

The Knowledge–Uptake Gap in HPV Vaccination Among Medical Students: A Mixed Methods Study from North India

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ABSTRACT

Background: HPV vaccination is an effective way to prevent cervical cancer, but vaccine uptake among medical students in India remains low despite good awareness. We aimed to assess HPV-related knowledge, vaccine awareness, attitudes and vaccination uptake among undergraduate medical students, and to understand why many informed students still remain unvaccinated.

Methods: We conducted a convergent mixed-methods cross-sectional study among MBBS students at a medical college in North India. A questionnaire was used to assess knowledge, awareness, attitudes, vaccination status and barriers to vaccination. Of about 600 eligible students, 285 completed the survey. We also conducted a focus group discussion with nine final-year students to explore personal, social and practical reasons behind vaccination decisions. Quantitative data were analysed using descriptive statistics and logistic regression, while qualitative data were analysed thematically.

Results: Knowledge and attitude were generally good. Most students had heard of HPV (96.1%), knew that HPV infection is vaccine-preventable (93.3%), and considered vaccination necessary for medical students (88.1%). However, only 29.8% had received at least one dose and 20.4% were fully vaccinated. Female students were more likely to be vaccinated (aOR 1.97, 95% CI 1.12–3.46; p=0.018). Knowledge, vaccine-awareness and attitude scores were not independently associated with uptake. The focus group showed that family influence, cost, low perceived personal risk, delay, and the gap between knowing and acting were important reasons for non-vaccination.

Conclusion: Good knowledge alone did not lead to vaccination. Easier access, clear medical advice and lower financial barriers may improve vaccine uptake among medical students.

KEYWORDS: Human papillomavirus, HPV vaccination, medical students, cervical cancer, vaccine uptake, vaccine hesitancy, mixed-methods study.

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INTRODUCTION

The principal cause of cervical cancer is persistent infection with high-risk human papilloma virus [HPV] especially oncogenic HPV types 16 and 18.^{1,2} Globally we are fighting to decrease the incidence of cervical cancer by HPV vaccination and cervical screening. However, India is yet to witness acceptance of HPV vaccination on a mass level. Although we have a lot of literature on the knowledge and awareness of cervical cancer and HPV vaccination, studies exploring the reasons for non-vaccination amongst aware population are scanty.

In this context, medical students are an important group—they receive formal teaching on HPV infection, cervical carcinogenesis and vaccination, and they will be responsible for spreading the knowledge, and counseling masses in preventive healthcare. However, the existing Indian data suggest that awareness and favourable attitudes do not necessarily translate into personal vaccination. In a 2024 study, more than 80% of healthcare students expressed favourable attitudes towards HPV vaccination, while only

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7.7% had been vaccinated.³ More recently, a multicentre study involving 1,159 medical students from seven medical colleges in Himachal Pradesh reported that 93.0% had heard of HPV, but only 11.6% had received HPV vaccination.⁴

Similar gaps have been reported elsewhere in India. A study among medical students in Barabanki, Uttar Pradesh, identified substantial deficiencies in HPV-related knowledge despite students' medical training⁵ while we have studies from Bangalore and Nagpur reporting low vaccine uptake

and persistent barriers relating to knowledge, cost and vaccine acceptance.^{6,7}

Most of these studies relied predominantly on questionnaire-based knowledge, attitude, and practice assessments. These approaches are useful in measuring the extent of the problem, but they do not give an insight into why students who understand the importance of vaccination may still postpone or decline it.

We understand that vaccination decisions may also be influenced by cost and cultural concerns. In a qualitative study of undergraduate healthcare students, Shetty *et al.* [8] found generally positive attitudes towards HPV vaccination but identified high vaccine cost and cultural concerns as important barriers; physician recommendation emerged as a potential facilitator of uptake.

In the present study, we used a convergent mixed-methods design to assess HPV-related knowledge, vaccine awareness, attitudes and vaccination uptake among undergraduate medical students at a North Indian medical college. A focus group discussion [FGD] was additionally undertaken to explore the personal, social and practical factors influencing vaccination decisions. The study aimed not only to quantify the knowledge–uptake gap, but also to examine the factors that may underlie it.

MATERIAL AND METHODS

Study design and participants

We conducted a convergent mixed-method cross-sectional study among undergraduate MBBS students at the Career Institute of Medical Sciences and Hospital, Lucknow, Uttar Pradesh. The study was approved by the Institutional Ethics Committee. All participants gave written informed consent, participation was voluntary, and responses were kept confidential and anonymous. Data were collected between 1 July and 16 August 2026. All students enrolled in the MBBS programme were eligible to participate. With approximately 150 students in each academic year, the total eligible population was about 600. Invitations were circulated through the official class of WhatsApp groups. Of these students, 285 completed the questionnaire, corresponding to a response rate of 47.5%.

Quantitative component

The questionnaire was adapted from previously published work on HPV knowledge, attitudes and vaccination practices.³ Before use, three faculty members from the Medical Education Unit reviewed it for face validity. It was then pilot tested among 10 MBBS students to check-out clarity and comprehension; these responses were not included in the final analysis. The survey was administered through Google Forms and collected information on demographic characteristics, knowledge of HPV, awareness of the vaccine, attitudes towards vaccination, vaccination status, reasons for non-vaccination and factors that might

encourage uptake. For the main analysis, vaccine uptake was defined as having received at least one dose. Students who had received either one dose or a complete course were therefore classified as having initiated vaccination, while complete vaccination was reported separately.

Scoring of knowledge, awareness and attitudes

- I. General HPV knowledge was assessed using four questions covering previous awareness of HPV, its association with cervical cancer, recognition of viral infection as the main cause of cervical cancer, and knowledge that HPV infection can be prevented through vaccination. Each correct answer received one point, giving a total score from 0 to 4. The question asking which group was at greatest risk of cervical cancer was reported separately because the available response options did not allow a sufficiently clear correct classification.
- II. Vaccine awareness was assessed using three questions: awareness of professional recommendations for HPV vaccination, whether the vaccine was considered safe, and whether vaccination was known to reduce the risk of cervical cancer. Favourable responses were awarded one point each, producing a score from 0 to 3. Questions concerning the recommended age for vaccination and the number of doses were analysed separately because these recommendations vary according to age and guideline.
- III. Attitudes were assessed through three items: whether students considered HPV vaccination necessary for medical students, whether they would recommend the vaccine to future patients, and whether they would accept vaccination if it were offered on campus. Each favourable response was given one point, again producing a score from 0 to 3. All three composite scores were analysed as continuous variables. Multiple response questions were coded by the item. Reasons for not being vaccinated were analysed only among unvaccinated participants, whereas reported motivators were examined only among students who had received at least one dose.

Statistical analysis

Categorical variables were summarised as frequencies and percentages, while continuous variables were described using appropriate measures of central tendency and dispersion. Vaccination prevalence was reported with 95% confidence intervals. Associations between categorical variables and HPV-vaccine uptake were assessed using Pearson's chi-square test or Fisher's exact test, depending on the distribution of the data. Univariable logistic regression was first used to examine factors associated with having received at least one dose, with results reported as odds ratios and 95% confidence intervals.

A multivariable binary logistic regression model was then fitted with HPV-vaccine uptake as the dependent variable. Sex, age, residence, knowledge score, vaccine-awareness score and attitude score were included as explanatory variables. The academic year was not included in the principal model together with age because broadly reflected progression through medical training. Adjusted odds ratios with 95% confidence intervals were reported. All tests were two-sided, with $p < 0.05$ taken as statistically significant. Analyses were carried out in Python 3.13 using pandas, SciPy and statsmodels.

The relationship between willingness to receive vaccination on campus and current vaccination status was examined separately as an exploratory analysis. Since this item already contributed to the composite attitude score, it was not entered independently into the multivariable model.

Qualitative component

To explore some of the reasons behind students' vaccination decisions in greater depth, final-year MBBS students were invited to volunteer for an FGD. Nine participants were selected by simple random draw from those who volunteered. The discussion was held in the Department of Obstetrics and Gynaecology and was conducted by two faculty members who did not personally know the participants.

The session lasted approximately 45 minutes and followed a semi-structured discussion guide covering views on HPV vaccination, personal decision-making, perceived susceptibility and barriers to vaccination. The discussion was conducted in English, audio-recorded and transcribed verbatim.

The transcript was analysed inductively. The investigators first read the transcript closely to become familiar with the material, then identified initial codes and grouped related codes into broader themes. These themes were reviewed against the full transcript and refined where necessary. Representative quotations were selected to illustrate the final themes.⁹ The quantitative and qualitative findings were brought together at the interpretation stage. In particular, themes emerging from the focus group were used to help explain patterns seen in vaccine uptake, reported barriers and factors encouraging vaccination.

RESULTS

A total of 285 undergraduate medical students completed the survey, giving a response rate of 47.5%. The median age of participants was 22 years (IQR 21–23). Most respondents were female, in the second year of MBBS, unmarried, and living in hostels. The demographic profile of the sample is shown in Table 1.

HPV knowledge, vaccine awareness, attitudes and uptake

- I. Knowledge of HPV was generally high. Nearly all students had heard of HPV (96.1%), 93.3% knew that

HPV infection is vaccine-preventable, and 87.0% recognised its association with cervical cancer. The median knowledge score was 4 out of 4 (IQR 3–4), and 74.4% of participants obtained the maximum score.

- IV. Awareness of the vaccine was also high. Most students were aware of professional recommendations for HPV vaccination (84.9%), considered the vaccine safe (87.0%), and knew that vaccination reduces the risk of cervical cancer (91.6%). The median vaccine-awareness score was 3 out of 3 (IQR 3–3). Knowledge of the dosing schedule was less consistent: 44.6% selected two doses, while 29.8% were unsure how many doses were required.
- V. Attitudes towards vaccination were largely favourable. HPV vaccination was considered necessary for medical students by 88.1% of respondents, 89.1% said they would recommend it to future patients, and 77.2% said they would accept the vaccine if it were offered on campus. The median attitude score was 3 out of 3 (IQR 2–3).

Vaccination itself was much less common. Fifty-eight students (20.4%; 95% CI 16.1–25.4%) reported having completed vaccination, while a further 27 (9.5%) had received one dose. Overall, 85 students (29.8%; 95% CI 24.8–35.4%) had received at least one dose, whereas 200 students (70.2%) remained unvaccinated. Full details are presented in Table 2.

Barriers and factors encouraging vaccination

Among the 200 unvaccinated students, the most frequently reported reason for not being vaccinated was lack of awareness (44.5%). This was followed by not considering vaccination necessary (37.5%), fear of adverse effects (27.5%), high cost (15.5%), and social or cultural stigma (8.5%). Among the 85 students who had received at least one dose, doctor's advice was the most common motivator (61.2%), followed by family recommendation (54.1%). Institutional awareness programmes were reported by 20.0% and peer influence by 9.4%. When students were asked more generally about barriers, lack of knowledge (60.0%), concerns about vaccine safety (46.7%), and difficulty accessing the vaccine (40.0%) were reported most often. Awareness seminars (39.6%) and vaccination camps on campus (37.9%) were the two most commonly preferred measures for improving uptake.

Factors associated with vaccine uptake

Vaccination was more common among female than male students (35.7% vs 20.7%). In univariable analysis, female students had higher odds of having received at least one dose of HPV vaccine (OR 2.13, 95% CI 1.23–3.69; $p = 0.007$). No significant associations were found for age, residence, knowledge score, vaccine-awareness score, or attitude score.

An exploratory analysis was also carried out for willingness to receive vaccination on campus. Students who said they would accept vaccination if it were available on campus had higher existing uptake than those who were unwilling or unsure (33.2% vs 18.5%; OR 2.19, 95% CI 1.10–4.36; $p=0.025$). This item was not entered separately into the multivariable model because it was already included in the composite attitude score.

In the multivariable model, female sex remained associated with vaccine uptake (aOR 1.97, 95% CI 1.12–3.46; $p=0.018$). Age, residence, general knowledge, vaccine awareness and attitude scores were not independently associated with vaccination. The overall model was statistically significant (likelihood-ratio $p=0.039$), although the amount of variation explained by the model was small (McFadden pseudo- $R^2=0.038$). The unadjusted and adjusted estimates are shown in Table 3.

Qualitative findings

Six themes emerged from the focus group discussion: family influence on health decisions, financial barriers, a gap between theoretical knowledge and personal practice, low perceived susceptibility, denial or psychological distancing, and lack of initiative or procrastination. Representative quotations are presented in Table 4.

A recurring point in the discussion was that students could understand HPV vaccination academically without treating it as a personal priority. This was also reflected in the survey, where 37.5% of unvaccinated students said that vaccination had not seemed necessary to them. Family involvement was another prominent theme. Students described discussing vaccination with parents, while 54.1% of vaccinated students reported family recommendation as a reason for receiving the vaccine. Doctor's advice was even more common, being reported by 61.2% of vaccinated students.

Cost, access, and delay also came up repeatedly. Some participants described putting vaccination off because of expense or because it did not seem urgent. In the survey, 15.5% of unvaccinated students cited cost, while 40.0% of all respondents identified a lack of easy access as a barrier. The tendency to delay vaccination was also apparent in the contrast between the 77.2% who said they would accept the vaccine on campus and the 70.2% who were still unvaccinated at the time of the study. Figure 1 summarises the methodology.

DISCUSSION

The most striking finding in this study was not that knowledge of HPV was poor, but almost the opposite. Most students knew about HPV, understood its association with cervical cancer and were aware that vaccination could reduce that risk. Attitudes towards vaccination were also largely favourable. Yet fewer than one-third had received even one dose of the vaccine, and only around one-fifth

Table 1: Sociodemographic characteristics of study participants (N = 285).

Characteristic		n (%)
Age, years	Median (IQR)	22 (21–23)
	Range	18–29
	Mean $\pm$ SD	21.8 $\pm$ 1.7
Sex	Female	168 (58.9)
	Male	116 (40.7)
Year of study	First year	45 (15.8)
	Second year	182 (63.9)
	Third year	10 (3.5)
	Final year	47 (16.5)
Residence	Hostel	246 (86.3)
	Day scholar	39 (13.7)
Marital status	Unmarried	283 (99.3)
	Married	2 (0.7)

had completed vaccination. We therefore concluded that in our study population, knowledge of HPV and benefits of vaccination, did not necessarily lead to being vaccinated.

This gap has been observed elsewhere in India. Patel et al. reported favourable attitudes towards HPV vaccination in more than 80% of healthcare students, although only 7.7% had been vaccinated.³ More recently, Rathore et al., in a multicentre study from Himachal Pradesh, found that 93.0% of medical students had heard of HPV whereas only 11.6% had received the vaccine.⁴ Similar discrepancies between knowledge and actual practice have also been reported among young female doctors and nursing officers,¹⁰ and among medical and dental students.¹¹ The absolute vaccination rates differ considerably between studies, but the underlying pattern is familiar: awareness is much more common than vaccination.

One finding in our analysis deserves particular attention. Neither the general knowledge score, vaccine-awareness score nor attitude score was independently associated with vaccination. Rathore et al. found a somewhat different result, with higher knowledge scores associated with vaccination, although attitude was not independently associated with uptake.⁴ This difference may reflect the populations studied, the questions used and the way the scores were constructed. It would therefore be inappropriate to conclude from our findings that knowledge has no role in vaccination behaviour. Rather, once knowledge is already high—as it was in this group—the remaining differences in knowledge may tell us relatively little about who actually goes on to receive the vaccine.

This may also explain what initially appears to be a contradiction in our results. Among unvaccinated students, 'lack of awareness' was the most frequently reported reason for not being vaccinated, despite high scores on objective

Table 2: HPV-related knowledge, vaccine awareness, attitudes and vaccination uptake among study participants (N = 285).

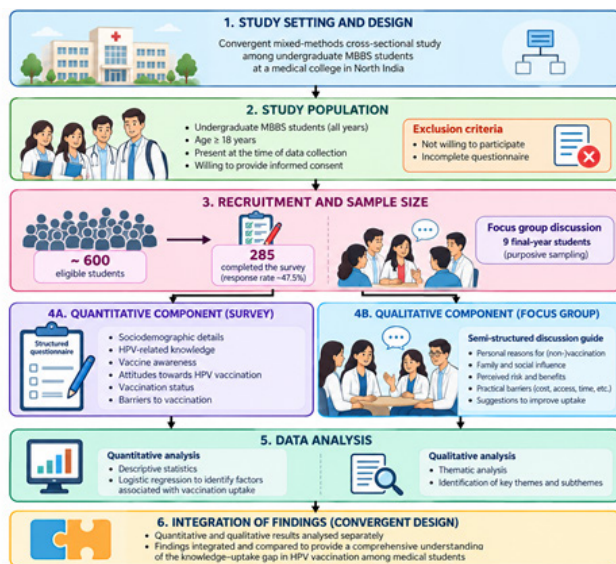
Domain	Item	n (%)
General HPV knowledge	(1) Had previously heard of HPV	(1) 274 (96.1)
	(2) Recognised an association between HPV and cervical cancer	(2) 248 (87.0)
	(3) Identified viral infection as the primary cause of cervical cancer	(3) 242 (84.9)
	(4) Knew that HPV infection is vaccine-preventable	(4) 266 (93.3)
	(5) Selected women of reproductive age as the highest-risk group*	(5) 253 (88.8)
	Knowledge score, median (IQR), range 0–4	4 (3–4)
	Maximum knowledge score (4/4)	212 (74.4)
HPV-vaccine awareness	(1) Aware that WHO/IAP recommend HPV vaccination for females	(1) 242 (84.9)
	(2) Considered HPV vaccination safe	(2) 248 (87.0)
	(3) Knew that HPV vaccination reduces the risk of cervical cancer	(3) 261 (91.6)
	Vaccine-awareness score, median (IQR), range 0–3	3 (3–3)
	Maximum awareness score (3/3)	216 (75.8)
Knowledge of vaccine schedule of Nonavalent vaccine†	(1) Selected 1 dose	(1) 13 (4.6)
	(2) Selected 2 doses	(2) 127 (44.6)
	(3) Selected 3 doses	(3) 55 (19.3)
	(4) Selected 4 doses	(4) 5 (1.8)
	(5) Unsure of number of doses	(5) 85 (29.8)
Attitudes	(1) Agreed/strongly agreed that HPV vaccination is necessary for medical students	(1) 251 (88.1)
	(2) Would recommend HPV vaccination to future patients\Would accept HPV vaccination if made available on campus	(2) 254 (89.1)
		(3) 220 (77.2)
	Attitude score, median (IQR), range 0–3	3 (2–3)
	Maximum attitude score (3/3)	206 (72.3)
Vaccination uptake	(1) Fully vaccinated	(1) 58 (20.4)
	(2) Partially vaccinated	(2) 27 (9.5)
	(3) Received ≥1 HPV-vaccine dose	(3) 85 (29.8)
	(4) Unvaccinated	(4) 200 (70.2)
*The risk-group item was reported descriptively but excluded from the composite knowledge score because the response options did not permit sufficiently unambiguous classification for scoring. †The vaccine-dose item was reported descriptively but excluded from the composite vaccine-awareness score because recommended dosing varies according to age and guideline. Abbreviations: HPV, human papillomavirus; IAP, Indian Academy of Pediatrics; IQR, interquartile range; WHO, World Health Organization.		

Table 3: Factors associated with receipt of at least one HPV-vaccine dose.

Variable	Unadjusted OR (95% CI)	p-value	Adjusted OR (95% CI)	p-value
Female sex	2.13 (1.23–3.69)	0.007	1.97 (1.12–3.46)	0.018
Age, per year	0.91 (0.78–1.06)	0.213	0.91 (0.77–1.07)	0.255
Day scholar vs hostel	1.38 (0.68–2.81)	0.374	1.61 (0.77–3.37)	0.208
Knowledge score, per point	0.94 (0.67–1.31)	0.701	0.89 (0.59–1.33)	0.576
Vaccine-awareness score, per point	1.18 (0.82–1.70)	0.379	1.18 (0.74–1.89)	0.480
Attitude score, per point	1.28 (0.92–1.79)	0.139	1.26 (0.86–1.86)	0.235
OR: odds ratio; aOR: adjusted odds ratio; CI: confidence interval.				

Table 4: Themes identified from the focus group discussion (n = 9)

Theme	Interpretation	Representative quotation
Family influence on health decisions	Participants continued to involve parents, particularly mothers, in vaccination decisions despite their medical training.	I need to ask my parents before getting vaccinated'
Financial barriers	Vaccine cost discouraged some students from independently pursuing vaccination or discussing it with their families.	The nonavalent vaccine is very costly. I dont want to burden my parents extra'
Theory–practice disconnect	Participants described knowing the academic facts about HPV without translating that knowledge into personal preventive action.	'I think when we study for exams, we dont apply it to ourselves.'
Low perceived personal susceptibility	Students recognised HPV vaccination as important in general but did not necessarily consider themselves personally at risk.	'I dont think it applies to me- I am not sexually active. Also, we dont have multiple sexual partners.'
Denial and psychological distancing	Some participants described avoiding or mentally distancing themselves from the possibility that HPV-related disease could affect them.	'Maybe we dont consider ourselves at risk'
Lack of initiative / procrastination	Vaccination was often regarded as worthwhile but repeatedly postponed in the absence of an immediate reason or opportunity to act.	'I thought of getting vaccine when it was taught in class, but I guess it just got delayed.'

**Figure 1:** Study Methodology

questions about HPV. The two findings need not be inconsistent. A student may know that HPV causes cervical cancer and that a vaccine exists yet still be uncertain about whether vaccination is personally necessary, where to obtain it, what it will cost or when it should be taken. The focus group repeatedly brought out this distinction between knowing the facts for academic purposes and applying them to oneself.

Perceived personal risk appeared to be particularly important. More than one-third of unvaccinated students said that vaccination had not seemed necessary, and several FGD participants described HPV vaccination as something they knew was important without feeling any immediate need to act on that knowledge. This fits reasonably well with the Health Belief Model, in which preventive behaviour is influenced not only by knowledge, but also by perceived susceptibility, perceived barriers, and cues to action. Studies among university students have similarly linked provider recommendation and perceived benefit with HPV-vaccine uptake.¹³

The influence of family and doctors remains important in our social milieu. More than half of vaccinated students reported family recommendation as a reason for vaccination, while advice from a doctor was the most common reported motivator. The FGD suggested that medical training did not necessarily remove the family from personal health decisions; some students continued to discuss vaccination with parents before acting. Shetty et al. identified physician recommendation as an important facilitator among healthcare students,[8] while research among young adults in rural Mysore has described the importance of family support, peer influence and perceived HPV risk.¹²

There were also quite ordinary practical reasons for the delay. Cost appeared both in the survey and in the FGD,

and 40.0% of respondents identified difficulty of access as a barrier. These findings are in keeping with previous Indian studies reporting cost, cultural concerns and accessibility as obstacles to HPV vaccination.^{6,8,12} Of particular interest, 77.2% of students said that they would accept the vaccine if it were available on campus, even though 70.2% were currently unvaccinated. We would be cautious about reading too much into this single item, but the finding suggests that some of the gap between intention and vaccination may simply lie in making vaccination easy enough to obtain.

Female students were almost twice as likely as male students to have received HPV vaccination after adjustment. Rathore et al. also reported an independent association between female sex and vaccination,^[4] and greater vaccination intention among women has been described in qualitative research involving Indian healthcare students.⁸ One possible explanation is the long-standing presentation of HPV vaccination primarily in relation to cervical-cancer prevention, which may make the vaccine seem more immediately relevant to women. Our study, however, was not designed to establish why this difference exists, and the finding should be interpreted accordingly.

Our results therefore point to a problem that is somewhat different from a simple lack of information. These students were, for the most part, already knowledgeable and favourably disposed towards HPV vaccination. What appeared to stand between knowledge and action were questions of personal relevance, family and medical advice, cost, access and, in some cases, simple postponement. This has practical implications. Further teaching about HPV may still have value, but teaching alone is unlikely to address all of these barriers. A clear recommendation from healthcare providers, easier access to vaccination within the medical college and attention to cost may have a more immediate effect on uptake. Similar institution-based and cost-sensitive approaches have been suggested in other Indian studies.^{4,6,11}

STRENGTHS AND LIMITATIONS

The mixed-methods approach was useful because the FGD helped us make sense of findings that the survey alone could only describe. It also allowed us to examine whether differences in knowledge, awareness and attitudes were reflected in actual vaccination behaviour. There are, however, important limitations. The study was conducted at a single institution, only 47.5% of eligible students responded, and participation varied considerably between academic years, so the sample may not fully represent the wider student body. Because the study was cross-sectional, we cannot determine whether the factors identified actually caused differences in vaccine uptake, and vaccination status depended on students' own reporting. The qualitative component was also small and limited to nine final-year students; it was intended to help interpret the survey's

findings rather than represent the views of students across all years. Finally, the regression model explained only a small proportion of the variation in vaccination uptake. This suggests that some influences on vaccination decisions—particularly behavioural, social or practical ones—were not captured by the questionnaire.

CONCLUSION

Although most students were well informed about HPV and viewed vaccination favourably, this did not translate into high vaccine uptake. Only 29.8% had received at least one dose and 20.4% were fully vaccinated. Knowledge, vaccine awareness and attitude scores were not independently associated with uptake, while female students were more likely to have been vaccinated. The focus group helped explain part of this gap: students described low perceived personal risk, family influence, cost, difficulty accessing the vaccine and simply putting vaccination off. In this setting, further classroom teaching alone is unlikely to make much difference. Easier access to vaccination on campus, clearer recommendations from healthcare providers and lower financial barriers may be more effective.

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