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ORIGINAL PAPER

Knowledge, Attitudes and HPV Vaccine Intention Among Women in India

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Abstract

In India, cervical cancer associated with human papillomavirus (HPV) infection is a leading cause of cancer-related mortality among women. However, uptake of the vaccine in India is low. We assessed knowledge and attitudes towards HPV, assess participants' willingness to accept the vaccination for themselves and their children, and determine factors associated with intention to receive the HPV vaccine among women in Mangalore, India. This cross-sectional study surveyed a convenient sample of 237 women aged 18–45 years using a semi-structured questionnaire. All respondents reported being aware of HPV infection. However, 22.36% ($n=53$) of the respondents have never heard about genital warts and 18.57% ($n=44$) have never heard about HPV vaccine. Participants displayed good general knowledge of HPV infection (median score, 1.26; Interquartile Range (IQR): 1.04–1.52) and average knowledge of HPV vaccine (e.g., median score, 1.18; IQR: 0.73–1.45). HPV general knowledge and vaccine knowledge were associated with intention to receive the HPV vaccine and recommend it to children. Participant awareness of the HPV vaccine predicted vaccine intent for themselves. Participants' willingness to recommend the vaccine for their children was associated with older age, married status, having one or more children, and having a college education. Lack of awareness about genital warts was strongly associated with participants' refusal to get the HPV vaccine or recommend it for their own children (Relative Risk Ratio RRR: 12.21; 95% C.I.: 2.33–63.99). Our study validated the questionnaire as a reliable tool for assessing HPV and HPV vaccine knowledge, attitudes, awareness, and vaccine intentions in women aged 18–45 years. Public health education should focus on increasing awareness of genital warts as a sequela of HPV, as well as promote awareness of role and safety of HPV vaccination in -children.

Keywords Knowledge · Attitudes · Human papillomavirus · Vaccine intent · Women · India

Introduction

Cervical cancer is the fourth most common cause of cancer among women globally, with low- and middle-income countries disproportionately affected compared to high-income countries [1]. Human papillomavirus (HPV) infection is linked to most cervical cancers, with HPV subtypes 16 and 18 appearing in about 70% of cervical cancers [2]. HPV vaccination has been proven to induce high protection against persistent incident infection and premalignant anogenital disease associated with subtypes 16 and 18 [3].

In India, cervical cancer is the second most common cancer in women and a leading cause of cancer-related mortality among women [4]. In the United States, current recommendations call for routine HPV vaccination (with bivalent, quadrivalent, or non-valent vaccine) of all children at 11 or 12 years of age and starting earliest at 9 years of age and may continue to 45 years for females and males [5].

Uptake of the vaccine in India is low, which could be related to the 2010 media reports of the death of four girls in alleged vaccine-related incidents. This caused suspension of two HPV vaccine projects and increased suspicion regarding the safety of the vaccine; yet, it was determined

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the deaths were not vaccine-related in a governmental investigation [6]. In fact, a four-year study from India reported no serious adverse events attributable to the vaccination of 34,856 girls ages 10–18 [7].

Other reasons for limited acceptance of HPV vaccine in India include lack of knowledge, doubts of efficacy, low perceived risk of contracting HPV, concerns regarding adverse side effects, and cultural influences [4, 8]. In a study involving focus groups of Indian women in London, age and country of birth were noted as barriers. Participants stated that their mothers, raised in India, have limited education and awareness about health and prefer not to utilize "orthodox" medicine, hospitals, and clinics [9].

Our study focuses on the city of Mangalore, India, in the state of Karnataka. A previous study conducted in Karnataka demonstrated the presence of high-risk HPV types in 90% of cervical cancer cases. The same study suggests HPV infection in 64% of the general population of Karnataka, a higher prevalence than in the general population of India and globally [10]. Knowledge of cervical cancer and HPV in women from Karnataka is low. In a study assessing this population, 15% of women interviewed knew what cervical cancer is, 36% had heard of HPV, and 28% recognized HPV as a cause of cervical cancer [8]. Among female students in an undergraduate medical program in Mangalore, 18% had never heard of the HPV vaccine and 79% were not vaccinated against HPV. The most common reasons for rejection of the vaccine were lack of information, belief that the vaccine is unnecessary for those sexually inactive, ability to access the vaccine, and cost [11]. Information and educational gaps among medical students and community physicians may contribute to lack of knowledge among patients. Among 210 academic and community physicians in Mangalore, the correct response to HPV-knowledge questions was identified only 50% of the time. Only 47% of physicians knew that there was an HPV vaccine approved for use in India, and only 30% reported that they would recommend the vaccine to their patients [4].

Another barrier to vaccine uptake is low perceived risk of contracting HPV among Indian women, with 46% of women surveyed reporting that they would use the vaccine if available in India. However, the majority of these women answered that the cost of the vaccine would prevent them from obtaining vaccination [8]

The objectives of this study were to collect and analyze survey data to assess knowledge and attitudes towards HPV, assess participants' willingness to accept the vaccination for themselves and their children, and determine factors associated with intention to receive the HPV vaccine among women in Mangalore, South India.

Materials and Methods

Study Design

The study consisted of a cross-sectional survey of a convenient sample of 237 women near the city of Mangalore, Dakshina Kannada District, State of Karnataka, India. The K.S. Hedge Medical Academy primary research site is located at Deralakatte, a town about 13 km from Mangalore.

Participants included are women, aged 18–45 years, who were either employees or students in one of the following programs: business, arts, or health professions. The survey was pre-tested among 15 women on the medical campus. The researcher and an interpreter at the study site approached the participants and provided information regarding the study. Those who agreed to participate in the study signed an individual consent form. Data was obtained through a semi-structured questionnaire given in an in-person single encounter with each participant. Women outside this age range, those not willing to participate, those who had not heard of HPV, those who had received the vaccine, surveys with questionable validity (e.g. if answers were selected randomly or in a specific pattern), and surveys with missing data (>5%) were excluded from the study.

The semi-structured questionnaire consisted of six sections, adapted from similar studies (Appendix S1). The first section collected data on demographic characteristics of participants including age, socioeconomic status, residence (urban/rural), educational status, marital status, and occupation. The second section assessed participants' awareness of HPV infection, cervical cancer, and HPV vaccine using four items with Yes–No responses (for instance, "have you heard of (1) HPV; (2) cervical cancer; (3) genital warts, and (4) HPV vaccine?").

The third and fourth sections consist of a 23-item validated HPV General Knowledge scale and 11-item HPV Vaccine Knowledge scale containing a 16-questions HPV general knowledge section and 7-question HPV vaccine knowledge section developed by Waller, et al., and extended by Perez, et al. [12, 13]. The Cronbach's alpha score for the original 16-question HPV general knowledge and 7-question HPV vaccine knowledge scales were 0.849 and 0.561, respectively, with a reported test–retest reliability value of 0.62 [12]. The addition of nine items to the general knowledge section and four items to the vaccine knowledge section resulted in increased internal validity scores across multiple samples [13]. Questions in these sections assessed participants' knowledge regarding HPV, availability of HPV vaccination, and HPV-related diseases with True/False/I do not know responses.

The fifth category contains questions about the participant's personal attitudes and beliefs about HPV

vaccination using the validated Carolina HPV Immunization Attitudes and Belief Scale (CHIAS) [14]. The CHIAS scale was used to assess four factors with acceptable internal validity: "harms" ($\alpha = 0.69$), "barriers" ($\alpha = 0.69$), "effectiveness" ($\alpha = 0.61$), and "uncertainty" ($\alpha = 0.66$) [15].

The sixth section consisted of questions that assessed the participants' sources of information regarding HPV. The seventh part of the questionnaire investigated the participants' intentions to receive HPV vaccination for themselves or to recommend it for their children. Responses to dummy coded 1 for "yes," 2 for "no," and 3 for "I don't know." We did not collapse "no" and "I don't know" to allow the discrete choice of the undecided to be equally assessed.

Analysis

This study took into consideration the 2019 CDC guideline expansion for shared clinical decision-making regarding HPV vaccination for some adults aged 27 through 45 years who are not adequately vaccinated [16]. Since the original scale included only women 18–26, and our sample included women of children bearing age up to 45 years of age, we performed a validation of the instruments to test their internal validity and reliability outside of their initial boundary conditions, using alpha Cronbach's coefficient and factor analysis to confirm the validity of the scales on the study population (see Appendix S2 for factor loading and correlation matrices).

The study population was described using percent, mean and standard deviation or median or inter quartile range depending on the underlying distribution (see Table 1). We used Chi-Squared test of independence to test whether the categorical baseline characteristics of the study population were independent from the outcomes of interests (e.g. intention to accept vaccine for themselves and their children). For continuous variables (e.g. scores for the different sections of the questionnaire), we used one way Anova or Kruskal—Wallis to test the null hypothesis that for the random values on each scale (e.g. general knowledge scale), the average scores of those who are willing to accept the vaccine were similar to that of those who are reluctant to accept the vaccine or those who are undecided.

We used simple logistic regression model to investigate the likelihood of vaccine acceptance for self and for children as a function of the awareness, knowledge, harms, barriers, uncertainty, effectiveness and availability of HPV vaccine. The model was also adjusted to account for the baseline sociodemographic characteristics of the study population through forward elimination. The final model was selected using the penalized information criteria: Akaike Information Criteria (AIC) and Bayesian Information Criteria (BIC). The final model was refitted and a Hosmer–Lemeshow test was performed to test for lack of fit. Odds ratios were reported and used for discussion. All analyses were performed in Stata Version 15.

Table 1 Psychometric validation of the scales

	N	Alpha
GK	237	0.83
VK	237	0.75

Results

Psychometric Validation of the Scales

Results from the psychometric analyses confirmed the reliability of all scales according to the conventional cut-off for a Cronbach alpha value of 0.7 (0.83 for general knowledge on HPV, 0.75 for HPV vaccine knowledge) (Table 1).

The attitude and beliefs questions were further broken into sub-scales (perceived harms, barriers, uncertainties, and effectiveness). The correlation matrices for each scale revealed that most items were correlated with each other. Approximation of monotone homogeneity assumption for the trace line with respect to the underlying dimension, yielded consistent results for the two main scales (Fig. 1). For instance, Fig. 1 displays a rest score plot for the HPV general knowledge against item 23 (*i.e.,* A person with no symptoms cannot transmit the HPV infection), and the smoothed line is perfectly monotonic. There is a similar result for vaccine knowledge against item 11, which indicates the question sets are good candidates for summated rating models.

A factor analysis, allowing for an orthogonal rotation yielded consistent results, showing that the two main scales (i.e., HPV general knowledge and HPV vaccine knowledge) measured each, a unique construct within the study population. Results from the scree plots, after varimax rotation are shown in the below graphs (Fig. 2). Therefore, the two scales were valid in a study population including women of reproductive age up to 45 years old, in a different location (India).

Sociodemographic Characteristics and Scores

Of the 237 participants who completed the survey, about 36% were under 21 years of age, mostly living in urban areas (69 respondents, representing 81.18% of those under the age of 21) and reflecting urban/rural distribution for the overall sample ($n = 193$; 81.43% urban versus $n = 44$; 18.57% rural). About two third (66.67%) of the overall sample reported being Hindu practitioners, while the remaining 33.33% reported other religious beliefs. More than three quarter (i.e., 78.48%) were never married and 68.78% ($n = 163$) had no college degree.

Fig. 1 Rest score plots

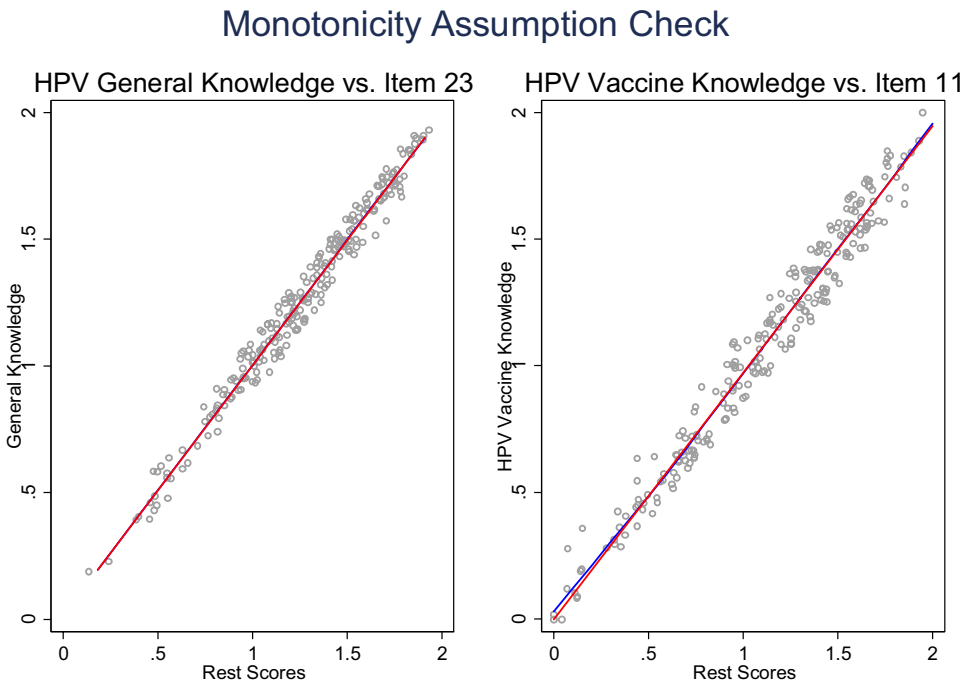
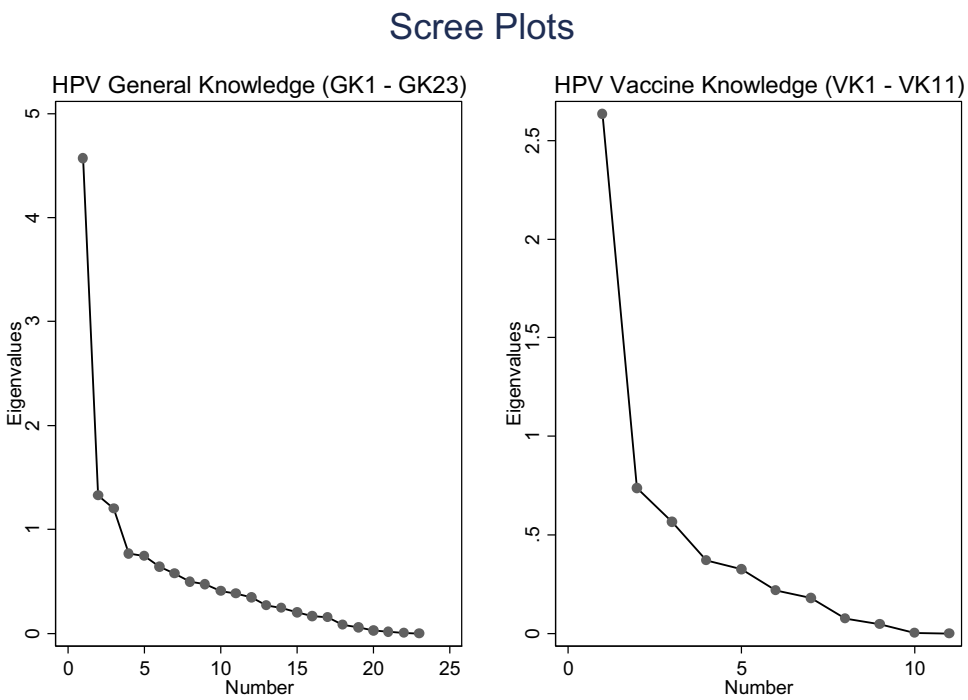


Fig. 2 Scree plots results, after varimax rotation



Consistent with our protocol, all respondents reported being aware of HPV infection; 4.64% ($n=11$) have never heard about cervical cancer. However, 22.36% ($n=53$) of the respondents have never heard about genital warts and 18.57% ($n=44$) have never heard about HPV vaccine.

Out of two possible points that one could have scored on the general knowledge scale, the median value was 1.26 (Interquartile Range—IQR: 1.04–1.52), suggesting a good general knowledge of HPV infection among participants. In addition, participants also displayed average knowledge of HPV vaccine (e.g., median score of 1.18; IQR: 0.73–1.45).

On average, participants displayed higher scores (mean: 2.94; std.: 0.93) on perceived harms, suggesting that they generally perceived HPV vaccine as harmful. Barriers to

accessing HPV vaccine also scored relatively higher (mean: 2.56; std.: 0.83). In terms of HPV vaccine effectiveness, participants scored generally higher (median: 3; IQR: 2–3.5), suggesting that they trust HPV vaccine to be effective in preventing cervical cancers.

Overall, 69.20% of the study participants reported positive intentions (i.e., being willing to take HPV vaccine for themselves), against 10.13% who reported negative (i.e., not willing to take HPV vaccine for themselves) and 20.68% who were undecided (i.e., don't know). In terms of recommending vaccine for their children, 60.76% accepted that they will recommend HPV vaccine for their children, against 7.17% who stated they will not recommend HPV vaccine for their children and 32.7% who were undecided (i.e., don't know).

The intentions to receive vaccine for self was not statistically different across different sociodemographic factors. However, intention to receive HPV vaccine was associated with HPV general knowledge, HPV vaccine knowledge, and the perceived harms and barriers and vaccine uncertainties scores (see Table 2 below).

Many sociodemographic factors were associated with respondents' intention to recommend vaccine to their children (see Table 3 below). These included age (p-value: < 0.05), marital status (p-value: < 0.05), number of children or parity (p-value: 0.001); education (p-value: 0.001). In terms of awareness, intention to recommend the vaccine to their children tend to be dependent on whether the respondents were aware of genital warts or not (p-value: 0.001). Likewise, respondents' responses on whether they would recommend the vaccine for their children or not tends to be associated with HPV general and vaccine knowledge, as well as attitudes.

Results from the multinomial logistic regression model estimating participants' willingness to accept the vaccine for themselves (see Table 4) suggested that no sociodemographic factor was a significant predictor of vaccine acceptance (e.g., replied yes to whether they will accept the vaccine for themselves). Compared to those who were undecided on whether they would receive HPV vaccine for themselves (i.e., don't know), participants who have heard of HPV vaccine were three times (Relative Risk Ratio (RRR): 3.24; 95% C.I.: 1.06–9.86) more likely to accept HPV vaccine if offered.

A unit increase on the score for perceived harms increased the likelihood of refusing to get HPV vaccine by threefold (RRR: 3.13; 95% C.I.: 1.29–7.58) compared to being undecided (e.g., don't know). A unit increase in the score of HPV vaccine effectiveness was associated with a 46% reduced likelihood (RRR: 0.54; 95% C.I.: 0.3–0.97) of refusing to get vaccine as opposed to being undecided (e.g., do not know). In addition, a unit increase on the uncertainties' score was associated with 58% (RRR: 0.42; 95% C.I.: 0.21–0.85) reduced likelihood of refusing the vaccine as compared to being undecided.

For the model estimating whether one would recommend HPV vaccine for their children (see Table 5), participants over 30 years of age were seven times (RRR: 6.7; 95% C.I.: 1.13–39.72) more likely to recommend HPV vaccine for their children compared to younger participants (i.e., 21 years). Participants practicing a religion other than Hindu were 54% less likely (RRR: 0.47; 95% C.I.: 0.23–0.96) to recommend HPV vaccine for their children compared to being undecided (e.g., do not know). A unit increase on the perceived harm scores was associated with 48% reduced likelihood (RRR: 0.52; 95% C.I.: 0.33–0.83) of recommending HPV vaccine for their children compared to being undecided.

Compared to younger participants (less than 21 years of age), those between 25 and 29 years of age were 12 times (RRR: 11.66; 95% C.I.: 1.23–110.38) more likely to refuse to recommend HPV vaccine compared to being undecided. Compared to those who have heard about genital warts, those who have not heard about genital warts were 12 times (RRR: 12.21; 95% C.I.: 2.33–63.99) more likely to refuse to recommend HPV vaccine for their children, compared to being undecided. Perceived vaccine uncertainties were associated reduced likelihood of refusing to recommend for children compared to being undecided.

Discussion

The HPV general knowledge and HPV vaccine knowledge scales tend to be reliable based on our analysis, despite its use on a population slightly different than the population studied using the original and expanded scales [12, 13]. Results from the factor analysis suggest that each of the two scales measured one latent factor each (see scree plots), suggesting the scales performed well outside of its initial boundary conditions.

No sociodemographic factors were significantly associated with participants' willingness to receive the HPV vaccine for themselves. However, age, marital status, number of children or parity, and education were associated with participants' willingness to recommend the vaccination for their children. Participants who were older compared to younger, married compared to unmarried, had one or more children compared to zero children, and had a college degree were more likely to recommend the HPV vaccine for their children. Being older than 30 and Hindu practitioner (compared to non-Hindu) were significant predictors of positive HPV vaccination intentions. In prior studies, the association of socio-demographic factors and intention to vaccinate self or children varied depending on populations studied. For example, no demographic factors were significantly associated

Table 2 Sociodemographic characteristics of the study population by their intent to accept human papillomavirus (HPV) vaccine for self

Characteristics	Would accept vaccine for self (*n*, [%])	Would not accept vaccine for self (*n*, [%])	Don't know (*n*, [%])	*p*-value
Age				
< 21	53 (62.35)	8 (9.41)	24 (28.24)	0.16[f]
21–24	52 (69.33)	8 (10.67)	15 (20.00)	
25–29	32 (78.05)	6 (14.63)	3 (7.32)	
30 and older	27 (75.00)	2 (5.56)	7 (19.44)	
Place of residence				
Urban	135 (69.95)	19 (9.84)	39 (20.21)	0.87
Rural	29 (65.91)	5 (11.36)	10 (22.73)	
Religion				
Hindu	114 (72.15)	15 (9.49)	29 (18.35)	0.36
Other	50 (63.29)	9 (11.39)	20 (25.32)	
Marital status				
Married	37 (72.55)	7 (13.73)	7 (13.73)	0.29
Not married	127 (68.28)	17 (9.14)	42 (22.58)	
Age at marriage				
< 21	5 (83.33)	0 (0.00)	1 (16.67)	0.84[f]
21–25	20 (68.97)	3 (10.34)	6 (20.69)	
25 +	21 (75.00)	4 (14.29)	3 (10.71)	
Never been married	118 (67.82)	17 (9.77)	39 (22.41)	
Parity				
0	139 (68.81)	20 (9.90)	43 (21.29)	0.59[f]
1	13 (81.25)	2 (12.50)	1 (6.25)	
2	12 (63.16)	2 (10.55)	5 (26.32)	
Education				
College degree	55 (74.32)	8 (10.81)	11 (14.86)	0.33
No College degree	109 (66.87)	16 (9.82)	38 (23.31)	
Awareness				
Ever heard of cervical cancer				
Yes	159 (70.35)	23 (10.18)	44 (19.47)	0.09
No	5 (45.45)	1 (9.09)	5 (45.45)	
Ever heard of genital warts				
Yes	132 (71.74)	17 (9.24)	35 (19.02)	0.29
No	32 (60.38)	7 (13.21)	14 (26.42)	
Ever heard of HPV vaccine				
Yes	132 (68.39)	19 (9.84)	42 (21.76)	0.68
No	32 (72.73)	5 (11.36)	7 (15.91)	
Knowledge score (median, IQR)	1.26 (1.04–1.57)	1.48 (1.17–1.57)	1.17 (0.87–1.35)	0.03[kw]
Vaccine knowledge Score (median, IQR)	1.18 (0.82–1.54)	1.18 (0.95–1.50)	0.82 (0.64–1.27)	0.003[kw]
Perceived harms (mean, sd)	2.74 (0.93)	3.41 (0.78)	3.39 (0.75)	0.001
Perceived barriers (mean, sd)	2.42 (0.84)	2.72 (0.72)	2.94 (0.72)	0.001
Perceived effectiveness (mean, sd)	3.00 (2.00–3.5)	2.5 (2.00–3.00)	3.00 (2.00–4.00)	0.07
Perceived uncertainties (mean, sd)	3.28 (1.02)	3.11 (0.97)	3.88 (0.73)	0.001

p-value from Pearson Chi-Square and one way Anova, if not otherwise specified

f: *p*-value from Fisher exact, *k*: *p*-value from Kruskal—Wallis

with parental intention to vaccinate children in one U.S. study; another U.S. study found factors such as higher salary, education, and age of mothers were associated with unwillingness to recommend the HPV vaccination for their daughters, which contrasts our study findings [17, 18]. This could be due in part to a different social context surrounding

Table 3 Sociodemographic characteristics of the study population by their intent to accept human papillomavirus (HPV) vaccine for their children

Characteristics	Would recommend vaccine for child (*n*, [%])	Would not recommend vaccine for child (*n*, [%])	Don't know (*n*, [%])	*p*-value
Age				
< 21	42 (49.41)	5 (5.88)	38 (44.71)	0.002
21–24	44 (58.67)	5 (6.67)	26 (34.67)	
25–29	28 (68.29)	6 (14.63)	7 (17.07)	
30 and older	30 (83.33)	1 (2.78)	5 (13.89)	
Place of residence				
Urban	119 (61.66)	13 (6.74)	1 (31.61)	0.69[f]
Rural	25 (56.82)	4 (9.09)	15 (34.09)	
Religion				
Hindu	103 (65.19)	11 (6.96)	44 (27.85)	0.12
Other	41 (51.90)	6 (7.59)	32 (40.51)	
Marital status				
Married	36 (70.59)	6 (11.76)	9 (17.65)	0.03
Not married	108 (58.06)	11 (5.91)	67 (36.02)	
Age at marriage				
< 21	4 (66.67)	0	2 (33.33)	0.20[f]
21–25	22 (75.86)	1 (3.45)	6 (20.69)	
25 +	19 (67.86)	4 (14.29)	5 (17.86)	
Never been married	99 (56.90)	12 (6.90)	63 (36.21)	
Parity				
0	115 (56.93)	13 (6.44)	74 (36.63)	0.001[f]
1	14 (87.50)	2 (12.50)	0 (0.00)	
2	15 (78.95)	2 (10.53)	2 (10.53)	
Education				
College degree	56 (75.68)	4 (5.41)	14 (18.92)	0.006[f]
No college degree	88 (53.99)	13 (7.98)	62 (38.04)	
Awareness				
Ever heard of cervical cancer				
Yes	140 (61.95)	17 (7.52)	69 (30.53)	0.081[f]
No	4 (36.36)	0	7 (63.64)	
Ever heard of genital warts				
Yes	123 (66.85)	8 (4.35)	53 (28.80)	0.001
No	21 (39.62)	9 (16.98)	25 (43.40)	
Ever heard of HPV vaccine				
Yes	119 (61.66)	13 (6.74)	61 (31.61)	0.69[f]
No	25 (56.82)	4 (9.09)	15 (34.09)	
General knowledge score (means, sd)	1.35 (1.04–1.63)	1.43 (1.17–1.52)	1.15 (0.86–1.35)	0.001 [k]
Vaccine knowledge score (mean, sd)	1.18 (0.82–1.55)	1.18 (0.95–1.50)	0.82 (0.64–1.27)	0.001 [k]
Perceived harms	2.68 (0.95)	3.07 (0.72)	3.39 (0.74)	0.001
Perceived barriers	2.36 (0.86)	2.66 (0.56)	2.92 (0.69)	0.001
Perceived effectiveness	3.00 (2.00–3.5)	3.00 (2.00–3.00)	3.00 (2.00–3.75)	0.38 [k]
Perceived uncertainties	3.22 (1.01)	2.90 (0.87)	3.82 (0.82)	0.001

p-value from Pearson Chi-Square and one way Anova, if not otherwise specified

f: *p*-value from Fisher exact, *k*: *p*-value from Kruskal—Wallis

Table 4 Multinomial logistic regression model predicting vaccine intention for self

Characteristics	Would accept vaccine for self vs. do not know (RRR, C.I.)	Would not accept vaccine for self vs. do not know (RRR, C.I.)
Age		
< 21	Ref	Ref
21–24	1.55 (0.64–3.76)	2.24 (0.49–10.23)
25–29	3.69 (0.84–16.27)	3.59 (0.44–28.91)
30 and older	1.09 (0.17–7.04)	0.18 (0.01–3.82)
Place of residence		
Urban	Ref	Ref
Rural	0.84 (0.34–2.07)	0.90 (0.21–3.82)
Religion		
Hindu	Ref	Ref
Other	0.70 (0.32–1.54)	1.66 (0.48–5.72)
Marital status		
Married	Ref	Ref
Not married	0.66 (0.13–3.31)	0.13 (0.02–1.06)
Education		
No college degree	Ref	Ref
College degree	1.04 (0.38–2.81)	0.72 (0.16–3.15)
Ever heard of cervical cancer		
Yes	Ref	Ref
No	0.22 (0.04–1.15)	0.48 (0.03–7.69)
Ever heard of genital warts		
Yes	Ref	Ref
No	1.14 (0.45–2.86)	2.25 (0.52–9.69)
Ever heard of HPV vaccine		
Yes	Ref	Ref
No	3.24 (1.06–9.86)	4.49 (0.80–25.26)
Knowledge score	0.70 (0.18–2.70)	1.76 (0.21–14.4)
Vaccine knowledge score	1.58 (0.55–4.53)	6.19 (1.00–38.3)
Perceived harms	0.78 (0.45–1.35)	0.93 (0.35–2.48)
Perceived barriers	0.60 (0.36–1.00)	3.13 (1.29–7.58)
Perceived effectiveness	0.92 (0.65–1.30)	0.54 (0.3–0.97)
Perceived uncertainties	0.75 (0.49–1.16)	0.42 (0.21–0.85)

vaccination in the U.S. compared to India and other developing countries [19]. Van Keulen, et al. found religion to be the only demographic factor associated with HPV vaccination intention of Dutch mothers and girls; Qin, et al. found, similar to our study, older age and higher education level significantly increased intention to vaccinate among women ages 20–45 in rural China [20, 21].

Because prior awareness of HPV was a requirement to participate in the study, 100% of the study population was aware of HPV infection, and the majority were aware of cervical cancer. However, awareness of genital warts was limited, and lack of awareness about genital warts was strongly associated with participants' refusal to get the HPV vaccine or recommend it for their own children. Furthermore, awareness of the vaccine was a strong predictor of intention to vaccinate, consistent with prior studies across multiple different populations [22–24]. These findings suggest implementing health education surrounding the HPV vaccine and its impact on preventing genital warts may be effective strategies in increasing HPV vaccine acceptability.

Aligning with previous findings, HPV general knowledge and vaccine knowledge were associated with intention to receive the HPV vaccine and recommend it to children [24–26]. Participants had relatively good general knowledge of HPV infections and average knowledge of the vaccine, which is reasonable given the higher levels of awareness of HPV infection compared to awareness of the HPV vaccine in this study population. The scales demonstrated good reliability in this population, similar to the original scales and other knowledge instruments validated in Italian women and Grecian adolescents [12, 13, 27, 28].

Table 5 Multinomial logistic regression model predicting intention to recommend vaccine for own children

Characteristics	Would accept vaccine for self vs. don't know	Would not accept vaccine for self vs. don't know
Age		
< 21	Ref	Ref
21–24	1.12 (0.5–2.5)	2.78 (0.43–17.96)
25–29	2.62 (0.79–8.75)	11.66 (1.23–110.38)
30 and older	6.7 (1.13–39.72)	2.91 (0.1–87.8)
Place of residence		
Urban	Ref	Ref
Rural	1.14 (0.49–2.61)	1.75 (0.3–10.41)
Religion		
Hindu	Ref	Ref
Other	0.47 (0.23–0.96)	1.5 (0.37–5.99)
Marital status		
Married	Ref	Ref
Not married	1.60 (0.44–5.80)	0.38 (0.06–2.4)
Education		
No college degree	Ref	Ref
College degree	0.87 (0.36–2.11)	1.78 (0.34–9.37)
Ever heard of cervical cancer		
Yes	Ref	Ref
No	0.38 (0.07–2.21)	–
Ever heard of genital warts		
Yes	Ref	Ref
No	0.65 (0.28–1.56)	12.21 (2.33–63.99)
Ever heard of HPV vaccine		
Yes	Ref	Ref
No	2.09 (0.82–5.37)	2 (0.31–12.94)
Knowledge score	1.07 (0.32–3.56)	2.75 (0.19–40.75)
Vaccine knowledge score	1.95 (0.76–5.03)	3.21 (0.43–24.16)
Perceived harms	0.91 (0.54–1.53)	1.25 (0.37–4.25)
Perceived barriers	0.52 (0.33–0.83)	1.19 (0.45–3.16)
Perceived effectiveness	1.32 (0.95–1.81)	0.64 (0.33–1.23)
Perceived uncertainties	0.71 (0.48–1.05)	0.32 (0.15–0.72)

Participants' attitudes towards the HPV vaccine demonstrated that perceived harms of the vaccine were associated with increased probability of refusal for vaccination. However, higher scores of perceived vaccine effectiveness were associated with lower probability of refusing the vaccination compared to being undecided. Similarly, higher perceived uncertainty regarding the vaccine increased likelihood of being undecided compared to refusing the vaccine. This demonstrates participants are both aware of vaccine effectiveness in preventing cervical cancer and uncertain about receiving or recommending it for their children. This could be due to lack of public health education and barriers such as beliefs the vaccine is unnecessary if not sexually active, stigma, and fear of judgement [11, 29, 30]. Addressing these two domains may help in scaling up HPV vaccination in this population. Finally, barriers to accessing the HPV vaccination, such as cost and finding a provider, seemed to play no role in vaccine intentions for self or for own children in this population. This could be attributed to the low levels of HPV vaccine promotion and HPV vaccine-seeking behaviors as previously described in this population, which could limit awareness of cost and availability [4, 30, 31].

Our study was limited by a small sample size, which yielded unstable estimates with wider confidence intervals on some characteristics. Another limitation is the oversampling of participants under the age of 25 years, resulting in a low number of participants who have children. Additionally, the study was conducted at one geographic location among a low to middle income population, so results may not be accurately generalized to other settings and middle-class or upper middle-class populations. This study has a potential for response bias due to unfamiliarity

with the topic of HPV and vaccination. Furthermore, the study does not include men in the survey, a population that may give further insight into community perceptions of the HPV virus and the vaccine. Questions about intent to receive the vaccination may not translate to actual vaccine uptake due to barriers such as cost, accessibility, and lack of promotion by local physicians.

Conclusions

Our study validated the questionnaire as a reliable tool for assessing HPV and HPV vaccine knowledge, attitudes, awareness, and vaccine intentions in women ages 18–45 in Mangalore, India. Further studies are required to demonstrate reliability of the questionnaire in other populations. HPV vaccine acceptability for the participants themselves was predicted only by awareness of the HPV vaccine; however, a greater proportion of participants was accepting of the vaccine for themselves versus for their children. Additionally, participants were more likely to be uncertain about vaccinating their children versus vaccinating themselves, which suggests a need to promote awareness of role and safety of HPV vaccination in children. Participants' willingness to recommend the vaccine for their children was associated with older age, married status, having one or more children, and having a college education. Awareness of genital warts was low, and lack of awareness predicted vaccine refusal for children; vaccine awareness predicted increased acceptability for children. Focusing public health education in South India on increasing awareness of genital warts as a sequela of HPV, as well as the HPV vaccine and its availability, benefits, and risks may promote positive vaccine intentions and increased uptake in this population.

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Data Availability The data that support the findings of this study are available from the corresponding author upon request.

Declarations

Conflict of interest The authors declare no conflict of interest. The funders had no role in the design of the study; in the collection, analyses, or interpretation of data; in the writing of the manuscript, or in the decision to publish the results.

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