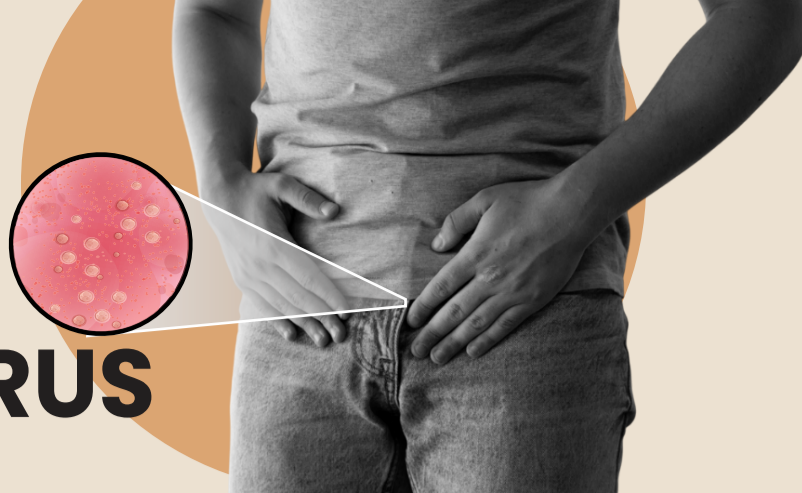


# HUMAN PAPILLOMAVIRUS

HPV AND HPV-ASSOCIATED DISEASES

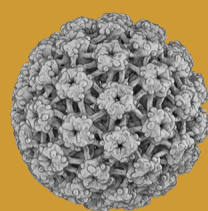


## What Are HPV-Associated Diseases?

HPV (human papillomavirus) comprises more than 200 types, of which at least 12 are classified as high-risk or oncogenic. HPV is the necessary etiological agent for nearly all cervical cancers and causes a substantial proportion of anogenital (vulvar, vaginal, anal, and penile) as well as oropharyngeal cancers. Low-risk types, notably HPV-6 and HPV-11, lead to benign proliferations such as genital warts and recurrent respiratory papillomatosis. High-risk types—particularly HPV-16 and HPV-18—are responsible for approximately 72% of all HPV-attributable cancers worldwide.

## Microbiology & Pathogenesis

HPVs are small, non-enveloped, double-stranded DNA viruses belonging to the *Papillomaviridae* family, with a strong tropism for squamous epithelium. The viral genome encodes early proteins—most notably E6 and E7—that disrupt cell cycle regulation by inactivating the tumor suppressors p53 and Rb. Persistent infection can lead to progression from low-grade to high-grade intraepithelial lesions and, eventually, invasive cancer, typically over several decades. There is no viremic phase; infection remains localized to the epithelium, where the virus employs multiple immune evasion strategies to establish chronic infection.



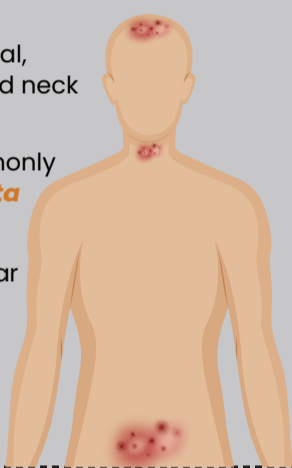
**Fig 1: Human Papillomavirus**

## Epidemiology (2025)

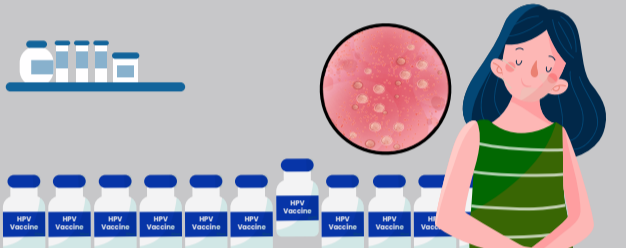
- HPV remains the most common sexually transmitted infection globally, and most sexually active individuals will acquire it at some point.
- Cervical cancer is the fourth most common cancer in women, with an estimated 604,000 new cases and 342,000 deaths worldwide in 2020. The highest mortality rates persist in low- and middle-income countries.
- In a major 2025 Chinese study (n=73,697), HPV infection rate was 17.3% in women, with a pronounced peak in prevalence under 21 years old and another peak at ages 51–56. The most frequent high-risk types in China were HPV-52 (16.3%), HPV-16 (12.3%), and HPV-58 (10.6%).
- Large-scale US longitudinal analysis (2025) confirms ongoing, significant reduction in high-risk HPV genotype prevalence—e.g., a >72% reduction for HPV-16 in 15–20-year-olds over the last decade, attributed to vaccination programs.

## Transmission & Clinical Disease

- Transmission occurs primarily via sexual contact (including skin-to-skin and mucosal contact). Most infections are asymptomatic and transient, but a minority persist.
- High-risk HPV can cause cervical, anogenital, and some head and neck cancers.
- Low-risk HPV types most commonly cause **condylomata acuminata** (genital warts).
- Most genital HPV infections clear within 1–2 years, but immune suppression (e.g., in HIV) raises risk for progression to cancer.



## Prevention

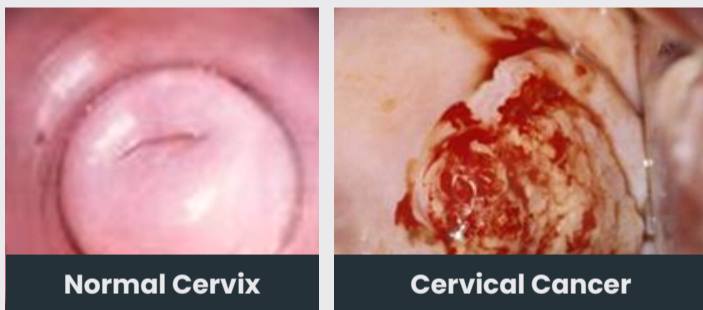


- **Primary prevention:** HPV vaccination (see below).
- **Secondary prevention:** High-quality screening (e.g., HPV DNA testing or cytology) and prompt treatment of precancerous lesions are essential, particularly in populations without comprehensive vaccination coverage.
- **Tertiary prevention:** Early detection and effective management of established cancers.

## Different Types of Genital Warts



## Normal and Cancerous Cervix



## Prevention

Four major prophylactic HPV vaccines are currently licensed worldwide. All are based on recombinant L1 virus-like particle (VLP) technology and have demonstrated >90% efficacy against vaccine-type infection and precancerous lesions in HPV-naïve populations, as shown in randomized controlled trials. Vaccine efficacy is highest when administered before sexual debut, typically between 9 and 14 years of age.

**The World Health Organization (WHO)** and most national health authorities recommend one or two doses before age 15, and up to three doses for older or immunocompromised individuals.

## Key to Table

- **CIN2+ =** Cervical intraepithelial neoplasia grade 2 or higher
- **GW =** Genital warts
- **WHO PQ =** World Health Organization Prequalification
- **NMPA =** Chinese regulatory authority
- **DCGI =** Drug Controller General of India

**Table: Most Relevant Licensed HPV Vaccines (2025)**

Brand Name	Manufacturer	Antigens (Types)	Endpoints	Efficacy/Effectiveness	Regions/Regulatory Status
Gardasil 9	Merck/MSD	6, 11, 16, 18, 31, 33, 45, 52, 58	CIN2+, genital warts, cancer	~97–99% for covered types	Global, US FDA, EMA, WHO PQ
Gardasil	Merck/MSD	6, 11, 16, 18	CIN2+, genital warts, cancer	90–98% (types 16, 18); GW ~99%	Global, US FDA, EMA, WHO PQ
Cervarix	GSK	16, 18	CIN3+, cervical cancer	90%+ for 16, 18; cross-protection (31, 33, 45)	Global, EMA, WHO PQ; used in Africa, Asia, LatAm
Cecolin	Innovax (China)	16, 18	CIN2+, cervical cancer	~97% (types 16, 18)	China NMPA, WHO PQ underway
Walrinvax	Walvax (China)	16, 18, 31, 33, 45, 52, 58	CIN2+, precancer, cancer	Non-inferior to Gardasil9 (RCTs)	China NMPA, WHO PQ filed
Cervavax	Serum Inst. India	16, 18	CIN2+, cervical cancer	Non-inferior (RCT)	India DCGI, used in India/Africa WHO PQ review

## References

1. Schuind A. Human Papilloma-Virus Associated Carcinomas and Warts. In: Schmitt HJ, ed. Essentials in Vaccinology. Singapore: Global Health Press; 2021.
2. Bai M, Li Y, Ma F, et al. Prevalence and genotype assessment of HPV in 73,697 females from Beijing, China. *Front Public Health*. 2025;13:1623627. doi:10.3389/fpubh.2025.1623627
3. Wheeler CM, Adcock R, Hunt WC, et al. Human papillomavirus genotype-specific prevalence and infection risks: a 10-year population-based study from the United States. *JNCI*. 2025;117(5):924–933.
4. World Health Organization. Human papillomavirus (HPV) and cervical cancer. Published March 2024. Accessed November 2025.
5. National Cancer Institute/NIH. "HPV vaccine as effective with one shot as two, NCI study finds." April 2025.
6. *Frontiers in Public Health*. Prevalence and Genotype Assessment of HPV in 73,697 Females from Beijing, China. 2025; 13:1623627. doi:10.3389/fpubh.2025.1623627
7. Global Cancer Observatory, International Agency for Research on Cancer. Cervix uteri fact sheet. 2024.
8. National implementation of HPV vaccination programs in low-resource countries: Lessons, challenges, and future prospects. *Front Public Health*. 2021;9:552028.
9. CDC. Pink Book. Chapter 11: Human Papillomavirus. 2025.

**READ MORE** ▶