

PREVALENCE AND DETERMINANTS OF VACCINE HESITANCY TOWARDS HUMAN PAPILLOMAVIRUS VACCINE AMONG CAREGIVERS OF GIRL CHILDREN AGED 9–14 YEARS ATTENDING THE OUTPATIENT CLINIC IN ANAKAPUTHUR, CHENGALPATTU DISTRICT, TAMIL NADU

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ABSTRACT

Background: Human papillomavirus (HPV) vaccination is an important strategy for preventing HPV-related diseases, including cervical cancer. However, vaccine hesitancy among parents and caregivers may limit vaccination uptake. This study assessed the prevalence and determinants of HPV vaccine hesitancy among caregivers of girls aged 9–14 years.

Methods: A facility-based cross-sectional study was conducted among 250 parents or primary caregivers of girls aged 9–14 years attending the outpatient department of Anakaputhur Primary Health Centre, Chengalpattu district, Tamil Nadu. Participants were recruited using consecutive sampling. Data were collected using a pretested, semi-structured, interviewer-administered questionnaire covering sociodemographic characteristics, knowledge regarding HPV and HPV vaccination, sources of information, vaccination willingness, reasons for hesitancy and the five domains of the 5C psychological antecedents of vaccination. Vaccine hesitancy was defined as being hesitant or refusing vaccination. Associations were assessed using the chi-square test, independent-samples t-test and multivariable binary logistic regression.

Results: Among 250 caregivers, 179 (71.6%) were willing to vaccinate their daughters, 51 (20.4%) were hesitant and 20 (8.0%) refused vaccination, resulting in an overall vaccine hesitancy prevalence of 28.4%. Good knowledge was observed in 87 (34.8%) participants, moderate knowledge in 131 (52.4%) and poor knowledge in 32 (12.8%). Educational status, knowledge level and source of information were significantly associated with hesitancy on bivariate analysis. Healthcare providers were the most commonly reported source of information (36.0%). Insufficient information was the leading reason for hesitancy (28.2%), followed by safety concerns and cost concerns (16.9% each). Compared with non-hesitant caregivers, hesitant caregivers had significantly lower confidence and collective responsibility scores and higher complacency, constraints and calculation scores (all $p < 0.001$). In multivariable analysis, absence of prior information (adjusted odds ratio [AOR] 7.62; 95% confidence interval [CI] 1.52–38.29), higher complacency (AOR 7.91; 95% CI 3.70–16.89) and greater perceived constraints (AOR 6.33; 95% CI 3.05–13.16) were independently associated with higher odds of hesitancy, whereas higher confidence was associated with lower odds (AOR 0.14; 95% CI 0.06–0.30). Knowledge score did not reach statistical significance after adjustment ($p = 0.053$).

Conclusion: HPV vaccine hesitancy affected more than one-fourth of caregivers and was associated with information gaps and psychological determinants of vaccination. Healthcare-provider-led counselling, reliable vaccine information, communication addressing vaccine safety and perceived necessity, and measures to reduce practical barriers may help improve caregiver acceptance of HPV vaccination.

KEYWORDS: Papillomavirus vaccines; Vaccination hesitancy; Caregivers; Uterine cervical neoplasms; Adolescent; India.

INTRODUCTION

Cervical cancer remains a major public health concern and is one of the most important preventable cancers affecting women worldwide. It develops predominantly as a consequence of persistent infection with high-risk (oncogenic) human papillomavirus (HPV) types. Despite the availability of effective preventive measures, cervical cancer continues to contribute substantially to cancer morbidity and mortality, particularly in low- and middle-income countries. The continuing global burden has reinforced the importance of strengthening primary prevention through HPV vaccination alongside screening and treatment services.[1]

The burden of cervical cancer is particularly relevant to India, which contributes substantially to the global number of cervical cancer cases. According to the International Agency for Research on Cancer (IARC) GLOBOCAN 2022 estimates, India recorded an estimated 127,526 new cases of cervical cancer, accounting for a considerable proportion of cancers occurring among women in the country. Cervical cancer therefore remains an important public health priority in

India, particularly because a large proportion of the disease burden can potentially be prevented through vaccination and effective screening.[2]

HPV vaccination represents a major component of cervical cancer prevention. The WHO recommends HPV vaccination primarily for adolescent girls because vaccination before exposure to HPV provides the greatest preventive benefit. Girls aged 9–14 years constitute the primary target population for HPV vaccination, and WHO recommendations permit either a one-dose or two-dose schedule depending on the vaccination strategy and programme context. The introduction and expansion of HPV vaccination among adolescent girls therefore provides an important opportunity to reduce future HPV infection and cervical cancer burden.[3]

The importance of HPV vaccination extends beyond individual protection and forms a central component of the global cervical cancer elimination strategy. The WHO Global Strategy to Accelerate the Elimination of Cervical Cancer as a Public Health Problem established the 90–70–90 targets, including the goal that 90% of girls should be fully vaccinated with the HPV vaccine by 15 years of age. Achieving high vaccination coverage among adolescent girls is therefore essential for progressing towards cervical cancer elimination, particularly in countries with a substantial existing disease burden.[4]

Human papillomavirus is a common sexually transmitted infection, and persistent infection with high-risk HPV types is responsible for the development of cervical cancer and several other anogenital and oropharyngeal malignancies. Although most HPV infections are transient and are cleared by the immune system, persistent infection with oncogenic HPV types can result in cervical precancer and, subsequently, invasive cervical cancer. Prevention of HPV infection through vaccination before exposure is consequently an important public health intervention.[5]

In India, HPV vaccination has progressively moved from limited demonstration and state-level initiatives towards broader national implementation.[6,7] In 2026, the Government of India initiated a national HPV vaccination campaign for eligible adolescent girls. According to the Ministry of Health and Family Welfare, more than 80 lakh HPV vaccine doses had been administered by 11 September 2026, representing an important expansion of HPV vaccination within the country's cervical cancer prevention programme.[8] With increasing availability of HPV vaccination, achieving adequate vaccine uptake depends not only on vaccine availability but also on acceptance by parents and caregivers.

Vaccine hesitancy is an important barrier to achieving high vaccination coverage. The Strategic Advisory Group of Experts on Immunization (SAGE) defined vaccine hesitancy as the delay in acceptance or refusal of vaccination despite availability of vaccination services. Vaccine hesitancy is considered to be complex and context-specific, varying according to factors such as confidence in vaccines, perceived disease risk, accessibility, social influences and the surrounding healthcare environment.[9] In the context of HPV vaccination, these factors may be particularly relevant because vaccination is recommended during early adolescence and the decision is frequently made by parents or caregivers.

To understand the psychological factors underlying vaccination behaviour, the 5C model describes five major psychological antecedents of vaccination: confidence, complacency, constraints, calculation and collective responsibility. Confidence relates to trust in vaccines and vaccination providers; complacency reflects perceived lack of need for vaccination; constraints refer to practical barriers; calculation represents extensive information searching; and collective responsibility reflects willingness to protect others through vaccination. The 5C framework therefore provides a structured approach for examining factors that may contribute to HPV vaccine hesitancy among caregivers.[10]

Despite increasing availability of HPV vaccination, caregiver acceptance remains critical for vaccination of girls aged 9–14 years. Understanding the extent of vaccine hesitancy and the factors contributing to it can help identify potentially modifiable barriers to vaccination. Therefore, the present study aims to assess the prevalence and determinants of HPV vaccine hesitancy among caregivers of girl children aged 9–14 years attending the outpatient clinic in Anakaputhur, Chengalpattu district, Tamil Nadu. The study focuses on caregiver-related factors and provides locally relevant evidence regarding HPV vaccine hesitancy in the context of increasing HPV vaccination efforts in India.

METHODOLOGY

The present study was conducted as a facility-based cross-sectional study to assess the prevalence and determinants of vaccine hesitancy towards human papillomavirus (HPV) vaccination among parents or primary caregivers of girl children aged 9–14 years attending the outpatient department of Anakaputhur Primary Health Centre, Chengalpattu district, Tamil Nadu. The study was conducted over a period of four months, from July 2026 to October 2026. The study population comprised parents or primary caregivers of girls aged 9–14 years who were residents of the Anakaputhur PHC service area and attended the outpatient department for any health-related complaint. Each eligible participant was interviewed only once during the study period. Information regarding sociodemographic characteristics, knowledge regarding HPV and HPV vaccination, sources of vaccine-related information, psychological antecedents of vaccination, willingness to receive HPV vaccination and reasons for vaccine acceptance or hesitancy was collected.

Participants were recruited using a consecutive sampling technique. Parents or primary caregivers of girls aged 9–14 years attending the outpatient department were screened for eligibility, and those fulfilling the predefined eligibility criteria and willing to participate were consecutively recruited until the required sample size was achieved. The sample size was calculated using the formula $n = 4pq/d^2$, where n represented the required sample size, p represented the anticipated prevalence of vaccine hesitancy, q represented $100 - p$, and d represented the absolute precision. In the absence of a reliable local estimate of HPV vaccine hesitancy, a prevalence of 50% was assumed, with a 95% confidence level and 7% absolute precision. Accordingly, the calculated sample size was $n = (4 \times 50 \times 50)/(7^2) = 10000/49 = 204.08$, giving a minimum sample size of 204 participants. After allowing for 10% non-response or incomplete responses ($204 \times 1.1 = 224.4$), the adjusted sample size was 225 participants. The final sample size was increased to 250 participants.

Parents or primary caregivers of girl children aged 9–14 years were included if they had been residents of the study area for at least six months and were willing to participate in the study. A primary caregiver was defined as the parent or

relative (such as a grandparent) primarily responsible for the girl's day-to-day care and health-care decisions. Written informed consent was obtained before enrolment. Parents or primary caregivers of girls aged 9–14 years who had already received HPV vaccination were excluded from the study. Individuals with cognitive impairment or communication difficulties that prevented meaningful participation in the interview were also excluded, as were temporary residents or visitors who did not satisfy the specified residency requirement.

Ethical approval was obtained from the Institutional Ethics Committee of Sree Balaji Medical College & Hospital, Chennai, before the commencement of the study. The purpose of the study was explained to all participants in Tamil or English, written informed consent was obtained, and the confidentiality of the information collected was maintained throughout the study.

Data were collected using a pretested, semi-structured, interviewer-administered questionnaire prepared in English and translated into Tamil using forward and backward translation. The questionnaire consisted of sections covering participant identification details, sociodemographic characteristics, knowledge regarding HPV and HPV vaccination, sources of vaccine-related information, psychological antecedents of vaccination, willingness to receive HPV vaccination and reasons for vaccine acceptance or hesitancy. Knowledge regarding HPV infection and HPV vaccination was assessed using 10 questions; each correct response was scored 1 and each incorrect or “don’t know” response 0, giving a total score of 0–10. Knowledge was categorised as poor (0–3), moderate (4–6) or good (7–10). Psychological antecedents of vaccination were assessed using the 5C scale developed by Betsch et al.,[10] adapted for HPV vaccination, which evaluates five domains: confidence, complacency, constraints, calculation and collective responsibility. Responses were recorded on a 5-point Likert scale (1 = strongly disagree to 5 = strongly agree), and each domain score was calculated as the mean of its item responses (range 1–5).

The primary outcome of the study was vaccine hesitancy towards HPV vaccination. Based on their stated willingness to vaccinate their eligible daughter, participants were categorized as willing to vaccinate, hesitant to vaccinate or refusing vaccination. The secondary outcomes included the scores of the five 5C domains, knowledge regarding HPV vaccination, and sociodemographic and behavioural factors associated with vaccine hesitancy. The independent variables assessed included caregiver age, educational status, occupation, socioeconomic status, knowledge level and score, source of information and individual 5C domain scores. Reasons for vaccine acceptance, uncertainty or refusal were also documented to identify the factors influencing caregiver decision-making.

Statistical analysis: Data were entered in Microsoft Excel and analysed using IBM SPSS Statistics version 26. Categorical variables were summarised as frequencies and percentages and continuous variables as mean $\pm$ standard deviation. The prevalence of vaccine hesitancy was reported with its exact (Clopper–Pearson) 95% confidence interval. Vaccine hesitancy was analysed as a binary outcome (hesitant or refusing versus willing). Associations between categorical variables and hesitancy were tested using the chi-square test, and crude odds ratios (COR) with 95% confidence intervals (CI) were calculated. Age and 5C domain scores were compared between hesitant and non-hesitant caregivers using the independent-samples t-test. Variables significantly associated with hesitancy on bivariate analysis were considered for multivariable binary logistic regression, and the final model was derived using backward stepwise (likelihood-ratio) elimination. Adjusted odds ratios (AOR) with 95% CI were reported, and model fit was assessed using the likelihood-ratio test and Nagelkerke R². A p-value <0.05 was considered statistically significant.

RESULTS

A total of 250 eligible caregivers were included in the analysis. The overall prevalence of HPV vaccine hesitancy, defined as participants who were either hesitant or refusing vaccination, was 28.4% (71/250). Among the participants, 179 (71.6%) were willing to vaccinate their daughters, 51 (20.4%) were hesitant, and 20 (8.0%) refused vaccination.

Table 1. Sociodemographic characteristics of study participants (n=250)

Sociodemographic characteristic	Category	n	%
Age group (years)	28–34	78	31.2
	35–44	103	41.2
	45–55	69	27.6
Age, mean $\pm$ SD	—	39.84 $\pm$ 8.83	—
Educational status	Primary/Secondary	47	18.8
	Higher secondary	66	26.4
	Graduate	98	39.2
	Postgraduate	39	15.6
Occupation	Homemaker	123	49.2
	Employed	73	29.2
	Self-employed	35	14.0
	Other	19	7.6
Socioeconomic status	Lower	41	16.4
	Middle	158	63.2
	Upper	51	20.4

Caregivers included mothers, fathers and other primary caregivers (e.g., grandparents) of girls aged 9–14 years.

The mean age of participants was 39.84 ± 8.83 years, and the largest proportion of caregivers were aged 35–44 years (41.2%). Graduates constituted the largest educational group (39.2%), while homemakers accounted for nearly half of the study population (49.2%). The majority of participants belonged to the middle socioeconomic group (63.2%).

Table 2. Knowledge regarding HPV infection and HPV vaccination among participants (n=250)

Knowledge category	Score range	n	%
Poor knowledge	0–3	32	12.8
Moderate knowledge	4–6	131	52.4
Good knowledge	7–10	87	34.8
Total	—	250	100.0

Knowledge parameter Mean $\pm$ SD

Overall knowledge score 5.62 ± 2.04

Among the participants, 87 (34.8%) had good knowledge regarding HPV and HPV vaccination, while 131 (52.4%) had moderate knowledge and 32 (12.8%) had poor knowledge. The overall mean knowledge score was 5.62 ± 2.04 .

Table 3. Willingness towards HPV vaccination among caregivers (n=250)

Vaccination decision	n	%
Willing to vaccinate	179	71.6
Hesitant to vaccinate	51	20.4
Refusing vaccination	20	8.0
Total	250	100.0

The overall prevalence of HPV vaccine hesitancy was 28.4% (95% CI 22.9–34.4%). Of the 250 participants, 20 (8.0%) were classified as refusing HPV vaccination, whereas 51 (20.4%) were uncertain or hesitant but had not completely refused vaccination.

Table 4. Sources of HPV vaccine information and reported reasons for hesitancy

A. Source of information among all participants (n=250)

Primary source of HPV vaccine information	n	%
Healthcare provider	90	36.0
Social media/internet	74	29.6
Friends/family	37	14.8
Television/print media	26	10.4
No prior information	23	9.2
Total	250	100.0

B. Reasons for hesitancy among hesitant caregivers (n=71)

Reported reason	n	%
Insufficient information	20	28.2
Safety concerns	12	16.9
Cost concerns	12	16.9
Low perceived need	11	15.5
Fear of side effects	11	15.5
Access/inconvenience	5	7.0
Total	71	100.0

Healthcare providers were the most commonly reported source of HPV vaccine information (36.0%), followed by social media/internet sources (29.6%). Among caregivers who were hesitant, insufficient information was the most frequently reported reason (28.2%), followed by safety concerns and cost concerns (16.9% each) (Figure 1).

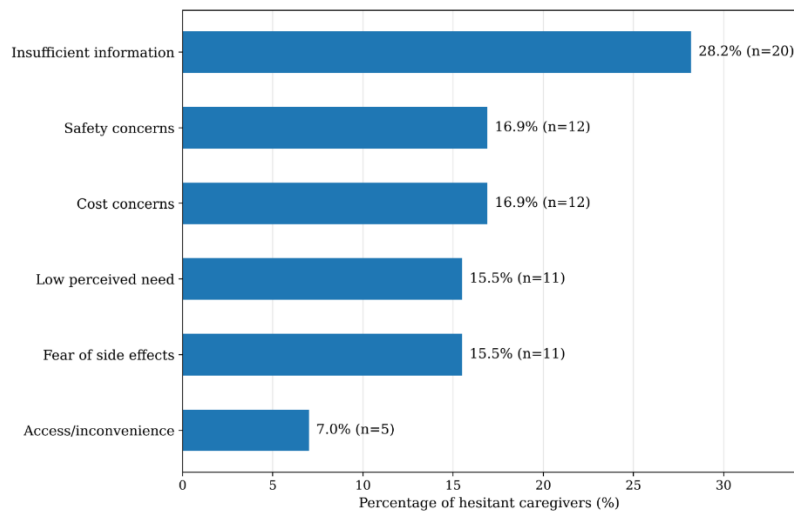


Figure 1. Reasons for HPV vaccine hesitancy among hesitant caregivers (n=71)

Table 5. Bivariate analysis of sociodemographic characteristics, knowledge, information sources and 5C domains associated with HPV vaccine hesitancy (n=250)

Categorical variables

Category	Hesitant n (%)	Non-hesitant n (%)	COR (95% CI)	χ^2 (df); p-value
Education				
Primary/Secondary	20 (42.6)	27 (57.4)	3.39 (1.24–9.22)	8.28 (3); 0.041*
Higher secondary	21 (31.8)	45 (68.2)	2.13 (0.81–5.62)	
Graduate	23 (23.5)	75 (76.5)	1.40 (0.55–3.60)	
Postgraduate	7 (17.9)	32 (82.1)	1 (Ref)	
Occupation				
Homemaker	38 (30.9)	85 (69.1)	1 (Ref)	0.74 (3); 0.863
Employed	19 (26.0)	54 (74.0)	0.79 (0.41–1.50)	
Self-employed	9 (25.7)	26 (74.3)	0.77 (0.33–1.81)	
Other	5 (26.3)	14 (73.7)	0.80 (0.27–2.38)	
Socioeconomic status				
Lower	14 (34.1)	27 (65.9)	2.13 (0.83–5.47)	2.75 (2); 0.253
Middle	47 (29.7)	111 (70.3)	1.74 (0.80–3.75)	
Upper	10 (19.6)	41 (80.4)	1 (Ref)	
Knowledge level				
Poor	15 (46.9)	17 (53.1)	3.63 (1.52–8.70)	8.85 (2); 0.012*
Moderate	39 (29.8)	92 (70.2)	1.75 (0.91–3.34)	
Good	17 (19.5)	70 (80.5)	1 (Ref)	
Information source				
Healthcare provider	23 (25.6)	67 (74.4)	1 (Ref)	17.94 (4); 0.001*
Social media/internet	13 (17.6)	61 (82.4)	0.62 (0.29–1.33)	
Friends/family	16 (43.2)	21 (56.8)	2.22 (0.99–4.96)	
Television/print	6 (23.1)	20 (76.9)	0.87 (0.31–2.44)	
No prior information	13 (56.5)	10 (43.5)	3.79 (1.46–9.80)	

B. Continuous variables

Variable	Hesitant (n=71) Mean $\pm$ SD	Non-hesitant (n=179) Mean $\pm$ SD	t	p-value
Age (years)	39.38 $\pm$ 8.76	40.02 $\pm$ 8.87	−0.52	0.606
Confidence	3.00 $\pm$ 0.66	3.74 $\pm$ 0.64	−8.17	<0.001*
Complacency	3.09 $\pm$ 0.70	2.15 $\pm$ 0.68	9.77	<0.001*
Constraints	2.94 $\pm$ 0.70	2.08 $\pm$ 0.67	9.04	<0.001*

Calculation	3.29 ± 0.75	2.70 ± 0.69	5.95	<0.001*
Collective responsibility	3.42 ± 0.79	3.79 ± 0.63	-3.89	<0.001*

Vaccine hesitancy = hesitant or refusing vaccination. COR, crude odds ratio; CI, confidence interval; Ref, reference category. Row percentages are shown. Panel A: chi-square test; Panel B: independent-samples t-test. 5C domain scores range from 1 to 5. *p<0.05.

On bivariate analysis, educational status (p=0.041), knowledge level (p=0.012) and source of HPV vaccine information (p=0.001) were significantly associated with vaccine hesitancy. Hesitancy declined progressively with education, from 42.6% among caregivers with primary/secondary education to 17.9% among postgraduates (COR 3.39; 95% CI 1.24–9.22). Caregivers with poor knowledge had higher odds of hesitancy than those with good knowledge (COR 3.63; 95% CI 1.52–8.70), and hesitancy was highest among caregivers with no prior information (56.5%; COR 3.79; 95% CI 1.46–9.80 versus healthcare provider) (Figure 2). Age, occupation and socioeconomic status were not significantly associated with hesitancy. Hesitant caregivers had significantly lower confidence and collective responsibility scores and higher complacency, constraints and calculation scores than non-hesitant caregivers (all p<0.001). The overall mean scores of the 5C domains are shown in Figure 3.

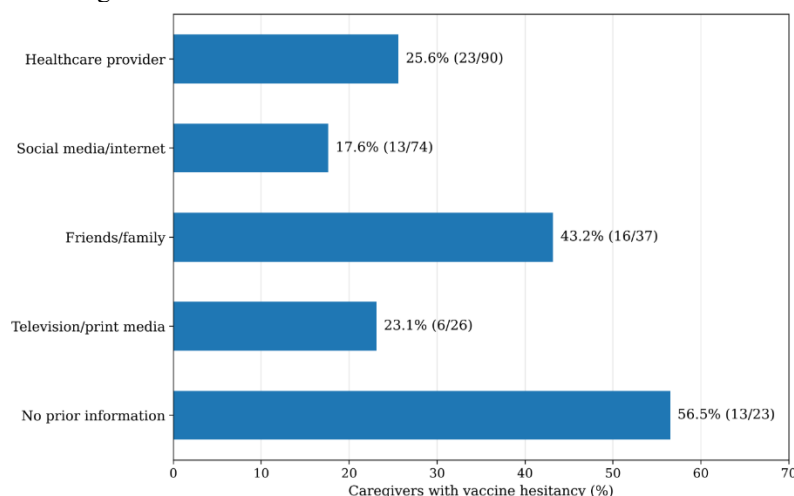


Figure 2. Prevalence of HPV vaccine hesitancy according to primary source of HPV vaccine information (n=250)

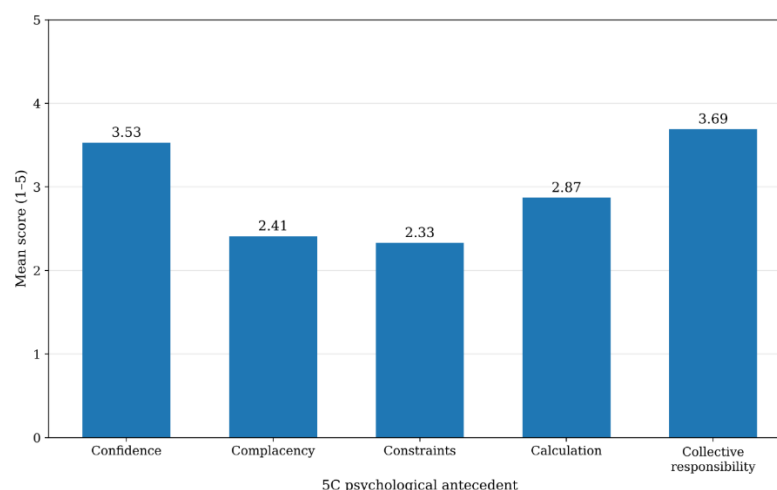


Figure 3. Mean scores of the 5C psychological antecedents of vaccination among caregivers (n=250). Scores range from 1 to 5; higher confidence and collective responsibility scores indicate more favourable antecedents, whereas higher complacency, constraints and calculation scores indicate greater barriers to vaccination.

Table 6. Multivariable logistic regression analysis of independent predictors of HPV vaccine hesitancy

Predictor	Adjusted OR	95% CI	p-value
Knowledge score	0.82	0.67–1.00	0.053
No prior information regarding HPV vaccine	7.62	1.52–38.29	0.014
Confidence score	0.14	0.06–0.30	<0.001
Complacency score	7.91	3.70–16.89	<0.001
Constraints score	6.33	3.05–13.16	<0.001

Model statistics: Nagelkerke $R^2 = 0.56$; likelihood-ratio test p <0.001.

AOR, adjusted odds ratio; CI, confidence interval. Reference for prior information: any prior source of information. The wide CI for no prior information reflects the small number of caregivers in this category (n=23). In the multivariable logistic regression model, absence of prior information regarding HPV vaccination, lower confidence, higher complacency and greater perceived constraints were independently associated with HPV vaccine hesitancy. Caregivers with no prior information had 7.62 times higher adjusted odds of hesitancy. Each one-point increase in the confidence score was associated with lower odds of hesitancy, whereas increasing complacency and constraints scores were associated with substantially higher odds. The wide confidence interval for absence of prior information reflects the small subgroup (n=23) and indicates an imprecise estimate, although the direction of association was consistent with the crude analysis (COR 3.79; 95% CI 1.46–9.80). Knowledge score showed a borderline inverse association after adjustment (p=0.053).

DISCUSSION

In the present study, the prevalence of human papillomavirus (HPV) vaccine hesitancy among caregivers of girls aged 9–14 years was 28.4% (71/250). Although 71.6% of caregivers expressed willingness to vaccinate their daughters, only 34.8% demonstrated good knowledge regarding HPV infection and vaccination, while 52.4% had moderate knowledge and 12.8% had poor knowledge. Educational status, knowledge level and source of information were significantly associated with hesitancy on bivariate analysis. However, multivariable analysis identified absence of prior information, lower confidence, higher complacency and greater perceived constraints as independent determinants of hesitancy. These findings indicate that HPV vaccine hesitancy is influenced by a combination of informational, educational and psychological factors rather than by demographic characteristics alone.

The willingness to vaccinate observed in the present study (71.6%) was comparable to the 72.7% reported by Singh et al. in an Indian community-based study, although knowledge regarding HPV vaccination was limited in their study as well. Higher educational attainment was associated with greater acceptability in their findings.[11] Similarly, the present study demonstrated a progressive decline in hesitancy with increasing educational status, from 42.6% among caregivers with primary or secondary education to 17.9% among those with postgraduate education. This association was statistically significant on bivariate analysis (p=0.041). However, educational status was not retained as an independent determinant in the multivariable model. This suggests that the relationship between education and hesitancy may partly reflect differences in information exposure, vaccine confidence and other behavioural factors rather than an independent effect of education alone. Previous Indian studies have also documented gaps in HPV-related knowledge. Jawahar et al. reported limited parental awareness of HPV infection and its vaccine,[12] while studies from North India and rural Kerala identified incomplete knowledge, misconceptions and concerns regarding vaccine safety.[13,14] The predominance of moderate knowledge in the present study and the identification of insufficient information as the leading reported reason for hesitancy further emphasise the need for accessible and understandable vaccine education. Studies from Saudi Arabia and Nigeria have similarly examined parental knowledge, perceptions, hesitancy and acceptance of HPV vaccination, indicating that these determinants are relevant across diverse settings.[15–18]

Knowledge regarding HPV vaccination was significantly associated with hesitancy on bivariate analysis (p=0.012). Caregivers with poor knowledge demonstrated higher odds of hesitancy than those with good knowledge (COR 3.63; 95% CI 1.52–8.70). Hesitancy was observed in 46.9% of caregivers with poor knowledge, compared with 19.5% of those with good knowledge. Nevertheless, the adjusted association between knowledge score and hesitancy did not reach conventional statistical significance in the multivariable model (AOR 0.82; 95% CI 0.67–1.00; p=0.053). This finding is important because it suggests that knowledge alone may not adequately explain vaccination decisions. Accurate information may facilitate informed decision-making, but its influence may depend on whether caregivers trust the vaccine, perceive HPV vaccination as necessary and consider vaccination practically accessible. The findings therefore support combining educational interventions with measures that address confidence, perceived need and practical barriers. The source of HPV vaccine information was also significantly associated with hesitancy (p=0.001). Healthcare providers were the most commonly reported source of information, accounting for 36.0% of participants, followed by social media or internet sources (29.6%), friends and family (14.8%), television or print media (10.4%), and absence of prior information (9.2%). Hesitancy was highest among caregivers who had no prior information (56.5%), followed by those who relied on friends and family (43.2%). In comparison, hesitancy was 25.6% among caregivers reporting healthcare providers as their primary information source. These findings highlight the potential importance of reliable information and healthcare-provider communication. Narayanan et al. reported that parental willingness towards HPV vaccination in Puducherry was associated with perceived disease risk, self-efficacy and beliefs regarding vaccine effectiveness.[19] Similarly, research from China has examined the relationship between social media exposure, perceptions of HPV disease and vaccine uptake among mothers.[20] The comparatively high hesitancy observed among caregivers relying on informal sources in the present study suggests that vaccine communication should extend beyond healthcare facilities and address information circulating within families and social networks.

The reported reasons for hesitancy further clarify the barriers influencing caregiver decisions. Insufficient information was the leading reason, reported by 28.2% of hesitant caregivers, followed by safety concerns and cost concerns, each reported by 16.9%. Low perceived need and fear of side effects accounted for 15.5% each, while access-related inconvenience accounted for 7.0%. These findings demonstrate that hesitancy is not attributable to a single concern. Instead, it reflects uncertainty about the vaccine, concerns about possible adverse effects, financial considerations and difficulties in accessing vaccination. Similar concerns have been described in Indian studies evaluating parental knowledge, acceptance and willingness to pay for HPV vaccination.[21–23] Studies examining willingness towards government-provided HPV vaccination have also highlighted the importance of affordability and confidence in vaccine safety.[24] Although reducing financial barriers may improve accessibility, the findings of the present study indicate that

information gaps and psychological determinants also require attention. As the present study did not directly compare different vaccine-delivery programmes, the independent contribution of free vaccination or government provision cannot be established from these results.

The 5C psychological antecedents of vaccination provide further insight into the factors associated with hesitancy. Hesitant caregivers had significantly lower mean confidence scores than non-hesitant caregivers (3.00 ± 0.66 versus 3.74 ± 0.64 ; $p < 0.001$). They also demonstrated higher complacency scores (3.09 ± 0.70 versus 2.15 ± 0.68), higher constraints scores (2.94 ± 0.70 versus 2.08 ± 0.67), and higher calculation scores (3.29 ± 0.75 versus 2.70 ± 0.69), with all differences statistically significant at $p < 0.001$. Collective responsibility scores were lower among hesitant caregivers (3.42 ± 0.79 versus 3.79 ± 0.63 ; $p < 0.001$). These findings suggest that hesitancy was associated with reduced trust in vaccination, lower perceived necessity, greater practical barriers, more extensive information processing and a weaker sense of collective responsibility. The 5C framework developed by Betsch et al. provides a structured approach to understanding these distinct psychological antecedents of vaccination behaviour.[10]

The multivariable logistic regression analysis identified confidence, complacency, constraints and absence of prior information as independent determinants of HPV vaccine hesitancy. Caregivers without prior information regarding HPV vaccination had 7.62 times higher adjusted odds of hesitancy than those with prior information (AOR 7.62; 95% CI 1.52–38.29; $p = 0.014$). However, the wide confidence interval indicates considerable uncertainty in the magnitude of this association, which should be interpreted in view of the small subgroup of caregivers without prior information ($n = 23$). Confidence was inversely associated with hesitancy (AOR 0.14; 95% CI 0.06–0.30; $p < 0.001$), indicating that higher confidence was associated with substantially lower odds of hesitancy. Conversely, higher complacency (AOR 7.91; 95% CI 3.70–16.89; $p < 0.001$) and greater constraints (AOR 6.33; 95% CI 3.05–13.16; $p < 0.001$) were independently associated with higher odds of hesitancy. Knowledge score showed a borderline inverse association after adjustment but did not reach statistical significance ($p = 0.053$). These findings suggest that confidence in vaccination, perceived necessity and practical accessibility may be particularly important intervention targets, alongside the provision of accurate information.

The findings have practical implications for HPV vaccination programmes. Healthcare-provider-led counselling could address concerns regarding vaccine safety and explain the preventive benefits of vaccination. Community-based educational activities may help reach caregivers who have not previously received HPV-related information. Communication strategies should also address practical barriers and financial concerns, while using accessible language and reliable information channels to counter misinformation. Previous research in India has demonstrated the potential value of structured health education in improving parental acceptance of HPV vaccination.[25] However, the effectiveness of specific interventions in the present study population would need to be evaluated through appropriately designed intervention studies.

Strengths and limitations: The study included 250 caregivers and assessed vaccine hesitancy using sociodemographic variables, knowledge measures, reported reasons for hesitancy and the 5C psychological antecedents framework. The use of multivariable logistic regression enabled the identification of factors independently associated with hesitancy after adjustment for other variables. Nevertheless, the facility-based, single-centre design and consecutive sampling limit the generalisability of the findings to the wider population of caregivers in Tamil Nadu. The cross-sectional design does not establish causal relationships between the identified factors and vaccine hesitancy. Willingness to vaccinate was self-reported and may not necessarily translate into actual vaccination uptake, and responses may have been influenced by social desirability bias because data were collected through face-to-face interviews. Furthermore, the small number of caregivers without prior information resulted in an imprecise adjusted estimate. The association between knowledge and hesitancy was statistically significant in the bivariate analysis but did not reach statistical significance after adjustment, underscoring the importance of distinguishing crude associations from independent determinants.

Overall, the present study demonstrates that HPV vaccine hesitancy among caregivers is multidimensional. Although educational status, knowledge and information source were associated with hesitancy on bivariate analysis, the independent determinants identified in the adjusted model were absence of prior information, lower confidence, higher complacency and greater perceived constraints. Interventions that combine reliable vaccine information with healthcare-provider counselling, improved vaccine confidence, communication addressing perceived necessity and measures to reduce practical barriers may help strengthen caregiver acceptance of HPV vaccination.

CONCLUSION

The present study found that HPV vaccine hesitancy affected 28.4% of caregivers of girls aged 9–14 years, while 71.6% expressed willingness to vaccinate their daughters. Knowledge regarding HPV infection and vaccination was predominantly moderate, with only 34.8% of participants demonstrating good knowledge. Educational status, knowledge level and source of information were significantly associated with hesitancy on bivariate analysis. However, multivariable analysis identified absence of prior information, lower confidence, higher complacency and greater perceived constraints as independent determinants. Insufficient information was the most frequently reported reason for hesitancy, followed by safety and cost concerns. These findings highlight the need for comprehensive strategies that extend beyond knowledge dissemination alone. Strengthening healthcare-provider-led counselling, improving access to reliable vaccine information, addressing safety concerns and reducing financial and practical barriers may help improve caregiver confidence and acceptance of HPV vaccination. Further community-based studies and intervention research are warranted to assess whether these strategies translate into improved vaccination uptake among eligible girls.

REFERENCES

1. World Health Organization. Cervical cancer [Internet]. Geneva: World Health Organization; 2026 Jul 3 [cited 2026 Sep 29]. Available from: <https://www.who.int/news-room/fact-sheets/detail/cervical-cancer>

2. International Agency for Research on Cancer. Global Cancer Observatory: Cancer Today. India fact sheet, GLOBOCAN 2022 [Internet]. Lyon: IARC; 2024 [cited 2026 Sep 29]. Available from: <https://gco.iarc.who.int/media/globocan/factsheets/populations/356-india-fact-sheet.pdf>
3. World Health Organization. Human papillomavirus vaccines: WHO position paper, December 2022. *Wkly Epidemiol Rec.* 2022;97(50):645-672. Available from: <https://www.who.int/publications/i/item/who-wer9750-645-672>
4. World Health Organization. Global strategy to accelerate the elimination of cervical cancer as a public health problem. Geneva: World Health Organization; 2020. Available from: <https://www.who.int/publications/i/item/9789240014107>
5. World Health Organization. Human papillomavirus and cancer [Internet]. Geneva: World Health Organization; 2024 Mar 5 [cited 2026 Sep 29]. Available from: <https://www.who.int/news-room/fact-sheets/detail/human-papilloma-virus-and-cancer>
6. Sankaranarayanan R, Bhatla N, Basu P. Current global status and impact of human papillomavirus vaccination: implications for India. *Indian J Med Res.* 2016;144(2):169-180. doi:10.4103/0971-5916.195023.
7. Sankaranarayanan R, Basu P, Kaur P, Bhaskar R, Singh GB, Denzongpa P, et al. Current status of human papillomavirus vaccination in India's cervical cancer prevention efforts. *Lancet Oncol.* 2019;20(11):e637-e644. doi:10.1016/S1470-2045(19)30531-5.
8. Ministry of Health and Family Welfare, Government of India. India administers 80 lakh HPV vaccine doses, marking major milestone in cervical cancer prevention [Internet]. New Delhi: Press Information Bureau; 2026 Sep 11 [cited 2026 Sep 29]. Available from: <https://www.pib.gov.in/PressReleasePage.aspx?PRID=2309109&lang=1®=22>
9. MacDonald NE; SAGE Working Group on Vaccine Hesitancy. Vaccine hesitancy: definition, scope and determinants. *Vaccine.* 2015;33(34):4161-4164. doi:10.1016/j.vaccine.2015.04.036.
10. Betsch C, Schmid P, Heinemeier D, Korn L, Holtmann C, Böhm R. Beyond confidence: development of a measure assessing the 5C psychological antecedents of vaccination. *PLoS One.* 2018;13(12):e0208601. doi:10.1371/journal.pone.0208601.
11. Singh A, Kumar SGV, Prabhakaran A, Shaw PD, Rao AP, et al. Parental knowledge, attitude and acceptability of human papillomavirus vaccine: implications for the prevention of cervical cancer in India. *Sci Rep.* 2026;16. doi:10.1038/s41598-026-67841-y.
12. Jawahar N, Shah PB. Knowledge among parents of daughters towards human papillomavirus attending rural and urban health and training centres of a teaching medical institution in India. *J Family Med Prim Care.* 2025;14(9):3939-3945. doi:10.4103/jfmpe.jfmpe_379_25.
13. John A, Rasheed R, Idikula MJ. Perceptions and practices among students, parents, and teachers of the human papillomavirus vaccination: a pilot feasibility study from rural Kerala. *PLoS One.* 2026;21(8):e0340559. doi:10.1371/journal.pone.0340559.
14. Anand A, Mala YM, Tyagi S, Sharma P. Knowledge, awareness and practices regarding human papillomavirus vaccine amongst secondary school girls and mothers in North India. *Eur J Obstet Gynecol Reprod Biol.* 2026;318:114945. doi:10.1016/j.ejogrb.2026.114945.
15. Khaled A, Orayj K, Talkhan H, Ali R, Alfifi A, Bin Ghamia S, et al. Exploring parental hesitancy and acceptance of HPV vaccination in a Saudi population. *Vaccines (Basel).* 2026;14(3):229. doi:10.3390/vaccines14030229.
16. Alghanmi R, Alkhalawi E, Albeladi R, Albeladi S, Alghamdi M, Fayoumi A, et al. Parental knowledge and acceptance of HPV vaccine in Rabigh's school, Saudi Arabia. *Ann Glob Health.* 2026;92(1):13. doi:10.5334/aogh.4866.
17. Onaghinor I, Alao AO, Ilikannu SO, et al. Comparing knowledge, attitude and parental acceptance of human papillomavirus vaccination among healthcare and non-healthcare providers in Nigeria. *Discov Public Health.* 2026;23:74. doi:10.1186/s12982-026-01390-7.
18. Ogundele OA, Fehintola FO, Ogundare OO, Adejuwon AM, Atoyebi ET, Igweshi KC, et al. Parental perception and intention to vaccinate female children 9-14 years with the human papillomavirus vaccine in Ile-Ife, Nigeria: theory of planned behaviour approach. *Sci Rep.* 2026. doi:10.1038/s41598-026-72502-1.
19. Narayanan PP, Murugan A, Ramakrishnan J, Parasuraman Udayakumar KR, Raj RL, Thulasisingam M. Parental perspectives: a mixed method study on perceived risk, self-efficacy, vaccine response efficacy, and willingness for adolescent HPV vaccination in Puducherry, South India. *Int J Adolesc Med Health.* 2025;37(5):359-369. doi:10.1515/ijamh-2024-0096.
20. Lin Z, Chen S, Su L, et al. Influences of HPV disease perceptions, vaccine accessibility, and information exposure on social media on HPV vaccination uptake among 11,678 mothers with daughters aged 9-17 years in China: a cross-sectional study. *BMC Med.* 2024;22:328. doi:10.1186/s12916-024-03538-1.
21. 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(2):76-83. doi:10.1177/13558196231215969.
22. Mounika B, Sankar J. Knowledge, Attitude, and Practices of Human Papillomavirus Vaccination among Parents. *Ann Child Health.* 2025;2:26-30. doi:10.25259/ACH_31_2024.
23. Badakali MA, Rangappa M. A study on assessment of knowledge and acceptance of human papilloma virus vaccination among the parents of adolescent girls of North Karnataka. *Int J Reprod Contracept Obstet Gynecol.* 2024;13(9):2410-2414. doi:10.18203/2320-1770.ijrcog20242491.
24. Wu D, Liu P, Wang H, Wan W, et al. Willingness and hesitancy towards the governmental free human papillomavirus vaccination among parents of eligible adolescent girls in Shenzhen, Southern China. *BMC Womens Health.* 2024;24:253. doi:10.1186/s12905-024-03083-2.

25. 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(3-4):346-353. doi:10.25259/IJMR_49_2024.