies. Current Cancer Drug Targets, 25. http ://doi: 10.2174/0115680096333058241114064802. https://doi.org/10.2174/0115680096333058241114064802

Deshmukh, V. N., Patil, S., & Hinge, D. D. (2024). The burden and prevention of human papillomavirus (Hpv) infections and cervical cancer in india: A literature review. Cureus. https://doi, 16(10), Article e72435. https://doi.org/10.7759/cureus.72435

Donovan, B., Franklin, N., Guy, R., Grulich, A. E., Regan, D. G., Ali, H., Wand, H., & Fairley, C. K. (2011). Quadrivalent human papillomavirus vaccination and trends in genital warts in Australia: Analysis of national sentinel surveillance data. The Lancet. Infectious Diseases, 11(1), 39-44, https://doi.org/10.1016/S1473-3099(10)70225-5

Doorbar, J., Quint, W., Banks, L., Bravo, I. G., Stoler, M., Broker, T. R., & Stanley, M. A. (2012). The biology and life-cycle of human papillomaviruses. Vaccine, 30(Suppl. 5), F55-F70. https://doi.org/10.1016/j.vaccine.2012.06.083

Drolet, M., Bénard, É., Pérez, N., Brisson, M., & HPV Vaccination Impact Study Group. (2019). Population-level impact and herd effects following the introduction of human papillomavirus vaccination programmes: Updated systematic review and meta-analysis. The Lancet, 394(10197), 497-509, https://doi.org/10.1016/S0140-6736(19)30298-3

Dubey, A. (2023). A review on current epidemiology and molecular studies of lumpy skin disease virus-an emerging worldwide threat to domestic animals. Journal of Medical Pharmaceutical and Allied Sciences, 12(1), 5635-5643. https://doi. https://doi.org/10.55522/jmpas.V12I1.4583

Dubey, A., Ghosh, N. S., Rathor, V. P. S., Patel, S., Patel, B., & Purohit, D. (2022). Sars-COV-2 infection leads to neurodegenerative or neuropsychiatric diseases.

International Journal of Health Sciences, 6(Suppl. 3), 2184-2197. https://doi.org/10.53730/ijhs.v6nS3.5980

Dubey, A., Singh, R., Kumar, A., Gupta, A., Sonker, A., & Mishra, A. (2022). A critical review on changing epidemiology of human monkeypox-a current threat with multi-country outbreak. Journal of Pharmaceutical Negative Results, 13(Suppl. 01). https://doi. https://doi.org/10.47750/pnr.2022.13.S01.82

Errata corrige airtum. (2016). Epidemiologia e Prevenzione, 40(2), 83-83. http://doi: 10.19191/EP16.2.P083.060

Franceschi, S., Chantal Umulisa, M., Tshomo, U., Gheit, T., Baussano, I., Tenet, V., Tshokey, T., Gatera, M., Ngabo, F., Van Damme, P., Snijders, P. J. F., Tommasino, M., Vorsters, A., & Clifford, G. M. (2016). Urine testing to monitor the impact of hpv vaccination in Bhutan and Rwanda. International Journal of Cancer, 139(3), 518-526. https://doi. https://doi.org/10.1002/ijc.30092

Gupta, K., Mandal, R., & Chatterjee, P. (2024). Navigating the landscape of cervical cancer in India: Epidemiology, prevention, current status, and emerging solutions. The Journal of Obstetrics and Gynaecology Research, 50(Suppl. 1), 55-64. https://doi. https://doi.org/10.1111/jog.16030

Hung, C.-F., Ma, B., Monie, A., Tsen, S.-W., & Wu, T. C. (2008). Therapeutic human papillomavirus vaccines: Current clinical trials and future directions. Expert Opinion on Biological Therapy, 8(4), 421-439. https://doi. https://doi.org/10.1517/14712598.8.4.421

Jedy-Agba, E., Curado, M. P., Ogunbiyi, O., Oga, E., Fabowale, T., Igbinoba, F., Osubor, G., Otu, T., Kumai, H., Koechlin, A., Osinubi, P., Dakum, P., Blattner, W., & Adebamowo, C. A. (2012). Cancer incidence in Nigeria: A report from population-based cancer registries. Cancer Epidemiology, 36(5), e271-e278. http://doi: 10.1016/j.canep.2012.04.007. https://doi.org/10.1016/j.canep.2012.04.007

Kaarthigeyan, K. (2012). Cervical cancer in India and HPV vaccination. Indian Journal of Medical and Paediatric Oncology, 33(1), 7-12. https://doi. https://doi.org/10.4103/0971-5851.96961

Keelan, J., Pavri, V., Balakrishnan, R., & Wilson, K. (2010). An analysis of the Human Papilloma Virus vaccine debate on MySpace blogs. Vaccine, 28(6), 1535-1540. https://doi. https://doi.org/10.1016/j.vaccine.2009.11.060

Kolatorova, L., Adamcova, K., Vitku, J., Horackova, L., Simkova, M., Hornova, M., Vosatkova, M., Vaisova, V., Parizek, A., & Duskova, M. (2022). Covid-19, vaccination, and female fertility in the Czech republic. International Journal of Molecular Sciences, 23(18), Article 10909. https://doi. https://doi.org/10.3390/ijms231810909

Kumar, S., Biswas, M., & Jose, T. (2015). HPV vaccine: Current status and future directions. Medical Journal, Armed Forces India, 71(2), 171-177. https://doi. https://doi.org/10.1016/j.mjafi.2015.02.006

Mishra, R. K., Pande, A., Ramachandran, R., Trikha, A., Singh, P. M., & Rewari, V. (2021). Effect of change in body weight on clinical outcomes in critically ill patients. Indian Journal of Critical Care Medicine, 25(9), 1042-1048. https://doi. https://doi.org/10.5005/jp-journals-10071-23978

Moher, D., Liberati, A., Tetzlaff, J., Altman, D. G., the PRISMA Group. (2009). Preferred Reporting Items for Systematic Reviews and Meta-Analyses: The prisma statement. PLOS Medicine, 6(7), Article e1000097. http://doi: 10.1371/journal.pmed.1000097. https://doi.org/10.1371/journal.pmed.1000097

Moreira, E. D., Block, S. L., Ferris, D., Giuliano, A. R., Iversen, O.-E., Joura, E. A., Kosalaraksa, P., Schilling, A., Van Damme, P., Bornstein, J., Bosch, F. X., Pils, S., Cuzick, J., Garland, S. M., Huh, W., Kjaer, S. K., Qi, H., Hyatt, D., Martin, J., Luxembourg, A. (2016). Safety profile of the 9-valent hpv vaccine: A combined analysis of 7 phase III clinical trials. Pediatrics, 138(2), Article e20154387. https://doi. https://doi.org/10.1542/peds.2015-4387

Nguyen, N. Y., Okeke, E., Anglemyer, A., & Brock, T. (2020). Identifying perceived barriers to human papillomavirus vaccination as a preventative strategy for cervical cancer in Nigeria. Annals of Global Health, 86(1), 118. http://doi: 10.5334/aogh.2890. https://doi.org/10.5334/aogh.2890

Pahwa, V., Pimple, S. A., Mishra, G. A., Majmudar, P., Biswas, S. K., & Deodhar, K. (2024). Prevalence of human papilloma virus infection and risk of cervical intraepithelial neoplasia among female sex workers in Mumbai, India. Ecancermedicalscience, 18, 1772. https://doi.org/10.3332/ecancer.2024.1772

Parvez, F., Sangpal, D., Paithankar, H., Amin, Z., & Chugh, J. (2024). Differential conformational dynamics in two type-A RNA-binding domains drive the double-stranded RNA recognition and binding. eLife, 13, Article RP94842. https://doi. https://doi.org/10.7554/eLife.94842

Parvez, R., Vijayachari, P., Thiruvengadam, K., Roy, A., Saha, M. K., Ramasamy, J., Vins, A., Biswas, L., Vaz, A., Kaur, H., & Nagarajan, M. (2024). A population-based study on human papillomavirus infection and associated risk factors among women of the remote South Andaman Island, India. BMC Women's Health, 24(1), 139. https://doi.org/10.1186/s12905-024-02967-7

Phukan, P. K., Dutta, A., Deuri, A., Choudhury, G., Borpujari, P., Bhattacharyya, N., & Gogoi, G. (2025). Prevalence of 14 high-risk human papillomavirus subtypes among volunteers of cervical cancer screening by Papanicolaou smear cytology from a tertiary care institute of Assam, India. Annals of Oncology Research and Therapy, 5(1), 56-62. https://doi.org/10.4103/aort.aort_28_24

Rabiu, I., & Yahuza, Z. (2023). Knowledge and attitude towards human papilloma virus infection, vaccines, and cervical cancer prevention among school students in kano, Nigeria. Advances in Virology, 2023, 1-10. http://doi: 10.1155/2023/2803420. https://doi.org/10.1155/2023/2803420

Ramamoorthy, T., Sathishkumar, K., Das, P., Sudarshan, K. L., & Mathur, P. (2022). Epidemiology of human papillomavirus related cancers in India: Findings from the National Cancer Registry Programme. Ecancermedicalscience, 16. https://doi, 1444. https://doi.org/10.3332/ecancer.2022.1444

Rosenthal, S. L., Weiss, T. W., Zimet, G. D., Ma, L., Good, M. B., & Vichnin, M. D. (2011). Predictors of HPV vaccine uptake among women aged 19-26: Importance of a physician's recommendation. Vaccine, 29(5), 890–895. https://doi. https://doi.org/10.1016/j.vaccine.2009.12.063

Santin, A. D., Bellone, S., Palmieri, M., Zanolini, A., Ravaggi, A., Siegel, E. R., Roman, J. J., Pecorelli, S., & Cannon, M. J. (2008). Human papillomavirus type 16 and 18 e7-pulsed dendritic cell vaccination of stage ib or iia cervical cancer patients: A phase I escalating-dose trial. Journal of Virology, 82(4), 1968-1979. https://doi.org/10.1128/JVI.02343-07

Sarkar, S., Alam, N., Chakraborty, J., Biswas, J., Mandal, S. S., Roychoudhury, S., & Panda, C. K. (2017). Human papilloma virus (Hpv) infection leads to the development of head and neck lesions but offers better prognosis in malignant Indian patients. Medical Microbiology and Immunology, 206(3), 267-276. https://doi. https://doi.org/10.1007/s00430-017-0502-5

Saslow, D., Andrews, K. S., Manassaram-Baptiste, D., Smith, R. A., Fontham, E. T. H.,, & American Cancer Society Guideline Development Group. (2020). Human papillomavirus vaccination 2020 guideline update: American Cancer Society guideline adaptation. CA: A Cancer Journal for Clinicians, 70(4), 274-280. https://doi. https://doi.org/10.3322/caac.21616

Sindi, R. (2024). Human papilloma virus knowledge and acceptance of its national immunization program among female university students in makkah region. Journal of Umm Al-Qura University for Medical Sciences, 10(2), 33-45. http://doi: 10.54940/ms891552318. https://doi.org/10.54940/ms89155231

Wen, Y., Pan, X.-F., Zhao, Z.-M., Chen, F., Fu, C.-J., Li, S.-Q., Zhao, Y., Chang, H., Xue, Q.-P., & Yang, C.-X. (2014). Knowledge of human papillomavirus (Hpv) infection, cervical cancer, and hpv vaccine and its correlates among medical students in southwest china: A multi-center cross-sectional survey. Asian Pacific Journal of Cancer Prevention: APJCP, 15(14), 5773-5779. http://doi: 10.7314/APJCP.2014.15.14.5773. https://doi.org/10.7314/apjcp.2014.15.14.5773

Yang, A., Farmer, E., Wu, T. C., & Hung, C.-F. (2016). Perspectives for therapeutic HPV vaccine development. Journal of Biomedical Science, 23(1), 75. https://doi. https://doi.org/10.1186/s12929-016-0293-9

Cite this article: Obbalareddy S, Dubey A, Kumari M, Mukherjee C, Shahi S. A Systematic Review of Vaccination, Prevention, and Public Health Measures for the Human Papillomavirus Epidemic Among Patients in India. Int. J. Pharm. Investigation. 2026;16(1):58-65.