Indian J Med Res 162, December 2025, pp 743-753
DOI: 10.25259/IJMR_1834_2025

Review Article

Barriers to HPV vaccination among adolescent girls in India: A scoping review

Kripa Josten[1], Redolen Rose Dhar[2], Bhageerathy Reshmi[2], Veena Natti Krishna[3] & Vennila J.[1]

[1]Division of Statistics, and Departments of [2]Health Information Management, [3]Renal Replacement Therapy and Dialysis Technology Program, Manipal College of Health Professions, Manipal Academy of Higher Education, Manipal, Karnataka, India

Received July 14, 2025; Accepted September 26, 2025; Published January 31, 2026

***Background & objectives*: The aim of this scoping review is to systematically map the existing research on human papillomavirus (HPV) vaccination uptake among adolescent girls in India, with a focus on (*i*) identifying the current trends, and (*ii*) examining the challenges and facilitators of vaccine uptake.**

***Methods*: The review adheres to the scoping review framework developed by Arksey and O'Malley. A thorough search of peer-reviewed literature was carried out utilizing databases such as PubMed, Scopus, and Web of Science. Studies published between 2008 and 2025 were assessed for relevance. The socio-ecological model was used to chart and synthesize data, categorizing barriers and enablers at the individual, interpersonal, community, institutional, and policy levels.**

***Results*: A total of 37 studies were included. Lack of awareness, sociocultural stigma, economic constraints, and insufficient assistance from the health system were highlighted as some of the main barriers. Government awareness initiatives, healthcare provider recommendations, and school-based interventions were found to facilitate HPV vaccination.**

***Interpretation & conclusions*: Improving HPV vaccine uptake in India requires addressing multi-level barriers with integrated public health initiatives and policy interventions.**

Key words Adolescent - barriers - HPV - human papillomavirus - India - parents

In India, cervical cancer is the second leading cause of mortality related cancer among women. Despite the introduction of human papillomavirus (HPV) vaccines in 2008 and recent policy moves toward the introduction of a national programme for the prevention and control of noncommunicable illnesses[1], uptake remains extremely low. According to National Family Health Survey (NFHS)-5, <1 per cent of girls in India are already vaccinated, and just around two per cent of Indian women have ever done any testing, indicating a significant gap in meeting the 90 per cent eradication goal set for 2030[2]. Due to their increased risk of HPV-related cervical cancer, the cost-effectiveness of vaccinating them, and the design of national public health initiatives, adolescent girls are India's top priority group for HPV vaccination. However, obstacles like low awareness, social stigma, budgetary limitations, and problems with the health system still prevent uptake.

This scoping review aims to map the existing literature on HPV vaccination uptake among adolescent girls and the parental willingness to identify the current trends, barriers and facilitators among parents and adolescent girls in India. The socio-ecological model (SEM)[3,4] is adopted in this study to understand these barriers, and it identifies health at multiple levels (individual, interpersonal, community and policy) to organise our results.

Materials & Methods

Study design and methods: The framework used for this scoping review was Arksey and O'Malley's methodological guidance for scoping reviews[5]. This framework constitutes (*a*) identifying the research question, (*b*) identifying relevant studies, (*c*) study selection (*d*) charting the data, and (*e*) collating and summarizing the results. This review was conducted and reported in accordance with the Preferred Reporting Items for Systematic reviews and Meta-Analyses extension for Scoping Reviews (PRISMA-ScR) guidelines to ensure methodological transparency and rigor (Supplementary material). The protocol for this review was prospectively registered on the Open Science Framework. (registration DOI: *https://doi.org/10.17605/OSF.IO/EDKCN*).

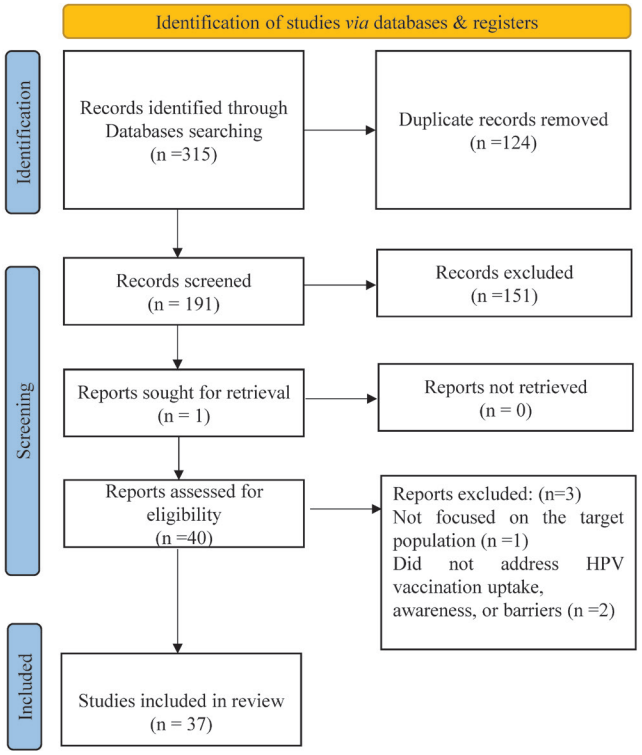

Fig. 1. PRISMA flow diagram of studies. This figure illustrates the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) flow diagram, showing the number of records identified, screened, excluded, and included in the review.

Step 1: Identifying the research question: The team formulated the review question through brainstorming, refining ideas, and narrowing down a research question derived from a literature review on the barriers of HPV vaccination among adolescent girls in India.

1. "What are the current HPV vaccination rates among adolescent girls in urban and rural areas of India, and what demographic factors influence vaccine accessibility and acceptance?
2. "What are the barriers and facilitators in HPV vaccination in adolescent girls in India?
3. "What targeted strategies and interventions can be implemented to increase HPV vaccination coverage among adolescent girls in India?"

This study developed the research question in supplementary table I using the 'PCC (population, concept, context) format defined by the Joanna Briggs Institute (JBI) manual for evidence synthesis 2020[6].

Step 2: Identifying a relevant study: The search strategy was developed collaboratively by the research team. Only Studies published between January 2008 and January 2025 were included, since the vaccination programme in India started in that year[7] (Annexure A included in the Supplementary Material). Using defined search phrases tailored to each database's requirements and updated by the research team, a systematic search was conducted across electronic databases. The search was conducted in October 2024 and used the databases Scopus, PubMed, Embase, CINAHL, and Web of Science. With a focus on "Human Papillomavirus," "HPV," "Barriers," "Adolescent," "Parents," and "India", the search was carried out using MeSH (Medical Subject Headings in PubMed) phrases. Search queries were combined using the Boolean operators AND, OR, and NOT. An additional search was conducted using changed search terms if the original search terms were not comprehensive.

Step 3: Study selection: The titles and abstracts of all retrieved records were independently screened by two reviewers (KJ and RRD) using pre-defined inclusion and exclusion criteria on the Rayyan web-based systematic review platform[8]. In cases of uncertainty, a third reviewer was consulted to reach a consensus. Full-text articles of potentially eligible studies were subsequently retrieved and assessed independently. The selection process is illustrated in a PRISMA 2020[9] flow diagram figure 1. Supplementary table II consists

Table. Summary table

Author & year	Title of study	Study design	Setting & population	Key findings
Basu *et al*[10], 2021	Vaccine efficacy against persistent HPV 16/18 infection at 10 years after 1, 2, & 3 doses of quadrivalent HPV vaccine in girls in India	Cluster-randomised + cohort	10–18 y/o girls, 9 Indian sites	Single dose provided comparable long-term protection to 2/3 doses.
Sharma *et al*[11], 2023	Immunogenicity and safety of a new quadrivalent HPV vaccine in girls and boys aged 9–14 yr *vs.* an established quadrivalent HPV vaccine in women aged 15–26 yr in India: a randomised, active-controlled, multicentre, phase 2/3 trial	RCT, multicenter phase 2/3	2307 participants, 12 Indian cities	Cervavac non-inferior to Gardasil; strong immune response; safe.
Hussain *et al*[12], 2014	Perception of HPV infection, cervical cancer, and HPV vaccination in North Indian population	Cross-sectional survey	2500 students (12–22 yr), Delhi & NCR regions	Very low awareness; only 13% parental acceptance.
Mandal *et al*[13], 2021	Experience of HPV Vaccination Project in a Community Setup	Community-based intervention	555 girls, rural West Bengal	98% completion; no serious adverse events; good acceptance.
Hussain *et al*[14], 2012	HPV Infection Among Young Adolescents in India: Impact of Vaccination	Cross-sectional survey	940 adolescents (8–17 yr), Delhi & Noida	HPV prevalence: girls 3.2%, boys 2.1%; age >13 linked to higher risk.
Rehman *et al*[15], 2022	Awareness and uptake of HPV vaccine in North India	Cross-sectional	1020 women, Delhi & Rohtak	Vaccine awareness: 18%, uptake: 0.6%.
Man *et al*[16], 2022	Evidence based Impact projections of single-dose HPV vaccination in India: a modelling study	Modeling study	Nationwide (India)	97% HPV prevalence reduction, 71–78% cervical cancer risk reduction over 50 yr.
Madhivanan *et al*[17], 2009	Attitudes toward HPV vaccination among parents of adolescent girls in Mysore, India	Qualitative (focus groups)	Parents of adolescent girls, Mysore	Acceptance: 79.9%; barriers: cost, safety.
Degarege *et al*[18], 2018	HPV vaccine acceptability among parents of adolescent girls in rural India	Cross-sectional survey	831 parents, rural Mysore	Acceptance: 79.9%; influenced by safety beliefs, family support.
Madhivanan *et al*[19], 2014	Human papillomavirus vaccine acceptability among parents of adolescent girls: Obstacles and challenges in Mysore, India	Cross-sectional survey	Parents, Mysore	71% willing to vaccinate daughters; concerns included safety and family approval.
Ramavath *et al*[20], 2013	Knowledge & Awareness of HPV Infection and Vaccination Among Urban Adolescents in India: A cross-sectional study	Cross-sectional survey	1000 girls, 5 Indian cities	Very low awareness; knowledge improved after educational sessions.
Prinja *et al*[21], 2014	Cost-effectiveness of human papillomavirus vaccination for adolescent girls in Punjab State: Implications for India's universal immunization programme	Cost-effectiveness modeling	Preadolescent girls, Punjab	Two-dose schedule cost-effective; supports national inclusion.
Gupta *et al*[22], 2021	Prevalence of human papillomavirus 16 genotype in Anuppur district, Madhya Pradesh	Cross-sectional study	782 married women, Anuppur district	High prevalence of HPV-16 (95% of positive cases); highest in women aged 15–29.
Basu *et al*[23], 2011	Acceptability of human papillomavirus vaccine among the urban, affluent and educated parents of young girls residing in Kolkata, Eastern India	Cross-sectional survey	Married couples with daughters, Kolkata	Education improved vaccine acceptance from 27 to 74%.

Contd...

Author & year	Title of study	Study design	Setting & population	Key findings
Singh *et al*[24], 2018	Cervical cancer awareness and HPV vaccine acceptability among females in Delhi: A cross-sectional study	Cross-sectional survey	Women 18+, Delhi	63.1% accepted for daughters, fewer for themselves; fear of side effects common.
Sankaranarayanan *et al*[25], 2018	Can a single dose of human papillomavirus (HPV) vaccine prevent cervical cancer? Early findings from an Indian study	Prospective cohort	10–18 y/o girls, 9 Indian locations	2-dose group had higher immunity; 1-dose shows promise.
Sankaranarayanan *et al*[26], 2016	Immunogenicity and HPV infection after 1, 2, & 3 doses of quadrivalent HPV vaccine in girls in India: A multicentre prospective cohort study	Multicenter cohort study	Girls 10–18 yr, India	One dose offers some protection; long-term validation needed.
Degarege *et al*[27], 2018	Urban-Rural inequities in the parental attitudes and beliefs towards human papillomavirus infection, cervical cancer, & human papillomavirus vaccine in Mysore, India	Cross-sectional survey	Parents, Mysore	Rural parents less aware and more hesitant; 67% doubted efficacy.
Degarege *et al*[28], 2018	Determinants of attitudes and beliefs toward HPV infection, cervical cancer, and HPV vaccine among parents of adolescent girls in Mysore, India	Cross-sectional survey	800 parents, Mysore	Religion, education, demographics influence beliefs.
Datta *et al*[29], 2012	Type-Specific Incidence and Persistence of HPV Infection among Young Women: A Prospective Study in North India	Prospective cohort	Married women 16–24, Delhi	HPV16 most common; persistent infections found.
Degarege *et al*[30], 2020	Structural equation modeling to detect correlates of childhood vaccination	Cross-sectional + SEM	Parents across India	Parental education and benefit perception predicted uptake.
Ray *et al*[31], 2024	Demand and willingness to pay for HPV vaccine among mothers in Haryana, India	Cross-sectional survey	Mothers of girls, Gurgaon	79% willing to pay; mean WTP ₹629; subsidy needed.
Joshi *et al*[32], 2018	Effect of education on awareness, knowledge, and willingness to be vaccinated in females of Western India	Observational, pre-post	693 female participants between the age group of 16-40, western India	Awareness improved, but acceptability remained low.
Jacob *et al*[33], 2021	Impact of indirect education on knowledge and perception on cervical cancer and its prevention among the parents of adolescent girls: : an interventional school-based study	Interventional school-based	Parents of girls 11–16, Mysuru	Knowledge improved post-intervention, perception unchanged.
Raychaudhuri *et al*[34], 2012	Socio-demographic and behavioural risk factors for cervical cancer and knowledge, attitude & practice in rural and urban areas of North Bengal, India	Cross-sectional study	221 rural/urban women, North Bengal	Rural-urban disparities; education linked to awareness.
Holroyd *et al*[35], 2022	Designing a Pro-Equity HPV Vaccine delivery program for girls who have dropped out of School: Community perspectives from Uttar Pradesh, India	Qualitative study	Adolescent girls, Uttar Pradesh	Community engagement key; school-based programs leave gaps.
Degarege *et al*[36], 2019	An integrative behavior theory derived model to assess factors affecting HPV vaccine acceptance	Cross-sectional, SEM	1609 parents, Mysore District	Attitudes and norms major predictors of vaccine intention.
Krupp *et al*[37], 2013	Acceptability of HPV Vaccination Among Parents of Adolescent School-Going Girls in Mysore, India	Cross-sectional survey	Parents of girls 11–15, Mysore	72% accepted; barriers: safety concerns, sexual behavior fears.

Contd...

Author & year	Title of study	Study design	Setting & population	Key findings
Apurva *et al*[38], 2024	Effect of Health Education on the Knowledge and Attitude Regarding the Human Papillomavirus Vaccine among Adolescent School Girls of a City in Western Maharashtra	Quasi-experimental	200 girls, Pune	94% awareness improvement; positive behavioral change.
Swain *et al*[39], 2018	Preparedness of Young Girls for Prevention of Cervical Cancer and Strategy to Introduce the HPV Vaccine	Pretest-posttest quasi-experimental	60 girls, Odisha	Knowledge improved; 58% took vaccine.
Jacob *et al*[40], 2010	Assessing the environment for Introduction of HPV Vaccine in India	Qualitative policy review	10- to 14-yr-old girls, Andhra Pradesh & Gujarat	Delivery feasible with public education and support.
Divakar[41], 2012	Knowledge and awareness about preventive health seeking behavior and acceptability of cervical cancer vaccine in urban women in comparison with school students	Cross-sectional comparison	10- to 14-year-old girls and 236 urban women attending OPD and IP	Education and demographics influenced awareness.
Paul *et al*[42], 2014	Acceptability of HPV Vaccine Implementation Among Parents in India	Qualitative interview study	Mothers with daughter(s) under 18 yr old, in Andhra Pradhesh	Cost and side effects were key concerns.
Dhinu K *et al*[43], 2024	Effect of health education on acceptance of human papilloma virus vaccine among parents of adolescent girls of Bishnupur, Manipur: A quasi-experimental study	Quasi-experimental	70 parents, Bishnupur	Acceptance rose from 61% to 88.6% post-education.
Budukh *et al*[44], 2018	Prevalence and Non-Sexual Transmission of HPV in Adolescent Girls in Rural Maharashtra	Population-based study	57 mother-daughter pairs, Maharashtra	HPV prevalence: 10.7%; poor hygiene linked.
Ahlawat *et al*[45], 2018	Effect of health education on the knowledge and attitude regarding the human papillomavirus vaccine among adolescent school girls of a city in Western Maharashtra	Cross-sectional survey	100 pairs, Delhi (urban slum)	Only 13% aware HPV is a risk factor; maternal education linked.
Madhivanan *et al*[46], 2009	Indian parents prefer vaccinating their daughters against HPV at older ages	Cross-sectional survey	Parents of school girls, Mysore	Preference for later vaccination ages; safety concerns.

This table provides a consolidated summary of the reviewed studies, including author & year of publication, study design, setting, population, & key findings

of all studies that met predefined criteria, regardless of quality. Studies employing quantitative, qualitative, and mixed-methods designs were included, regardless of their quality. To ensure a comprehensive review, the reference lists of all included articles were manually searched for additional relevant studies.

Step 4: Charting the data: A standardised data charting form was developed by the review team to systematically extract and organize relevant information from the included studies (Annexure B in the Supplementary Material). title, authors, year of publication, methodological elements (study design, theoretical framework, population, sample size, and intervention), outcome, relevant findings, conclusion, and recommendations reported as shown in the annexure in Supplementary material. Quality appraisal was not conducted, as the focus of this research was to identify and describe the nature of studies on HPV research in this area, not to assess their quality. This is overviewed in table[10-46] and supplementary table III.

Step 5: Collating and summarizing the results: The narrative report was produced based on the evidence synthesized using the data charting. Various

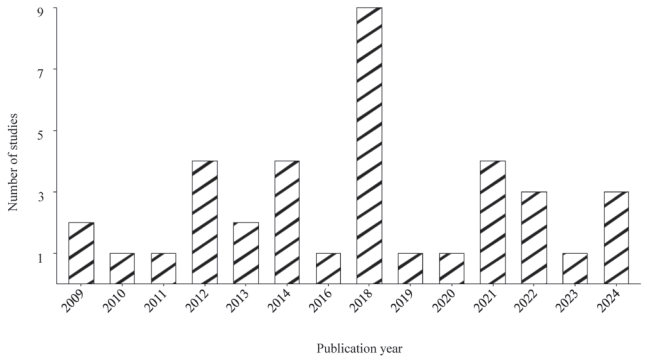

Fig. 2. Study counts by publication year. This figure presents the distribution of included studies according to their year of publication.

characteristics and findings from the review are presented in a tabular format based on the research questions and objectives. Through an objective comparison of study and participant characteristics, knowledge gaps were identified about any existing stigma of the cervical cancer screening and HPV vaccination.

Results

The PRISMA flow diagram illustrates the search and selection process (Fig. 1). A total of 37 studies published between 2009 and 2025 were included in this scoping review[10-46]. These studies differed widely in their design, setting, and population. Figure 2 presents the study counts for each year publications. The majority of studies included employed cross-sectional survey designs (n=24), followed by cohort studies (n=5), interventional studies including quasi-experimental designs (n=4), randomized controlled trials (n=2), and model-based projections (n=2). Sample populations ranged from adolescent girls (typically aged 9–19 yr), their parents or caregivers (Table 1).

The study settings spanned both in urban and rural areas, with both school- and community-based recruitment strategies in various states of India. Sampling methods included in these articles were random, stratified, cluster, convenience, and probability proportionate-to-size sampling techniques. Data collection involved structured questionnaires, focus group discussions, in-depth interviews, and in selected scenarios, biological testing such as polymerase chain reaction (PCR) based assays to detect HPV prevalence.

Most studies concentrated on the adolescent population, particularly girls aged 9 to 18 yr, along with their parents or guardians, recognizing the critical role of caregivers in vaccine decision-making. Some studies also included healthcare providers, reproductive-age women, and community members to provide a broader context on knowledge, attitudes, and barriers surrounding HPV vaccination. Sample sizes ranged from small qualitative cohorts (20–50 participants) to large surveys exceeding 2,000 respondents, providing both depth and breadth of evidence.

Theoretical framework: The theoretical framework used for the review is the socio-ecological model (SEM) to map and interpret the various influences on HPV vaccination awareness and uptake among adolescent girls in India[47,48]. The SEM recognizes that health behaviors are shaped by interactions across multiple levels: individual, interpersonal, organizational/ institutional, community, and policy.

At the individual level, limited knowledge, cultural misconceptions, and attitudinal barriers, such as fear of side effects or concerns about morality were key problems, especially among less educated or rural populations[12,14,17,19,28,37,38]. Interpersonal factors like parental influence, peer support, and healthcare provider recommendations also shaped decisions, though outreach was inconsistent in underserved areas[31,39,45]. Institutional settings, particularly schools and health centres, proved effective for vaccine delivery when adequately supported, yet out-of-school girls remained underserved[33,35,40]. Community-level factors, including stigma, cultural norms, and religious beliefs, often reinforced vaccine hesitancy, though engagement with local leaders and culturally tailored interventions showed promise [28,30,34,36]. At the policy level, high vaccine costs, lack of integration into national immunisation programmes, and limited public funding restricted access, although there were recent developments such as the introduction of low-cost vaccines like Cervavac[11,17,21]. Thus, by applying the SEM framework, we expect to enable a holistic examination of barriers and facilitators to HPV vaccine uptake.

Socio-ecological model:

I. Individual level: Individual-level factors emerged as a significant barrier to vaccine uptake and awareness in India.

A primary finding across studies was the extremely low baseline awareness of HPV and its vaccine among adolescents and their parents. Hussain *et al*[12] reported awareness levels of only 5.7 per cent, while Raychaudhuri *et al*[34] noted an even lower rate of 2.2 per cent. Ramavath *et al*[20] highlighted limited knowledge, with many participants unaware of the link between HPV and cervical cancer. The limited

knowledge is often accompanied by misinformation and myths, including the belief that HPV vaccines lead to infertility hence, they prefer vaccinating their daughters at an older age[46]. These misconceptions were especially prevalent in conservative or rural settings, where this was considered a stigma[36,37]. Datta *et al*[29] reported high persistence of HPV types among young married women, underlining a need for earlier individual awareness.

Hesitancy to get vaccines was largely caused by attitudes influenced by personal beliefs and cultural norms[38]. Many respondents, especially mothers, said they were uncomfortable with their daughters receiving a vaccine against a sexually transmitted disease, frequently attributing this to ethical issues and the belief that it encourages immorality[36,37,45]. These attitudes were more prevalent among populations with lower education levels or those influenced by traditional gender roles.

Targeted educational programs demonstrated significant gains in vaccine intent and knowledge[38,43]. While Jacob *et al*[33] implemented community-based education using videos and expert talks. Joshi *et al*[32] employed interactive PowerPoint presentations in school settings. Both studies demonstrated notable improvements in awareness scores, with post-intervention knowledge gains exceeding 50 per cent in some groups. Despite this, a subset of participants remained hesitant, often citing concerns about vaccine cost, availability, or insufficient information from healthcare providers[31,32,38,43]. Many interventions were short-term or evaluated only immediate knowledge outcomes, not the participants 'long-term change towards the intake of vaccines.

Demographic characteristics such as age, gender, educational level, place of residence, socioeconomic status, and religion were found to influence both HPV awareness and vaccine acceptance[18,27,28,30,36]. Older adolescent girls (15–19 yr) were generally more informed and receptive to HPV vaccination than younger adolescents, likely due to greater exposure to health education or peer discussions[12,20,34]. Girls from urban and higher socioeconomic backgrounds were more likely to have heard of HPV and the vaccine, whereas those from rural or tribal areas were found to have lower awareness and greater scepticism[31,32,36]. Religion was also found to be another factor, with some communities expressing stronger resistance due to their religious norms or misinformation within their social circles[36,42]. Psychosocial constructs, such as perceived susceptibility to HPV, perceived severity of cervical cancer, and self-efficacy regarding health decisions, were either under-assessed or inconsistently reported across studies. Degarege *et al*[36] demonstrated that perceived benefits and social norms significantly influenced parental willingness to vaccinate.

II. Interpersonal level: Evidence from the previous studies consistently shows that interpersonal relationships can either serve as significant enablers or barriers. The decisive influence of parents, especially mothers played a pivotal role on vaccine decision-making. Studies like Degarege *et al*[28] and Ray *et al*[31] showed that maternal education, perception of disease severity, and intention were key predictors of adolescent vaccine uptake. Divakar[41] linked higher parental education with better vaccine uptake among daughters. Family disapproval, particularly in patriarchal or conservative settings, often resulted in refusal to vaccinate, with rural households being more hesitant[24,45]. Peer-led education and school-based peer counselling showed promise, although less studied. According to Basu *et al*[10], teenagers who got knowledge or support from their peers expressed better acceptance towards vaccines and were more inclined to talk to their parents and healthcare providers. Trust in medical professionals was also a powerful facilitator. Shah *et al*[49], Swain *et al*[39], and Krupp *et al*[37] found that trusted physician recommendations were among the strongest motivators for parents to accept HPV vaccination. However, Joshi *et al*[32] reported that providers were often ignored in rural and semi-urban regions, either due to lack of training, time constraints, or due to communication gaps.

III. Institutional level: Programs implemented through schools demonstrated high efficiency and coverage[35,40]. According to Mandal *et al*[13], a remarkable 98 per cent vaccination completion rate through school initiatives coupled with parent engagement and community mobilization. The school setting allowed for mass outreach, consistent communication, and practical convenience. Not all schools were adequately equipped. Jacob *et al*[33] pointed to the absence of structured health education programs and the need for awareness about the same for the teachers, which could otherwise amplify message delivery and dispel myths among students and parents. Institutional outreach through hospitals and primary health centers was also found to be effective. Rehman *et al*[15] showed that PHC-led awareness drives significantly improved both knowledge and intent to vaccinate for the adolescents, especially when healthcare workers used visualization

tools and community meetings. Holroyd *et al*[35] highlighted the exclusion of out-of-school girls from school-based programs as a major equity issue. These girls, often from marginalized backgrounds, lacked access to structured health communication, reinforcing disparities in awareness and vaccination. Organizational success depended heavily on the coordination of communication, adequate training of staff, and inclusive strategies to reach all adolescent groups.

IV. Community level: Community-level factors such as social norms, cultural beliefs, etc, significantly shaped vaccine awareness and acceptability. The influence of community leaders, religious beliefs, and stigma surrounding HPV as a sexually transmitted infection (STI) was pivotal.

Cultural barriers were prominent, particularly in conservative and rural regions. Degarege *et al*[28] and Raychaudhuri *et al* [34] reported that HPV was perceived as a sexually transmitted disease linked leaded by denial, shame, and parental resistance. Myths such as "HPV vaccine promotes early sexual activity" persisted across multiple study sites[12]. Some studies noted regional differences in attitudes. For instance, Northern states with higher religious conservatism exhibited lower vaccine acceptability compared to more urbanized Southern States[14,22]. Basu et al[23] noted that minority religious groups had concerns about vaccine permissibility and safety. Budukh *et al*[44] discovered that beliefs regarding non-sexual HPV transmission were associated with inadequate menstrual hygiene practices. Joshi *et al*[32] described effective campaigns using media, street plays, and community meetings that addressed cultural fears and built trust. Community-based programmes must be culturally sensitive, locally adapted, and sustained through trusted community voices to normalize HPV vaccination.

V. Policy level: Policy-level determinants formed the structural and economic background that either facilitated or hindered widespread HPV vaccine adoption. Issues of cost, availability, programmatic support, and integration into public health infrastructure were central themes. Cost emerged as a primary barrier. Several studies cited the high cost per dose for commercially available vaccines like Gardasil and Cervarix, making them unaffordable for most Indian families, particularly in rural and low-income settings[17,21,31]. Multiple studies emphasized that the exclusion of the HPV vaccine from India's national immunization schedule had stymied uptake, especially among marginalized groups[15,21,25,26]. The lack of programmatic support also meant that awareness campaigns remained fragmented and sporadic. Feasibility of single-dose regimens: Studies done by Man *et al*[16], Basu *et al*[10], and Sankaranarayanan *et al*[25] *etc*, on modelling and efficacy of vaccine supported a shift to single-dose strategies. These findings are aligned with WHO's updated guidance and hold promise for broader, more cost-effective coverage. The recent approval and rollout of Cervavac, a low-cost, domestically produced HPV vaccine priced at ~ INR 200–INR 400 per dose, marks a critical policy milestone, as reported by Sharma *et al*[11]. Global Alliance on Vaccines and Immunizations (now GAVI, the Vaccine Alliance) and government-backed initiatives are expected to reduce financial barriers and increase equitable access, especially if integrated into the national immunization programmes.

Discussion

The findings from this review reveal that individual-level barriers, such as inadequate awareness and widespread misconceptions, were significant barriers. Multiple studies reported knowledge gaps of more than 90 per cent, due to the widespread myths related to vaccine safety, and infertility. Similar issues have been identified in countries such as China and Turkey, where parental understanding does not necessarily convert into vaccine adoption unless combined with affordability and trustworthy healthcare communication[49,50]. Although awareness using education-led interventions showed promise in increasing intent to vaccinate, there existed a hesitancy[13,32,33]. These findings are consistent with international research, which has shown that even with increased awareness, factors such as vaccine cost, perceived necessity, and cultural sensitivity influence decision-making[51]. Given these findings, policymakers should implement multifaceted interventions, including health education, HPV awareness integration into school curriculum, and other financial support measures, to effectively reduce vaccine hesitancy and increase HPV vaccine uptake.

At the interpersonal level, the involvement of family, particularly mothers, was critical to vaccine decisions. Maternal support increased vaccine acceptance, while conservative beliefs served as barriers. These dynamics are consistent with findings from Turkey[50], Latina populations[52], Senegalese adolescents[53] and U.S.[54] where cultural and gender norms heavily influenced vaccine intent. Healthcare provider recommendations emerged as one of the strongest facilitators. However, physicians in rural and semi-urban India remain under-utilized, a challenge

echoed in other LMICs[49,53]. This highlights the need for healthcare professionals to be more involved in HPV vaccine advocacy and education campaigns.

At the Institutional level, school-based vaccination programs in India from Punjab and Sikkim demonstrated high effectiveness. In India, the state-level HPV vaccination programmes, particularly from Punjab and Sikkim, provide practical models for effective implementation, among the school-going girls[55], supported by mandatory school enrolment, integration of health and education departments, comprehensive training, and strong community engagement[56]. Out-of-school girls often come from marginalized or tribal populations, which remain underrepresented, echoing equity challenges seen across LMICs[56].School-based interventions were often successful in generating community-level awareness, but broader social barriers due to stigma and conservative norms remained unaddressed.

The high cost of the HPV vaccine was a major policy-level barrier in India, particularly as the HPV vaccine remains outside the national immunization program. However, the introduction of India's low-cost vaccine, like Cervavac, and WHO's endorsement of a single-dose schedule are major milestones with the potential to reduce cost and logistical hurdles. Similarly, countries such as Myanmar integrated HPV vaccination into their national immunization programme, financed through GAVI[57]. In Kenya and Uganda, mobile vaccination camps have been deployed to reach remote and rural populations, ensuring greater coverage among out-of-school adolescents[58,59]. In settings like Senegal, China, and Nigeria, the integration of culturally sensitive messaging and the involvement of community health workers and peer educators have proven effective in increasing vaccination acceptance.

The main strength of this study is the application of SEM framework, which gives a comprehensive outlook of barriers in HPV vaccine uptake across multiple levels. However, the variability in study design, locations, and population coverage among the included sources poses challenges in drawing generalized conclusions. Despite increasing research, there remains a shortage of empirical studies evaluating the implementation and effectiveness of targeted strategies. Evidence evaluating the long-term effectiveness, scalability, and cultural adaptability in the Indian context, especially among marginalized and out-of-school adolescent girls remains limited.

We conclude that HPV vaccine uptake among adolescents in India is shaped by multilevel influences. To address these issues, multifaceted strategies are required, combined with education based in institutions, community engagement, culturally tailored interventions and financial support. Such approaches are essential to advance the HPV coverage among adolescent girls in India. In clinical practice, strengthening the role of healthcare providers by initiating routine checkups for adolescents through communication, and preventive health check-up scan help in bridging the gaps between awareness and actual vaccine uptake. Timely and strong recommendations during clinical visits can help in addressing the hesitancy, misconceptions, and vaccine acceptability among adolescent girls and their families.

Financial support & sponsorship: None.

Conflicts of Interest: None.

Use of Artificial Intelligence (AI)-Assisted Technology for manuscript preparation: The authors confirm that artificial intelligence tools, including Grammarly and Quill Bot, were used to assist in language refinement, grammar correction, and formatting during the preparation of this manuscript. These tools were not involved in the conceptualisation, analysis, or interpretation of findings and no images were manipulated using AI.

References

1. National Health Mission. Ministry of Health & Family Welfare, Government of India. *National Programme for prevention & Control of Cancer, Diabetes, Cardiovascular Diseases & stroke (NPCDCS*). Available form: *https://nhm.gov.in/index1.php?lang=1&level=2&sublinkid=1048&lid=604*, accessed on August 22, 2025.
2. Rajiv Gandhi Cancer Institute & Research Centre. *HPV Vaccination in India : New Progress and the way forward. RGCIRC Team.* Available from: *https://www.rgcirc.org/blog/hpv-vaccination-in-india-new-progress-and-the-way-forward/*, accessed on August 22, 2025.
3. Ryan G, Avdic L, Daly E, Askelson N, Farris PE, Shannon J, *et al*. Influences on HPV vaccination across levels of the social ecological model: Perspectives from state level stakeholders. *Hum Vaccin Immunother* 2021; *17* : 1006-13.
4. Akinyemiju T, Ogunsina K, Gupta A, Liu I, Braithwaite D, Hiatt RA. A socio-ecological framework for cancer prevention in low and middle-income countries. *Front Public Health* 2022; *10* : 884678.
5. Arksey H, O'Malley L. Scoping studies: Towards a methodological framework. *Int J Soc Res Methodology* 2005; *8* : 19-32.
6. Peters MDJ, Marnie C, Tricco AC, Pollock D, Munn Z, Alexander L, *et al*. Updated methodological guidance for the conduct of scoping reviews. *JBI Evid Synth* 2020; *18* : 2119-26.
7. Lahariya C. A brief history of vaccines & vaccination in India. *Indian J Med Res* 2014; *139* : 491-511.

8. Ouzzani M, Hammady H, Fedorowicz Z, Elmagarmid A. Rayyan-a web and mobile app for systematic reviews. *Syst Rev* 2016; *5* : 210.
9. Page MJ, McKenzie JE, Bossuyt PM, Boutron I, Hoffmann TC, Mulrow CD, *et al*. The PRISMA 2020 statement: An updated guideline for reporting systematic reviews. *BMJ* 2021; *372* : n71.
10. Basu P, Malvi SG, Joshi S, Bhatla N, Muwonge R, Lucas E, *et al*. Vaccine efficacy against persistent human papillomavirus (HPV) 16/18 infection at 10 years after one, two, and three doses of quadrivalent HPV vaccine in girls in India: A multicentre, prospective, cohort study. *Lancet Oncol* 2021; *22* : 1518-29.
11. Sharma H, Parekh S, Pujari P, Shewale S, Desai S, Bhatla N, *et al*. Immunogenicity and safety of a new quadrivalent HPV vaccine in girls and boys aged 9–14 years versus an established quadrivalent HPV vaccine in women aged 15–26 years in India: A randomised, active-controlled, multicentre, phase 2/3 trial. *Lancet Oncol* 2023; *24* : 1321-33.
12. Hussain S, Nasare V, Kumari M, Sharma S, Khan MA, Das BC, *et al*. Perception of human papillomavirus infection, cervical cancer and HPV vaccination in North Indian population. *PLoS One* 2014; *9* : e112861.
13. Mandal R, Banerjee D, Gupta K, Chatterjee P, Vernekar M, Ray C. Experience of human papillomavirus vaccination project in a community set up-an Indian study. *Asian Pac J Cancer Prev* 2021; *22* : 699-704.
14. Hussain S, Bharadwaj M, Nasare V, Kumari M, Sharma S, Hedau S, *et al*. Human papillomavirus infection among young adolescents in India: Impact of vaccination. *J Med Virol* 2012; *84* : 298-305.
15. Rehman A, Srivastava S, Garg PR, Garg R, Kurian K, Shumayla S, *et al*. Awareness about human papillomavirus vaccine and its uptake among women from North India: Evidence from a cross-sectional study. *Asian Pac J Cancer Prev* 2022; *23* : 4307-13.
16. Man I, Georges D, de Carvalho TM, Ray Saraswati L, Bhandari P, Kataria I, *et al*. Evidence-based impact projections of single-dose human papillomavirus vaccination in India: A modelling study. *Lancet Oncol* 2022; *23* : 1419-2.
17. Madhivanan P, Krupp K, Yashodha MN, Marlow L, Klausner JD, Reingold AL. Attitudes toward HPV vaccination among parents of adolescent girls in Mysore, India. *Vaccine* 2009; *27* : 5203-8.
18. Degarege A, Krupp K, Fennie K, Srinivas V, Li T, Stephens DP, *et al*. Human papillomavirus vaccine acceptability among parents of adolescent girls in a rural area, Mysore, India. *J Pediatr Adolesc Gynecol* 2018; *31* : 583-91.
19. Madhivanan P, Li T, Srinivas V, Marlow L, Mukherjee S, Krupp K. Human papillomavirus vaccine acceptability among parents of adolescent girls: Obstacles and challenges in Mysore, India. *Prev Med* 2014; *64* : 69-74.
20. Ramavath KK, Olyai R. Knowledge and awareness of hpv infection and vaccination among urban adolescents in India: A cross-sectional study. *J Obstet Gynaecol India* 2013; *63* : 399-404.
21. Prinja S, Bahuguna P, Faujdar DS, Jyani G, Srinivasan R, Ghoshal S, *et al*. Cost-effectiveness of human papillomavirus vaccination for adolescent girls in Punjab state: Implications for India's universal immunization program. *Cancer* 2017; *123* : 3253-60.
22. Gupta B, Sunnam LB, Kumar A, Parikipandla S. Prevalence of human papillomavirus 16 genotype in Anuppur district, Madhya Pradesh. *Mol Biol Rep* 2021; *48* : 503-11.
23. Basu P, Mittal S. Acceptability of human papillomavirus vaccine among the urban, affluent and educated parents of young girls residing in Kolkata, Eastern India. *J Obstet Gynaecol Res* 2011; *37* : 393-401.
24. Singh J, Roy B, Yadav A, Siddiqui S, Setia A, Ramesh R, *et al*. Cervical cancer awareness and HPV vaccine acceptability among females in Delhi: A cross-sectional study. *Indian J Cancer* 2018; *55* : 233-7.
25. Sankaranarayanan R, Joshi S, Muwonge R, Esmy PO, Basu P, Prabhu P, *et al*. Can a single dose of human papillomavirus (HPV) vaccine prevent cervical cancer? Early findings from an Indian study. *Vaccine* 2018; *36* : 4783-91.
26. Sankaranarayanan R, Prabhu PR, Pawlita M, Gheit T, Bhatla N, Muwonge R, *et al*. Immunogenicity and HPV infection after one, two, and three doses of quadrivalent HPV vaccine in girls in India: A multicentre prospective cohort study. *Lancet Oncol* 2016; *17* : 67-7.
27. Degarege A, Krupp K, Fennie K, Li T, Stephens DP, Marlow LAV, *et al*. Urban-rural inequities in the parental attitudes and beliefs towards human papillomavirus infection, cervical cancer, and human papillomavirus vaccine in Mysore, India. *J Pediatr Adolesc Gynecol* 2018; *31* : 494-502.
28. Degarege A, Krupp K, Srinivas V, Ibrahimou B, Marlow LAV, Arun A, *et al*. Determinants of attitudes and beliefs toward human papillomavirus infection, cervical cancer and human papillomavirus vaccine among parents of adolescent girls in Mysore, India. *J Obstet Gynaecol Res* 2018; *44* : 2091-100.
29. Datta P, Bhatla N, Pandey RM, Dar L, Patro AR, Vasisht S, *et al*. Type-specific incidence and persistence of HPV infection among young women: A prospective study in North India. *Asian Pac J Cancer Prev* 2012; *13* : 1019-24.
30. Degarege A, Krupp K, Srinivas V, Ibrahimou B, Madhivanan P. Structural equation modeling to detect correlates of childhood vaccination: A moderated mediation analysis. *PLoS One* 2020; *15* : e0240749.
31. Ray S, Mulchandani R, Patel P. Demand and willingness to pay for human papilloma virus vaccine for their daughters among mothers in Haryana, India: A contingent valuation study. *J Health Serv Res Policy* 2024; *29* : 76-83.
32. Joshi SV, Chaudhari HR, Chaudhari NA. Effect of education on awareness, knowledge, and willingness to be vaccinated in females of Western India. *J Cancer Educ* 2020; *35* : 61-8.
33. Jacob RA, Abraham PS, Thomas FR, Navya V, Sebastian J, Ravi MD, *et al*. Impact of indirect education on knowledge and perception on cervical cancer and its prevention among the parents of adolescent girls: An interventional school-based study. *Ther Adv Vaccines Immunother* 2021; *9* : 2515135521990268.
34. Raychaudhuri S, Mandal S. Socio-demographic and behavioural risk factors for cervical cancer and knowledge,

attitude and practice in rural and urban areas of North Bengal, India. *Asian Pac J Cancer Prev* 2012; *13* : 1093-6.

35. Holroyd TA, Yan SD, Srivastava V, Srivastava A, Wahl B, Morgan C, *et al*. Designing a pro-equity HPV vaccine delivery program for girls who have dropped out of school: community perspectives from Uttar Pradesh, India. *Health Promot Pract* 2022; *23* : 1039-4.
36. Degarege A, Krupp K, Fennie K, Srinivas V, Li T, Stephens DP, *et al*. An integrative behavior theory derived model to assess factors affecting HPV vaccine acceptance using structural equation modeling. *Vaccine* 2019; *37* : 945-5.
37. Krupp K, Srinivas V, Marlow L, Li T, Albetini A, Gowda S, *et al*. O19.4 Acceptability of HPV vaccination among parents of adolescent school going girls in Mysore city, India. *Sex Transm Infect* 2013; *89* : 3-A64.
38. Apurva UT, Muralidhar PT, Malangori AP, Poonam VS, Pradip SB. Effect of health education on the knowledge and attitude regarding the human papillomavirus vaccine among adolescent school girls of a city in Western Maharashtra. *Indian J Community Health* 2024; *36* : 549-55.
39. Swain D, Parida SP. Preparedness of young girls for prevention of cervical cancer and strategy to introduce the HPV vaccine. *Indian J Community Med* 2018; *43* : S38-41.
40. Jacob M, Mawar N, Menezes L, Kaipilyawar S, Gandhi S, Khan I, *et al*. Assessing the environment for introduction of human papillomavirus vaccine in India. *Open Vaccine J* 2010; *3* : 96-107.
41. Divakar H. Knowledge and awareness about preventive health seeking behavior and acceptability of cervical cancer vaccine in urban women in comparison with school students. *J SAFOG* 2012; *4* : 47-53.
42. Paul P, Tanner AE, Gravitt PE, Vijayaraghavan K, Shah KV, Zimet GD, *et al*. Acceptability of HPV vaccine implementation among parents in India. *Health Care Women Int* 2014; *35* : 1148-61.
43. Dhinu K, Fernandez S, Gupta A, Elangbam V. Effect of health education on acceptance of human papilloma virus vaccine among parents of adolescent girls of Bishnupur, Manipur: A quasi-experimental study. *Indian J Med Res* 2024; *160* : 346-53.
44. Budukh A, Maheshwari A, Palayekar V, Bagal S, Purwar P, Deodhar K, *et al*. Prevalence and nonsexual transmission of human papilloma virus (HPV) in the adolescence girls from rural area of Maharashtra state, India. *Indian J Cancer* 2018; *55* : 336-9.
45. Ahlawat P, Batra N, Sharma P, Kumar S, Kumar A. Knowledge and attitude of adolescent girls and their mothers regarding cervical cancer: A community-based cross-sectional study. *J Midlife Health* 2018; *9* : 145-9.
46. Madhivanan P, Srinivas V, Marlow L, Mukherjee S, Narayanappa D, Mysore S, *et al*. Indian parents prefer vaccinating their daughters against HPV at older ages. *Asian Pac J Cancer Prev* 2014; *15* : 107-10.
47. McLeroy KR, Bibeau D, Steckler A, Glanz K. An ecological perspective on health promotion programs. *Health Educ Q* 1988; *15* : 351-77.
48. Shah P, Shetty V, Ganesh M, Shetty AK. Challenges to human papillomavirus vaccine acceptability among women in south India: an exploratory study. *Am J Trop Med Hyg* 2021; *105* : 966-73.
49. Xie H, Zhu HY, Jiang NJ, Yin YN. Awareness of HPV and HPV vaccines, acceptance to vaccination and its influence factors among parents of adolescents 9 to 18 years of age in China: A cross-sectional study. *J Pediatr Nurs* 2023; *71* : 73-8.
50. Çelik P, İncesoy Özdemir S. Awareness, Knowledge, attitudes, and behaviors of the parents of 9-18 year-old children about HPV infection and HPV vaccine in a developing country. *J Pediatr Inf* 2021; *15* : 84-90.
51. Xu MA, Choi J, Capasso A, DiClemente RJ. Improving HPV vaccination uptake among adolescents in low resource settings: Sociocultural and socioeconomic barriers and facilitators. *Adolesc Health Med Ther* 2024; *15* : 73-82.
52. Lechuga J, Vera-Cala L, Martinez-Donate A. HPV vaccine awareness, barriers, intentions, and uptake in latina women. *J Immigr Minor Health* 2016; *18* : 173-8.
53. Massey PM, Boansi RK, Gipson JD, Adams RM, Riess H, Dieng T, *et al*. Human papillomavirus (HPV) awareness and vaccine receptivity among Senegalese adolescents. *Trop Med Int Health* 2017; *22* : 113-21.
54. Bodson J, Wilson A, Warner EL, Kepka D. Religion and HPV vaccine-related awareness, knowledge, and receipt among insured women aged 18-26 in Utah. *PLoS One* 2017; *12* : e0183725.
55. Mehrotra R, Hariprasad R, Rajaraman P, Mahajan V, Grover R, Kaur P, *et al*. Stemming the wave of cervical cancer: Human papillomavirus vaccine introduction in India. *J Glob Oncol* 2018; *4* : 1-4.
56. Ahmed D, Vander Ende K, Harvey P, Bhatnagar P, Kaur N, Roy S, *et al*. Human papillomavirus (HPV) vaccine introduction in Sikkim state: Best practices from the first statewide multiple-age cohort HPV vaccine introduction in India-2018-2019. *Vaccine* 2022; *40* : A17-25.
57. Basa JE, Clemens R, Clemens SAC, Nicholson M. Landscaping analysis of immunization progress and program structures in selected middle income Southeast Asian countries. *Vaccine* 2024; *42* : 2326-3.
58. Sadoh AE, Okonkwobo C, Nwaneri DU, Ogboghodo BC, Eregiea C, Oviawe O, *et al*. Effect of peer education on knowledge of human papilloma virus and cervical cancer among female adolescent students in Benin city, Nigeria. *Ann Glob Health* 2018; *84* : 121-8.
59. Watson-Jones D, Mugo N, Lees S, Mathai M, Vusha S, Ndirangu G, *et al*. Access and attitudes to HPV vaccination amongst hard-to-reach populations in Kenya. *PLoS One* 2015; *10* : e0123701.

For correspondence: Dr Vennila J., Division of Statistics, Manipal College of Health Professions, Manipal Academy of Higher Education, Manipal, Karnataka 576 104, India
e-mail: vennila.j@manipal.edu