Original article

Parents' knowledge and hesitancy about human papillomavirus vaccine

Amen Bawazir[1]*, Hadil Essam Salem[1], Alanood Alassaf[1], Alanoud Aljohani[1], Dana Alzahrani[1], Ghala Binshafi[1], Rahaf Almarjan[1], Sara Alhemaidi[1], Shouq Alkharji[1], Lina Abed[1], Sofia Abualmeza[1]

ABSTRACT

Background: Despite the proven effectiveness of the human papillomavirus (HPV) vaccine in preventing HPV-related diseases, parental knowledge and acceptance remain limited in Saudi Arabia and many other countries. Evidence regarding Saudi parents' knowledge, attitudes, and vaccine hesitancy toward HPV vaccination remains limited. This study aimed to assess parents' knowledge of HPV and its vaccine, their willingness to vaccinate their children, and the factors associated with vaccine hesitancy in Riyadh, Saudi Arabia.

Materials and Methods: A cross-sectional survey was conducted among 500 parents of children aged 11-20 years in Riyadh, Saudi Arabia. The questionnaire assessed sociodemographic characteristics, knowledge of HPV and its vaccine, willingness to vaccinate, and reasons for vaccine hesitancy. Multivariable logistic regression analysis was performed to identify factors associated with knowledge and willingness to vaccinate.

Results: Among the 500 participants, 48.6% demonstrated sufficient knowledge about HPV, 54.4% were aware of the HPV vaccine, and 54.0% reported willingness to vaccinate their children. The most frequently reported reasons for vaccine hesitancy were lack of knowledge (52.3%) and fear or anxiety regarding the vaccine (38.1%). Healthcare professionals were significantly more likely to have adequate knowledge and express willingness to vaccinate their children than participants in other occupations (adjusted odds ratio = 4.5, 95% confidence interval (CI): 2.1-9.3; $p < 0.001$).

Conclusion: Parental education and occupation were significant predictors of HPV vaccine knowledge and acceptance. Public health initiatives focusing on parental education and awareness may improve HPV vaccine uptake among adolescents in Saudi Arabia.

Keywords: HPV Vaccine, parents awareness, public health, parents hesitancy.

Introduction

Human papillomavirus (HPV) is one of the most common sexually transmitted infections worldwide and is responsible for nearly all cases of cervical cancer, as well as a substantial proportion of anal, vulvar, vaginal, penile, and oropharyngeal cancers. Although most HPV infections resolve spontaneously, persistent infection with high-risk HPV types can lead to precancerous lesions and invasive cancers. HPV vaccination is recognized as one of the most effective public health strategies for preventing HPV-related diseases. Despite the availability of safe and highly effective vaccines, vaccination coverage remains suboptimal in many countries because of inadequate awareness, misconceptions, and parental vaccine hesitancy.

In Saudi Arabia, cervical cancer remains an important public health concern despite being largely preventable through vaccination and early screening. Parents play a central role in HPV vaccine decision-making for adolescents, making their knowledge, perceptions, and acceptance crucial determinants of vaccine uptake. Previous Saudi studies have consistently reported low awareness of HPV infection and its vaccine among parents, highlighting the need for targeted educational interventions.

Correspondence to: Amen Ahmed Bawazir
*Community Medicine Unit, Basic Medical Science Department, College of Medicine, AlMaarefa University, Riyadh, Saudi Arabia.
Email: abawazir@um.edu.sa and bawazir56@gmail.com
Full list of author information is available at the end of the article.
Received: 11 September 2026 | **Accepted:** 06 October 2026

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Several studies across different countries have explored factors contributing to HPV vaccine refusal or hesitancy. A large proportion of young adult women in Palermo, Italy, remained unvaccinated, with factors such as higher education levels, absence from informative meetings, fear of side effects, and geographic distance to vaccination centers influencing this decision [1]. Conversely, a Chinese study identified vaccine worthiness, marriage plans, sexual experience, stigma, information gaps, and distrust in healthcare as factors impacting HPV vaccine uptake [2]. In Bahrain, participants expressed concerns about the vaccine's adverse effects rather than its effectiveness or cost. However, a significant portion showed a willingness to vaccinate if recommended and believed in vaccinating both genders. Healthcare professionals displayed high confidence in the vaccine's safety and efficacy [3].

A study in the United States examined demographic factors and practical barriers to HPV vaccine hesitancy, revealing that a substantial number of parents were hesitant, with disagreements about the vaccine's benefits being a common reason [4]. A systematic review in Japan identified four key factors affecting HPV vaccine uptake: perceptions of risk and benefits, trust in recommendations, information and knowledge, and sociodemographic characteristics [5]. Although several international and regional studies have investigated parental knowledge and attitudes toward HPV vaccination, evidence from Saudi Arabia remains limited, particularly regarding factors influencing parental willingness and vaccine hesitancy in community settings. Furthermore, differences in cultural beliefs, educational background, and sources of health information may influence parental decisions differently across populations.

Therefore, this study aimed to assess parents' knowledge of HPV infection and HPV vaccination, evaluate their willingness to vaccinate their children, identify the main reasons for vaccine hesitancy, and determine the sociodemographic factors associated with parental knowledge and vaccine acceptance among parents in Riyadh, Saudi Arabia.

Methods/Approach Study Design

A community-based cross-sectional study was conducted among parents residing in Riyadh, Saudi Arabia, who had children aged 11-20 years eligible for HPV vaccination.

Study setting

Data collection was conducted in major family gathering areas within Riyadh city, including malls and parks.

Participants

The study included parents residing in Riyadh who had children aged 11-20 years. Parents who were visitors to Riyadh, non-Arabic speakers, or unable to complete the questionnaire were excluded from the study.

Sample size calculation

The required sample size was calculated using the WHO formula for cross-sectional studies based on a previous Saudi study reporting 70.6% poor awareness of HPV vaccination, with a 95% confidence level and a 5% margin of error. After applying a design effect of 1.1, the required sample size was estimated at 444 participants. To compensate for possible nonresponse and incomplete questionnaires, the sample size was increased by 12.5%, resulting in a target sample of 500 participants.

Sampling technique

The study was conducted in five regions of Riyadh City (East, West, North, South, Center) with two mall centers selected from each region. Assuming equal population distribution among the ten mall centers, the sample size was divided equally across regions, with 100 participants recruited from each region and 50 from each mall center.

Data collection

Data were collected using a structured self-administered questionnaire consisting of six sections: (1) sociodemographic characteristics, (2) knowledge of HPV infection, (3) knowledge of the HPV vaccine, (4) willingness to vaccinate children against HPV, (5) reasons for vaccine hesitancy, and (6) sources of information regarding HPV and its vaccine.

Operational definition and measurement

Parents' knowledge of HPV infection was assessed using 11 questions. Knowledge of the HPV vaccine was evaluated using six questions. Willingness to vaccinate children against HPV was assessed using four questions, while reasons for vaccine hesitancy were evaluated using six questions. Scores for each domain were calculated by summing the responses and converting them into percentages. A score of more than 60% was considered adequate knowledge or willingness, whereas a score of 60% or less was considered inadequate.

Data analysis and presentation

Data were entered and analyzed using IBM SPSS Statistics version 25 (IBM Corp, Armonk, NY, USA). Descriptive statistics were presented as frequencies, percentages, means with standard deviations, or medians with ranges, as appropriate. Associations between categorical variables were assessed using Pearson's chi-square test or Fisher's exact test when appropriate. Logistic regression analysis was performed to identify factors associated with knowledge of HPV, knowledge of the HPV vaccine, and willingness to vaccinate. Statistical significance was set at $p < 0.05$.

Ethical consideration

Ethical approval for this study was obtained from the Institutional Review Board (IRB) of AlMaarefa University (Ref. No. IRB23-039). Written informed consent was obtained from all participants before completing the questionnaire. Participation was voluntary, and confidentiality and anonymity were maintained throughout the study.

Results

Sociodemographic characteristics

The questionnaire was completed by a total of 502 parents. The majority of them were in the age group of 46 years and older (32.5%), were married (88.8%), held a university degree (65.9%), and were employed (46.2%), as indicated in Table 1.

Knowledge of reproductive characteristics

Figure 1 displayed the level of parents' knowledge of HPV infection, knowledge of the HPV vaccine, and level of willingness for HPV vaccination. Knowledge of HPV Infection, HPV Vaccine, and Willingness to Vaccinate.

Figure 1 shows the distribution of parents according to their knowledge of HPV infection, knowledge of the HPV vaccine, and willingness to vaccinate their children. Overall, 75.5% of participants had inadequate knowledge of HPV infection, 77.9% had inadequate knowledge of the HPV vaccine, and 54.0% demonstrated low willingness to vaccinate their children.

Reasons for parents' unwillingness to the HPV vaccine

Parents' hesitancy toward the HPV vaccine is influenced by various factors [6]. A significant portion of parents (48.4%) were unable to articulate specific reasons for their reluctance toward the HPV vaccine. Among those who did provide explanations, a prevalent theme was a lack of knowledge about the vaccine, accounting for 25.5% of responses. Fear and anxiety surrounding the vaccine constituted another major reason for hesitancy, cited by 20.3% of parents. While less frequent, personal inconvenience and the perception of limited vaccine adoption were also mentioned as factors contributing to parental hesitancy, at 2.4% and 3.4%, respectively (Figure 2).

Source of information on HPV vaccine

Figure 3 illustrates the sources from which parents obtain information about the HPV vaccine. The majority of parents (36%) received information through friends and family. Others relied on the media (31.9%), while a significant portion learned about the vaccine from healthcare workers (24.7%). A smaller group utilized educational resources (4.2%), and a minority received information from other unspecified sources (2.6%).

Association between parents' knowledge of HPV infection and sociodemographic factors

The data indicate an association between parents' knowledge of HPV and various sociodemographic characteristics. Educational level and occupation influence parents' knowledge in the given context. Parents with higher education ($p = 0.012$) and those working as health professionals ($p < 0.001$) exhibit higher levels of knowledge. In contrast, age and marital status do not significantly impact parents' knowledge of HPV in this context.

Knowledge of HPV vaccine

Similarly, there is an association between parents' knowledge of the HPV vaccine and various sociodemographic characteristics. Educational level ($p = 0.004$) and occupation ($p = 0.001$) are significant determinants of parents' knowledge about the HPV vaccine, with health professionals and those possessing post-university education showing the highest knowledge levels. Conversely, age and marital status do not significantly influence parents' knowledge of the HPV vaccine.

Parents' willingness of the HPV vaccine

Association between parents' willingness to engage with HPV vaccination and sociodemographic factors. The data suggest that educational level and occupation are significantly associated with parents' willingness to

Table 1. *Sociodemographic characteristics of study participants.*

Characteristic	*n*	%
Age 30-35 years	119	23.7
Age 36-40 years	97	19.3
Age 41-45 years	123	24.5
Age 46-51 years	108	21.5
Age ≥52 years	55	11.0
Married	446	88.8
Divorced/widow	56	11.2
Secondary education and below	106	21.1
University	331	65.9
Post-university	65	12.9
Housewife	165	32.9
Employee	232	46.2
Self-employed	57	11.4
Health professional	48	9.6

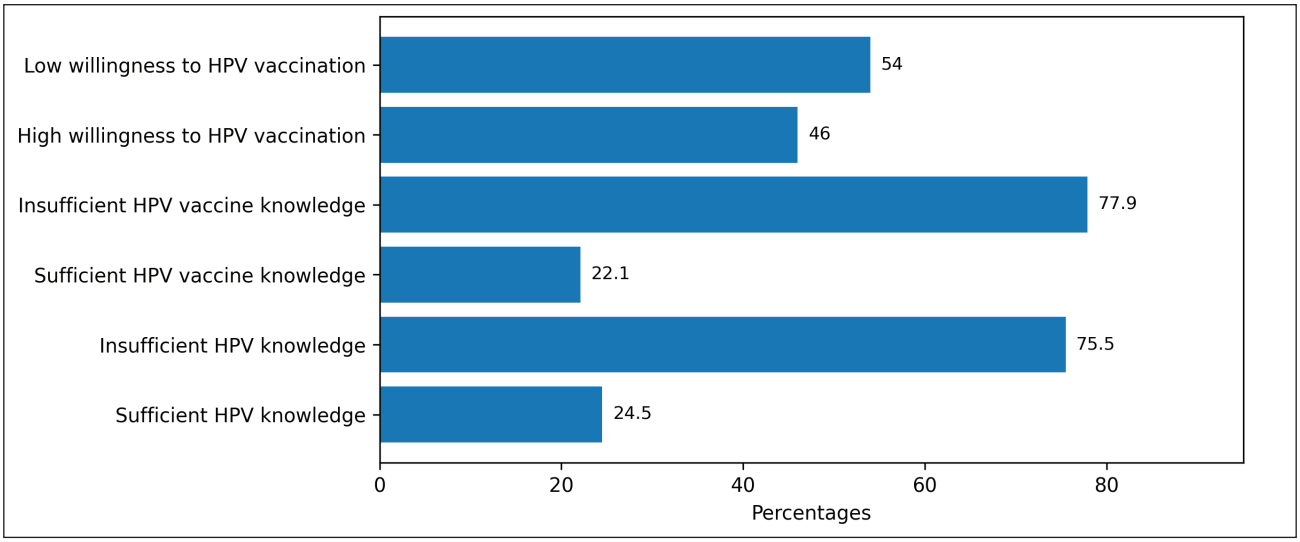


Figure 1. *Parental knowledge of HPV infection and HPV vaccine knowledge, and willingness toward HPV vaccination.*

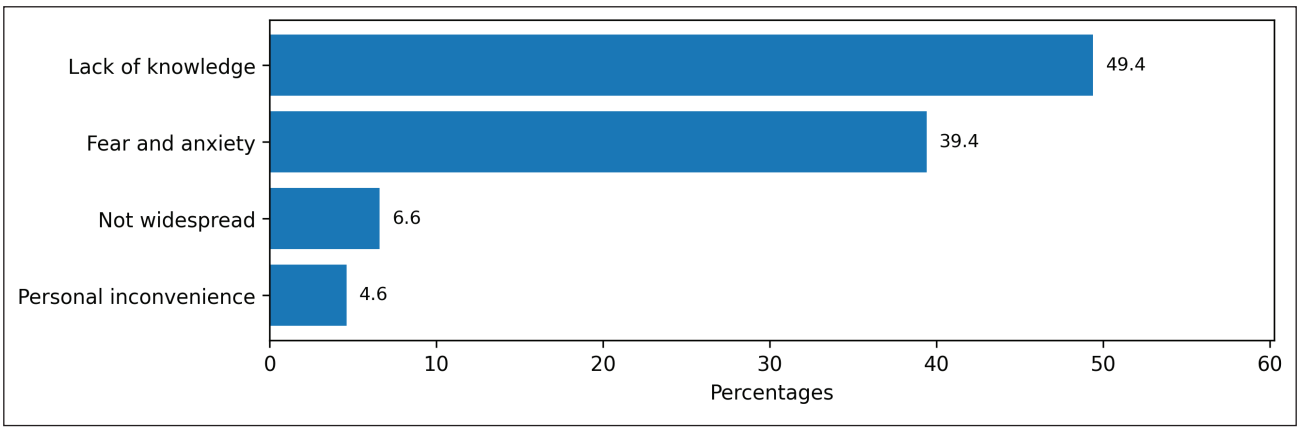


Figure 2. *Reasons reported by parents for unwillingness toward HPV vaccination.*

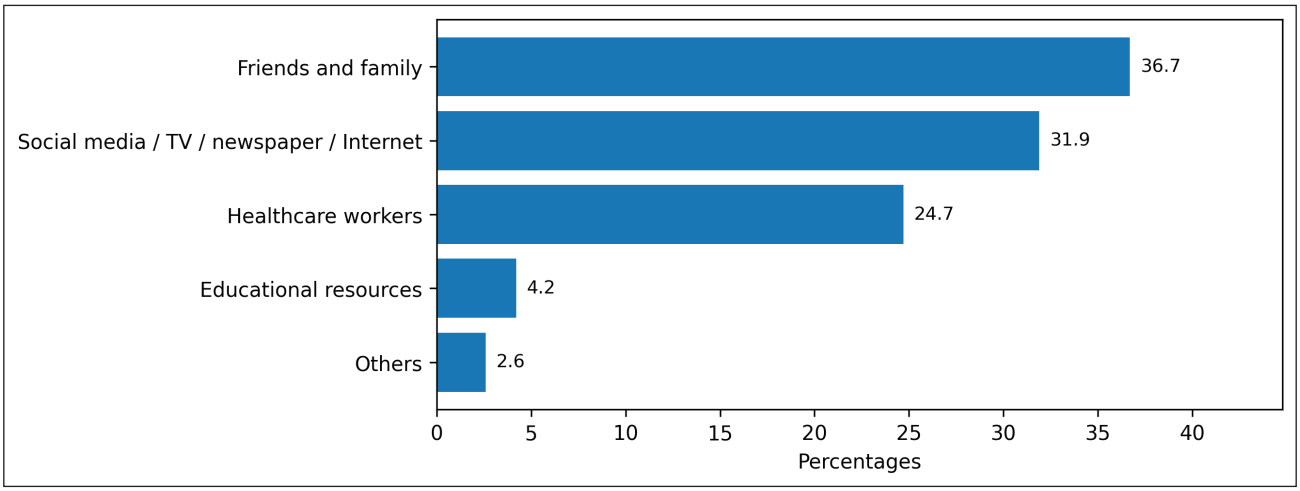


Figure 3. *Sources of information about HPV vaccination.*

engage with the HPV vaccination process (p of 0.002 and <0.001, respectively). Parents with higher education and those working as health professionals demonstrated a greater willingness to engage with HPV-related information or services. In contrast, age and marital status did not appear to significantly influence parents' willingness to engage with HPV (p of 0.857 and 0.229, respectively). These findings highlight the importance of targeted educational interventions aimed at parents with lower educational levels and those outside of healthcare

professions to increase HPV awareness and engagement (Table 2).

Modeling regression analysis of sociodemographic factors and level of knowledge on HPV, HPV vaccine, and level of willingness

Regression analysis explored the relationship between sociodemographic factors and HPV knowledge, HPV vaccine knowledge, and willingness to vaccinate. Results indicate that occupation significantly influenced both knowledge levels and vaccination willingness.

Health professionals exhibit a substantial odds ratio (OR) of 29.614, with a wide 95% confidence interval (CI) of 7.792-231.275 and a p of 0.001. Health professionals demonstrated substantially higher odds of possessing HPV knowledge and being willing to vaccinate their children compared to other occupations. Specifically, health professionals have an OR of 4.837 (95% CI: 2.374-9.856, $p < 0.001$) for higher knowledge levels and an OR of 3.654 (95% CI: 1.596-8.366, $p = 0.002$) for willingness to vaccinate, indicating a robust association with a higher tendency to get vaccinated.

Employees also show higher knowledge levels with an OR of 1.706 (95% CI: 1.133-2.569, $p = 0.011$). On the other hand, age, marital status, and educational level did not significantly predict knowledge or vaccination willingness. These findings underscore the importance of occupation, particularly in healthcare, in shaping parents' attitudes and behaviors regarding HPV (Table 3).

Discussion

The study surveyed 502 parents to evaluate their knowledge of HPV, the HPV vaccine, and their hesitance regarding the HPV vaccine. Results indicated that 75.5% of parents had insufficient knowledge about HPV infection, 77.9% had inadequate understanding of the HPV vaccine, and 54.0% were unwilling to vaccinate. These findings highlight significant gaps in awareness and acceptance of HPV-related health issues among parents, with a substantial portion demonstrating an inadequate understanding of the virus and its associated risks. These results are consistent with previous studies, which underscore the need for enhanced HPV education within the community [7]. For instance, research conducted in Ethiopia, Syria, and China reported insufficient knowledge of HPV infection among 68.6%, 62.5%, and 80.7% of surveyed parents, respectively, which is slightly higher than the levels found in this study [8,9,10]. Conversely, a survey among parents of girls of similar age in Greece and Poland revealed a very high level of knowledge about HPV infection (99.4% and 86.5%, respectively) [11,12,13].

Parents' knowledge of the HPV vaccine

Regarding the HPV vaccine, 54.4% of respondents in this study demonstrated satisfactory understanding. This finding aligns with previous studies in Ethiopia and Sharjah (UAE), where 48.7% and 50.9% of parents had heard of the HPV vaccine [9,14]. In contrast, a study in Riyadh, Saudi Arabia, reported that only 30% of parents were aware of the HPV vaccine [15], likely due to the larger sample size in the current study. A previous study also found that parents in three Arab countries had limited knowledge about the HPV vaccine, with only 14.2%-34.2% being aware of it [16]. Overall, the low level of awareness about the HPV vaccine appears to be a common issue in the Middle East and North Africa region, possibly due to a lack of understanding of the link between cervical cancer and HPV infection, as well as the limited availability of the HPV vaccine in many countries in the region or its recent introduction on a limited scale in some vaccination schedules [16]. These findings suggest that improving public awareness regarding the relationship between HPV infection and

Table 2. *Sociodemographic factors associated with HPV knowledge, HPV vaccine knowledge, and willingness for HPV vaccination.*

Variable	Category	Inadequate HPV knowledge n (%)	Inadequate HPV vaccine knowledge n (%)	Not willing *n* (%)	*p* value (HPV)	*p* value (vaccine/ willingness)
Age	30-35 years	35 (29.4)	56 (47.1)	60 (50.4)	0.911	0.425/0.857
Age	36-40 years	28 (28.9)	55 (56.7)	53 (54.6)		
Age	41-45 years	42 (34.1)	68 (55.3)	69 (56.1)		
Age	46-51 years	32 (29.6)	64 (59.3)	61 (56.5)		
Age	≥52 years	17 (30.9)	30 (54.5)	28 (50.9)		
Marital status	Married	136 (30.5)	245 (54.9)	245 (54.9)	0.801	0.484/0.229
Marital status	Divorced/widow	18 (32.1)	28 (50.0)	26 (46.4)		
Education	Secondary and below	41 (38.7)	59 (55.7)	58 (54.7)	0.012	0.004/0.002
Education	University	101 (30.5)	191 (57.7)	191 (57.7)		
Education	Post-university	12 (18.5)	23 (35.4)	22 (33.8)		
Occupation	Housewife	65 (39.4)	106 (64.2)	94 (57.0)	<0.001	<0.001/<0.001
Occupation	Employee	69 (29.7)	119 (51.3)	130 (56.0)		
Occupation	Self-employed	19 (33.3)	35 (61.4)	36 (63.2)		
Occupation	Health professional	1 (2.1)	13 (27.1)	11 (22.9)		

Table 3. *Multivariable logistic regression analysis of sociodemographic factors associated with HPV knowledge, HPV vaccine knowledge, and willingness for HPV vaccination.*

Variable/category	HPV knowledge OR (95% CI)	*p*	HPV vaccine knowledge OR (95% CI)	*p*	Willingness OR (95% CI)	*p*
Age 30-35	0.933 (0.450-1.934)	0.851	1.424 (0.722-2.808)	0.308	1.146 (0.583-2.251)	0.693
Age 36-40	0.985 (0.462-2.103)	0.969	0.946 (0.467-1.918)	0.879	0.944 (0.469-1.903)	0.872
Age 41-45	0.751 (0.370-1.527)	0.430	0.921 (0.471-1.797)	0.808	0.820 (0.422-1.595)	0.559
Age 46-51	0.897 (0.433-1.859)	0.771	0.756 (0.381[1.498)	0.423	0.748 (0.379-1.476)	0.402
Age ≥52 (reference)	Reference	—	Reference	—	Reference	—
Married	1.020 (0.544-1.911)	0.952	1.240 (0.689-2.231)	0.473	0.651 (0.362-1.171)	0.152
Divorced/widow (reference)	Reference	—	Reference	—	Reference	—
Secondary and below	0.880 (0.381-2.035)	0.766	0.820 (0.389-1.730)	0.602	0.650 (0.308-1.370)	0.257
University	1.014 (0.485-2.122)	0.970	0.553 (0.296-1.033)	0.063	0.550 (0.293-1.031)	0.062
Post-university (reference)	Reference	—	Reference	—	Reference	—
Housewife (reference)	Reference	—	Reference	—	Reference	—
Employee	1.478 (0.937-2.330)	0.093	1.815 (1.157-2.848)	0.009	1.031 (0.664-1.600)	0.893
Self-employed	1.248 (0.650-2.396)	0.506	1.103 (0.579-2.104)	0.765	0.715 (0.376-1.360)	0.306
Health professional	29.614 (3.792-231.275)	0.001	4.328 (1.929-9.713)	<0.001	3.654 (1.596-8.366)	0.002

cervical cancer may contribute to greater acceptance of HPV vaccination. Educational initiatives led by healthcare professionals and public health authorities may help address misconceptions and improve vaccine confidence among parents.

Level of potential acceptability of HPV vaccine

Our study also evaluated parental willingness and hesitancy toward the HPV vaccine. A majority of parents (54%) expressed a high willingness to vaccinate their children, providing positive responses to questions about the availability and effectiveness of the HPV vaccine. This result aligns with findings by Darraj et al. [17] in a study conducted in Jazan, Saudi Arabia, where 54% of parents showed a similar willingness to vaccinate. However, this prevalence is lower compared to studies from Canada (70%) [18], Sharjah (UAE) (76.6%) [14], Nigeria (81.8%) [14], Poland (85%) [1], and Kenya (89%) [19], where parents reported a higher willingness to vaccinate their children. The lower rate in our study suggests that some parents may not consider the vaccine important for their children, possibly due to concerns about the vaccine. Factors contributing to this gap may include a lack of knowledge about the benefits of HPV vaccination, anxiety about side effects (39.5%), limited availability of the HPV vaccine (6.6%), cultural factors, and cost. These findings indicate that parental willingness is influenced by both knowledge-related and perception-related factors. Addressing these concerns through evidence-based education and physician counseling may improve vaccine acceptance.

Causes of hesitation regarding the HPV vaccine

Parental hesitancy toward the HPV vaccine was primarily driven by concerns about safety (45.2%) and efficacy (45.4%), aligning with general vaccine hesitancy trends. Notably, these rates were significantly higher than those reported in previous studies from Ethiopia (21.8%) [9] and the United States (30%) [20]. This suggests a critical role for knowledge in shaping parental attitudes toward the HPV vaccine.

Lack of knowledge was identified as a key determinant of vaccine hesitancy, supporting previous research [21,12]. Fear and anxiety also emerged as significant factors, consistent with prior findings [21]. While the lack of widespread HPV vaccine information influenced hesitancy, as supported by some studies [5], its impact was inconsistent with other research [22]. Finally, personal experiences were found to be influential, aligning with previous studies [23]. Overall, the current study reinforces the importance of parental knowledge in vaccine acceptance, emphasizing the need for targeted educational interventions to address safety and efficacy concerns. Future awareness campaigns should specifically address misconceptions regarding vaccine safety and effectiveness while emphasizing the proven role of HPV vaccination in preventing HPV-related cancers.

Our study found significant associations between sociodemographic characteristics and parents' knowledge of HPV infection, the HPV vaccine, and their willingness to vaccinate their children. Parents who are health professionals and those with higher education levels exhibited the highest levels of knowledge and willingness to vaccinate. Health professionals were four times more likely to vaccinate their children, likely due to their exposure to extensive information about HPV and its associated risks, as well as their understanding of the benefits, safety, and effectiveness of vaccines. The strong association between occupation and both HPV knowledge and vaccination willingness highlights the crucial role of healthcare providers in disseminating accurate information and influencing parental decisions. However, the relatively low levels of knowledge among other occupational groups emphasize the need for targeted educational interventions. Education level also emerged as a significant predictor of HPV knowledge, but its influence on vaccination willingness was less pronounced, suggesting that factors such as perceived risk, trust in healthcare providers, and social norms may also impact vaccine acceptance. This indicates that parents' vaccination knowledge plays a crucial role in their willingness to vaccinate and in making vaccination decisions. These findings highlight the importance of tailoring educational interventions according to parents' educational and occupational backgrounds. Increasing healthcare provider engagement may further improve parental awareness and promote informed vaccination decisions.

Our study identified key factors influencing parental decisions about the HPV vaccine, a critical step in addressing vaccine hesitancy. A majority of parents relied on friends and family for information, highlighting the power of social networks in shaping attitudes. While this emphasizes the importance of interpersonal connections, it also raises concerns about misinformation spread. The media played a significant role, but its reliability can be inconsistent due to bias and sensationalism. Surprisingly, healthcare providers were less frequently cited as information sources, suggesting a need for increased engagement with parents. Educational resources were underutilized, emphasizing the need for improved accessibility and awareness.

Comparisons with other studies reveal variations in information sources. While our study found a significant reliance on friends and family (36.7%), research in Greece showed a higher reliance on physicians (45%) [11]. Both studies underscore the impact of social media, with our study reporting 31.9% of participants using these platforms compared to 18.6% in Greece [11]. A study in Kazakhstan highlights the influence of social media and television (40%) and the significant role of physicians (35%) [24]. These findings emphasize the complex interplay between various information sources and the need for strategic interventions to improve HPV vaccine uptake. To effectively address vaccine hesitancy, it is crucial to improve the quality and accessibility of information, particularly through healthcare providers and educational resources. Engaging social networks and countering misinformation are also essential components of a comprehensive strategy. Strengthening physician-parent communication and expanding access to reliable educational materials may reduce misinformation and improve HPV vaccine uptake.

The findings of this study have significant implications for public health policy. The substantial knowledge gaps identified underscore the need for comprehensive HPV education programs targeted at parents. These programs should be tailored to different socioeconomic and educational backgrounds to ensure maximum impact. Moreover, integrating HPV vaccination into routine childhood immunization schedules can enhance uptake. In addition, collaboration between healthcare institutions, schools, and public health authorities may improve community awareness and facilitate informed parental decision-making regarding HPV vaccination. Future national campaigns should focus on correcting misconceptions, increasing trust in vaccine safety, and promoting the long-term benefits of HPV vaccination.

Strengths

This study included a relatively large sample of parents from different areas of Riyadh, providing a comprehensive assessment of parental knowledge, willingness, and vaccine hesitancy regarding HPV vaccination. Furthermore, the study evaluated multiple factors that may influence parental decision-making, providing useful evidence for future public health interventions.

Limitation

This study has several limitations. First, its cross-sectional design prevents establishing causal relationships between the identified factors and parental vaccine hesitancy. Second, the use of a self-administered questionnaire may have introduced recall and reporting bias. Finally, as the study was conducted only in Riyadh, the findings may not be generalizable to other regions of Saudi Arabia.

Conclusion

Our findings indicate that parents' educational background and occupation significantly impact their willingness to vaccinate their children against HPV. Those with higher education and healthcare professionals demonstrated greater acceptance. This underscores the importance of recognizing diverse influences on parental decision-making regarding HPV vaccination. Healthcare providers are crucial in shaping parental attitudes. To effectively address vaccine hesitancy, healthcare professionals and educational institutions should collaborate to provide accurate information, dispel misinformation, and enhance accessibility to educational resources. Addressing language barriers and promoting reliable information sources are essential for informed parental decision-making. We recommend implementing targeted health campaigns to raise parental awareness about the HPV vaccine and its benefits.

Acknowledgments

The authors express sincere gratitude to Al Maarefa University for their invaluable support, which greatly assisted

in overcoming numerous logistical challenges encountered during data collection.

List of Abbreviations

AOR	Adjusted odds ratio
CI	Confidence interval
HPV	Human papillomavirus
IRB	Institutional Review Board
OR	Odds ratio
WHO	World Health Organization

Conflict of interest

No conflict of interest.

Funding

No financial budget.

Consent for publication

Ethical approval

This research was approved by the IRB from ALMaarefa University Ref. No: IRB23-039.

Data availability

The datasets generated and/or analyzed during the current study are available from the corresponding author upon reasonable request.

Author details

Amen Bawazir[1], Hadil Essam Salem[1], Alanood Alassaf[1], Alanoud Aljohani[1], Dana Alzahrani[1], Ghala Binshafi[1], Rahaf Almarjan[1], Sara Alhemaidi[1], Shouq Alkharji[1], Lina Abed[1], Sofia Abualmeza[1]

1. College of Medicine, AlMaarefa University, Riyadh, Saudi Arabia.

Supplementary content (if any) is available online.

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