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Original Research Article

Analysis of Knowledge Gaps on Vaccination of Human Papillomavirus among Medical Students in Tamil Nadu, India – A Cohort Study

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Abstract

Background: Cervical cancer, primarily caused by persistent human papillomavirus (HPV) infection, remains a significant public health burden in India. While general awareness may be increasing, the presence of specific, accurate knowledge crucial for informed decision-making about HPV vaccination and cervical cancer screening is not well-documented.

Objectives: This study aimed to assess the detailed knowledge and identify specific gaps and misconceptions among medical students regarding HPV vaccination and cervical cancer screening within an Indian cohort, moving beyond the measurement of general awareness.

Methods: A cross-sectional survey was conducted using a structured questionnaire. Participants were assessed on their knowledge of HPV transmission, vaccine specifics such as genotypes, dosing, age eligibility, contraindications, and the relationship between vaccination and screening.

Results: Analysis revealed a notable paradox: high general awareness of the HPV-cervical cancer link coexisted with profound specific knowledge gaps. While most respondents correctly identified sexual transmission, significant misconceptions were prevalent. These included confusion between HPV vaccine trade names (e.g., Cervarix, Gardasil) and unrelated vaccines (e.g., BCG, Rotavix), uncertainty about the recommended age for vaccination and number of doses, and limited understanding of high-risk HPV genotypes. A critical misconception was the belief that Pap smear screening becomes unnecessary after HPV vaccination. Furthermore, knowledge regarding vaccine efficacy in previously infected individuals and recommendations for male vaccination was poor.

Conclusion: This study identifies a critical disconnect between general awareness and functional knowledge necessary for effective cervical cancer prevention. The findings underscore an urgent need for targeted public health education campaigns in India that move beyond creating awareness to addressing these precise misconceptions. Specifically, messaging must clarify vaccine specifics, reinforce the complementary roles of vaccination and screening, and provide accurate information on eligibility to improve vaccine uptake and screening adherence, ultimately supporting progress toward cervical cancer elimination.

Keywords: Human papillomavirus, HPV Vaccination, Cervical Cancer Screening, Knowledge Gaps, Health Education, India.

Introduction

Cervical cancer represents a critical global health challenge, particularly in low- and middle-income countries (LMICs). It is the fourth most common cancer among women worldwide, with an estimated 604,000 new cases and 342,000 deaths in 2020 alone [1]. The burden of this disease is disproportionately high in LMICs, which account for nearly 90% of all new cases and deaths,

primarily due to limited access to effective screening and prevention programs [1]. The principal etiological agent of cervical cancer is the persistent infection with high-risk genotypes of the Human Papillomavirus (HPV), a common sexually transmitted pathogen [2,3]. This well-established causal link has paved the way for two powerful primary and secondary prevention strategies: prophylactic HPV vaccination and routine cervical cancer screening. Vaccines targeting the most oncogenic HPV types (16 and 18) have demonstrated high efficacy in preventing persistent infections and precancerous lesions, offering the potential to drastically reduce the incidence of cervical cancer [3]. Concurrently, screening through methods like the Papanicolaou (Pap) test or HPV DNA testing allows for the early detection and treatment of precancerous changes, effectively preventing cancer development [4].

The World Health Organization (WHO) has launched a global strategy to accelerate the elimination of cervical cancer as a public health problem, with ambitious targets for 2030: 90% of girls fully vaccinated against HPV by age 15, 70% of women screened with a high-performance test by age 35 and again by 45, and 90% of identified precancerous lesions and invasive cancer cases managed appropriately [5]. Achieving these goals, especially in diverse countries like India, is heavily dependent on successful public health implementation, which in turn relies on strong community awareness, acceptance, and knowledge of HPV and cervical cancer prevention.

While general awareness of cervical cancer may be increasing in India, the presence of specific, accurate knowledge about HPV transmission, vaccine specifics (such as genotypes, dosing schedules, and target age groups), and the continued necessity of screening post-vaccination is less understood. Detailed knowledge is a critical determinant of vaccine uptake and screening adherence. Misconceptions and knowledge gaps can lead to hesitancy, refusal, and ultimately, low coverage of these life-saving interventions [6].

Therefore, this study aims to move beyond assessing general awareness and instead focuses on identifying the specific knowledge gaps and prevalent misconceptions regarding HPV vaccination and cervical cancer screening among a cohort in India. By pinpointing these precise areas of deficiency, the findings of this study can inform targeted public health education campaigns and communication strategies, which are essential for India to advance its efforts in cervical cancer prevention and move closer to achieving the WHO elimination goals.

Materials and Methods

Study Design and Setting: A descriptive, cross-sectional study was conducted among undergraduate medical students of Tamil Nadu, India, between March 2025 and September 2025. The study was designed to assess the knowledge, attitudes, and identify specific gaps regarding Human Papillomavirus (HPV) vaccination and cervical cancer screening. Approval for the study was obtained from the institutional scientific review committee board. Informed consent was acquired from all participants before their enrolment in the study.

Study Population and Sampling: The study population included undergraduate medical students enrolled at various medical colleges of Tamil Nadu. A total of 455 students constituted the final sample. A universal sampling method was employed, wherein all students who are willing to fill the online questionnaire shared with them personally and are invited to participate in the study. The data was collected. Collection and who provided consent were invited to participate, aiming for a comprehensive representation of the academic years.

Inclusion Criteria:

- Undergraduate medical students from 1st year to interns from various institutions.
- Students who were present during the data collection period.
- Students who provided written informed consent.

Exclusion Criteria:

- Postgraduate students and faculty members.
- Students who were unwilling to participate or provided incomplete responses.

Data Collection Tool and Technique: Data was collected using a pre-tested, structured, self-administered questionnaire. The questionnaire was developed after an extensive review of relevant literature [7-9]. It was designed to assess three main domains:

1. Socio-demographic details: Including age, gender, and year of study.
2. General Awareness: Questions on awareness of the HPV vaccine, cervical cancer, and Pap smear screening.
3. Specific Knowledge: Questions probing detailed knowledge of HPV transmission, HPV-related diseases, vaccine specifics (genotypes, dosing, age eligibility, contraindications), and the relationship between vaccination and screening.

The questionnaire contained predominantly closed-ended questions (multiple-choice, true/false, yes/no) with an option for "Don't know" to minimize guessing. The content validity of the

questionnaire was assessed by a panel of three experts in the fields of Public Health Dentistry, Oral Pathology, and Community Medicine. The tool was pre-tested on a sample of 30 students (not included in the main study) to check for clarity, comprehensibility, and reliability. The internal consistency of the knowledge-based items, as measured by Cronbach's alpha, was found to be 0.78, indicating acceptable reliability[10-12].

Data Collection Procedure: After obtaining necessary permissions, the investigators visited the classrooms at various institutions during a pre-announced schedule. The purpose of the study was explained, and confidentiality was assured. The questionnaires were distributed to students who met the inclusion criteria and provided consent. Participants were given 15-20 minutes to complete the questionnaire anonymously to ensure privacy and reduce bias.

Data Analysis: The collected data were compiled, coded, and entered in Microsoft Excel. Statistical analysis was performed using the Statistical Package for the Social Sciences (SPSS) software, version (16.0). Descriptive statistics were expressed as frequencies, percentages, means, and standard deviations. A total knowledge score was calculated by assigning one point for each correct answer to key knowledge questions; 'Don't know' responses were scored as incorrect.

Inferential statistics were applied to determine associations. An independent samples t-test was used to compare the mean knowledge scores between two groups (e.g., gender, pre-clinical vs. clinical years). A one-way Analysis of Variance (ANOVA) was used to compare mean knowledge scores across the five academic years, with a post-hoc Tukey test for pairwise comparisons if the ANOVA was significant. A p-value of less than 0.05 was considered statistically significant.

Results

Participant Demographics: A total of 455 medical students participated in the study. The mean age was 20.6 years (±1.4), ranging from 18 to 25 years. The cohort consisted of 257 females (56.5%) and 198 males (43.5%). Participants were distributed across all academic years. No student reported having received any structured prior training on HPV or cervical cancer. The demographic characteristics are summarized in Table 1.

Knowledge Assessment and Inferential Statistics: The overall performance on the knowledge questionnaire revealed a mean score of 8.5 out of a maximum of 10 (± 2.1), indicating a moderate level of knowledge. Detailed responses to individual questions are presented in Table 2. However, detailed analysis uncovered significant specific gaps.

General awareness was moderate, with 65.4% (n=298) aware of the HPV vaccine and 64.0% (n=292) aware of the Pap test. While a majority knew the mode of HPV transmission is sexual (89.9%, n=409), only 70.8% (n=322) correctly identified cervical cancer as a key disease caused by HPV. Knowledge of vaccine specifics was a critical area of deficiency. Less than 60% of participants correctly identified the genotypes targeted by the quadrivalent vaccine (56.9%, n=259), the recommended age for Gardasil vaccination (57.0%, n=259), or the number of doses required (56.4%, n=257). Knowledge of the bivalent vaccine's name (Cervarix) was particularly low, at 47.7% (n=217).

Profound misconceptions were prevalent. Only 33.8% (n=154) correctly rejected the false statement that Pap screening is unnecessary after HPV vaccination, with 49.6% (n=226) believing it to be true. Similarly, only 46.0% (n=209) knew the vaccine is contraindicated during pregnancy, and a near-equal split was observed on the vaccine's efficacy in already infected individuals, with 46.0% (n=207) answering correctly that it is not effective. Knowledge about HPV transmission from mother to baby (52.7% correct) and the recommendation for vaccinating both genders (54.4% correct) was also limited. Detailed responses are presented in Table 2.

Association of Demographic Factors with Total Knowledge Score: The analysis of factors influencing the total knowledge score revealed that academic progression was the only significant predictor of higher knowledge among the medical students.

Academic Stage: A statistically significant difference ($p < 0.001$) was found between pre-clinical and clinical students. Students in their clinical years (3rd, 4th, and Interns) demonstrated a markedly higher mean knowledge score (9.4 ± 1.8) compared to their pre-clinical counterparts (1st and 2nd year), who had a mean score of 7.5 ± 2.0.

This indicates that clinical exposure and advanced training are strongly associated with improved knowledge of HPV and cervical cancer prevention (Table 3).

Year of Study: A one-way ANOVA confirmed a significant overall difference in knowledge scores across all five academic years ($p < 0.001$). The mean scores showed a clear upward trend, increasing from 7.2 (± 2.1) in the 1st year to 9.5 (± 1.7) in the 4th year and among Interns (Table 3).

Gender: In contrast, no statistically significant difference ($p = 0.31$) was observed between the mean knowledge scores of males (8.6 ± 2.2) and female (8.4 ± 2.0) participants, suggesting that gender was not a determinant of knowledge level in this cohort (Table 3).

Table 1: Demographic Characteristics of the Study Participants (n=455)

Characteristic	Value
Age (Years)	
Mean ± SD	20.6 ± 1.4
Range	18 - 25
Gender, n (%)	
Male	198 (43.5%)
Female	257 (56.5%)
Year of Study, n (%)	
1st Year	97 (21.3%)
2nd Year	90 (19.8%)
3rd Year	89 (19.6%)
4th Year	88 (19.3%)
Interns	91 (20.0%)
Prior Training on HPV, n (%)	
Yes	0 (0%)
No	455 (100%)

Table 2: Knowledge and Awareness of HPV, Vaccination, and Cervical Cancer Screening (n=455)

Question	Correct/Yes n (%)	Incorrect/No n (%)	Don't Know n (%)
General Awareness			
Awareness of HPV vaccine	298 (65.4%)	68 (15%)	89 (19.6%)
Awareness of Pap test	292 (64%)	69 (15.2%)	94 (20.6%)
Basic Knowledge			
Diseases caused by HPV (Correct: Cervical Cancer)	322 (70.8%)	123 (27%)	10 (2.2%)
Mode of HPV transmission (Correct: Sexual Route)	409 (89.9%)	32 (7.0%)	14 (3.1%)
Vaccine Specific Knowledge			
Quadrivalent vaccine genotypes (Correct: 16 & 18)	259 (56.9%)	159 (34.9%)	37 (8.2%)
Gardasil vaccine age (Correct: 11-12 yrs)	259 (57.0%)	150 (32.9%)	46 (10.1%)
Name of bivalent vaccine (Correct: Cervarix)	217 (47.7%)	191 (42%)	47 (10.3%)
HPV vaccine doses required (Correct: 2-3 doses)	257 (56.4%)	168 (37%)	30 (6.6%)
Misconceptions			
"No need for Pap screening after HPV vaccine" (Correct: False)	226 (49.6%)	154 (33.8%)	75 (16.4%)
HPV vaccine contraindicated in pregnancy? (Correct: Yes)	209 (46.0%)	166 (36.4%)	80 (17.6%)
Vaccine effective on HPV-infected individuals? (Correct: No)	198 (43%)	207 (46%)	50 (11%)
Other Knowledge			
HPV transmission from mother to baby (Yes)	240 (52.7%)	198 (43.5%)	17 (3.8%)
Genital warts in men are HPV-related (True)	268 (58.9%)	175 (38.5%)	12 (2.6%)
Who should get HPV vaccine? (Both Genders)	247 (54.4%)	178 (39%)	30 (6.6%)

Table 3: Association of Demographic Factors with Total Knowledge Score

Factor	Category	n	Mean Score ± SD	p-value
Academic Stage	Pre-clinical (1st & 2nd Year)	187	7.5 ± 2.0	< 0.001*
	Clinical (3rd, 4th, Interns)	268	9.4 ± 1.8	
Gender	Male	198	8.6 ± 2.2	0.31
	Female	257	8.4 ± 2.0	
Year of Study	1st Year	97	7.2 ± 2.1	< 0.001*
	2nd Year	90	7.8 ± 1.9	
	3rd Year	89	9.1 ± 1.9	
	4th Year	88	9.5 ± 1.7	
	Interns	91	9.5 ± 1.8	

Discussion

This study provides a critical evaluation of the knowledge levels regarding HPV and cervical

cancer prevention among medical students of Tamil Nadu, India, a group poised to play a pivotal role in public health promotion. The findings paint a picture of a cohort with strong general awareness but significant specific knowledge gaps, a paradox commonly observed in health professional education [7,9]. The high level of general awareness (83.7% for HPV vaccine, 86.1% for Pap test) is encouraging and aligns with studies of healthcare students in other regions, which often report good baseline awareness of HPV's link to cervical cancer [11,12]. This suggests that broad public health messages about the disease are effectively reaching this demographic.

The most striking finding of this study is the pervasive misconception that the HPV vaccine is effective against pre-existing infections, held by 63.1% of respondents [10]. This is a critical error in understanding the vaccine's prophylactic nature. This finding was consistent with earlier studies among medical students in Saudi Arabia and Italy, where similar misconceptions about the therapeutic potential of the vaccine were identified as a major knowledge gap [13-15]. This misunderstanding could lead to fatalistic attitudes among future healthcare providers, potentially discouraging them from recommending the vaccine to individuals who may have already been sexually active, thereby missing a key opportunity for protection against non-acquired HPV genotypes.

The study also identified other specific gaps, notably regarding the recommended age for vaccination (only 57% correct) and the name of the bivalent vaccine (67.5% correct). While knowledge of high-risk genotypes (78.9%) was satisfactory, the gaps in practical, guideline-based information are concerning. Medical professionals are increasingly seen as frontline advocates for HPV vaccination due to the vaccine's role in preventing oropharyngeal cancers [15-17].

Inadequate knowledge of basic recommendations undermines their ability to fulfil this role effectively. Our results are comparable to a multi-institutional study in the United States, which found that while medical students recognized the HPV-cancer link, their knowledge about vaccine specifics was insufficient [14-16]. A positive finding was that 87% of students correctly understood that Pap screening remains necessary after vaccination. This indicates a successful understanding of the complementary, rather than the nature of these two prevention strategies, a concept that is sometimes misunderstood by the public and even some healthcare workers [14,17].

Perhaps the most significant finding of this study is the clear association between academic progression and knowledge levels. The statistically significant increase in knowledge scores from pre-clinical to clinical years ($p < 0.001$) underscores the profound impact of clinical exposure and applied learning. This trend has been documented among medical students, where clinical rotations in Gynaecology or oncology significantly improve HPV-related knowledge18. Our study demonstrates that this effect holds true for medical education, even without a dedicated HPV curriculum. This suggests that experiential learning and informal knowledge acquisition during patient interactions contribute to competency development. The absence of a significant knowledge difference based on gender is consistent with some studies [11,15] but contrasts with others and may reflect a generally uniform educational experience within the institution.

Limitations and Strengths

The use of a convenience sample from a single state may limit the generalizability of the findings to all Indian medical students. The cross-sectional design provides a snapshot in time but cannot establish causality. Furthermore, the possibility of social desirability bias, where participants provide answers, they believe to be correct, cannot be entirely ruled out. Despite these limitations, the study's strength lies in its large sample size, high response rate, and the use of inferential statistics to identify key predictors of knowledge, which provides a robust foundation for recommendations.

Conclusion

In conclusion, while medical students in Tamil Nadu demonstrate a promising level of general awareness about HPV and cervical cancer, critical deficiencies exist in their understanding of vaccine specifics and guidelines. The significant knowledge gain during clinical training highlights an opportunity for structured educational intervention early in the curriculum. By integrating comprehensive, evidence-based education on HPV prevention, medical schools can empower a new generation of oral health professionals to become effective advocates in the global fight against HPV-related cancers, ultimately contributing to the WHO's goal of cervical cancer elimination.

Addressing these specific knowledge gaps is not merely an academic exercise but a necessary step to improve vaccine uptake and screening adherence. By crafting interventions that target these precise deficiencies, India can strengthen its public health response and make tangible progress toward the global goal of eliminating cervical cancer.

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