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Knowledge, attitude, and reasons for non-uptake of human papilloma virus vaccination among nursing students

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Abstract

Background Cervical cancer is a significant health issue, especially in low- and middle-income countries like India, where it ranks fourth among women. The Human papillomavirus (HPV) vaccination, a vital preventive measure, has suboptimal uptake among nursing students. We aimed to assess the level of knowledge, attitudes, willingness, and reasons for non-uptake of HPV vaccination among nursing students.

Methods A descriptive cross-sectional study was conducted from April to June 2023, using a total enumeration method. Data were collected from 313 nursing students using a validated questionnaire covering sociodemographic information, knowledge, attitudes, and reasons for non-uptake of HPV vaccination. Statistical analysis was performed using SPSS version 26.0. Descriptive statistics summarized the data, while binary and multivariable logistic regression analyses identified factors associated with knowledge, attitude, and willingness for HPV vaccination.

Results The mean age of the students was 20.98 ± 2.38 years, with the majority being females (81.2%) and unmarried (93.0%). About half of the participants demonstrated moderate knowledge (52.4%) and negative attitudes (50.1%) towards HPV vaccination, with none having received the vaccine. Female students had 4.24 times the odds of having good knowledge (AOR = 4.24, 95% CI = 1.66–10.80), while those pursuing a bachelor's degree exhibited 2.70 times the odds of good knowledge (AOR = 2.70, 95% CI = 1.40–5.21). In contrast, first-year students had 0.30 times the odds of having good knowledge (AOR = 0.30, 95% CI = 0.11–0.79) but displayed 4.69 times the odds of having a positive attitude (AOR = 4.69, 95% CI = 1.92–11.41). Additionally, Hindu students had 2.44 times the odds of being willing to receive the vaccine (AOR = 2.44, 95% CI = 1.15–5.20). Most participants expressed willingness to receive the vaccine (62.0%), citing reasons such as not being sexually active (35.8%) and needing more information (18.2%) for non-uptake of the vaccine.

Conclusions The study highlights gaps in knowledge and negative attitudes towards HPV vaccination among nursing students. Targeted educational interventions and policy initiatives are essential to improve awareness, promote positive attitudes, and increase HPV vaccination uptake among nursing students.

Keywords Cross-sectional studies, Health Knowledge, Attitude, Practices, Papillomavirus infection, Students, Nursing, Vaccination

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Background

Cervical cancer is a significant global public health issue, ranking as the fourth most common cancer among women. Its burden is particularly heavy in low- and middle-income countries, with China and India together accounting for over one-third of global cases. [1] In 2020, approximately 604,127 new cases and 341,831 deaths were reported worldwide due to cervical cancer, underscoring its impact on women's health [2]. Human papillomavirus (HPV) is a primary cause of cervical cancer, affecting nearly 75% of sexually active adults at some point in their lives. Despite the availability of routine Pap smear screenings and preventive vaccines, barriers to implementation persist, especially in developing countries like India, where logistical and cultural factors pose challenges [3].

India has introduced two globally licensed vaccines: Gardasil™ (a quadrivalent vaccine by Merck) and Cervarix™ (a bivalent vaccine by GlaxoSmithKline), designed to prevent HPV infections. [4] Adequate knowledge of and positive attitudes towards these vaccines are critical, particularly among nursing students, who represent the future frontline in healthcare. [5] Their ability to educate communities and advocate for public health initiatives can significantly influence vaccination rates and reduce HPV-related diseases. Nursing students equipped with comprehensive knowledge can dispel common misconceptions and promote vaccine uptake, ultimately improving public health outcomes for women. [6]

Given these challenges, there is an urgent need to develop a health promotion model focused on increasing HPV vaccine uptake. A comprehensive model could address barriers such as knowledge gaps, misconceptions, and logistical issues while empowering nursing students to advocate for vaccination in their communities. The Health Belief Model is suitable for this purpose, emphasizing perceived susceptibility, severity, benefits, barriers, cues to action, and self-efficacy, which are critical in shaping health behaviors like vaccine uptake. [7] This study aims to provide insights to inform the development of such a health model to promote HPV vaccination.

While previous studies have examined awareness and attitudes toward HPV vaccination among various student populations, limited data exists on factors influencing knowledge, attitudes, willingness to be vaccinated, and reasons for non-uptake among nursing students. [8, 9] Even with an effective vaccine, the completion rate remains suboptimal among young adults, falling short of public health targets. [10] Therefore, this study was designed to evaluate nursing students' knowledge, attitudes, willingness, and factors contributing to the non-uptake of HPV vaccination in the Indian context,

focusing on identifying key elements that could contribute to an effective health model promoting vaccination.

Methods

Study design, setting, and participants

A descriptive cross-sectional study was conducted from April to June 2023 among nursing students at a state government university in Northern India. This study aimed to assess students' knowledge, attitudes, willingness, and reasons for the non-uptake of HPV vaccination. The total enumeration method was used, and students who were available and willing to participate during the data collection period were included. Students were invited via in-person announcements made in classrooms and personal email notifications. The study's purpose, voluntary nature, and confidentiality measures were clearly explained, allowing students to ask questions before enrollment.

Sample size

The sample size was calculated using the formula, $n = \frac{Z^2 P (1 - P)}{d^2}$, where Z represents the Z-score corresponding to the confidence level, P denotes the estimated proportion of knowledge regarding HPV vaccination, and d represents the desired precision level. At a 95% Confidence Interval, the estimated proportion of knowledge was 26.5% [11], and with 5% precision, the calculated sample size was 305.

Ethical considerations

The study has ethical approval vide reference number 126/19.10.2022, and all procedures followed the guidelines of the Helsinki Declaration (2013). Written informed consent was obtained from participants after explaining the study's purpose. Participation was voluntary, and confidentiality and anonymity were ensured.

Development of the questionnaire

During the literature review, we found no standardized tools assessing knowledge, attitudes, and reasons for the non-uptake of the HPV vaccine among nursing students in India. To address this gap and align with the study's objectives, we developed a self-reported questionnaire tailored specifically to Indian nursing students. This tool was designed to capture culturally relevant insights regarding HPV vaccination, providing a more accurate reflection of the students' perspectives.

The development and validation process of the knowledge and attitude questionnaire followed a standard methodology, including a literature review, expert validation, and pilot testing. [12] Initially, a thorough literature review was conducted using medical search engines like PubMed and Google Scholar, generating 52 items

categorized into knowledge and attitude regarding HPV vaccination. The developed questionnaire underwent evaluation by five experts from diverse fields, including gynecologists public health, and nurse educators, ensuring they possessed substantial knowledge of HPV vaccination and relevant public health issues. Content validity was assessed using a 3-point Likert scale (0=not necessary, 1=useful but not essential, 2=essential) for necessity and a 4-point Likert scale (1=not relevant/ clear, 2=slightly relevant/ clear, 3=relevant/ clear and 4=very relevant/ clear) for clarity and relevance. Items scoring below an acceptable content validity index (CVI, <0.7) were discarded. The final version was approved by the research team and underwent pilot testing with 30 nursing students, confirming clarity, relevance, and acceptability without requiring revisions. The pilot study population was similar to the main study population, comprising nursing students from the same university. The pilot testing data were not included in the main study to avoid bias.

Study instrument

Four tools were employed in the study. Tool I was a sociodemographic proforma collecting information on age, gender, marital status, course, academic year, father's education, and family monthly income. Tool II comprised a knowledge questionnaire with 20 multiple-choice questions assessing knowledge across various domains relevant to HPV vaccination. These domains included cervical cancer, HPV infection prevention, transmission, existence and efficacy of HPV vaccine, appropriate age groups and target population for vaccination, route of administration, and types of vaccine available. Participants were awarded one mark for each correct response and zero marks for each incorrect response, thus total score ranging between 0 to 20.

Tool III comprised a 20-item attitude questionnaire on a 3-point Likert scale (Agree, uncertain, disagree). Participants were given three points for 'agree' and one point for 'disagree'. Tool IV explored willingness and reasons for non-uptake of the HPV Vaccine. To ensure in-depth knowledge and attitude and avoid bias, Items 5, 11, and 12 of the knowledge questionnaire and Items 4, 5, 6, 7, 8, 10, 12, 17, and 19 of the attitude questionnaire were negatively framed, and reverse scoring was applied. The Knowledge and Attitude questionnaire demonstrated good validity (CVI- 0.82–1.0) and internal consistency (Cronbach's alpha coefficient = 0.71, and 0.75 respectively).

Data collection procedure

Participants were approached after receiving a detailed explanation of the study's aims. Questionnaires were

administered after lunch, taking 25–30 min to complete. This timing aimed to accommodate students' academic schedules and maximize participation while minimizing fatigue or distraction, which could occur earlier or later in the day, thus minimizing the risk of rushed or incomplete responses. Clear instructions were provided, and researchers monitored compliance to prevent smartphone use or consultation among students. Upon completion, queries were addressed, and participants were thanked for their time and cooperation.

Statistical analysis

The collected data were coded and summarized using Microsoft Excel. Both descriptive and inferential statistics were performed using the IBM SPSS Statistics for Windows, Version 26.0 (IBM Corp., Armonk, N.Y.). Descriptive statistics included frequency, percentage, mean, and standard deviation. The reliability of the scales was evaluated using Cronbach's alpha coefficient. A two-step cluster analysis classified knowledge and attitudes regarding HPV vaccination among nursing students. The choice of similarity measure and determination of the number of clusters was based on Log-likelihood distance and Schwarz's Bayesian Information Criterion (BIC). Binary and multivariable logistic regression analyses were conducted to identify factors associated with knowledge, attitude, and willingness for HPV vaccination. Model fitness was assessed using the Hosmer–Lemeshow goodness-of-fit test, which indicated a well-fitted model (Knowledge, $p=0.228$; Attitude, $p=0.0835$; Willingness, $p=0.770$). Furthermore, all variables fulfilled the chi-square assumption, and their odds ratios were examined. Variables with a p -value less than 0.2 in the bivariable analysis were included in the multivariable analysis. Significant associations with outcome variables were determined based on a p -value less than 0.05 with a 95% confidence interval.

Results

The study included 313 nursing students. Most participants were young (86.3%, $n=270$), female (81.2%, $n=254$), Hindu (89.5%, $n=280$), unmarried (93.0%, $n=291$), pursuing a bachelor's degree in nursing (59.4%, $n=186$), and in their first academic year (37.7%, $n=118$). The mean age was 20.98 ± 2.38 years. (Table 1).

Cluster analysis divided the participants' knowledge and attitude regarding HPV vaccination into three and two groups, respectively. Silhouette's measure of cohesion and separation, which assesses how closely related objects within a cluster are, indicated strong clustering for both knowledge and attitude. Cluster 3 (23.6%, $n=74$) had the highest mean scores and was labeled as the "Good Knowledge" group, while Cluster 1 (24.0%, $n=75$)

Table 1 Socio-demographic characteristics of nursing students ($n = 313$)

	Frequency (%)
Age (years)	
Mean $\pm$ SD (Range)	20.98 $\pm$ 2.38 (18–30)
Age group (years)	
Young (18–23)	270 (86.3)
Old (24–30)	43 (13.7)
Gender	
Female	254 (81.2)
Male	59 (18.8)
Religion	
Hindu	280 (89.5)
Others	33 (10.5)
Marital status	
Unmarried	291 (93.0)
Married	22 (7.0)
Course	
Diploma in Nursing	127 (40.6)
Bachelors in Nursing	186 (59.4)
Academic Year	
First	103 (37.7)
Second	104 (33.2)
Third	75 (24.0)
Fourth	31 (19.9)
Fathers education	
Illiterate	27 (8.6)
Upto Intermediate	148 (47.3)
Graduate or above	138 (44.1)
Monthly Family Income (in Rupees)	
1000–15,000	131 (41.9)
15,001–30,000	106 (33.9)
30,001–45,000	36 (11.5)
> 50,000	40 (12.8)

had the lowest mean scores and was termed the “Poor Knowledge” group. Regarding attitude, Cluster 1 (48.9%, $n = 153$) represented the “Positive Attitude” group, and

Cluster 2 (50.1%, $n = 160$) represented the “Negative Attitude” group. (Table 2).

Table 3 shows that 62.0% of nursing students were willing to get the HPV vaccine, but none had been vaccinated. The most common source of information was healthcare professionals (27.8%, $n = 87$). The most common reason for not getting vaccinated was not being sexually active (35.8%, $n = 71$), followed by needing more information (18.2%, $n = 36$) and not knowing where to get the vaccine (11.8%, $n = 24$). The least common reasons included cultural beliefs (1.6%, $n = 5$) and the high cost of the vaccine (5.8%, $n = 18$).

In Table 4, over half of the students were concerned about their risk of HPV infection (51.1%, $n = 160$) and worried about the vaccine’s short-term side effects (50.8%, $n = 159$). Despite these concerns, three-fourths believed that the HPV vaccination could reduce the risk of infection (74.4%, $n = 233$), keep them safe and healthy (81.8%, $n = 256$), and should be included in the national immunization schedule (73.2%, $n = 229$). Moreover, 74.1% ($n = 232$) believed the vaccine would help prevent the spread of HPV to others.

Table 5 highlights factors linked with knowledge, attitude, and willingness for HPV vaccination. Female students had 4.24 times the odds of having good knowledge compared to males (AOR = 4.24, 95% CI = 1.66–10.80), meaning that the odds of good knowledge among female students were 4.24 times those of male students. Similarly, bachelor’s nursing students had 2.70 times the odds of having good knowledge compared to diploma students (AOR = 2.70, 95% CI = 1.40–5.21). First-year students had 0.30 times the odds of having good knowledge compared to fourth-year students (AOR = 0.30, 95% CI = 0.11–0.79), indicating lower odds among first-year students. For attitude, first-year students had 4.69 times the odds of a positive attitude compared to fourth-year students (AOR = 4.69, 95% CI = 1.92–11.41). Finally, Hindu students had 2.44 times the odds of willingness to get vaccinated compared to students from other religions (AOR = 2.44, 95% CI = 1.15–5.20).

Table 2 Knowledge and attitude regarding HPV vaccination among nursing students ($n = 313$)

Variable	Frequency (%)
Knowledge level	
Good	74 (23.6)
Moderate	164 (52.4)
Poor	75 (24.0)
Attitude level	
Positive	153 (48.9)
Negative	160 (50.1)

Table 3 Willingness, Source of information and Reasons for non-uptake of HPV Vaccination ($n = 313$)

	Frequency (%)
Ever vaccinated for HPV	
No	313 (100.0)
Willingness to be vaccinated	
Yes	194 (62.0)
No	119 (38.0)
Source of information	
Book or magazine	45 (14.4)
Media, Radio, Television	69 (22.0)
Family, friends or relatives	44 (14.1)
Healthcare Professionals	87 (27.8)
Teachers	68 (21.7)
Reasons for non-uptake	
Don't know where to get the vaccine	
I do not believe that I will be in danger of HPV	25 (8.0)
Need more information about the vaccine	57 (18.2)
Not sexually active	112 (35.8)
Not sure about safety of the vaccine	34 (10.9)
The vaccine is against my cultural beliefs	5 (1.6)
Too old for vaccination	25 (8.0)
Vaccine is too much expensive	18 (5.8)

Discussion

This study examined nursing students' knowledge, attitudes, and willingness regarding HPV vaccination. Key findings revealed that nearly half of the participants exhibited moderate knowledge and negative attitudes toward the HPV vaccine. Interestingly, although two-thirds expressed willingness to be vaccinated, none of the participants had received the HPV vaccine. The predominant reason for non-vaccination was the belief that it was unnecessary due to not being sexually active. Several associations from the regression analysis offered additional insights. Female nursing students had 4.24 times the odds of having good knowledge about HPV vaccination compared to males, indicating that female students had over four times the odds of good knowledge compared to males. Similarly, bachelor's nursing students had 2.70 times the odds of good knowledge compared to diploma students. First-year students had 0.30 times the odds of having good knowledge compared to fourth-year students but showed 4.69 times the odds of a positive attitude toward the vaccine. Additionally, Hindu students had 2.44 times the odds of being willing to receive the vaccine compared to students from other religions, potentially reflecting cultural influences that warrant further exploration.

The importance of HPV vaccination knowledge among nursing students cannot be overstated, as they will play a critical role in educating the public and advocating for

Table 4 Attitude towards HPV Vaccination ($n = 313$)

	Agree	Undecided	Disagree
I am susceptible to acquire HPV infection	160 (51.1)	50 (15.0)	103 (32.9)
HPV vaccine is safe and effective in preventing cervical cancer	245 (78.3)	16 (5.1)	52 (16.6)
Being vaccinated for HPV can reduce risk of having HPV infection	233 (74.4)	26 (8.3)	54 (17.3)
HPV vaccine will lead to complicated sexual activities in future	141 (45.0)	50 (16.0)	122 (39.0)
HPV vaccine will promote risky sexual behavior	123 (39.3)	37 (11.8)	153 (48.9)
HPV vaccine will encourage early sexual activity	121 (38.7)	44 (14.1)	148 (47.3)
Are you afraid of side effects of HPV vaccine like redness, pain, etc	183 (58.5)	43 (13.7)	87 (27.8)
Do you fear infertility due to HPV vaccination	145 (46.3)	31 (9.9)	137 (43.8)
Those who are multiple sexual partner would benefit from the HPV vaccine	202 (64.5)	36 (11.5)	75 (24.0)
I feel embarrassed to get HPV vaccine	96 (30.7)	46 (14.7)	171 (54.6)
I think taking vaccine will keep me safe and healthy	256 (81.8)	27 (8.6)	30 (9.6)
The cost of vaccine discourages me from taking HPV vaccine	124 (39.6)	56 (17.9)	133 (42.5)
HPV vaccine should be prescribed routinely to young population in India	222 (70.9)	34 (10.9)	57 (18.2)
I feel it is better to be vaccinated before becoming sexually active	207 (66.1)	43 (13.7)	63 (20.2)
I feel only sexually active women should take vaccine	127 (40.6)	42 (13.4)	144 (46.0)
Are you worried about short term side effects of HPV vaccine	159 (50.8)	48 (15.3)	106 (33.9)
HPV vaccine may have long term side effect on me	102 (32.6)	67 (21.4)	144 (46.0)
HPV vaccine should be included in National immunization schedule	229 (73.2)	32 (10.2)	52 (16.6)
Vaccine must be carried out only in severe disease cases	149 (47.6)	46 (14.7)	118 (37.7)
If I am vaccinated, I can protect other people by preventing spread of infection	232 (74.1)	31 (9.9)	50 (16.0)

Table 5 Factors Associated with Knowledge, Attitude and willingness regarding HPV Vaccination among nursing students

Variables	Good Knowledge			Positive Attitude			Willingness		
	n (%)	COR (95% CI)	AOR (95% CI)	n (%)	COR (95% CI)	AOR (95% CI)	n (%)	COR (95% CI)	AOR (95% CI)
Age group									
Young (18–23)	62 (83.8)	0.77 (0.37–1.58)		129 (84.3)	1.38 (0.72–2.63)		163 (84.0)	0.59 (0.20–1.19)	
Old (24–30)	12 (16.2)	1		24 (15.7)	1		31 (16.0)	1	
Gender									
Female	68 (91.9)	3.22 (1.32–7.85)*	4.24 (1.66–10.80)**	126 (82.4)	0.85 (0.48–1.51)		161 (83.3)	1.36 (0.76–2.42)	
Male	6 (8.1)	1	1	27 (17.6)	1		33 (17.0)	1	
Religion									
Hindu	69 (93.2)	1.83 (0.68–4.92)		135 (88.2)	1.28 (0.62–2.65)		181 (93.3)	2.81 (1.34–5.89)**	2.44 (1.15–5.20)*
Others	5 (6.8)	1		18 (11.8)	1		13 (6.7)	1	1
Marital status									
Unmarried	70 (94.6)	1.42 (0.46–4.35)		144 (94.1)	0.70 (0.29–1.70)		177 (91.2)	1	1
Married	4 (5.4)	1		9 (5.9)	1		17 (8.8)	2.19 (0.78–6.10)	1.87 (0.66–5.27)
Course									
Diploma	21 (28.4)	1	1	97 (63.4)	1	1	76 (39.2)	1	
Bachelors	53 (71.6)	2.01 (1.14–3.54)*	2.70 (1.40–5.21)**	56 (36.6)	0.72 (0.46–1.13)	0.69 (0.42–1.13)	118 (60.8)	1.16 (0.73–1.85)	
Academic Year									
First	14 (18.9)	0.24 (0.10–0.62)**	0.30 (0.11–0.79)*	33 (21.6)	5.18 (2.15–12.48)**	4.69 (1.92–11.41)**	68 (35.1)	2.07 (0.91–4.67)	1.84 (0.80–4.23)
Second	30 (40.5)	0.64 (0.27–1.48)	1.06 (0.42–2.70)	60 (39.2)	1.79 (0.75–4.26)	1.52 (0.62–3.73)	60 (30.9)	1.45 (0.65–3.25)	1.38 (0.61–3.14)
Third	18 (34.3)	0.50 (0.20–1.22)	1.15 (0.41–3.18)	38 (24.8)	2.38 (0.97–5.84)	1.94 (0.75–4.96)	51 (26.3)	2.26 (0.96–5.33)	1.96 (0.82–4.70)
Fourth	12 (16.2)	1	1	22 (14.4)	1	1	15 (7.7)	1	1
Fathers education									
Illiterate	7 (7.5)	1.92 (0.39–2.58)		15 (9.8)	0.77 (0.34–1.77)		20 (10.3)	1.59 (0.63–4.01)	
Upto Intermediate	38 (51.4)	1		73 (47.7)	1		95 (49.0)	1	
Graduate or above	29 (39.2)	0.77 (0.44–1.33)		65 (42.5)	1.09 (0.68–1.73)		79 (40.7)	0.74 (0.46–1.20)	
Monthly Family Income (in Rs)									
1000–15,000	23 (31.3)	0.49 (0.22–1.12)	0.65 (0.27–1.54)	63 (41.2)	1.07 (0.53–2.19)		85 (43.8)	1.23 (0.59–2.54)	
15,001–30,000	34 (45.9)	1.10 (0.50–2.42)	1.33 (0.56–3.13)	52 (34.0)	1.03 (0.50–2.14)		60 (30.9)	0.87 (0.41–1.82)	
30,001–45,000	5 (6.8)	0.37 (0.11–1.20)	0.27 (0.08–0.93)*	18 (11.8)	1.00 (0.40–2.46)		25 (12.9)	1.51 (0.58–3.91)	
>45,000	12 (16.2)	1	1	20 (13.1)	1		24 (12.4)	1	

* p -value < 0.05, ** p -value < 0.001

Abbreviations: COR Crude Odds Ratio, AOR Adjusted Odds Ratio, CI Confidence Interval

preventive measures. The finding that most students had only moderate knowledge is consistent with prior studies, which similarly found low to moderate levels of HPV-related knowledge among nursing students. [11, 13–15]

However, some studies noted higher knowledge levels among medical students and physicians. [8, 16]

A positive attitude toward HPV vaccination is essential for nurses to effectively educate patients and promote

public health. Unfortunately, this study found that most participants displayed negative attitudes toward the vaccine, which contrasts with several studies reporting positive attitudes towards HPV vaccination among healthcare students and mothers of eligible daughters. [17–19] Female medical professionals, in particular, have been found to exhibit more positive attitudes than their male counterparts. [18] Exposure to reliable, accurate information has been shown to play a key role in shaping positive attitudes, which, in turn, enhances the intention to recommend vaccination. [20]

A concerning finding in this study was the prevalent fear of HPV vaccine side effects. This fear aligns with concerns reported in other studies, particularly among newly eligible adults, where vaccine hesitancy is influenced by safety concerns. [21, 22] In contrast, studies from other cultural contexts, such as Indonesia, have found that students perceive the HPV vaccine as safe and effective. [23] These differing perceptions highlight the importance of culturally tailored communication strategies to address vaccine hesitancy.

Encouragingly, nearly three-fourths of the students in this study believed that the HPV vaccine should be included in India's National Immunisation Program. However, the high cost of the vaccine presents a significant barrier to widespread adoption, particularly in developing countries like India, where affordability is a major issue. [3]

Nurses are uniquely positioned to promote HPV vaccination, making their knowledge and attitudes toward the vaccine essential. Surprisingly, none of the nursing students in this study had received the HPV vaccine. This finding is consistent with other studies from India, which reported low vaccination rates among students. [14, 19, 24] Nevertheless, approximately two-thirds of the students in our study expressed a willingness to receive the vaccine, a finding consistent with other research. [8, 21]

The primary reason for non-vaccination was the perception that it was unnecessary for those not sexually active, followed by insufficient information about the vaccine. Barriers to vaccination, such as lack of knowledge, high costs, and concerns about safety, have been well-documented in the literature. [19, 23, 25, 26] A systematic review and meta-analysis of women in Southeast Asia and the Western Pacific highlighted the role of vaccine cost, perceived efficacy, safety, and access to information as key factors influencing vaccine acceptance. [27]

An interesting finding in this study is that female nursing students pursuing a bachelor's degree had higher odds of good knowledge about HPV vaccination. Previous studies have shown that HPV immunization rates are influenced by various factors, including age, ethnicity,

educational level, family income, perceived risk of HPV, and vaccine hesitancy. [20, 25, 28, 29] This finding suggests that demographic and educational characteristics significantly affect vaccination knowledge and attitudes.

Notably, first-year students had lower odds of possessing good knowledge about HPV vaccination, yet higher odds of having a positive attitude toward it. This discrepancy may result from limited exposure to health education early in their training, leading to less factual knowledge but more openness or enthusiasm about vaccination. As they progress through their studies and acquire more comprehensive health education, their knowledge may increase, while attitudes could shift based on clinical exposure.

While many students expressed positive beliefs about the HPV vaccine's ability to reduce infection risk, over half were concerned about susceptibility to infection and side effects. This paradox between positive beliefs and fear of side effects aligns with studies reporting vaccine hesitancy due to safety concerns. [30, 31] Such fear could hinder actual vaccine uptake, as concerns about side effects may lead to indecision or delay in seeking vaccination. Addressing these concerns through clear, evidence-based information is crucial to fostering a more informed and confident attitude toward HPV vaccination.

The association between the Hindu religion and a higher likelihood of willingness to receive the vaccine is an intriguing finding. A recent qualitative systematic review emphasized that improving vaccine acceptability requires addressing concerns about side effects, and sexuality, and providing accurate information. [32] Another study found a correlation between academic courses and attitude scores with the intention to receive the HPV vaccine. [8]

Limitations of the study

This study contributes valuable insights into the knowledge, attitudes, and reasons for non-uptake of HPV vaccination among nursing students. However, several limitations must be acknowledged. First, as a cross-sectional study, it cannot establish causal relationships between variables, limiting the ability to infer cause-and-effect connections. Additionally, the study was conducted at a single university in Northern India, with a population predominantly consisting of young, female, Hindu nursing students. This lack of diversity may restrict the generalizability of the findings to other regions or populations with different demographic, cultural, or religious contexts. Furthermore, the use of self-reported data may introduce recall or social desirability bias, wherein participants provide socially acceptable responses rather than accurate reflections of their views or experiences. Finally, although efforts were made to ensure a representative

sample, the study's reliance on total enumeration and potential non-response bias could affect the results. These limitations should be considered when interpreting the study's findings, and future research with larger, more diverse populations is recommended.

Practical implications

The findings of this study have practical implications for healthcare practice and policy. Targeted educational interventions are needed to improve HPV vaccination knowledge among nursing students, addressing misconceptions and fostering informed decision-making. Policymakers should advocate for the inclusion of HPV vaccination in national immunization programs, particularly in developing countries like India, where accessibility and affordability remain significant challenges. Healthcare professionals, particularly nurses, can utilize these findings to enhance patient education and promote HPV vaccination. Additionally, ongoing research is needed to explore barriers to vaccination and develop tailored interventions to address them, ultimately increasing vaccine acceptance and coverage rates.

Conclusions

This study highlights significant gaps in knowledge and attitudes toward HPV vaccination among nursing students, despite their potential role in promoting public health. Gender, academic year, and religious affiliation were identified as key factors influencing vaccination knowledge, attitudes, and willingness. These findings underscore the need for targeted educational programs to enhance HPV vaccination literacy among nursing students, enabling them to play a more active role in advocating for vaccination. Policymakers can use these insights to strengthen national immunization programs, addressing barriers such as cost and accessibility. Continued research is essential to develop strategies that promote HPV vaccine uptake, ultimately reducing the burden of cervical cancer and other HPV-related diseases globally.

Abbreviations

HPV	Human papillomavirus
CVI	Content validity index
BIC	Bayesian information criterion
AOR	Adjusted odds ratio
CI	Confidence interval

Acknowledgements

We express gratitude to all the study participants for their cooperation and devotion of time during the data collection period.

Authors' contributions

Study conception and design: SC, VD, SKT, PT, PP and NPSC. SC, PT, and AS collected the data. SKT analysed the data and SKT and SC drafted the manuscript. VD, PT, PP, AS, and NPSC review & editing the manuscript. All authors read and

approved the final manuscript. Additionally, SKT shares the responsibility of corresponding the manuscript.

Funding

This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

Data availability

The data that support the findings of this study are available on request from the corresponding author. The data are not publicly available due to privacy or ethical restrictions.

Declarations

Ethics approval and consent to participate

The Ethics Committee of Career College of Nursing, Lucknow reviewed and approved the study (approval number 126/19.10.2022). Written informed consent was obtained from all the eligible participants.

Consent for publication

Not applicable.

Competing interests

The authors declare no competing interests.

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Received: 13 September 2024 Accepted: 14 January 2025

Published online: 21 January 2025

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