Preventive Medicine Reports 37 (2024) 102566

Contents lists available at ScienceDirect

Preventive Medicine Reports

journal homepage: www.elsevier.com/locate/pmedr

Human papillomavirus (HPV) vaccination in males: Associations of HPV-related knowledge and perceptions with HPV vaccination intention among Korean mothers of boys

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ARTICLE INFO

Keywords:
Boys
Mothers
HPV
Vaccination
Knowledge
Attitudes
Beliefs
Intention

ABSTRACT

Objectives: Human papillomavirus (HPV) vaccination rates among males are suboptimal worldwide. In South Korea, little is known about parents' intention to vaccinate boys against HPV. Therefore, we examined the associations of HPV-related knowledge and perceptions with vaccination intention among Korean mothers of boys.
Methods: From August to December 2021, eligible mothers were surveyed about HPV-related knowledge, perceptions, and intention to vaccinate their sons against HPV. Mothers were categorized into no intention, contemplating, and intention to vaccinate groups. Using analysis of variance, we compared the groups' scores on the scales measuring HPV-related knowledge, attitudes, and beliefs. We conducted a multinomial logistic regression analysis to assess the associations between the variables and vaccination intention.
Results: Among 361 mothers, 43.9 % had no intention, 60.7 % were contemplating, and 4.4 % intended to vaccinate their sons. The mean percentage of correct answers on the HPV and vaccine knowledge scales were 52.5 % and 62.3 %, respectively. The mean scores on the HPV attitudes and beliefs subscales were significantly different. Higher scores on benefits (OR = 3.04, 95 % CI 1.96 – 4.70; OR = 3.94, 95 % CI 1.54 – 10.70) and influence (OR = 1.48, 95 % CI 1.03 – 2.13; OR = 2.97, 95 % CI 1.44 – 6.14) were associated with contemplating the vaccine and intending to vaccinate sons. Knowledge was not associated with mothers' vaccination intention.
Conclusions: Public health authorities and healthcare providers in Korea can use the results of this study to implement effective interventions that emphasize the importance of male HPV vaccination and encourage parent-son communication about the vaccine.

1. Introduction

Human papillomavirus (HPV) is one of the most common sexually transmitted infections (STI) for both genders, but HPV vaccination rates for males are suboptimal (Krakow and Rogers, 2016). Noncervical HPV-associated cancers are increasing worldwide, with men exhibiting higher incidence than women (Pan et al., 2019). In 2020, the global incidence rates of male and female oropharyngeal cancer were 2.00 and 0.50 per 100,000, respectively (Sung et al., 2021). In South Korea (hereafter referred to as Korea), the incidence of oropharyngeal cancer increased from 2.7 per 100,000 in 2013 to 3.1 in 2016 among males, while remaining stable during the same period among the female population (Choi et al., 2020). Moreover, Korea has a higher prevalence of noncervical HPV-associated cancers in men than the male prevalence of these cancers in all of Asia combined (Sung et al., 2021). HPV-associated cancers are preventable if vaccination occurs early in adolescence; the HPV vaccine is currently advised for 11–12-year-old boys and girls prior to sexual debut for maximum benefits (CDC, 2023). However, recent studies reported very low vaccination rates of 0.7–1.3 % among Korean boys (Jang, 2018; Choi and Kim, 2016), compared to 35.0–43.8 % for girls (Park et al., 2020a).

Robust evidence has accumulated regarding parental factors associated with male HPV vaccination in Western culture. In particular, perceived benefits of the HPV vaccine for boys was consistently associated with parents' vaccination intention (Reiter et al., 2010; Dempsey et al., 2011; Gainforth et al., 2012; Gilkey et al., 2012; Bianco et al.,

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https://doi.org/10.1016/j.pmedr.2023.102566
Received 28 May 2023; Received in revised form 14 December 2023; Accepted 15 December 2023
Available online 16 December 2023

2014; Donahue et al., 2014; Mortensen et al., 2015; Radisic et al., 2017). According to national assessments of parental attitudes about male HPV vaccination in the United States (US), the belief that vaccinating sons can protect the health of their future female partners increased parents' vaccination intention (Moss et al., 2015). A systematic review reported that the most cited reasons for HPV vaccine non-acceptance among parents of boys were perceived barriers and low perceived severity, for which the strength of association was consistent but low (Radisic et al., 2017). Parents' HPV knowledge was also associated with vaccination intention in previous research in North America and Europe (Donahue et al., 2014, Mortensen et al., 2015; Waller et al., 2020). Studies of American and Hispanic mothers in the US reported that while they generally supported male HPV vaccination, there was a discrepancy between their stated belief in the importance of vaccination and their intention to have their own sons vaccinated (Dempsey et al., 2011; Roncancio et al., 2019). In Korea, there is a paucity of research on male HPV vaccination and how it is viewed by parents of boys. This research gap coupled with the exclusion of boys in national HPV immunization program has led to poor vaccine coverage among boys in Korea.

To address the research gap, a comprehensive inquiry into parental knowledge, perceptions, and intention to vaccinate boys against HPV is necessary because parents are key decision agents for their adolescent's health (Thompson et al., 2017). Mothers are an especially important population to engage as they exhibit higher levels of characteristics than fathers that facilitate parent–child communication about sex-related topics such as STI prevention (Kirkman et al., 2002; Wilson and Koo, 2010). This study sought to examine how HPV-related knowledge and perceptions are associated with vaccination intention among mothers of boys in Seoul, Korea.

2. Methods

2.1. Study design

This study used a cross-sectional study design based on an online self-administered survey conducted in Seoul, the capital city of Korea. The layout of this paper adheres to the STROBE guidelines (Von Elm et al., 2007) for reporting observational studies.

2.2. Participants and recruitment

Eligible participants were a purposive sample of mothers who had middle school-aged (12–15 years) male adolescents, for whom the HPV vaccine is currently recommended. Mothers were eligible to participate if they lived in one of the 25 districts in Seoul, the most densely populated city in Korea. Mothers were recruited from each district's online "mom café", which served as an efficient medium to distribute the online survey. These social networking websites in Korea (Kim and Chung, 2021) are for mothers to share their child-rearing via interactive discussion forums (Park et al., 2020b).

Recruitment announcements and a direct link to the Google Survey were posted on the "announcements" board of each of the mom café websites from August to December 2021. The survey was administered in Korean and was not submitted if any of the questions was left unanswered. For confidentiality purpose, we ensured that the survey was not editable and the results were not viewable by anyone except for the research team. Informed consent was obtained from participants electronically prior to their participation. Participants were compensated with a coffee coupon worth the equivalent of US five dollars. All procedures began once the study protocols were approved from the Institutional Review Board at Seoul National University (IRB No. 2106/003–013).

Prior to survey administration, the instruments were translated from English to Korean and back translated into the source language. Translation was independently conducted by two researchers fluent in both languages and familiar with the instruments. Any discrepancies in translation were discussed until consensus was reached. The survey was pilot tested with 20 mothers from one district to ensure that psychometric properties were similar to the original scales.

2.3. Measures

We collected participants' sociodemographic characteristics and HPV-related experiences, including vaccination status, screening for HPV infections and cervical cancer, and history of ever being diagnosed with HPV-associated diseases for the mothers themselves and their family. Participants indicated the age of their youngest son (if they had more than one son), and whether they had a daughter.

To assess vaccination intention, mothers were asked to choose the statement that most closely described their level of intention to vaccinate their sons if the vaccine were available to boys. The response options were: *"I am not interested in HPV vaccination", "I do not plan/intend to get my son vaccinated", "I am thinking about getting my son vaccinated but I have not decided yet", "I intend to get my son vaccinated soon",* and *"My son is already vaccinated."*.

We used the HPV general knowledge scale (GK) and the HPV vaccine knowledge scale (VK) that were developed by Waller et al. (2013). The adapted version of the scales (GK23 and VK9) with moderate to high internal consistencies included additional items to capture knowledge relevant to males such as the association of HPV with oropharyngeal, penile, and anal cancers (Perez et al., 2016a). Example items measuring HPV and vaccine knowledge are as follows: *Men cannot get HPV* (false); *The HPV vaccine requires at least 2 doses* (true). A mixture of true and false items was included to minimize response bias. Scores were calculated by assigning 1 point to each correct answer and zero points for incorrect answer or 'do not know' responses (range = 0 – 23 for GK and range = 0 – 9 for VK).

We used an abbreviated version of the HPV Attitudes and Beliefs Scale (HABS) (Perez et al., 2016b) to measure mothers' HPV vaccination attitudes and beliefs. Items in this adapted scale are mapped onto seven subscales: (1) benefits *(I feel that the HPV vaccine would protect my son's sexual health*), (2) susceptibility and severity combined into threat (*I feel that it would be serious if my son contracted HPV later in life; I feel that without the HPV vaccine, my son would be at risk of getting genital warts later in life*), (3) influence (*I feel that most of my friends would think vaccinating my son against HPV is a good idea*), (4) barriers (*I feel that giving my son the HPV vaccine would be like performing an experiment on him*), (5) communication (*I feel that sex is not a subject that I talk about with my son*). High internal consistency (Cronbach's alpha 0.814 – 0.954) was observed for abbreviated versions of the HABS in a previous study (Perez et al., 2016b). Items were evaluated on a 7-point Likert scale rating from 1 (strongly disagree) to 7 (strongly agree).

2.4. Analysis

We calculated sample size based on an a priori two-tailed analysis (power = 0.8, alpha = 0.05, and effect size = 0.15) using the G*Power 3.1.9.7 software. The "not interested" group was merged with the no intention group as this phrase connotes negative willingness and indirectly expresses refusal (Ll, 2010; Wang, 2019). Mothers with already vaccinated sons were merged with the intention to vaccinate group. We tested for the associations of mothers' sociodemographic characteristics and HPV-related experiences with vaccination intention using Pearson's chi-square test or Fisher's exact test. We conducted analysis of variance (ANOVA) to compare the mean scores on HPV-related knowledge and perceptions among the three groups (no intention, contemplating and intention to vaccinate). We conducted a multinomial logistic regression analysis to examine the associations of HPV-related knowledge, attitudes, and beliefs with vaccination intention. Odds ratios (OR) and 95 % confidence intervals (CI) with a p-value of < 0.05 indicating statistical significance were calculated and reported for each outcome. We performed all analyses using SAS version 9.4 (SAS Institute, Cary, NC).

3. Results

Table 1 summarizes the participants' characteristics. Among 361 mothers (mean age = 25.6, SD ± 3.39), 34.9 % (n = 126) had no intention, 60.7 % (n = 219) were contemplating and 4.4 % (n = 16) intended to vaccinate their sons against HPV. Eighty percent of mothers had heard of HPV, 63.4 % indicated that they attended HPV screening regularly, 21.2 % reported that they were vaccinated against HPV, and 6.4 % reported that they had been previously diagnosed with HPV. Mothers' sons enrolled in the first, second, and third grade of middle school were similar in proportions. Less than half of mothers (44.0 %) indicated that they also had daughters in the household. Only mothers' age ($p = 0.001$), education ($p = 0.001$), HPV vaccination status ($p = 0.018$), and regular HPV screening ($p < 0.001$) were associated with mothers' intention to vaccinate their sons.

The mean scores on the GK23 and VK9 were 12.0 out of 23 (52.5 %) and 5.6 out of 9 (62.3 %), respectively. On the GK23, 85.4 % of mothers answered correctly on the item *"Having many sexual partners increases the risk of getting HPV"* while 7.8 % answered correctly on the false item *"HPV infections always lead to health problems."* More than half of the mothers responded "do not know" for the items *"HPV can cause anal cancer"* (53.2 %). On the VK9, 82.2 % of mothers answered correctly on the item *"Girls who have had the HPV vaccine do not need a pap smear test when they are older."* Mothers generally answered all the items correctly, except for the false item *"You can cure HPV by getting the HPV vaccine,"* for which 43.2 % of mothers answered correctly. The item that received the highest number of "do not know" response was *"The HPV vaccine requires at least 2 doses"* (30.7 %). Fig. 1 in Supplementary Material 1 presents the distribution of responses on the GK23 and VK9.

Table 2 summarizes the mean scores on the GK23, VK9 and HABS. On average, mothers in the contemplating group scored highest on the GK23, followed by the intention to vaccinate group; mothers in the no intention group had the lowest mean score. The intention to vaccinate group obtained the lowest mean score on the VK9. However, the differences between the groups were not significant. Mothers in the intention to vaccinate group scored highest on the benefits (5.6 out of 7) and threat (5.1 out of 7) subscales but scored lowest on the barriers (4.0 out of 7) and communication (4.0 out of 7) subscales. Mothers in the contemplating group scored highest on the communication (4.6 out of 7) subscale. Among the three groups, the no intention group had the lowest mean scores on the benefits (4.3 out of 7), threat (4.4 out of 7), and influence (3.3 out of 7) subscales. The groups' mean scores on the

Table 1
Sociodemographic characteristics and HPV-related experiences of mothers participating in the study (N = 361) in Seoul, Korea, August – December 2021.

Variable	Overall Sample n (%)	No intention n (%)	Contemplating n (%)	Intention to vaccinate n (%)	p-value[a]
Overall		126 (34.9)	219 (60.7)	16 (4.4)	
Sociodemographics					
Age – mean (SD)	45.6 (3.39)				
30–39 years	8 (2.2)	4 (1.1)	3 (0.8)	1 (0.3)	0.001
40–49 years	313 (86.7)	111 (30.8)	188 (52.1)	14 (3.9)	
50–59 years	40 (11.1)	11 (3.1)	28 (7.8)	1 (0.3)	
Education					
High school graduate	48 (13.3)	14 (3.9)	32 (8.9)	2 (0.6)	0.001
Bachelor's degree	277 (76.7)	99 (27.4)	166 (46.0)	12 (3.3)	
Master's degree or higher	36 (10.0)	13 (3.6)	21 (5.8)	2 (0.6)	
Employed					
Yes	171 (47.4)	60 (16.6)	101 (28.0)	10 (2.8)	0.447
No	190 (52.6)	66 (18.3)	118 (32.7)	6 (1.7)	
Religion					
Protestant	98 (27.2)	33 (9.1)	58 (16.1)	7 (1.9)	0.066
Catholic	46 (12.7)	10 (2.8)	34 (9.4)	2 (0.6)	
Buddhism	30 (8.3)	7 (1.9)	23 (6.4)	0	
No religion	187 (51.8)	76 (21.1)	104 (28.8)	7 (1.9)	
Have a daughter					
Yes	159 (44.0)	49 (13.6)	101 (28.0)	9 (2.5)	0.258
No	202 (56.0)	77 (21.3)	118 (32.7)	7 (1.9)	
Son's grade - mean age (SD)	14.0 (0.83)				
Middle school – 1st year	129 (35.7)	40 (11.1)	81 (22.4)	8 (2.2)	0.489
Middle school – 2nd year	122 (33.8)	48 (13.3)	69 (19.1)	5 (1.4)	
Middle school – 3rd year	110 (30.5)	38 (10.5)	69 (19.1)	3 (0.8)	
Monthly household income (KRW)[b,c]					
Under 5 million	154 (42.7)	55 (15.2)	94 (26.0)	5 (1.4)	0.635
Over 5 million	207 (57.3)	71 (19. 7)	125 (34.6)	11 (3.1)	
Mothers' HPV-related experience					
Ever heard of HPV					
Yes	290 (80.3)	94 (26.0)	184 (51.0)	12 (3.3)	0.091
No	71 (19.7)	32 (8.9)	35 (9.7)	4 (1.1)	
Previous HPV diagnosis					
Yes	23 (6.4)	7 (1.9)	15 (4.2)	1 (0.3)	0.894
No	338 (93.6)	119 (33.0)	204 (56.5)	15 (4.2)	
Vaccinated against HPV					
Yes	76 (21.2)	19 (5.3)	50 (13.9)	7 (1.9)	0.018
No	285 (79.0)	107 (29.6)	169 (46.8)	9 (2.5)	
Regular HPV screening(pap smear test)					
Yes	229 (63.4)	77 (21.3)	141 (39.1)	11 (3.1)	0.001
Sometimes	87 (24.1)	30 (8.3)	54 (15.0)	3 (0.8)	
No	45 (12.5)	19 (5.3)	24 (6.7)	2 (0.6)	

[a] Chi-square test or Fisher's exact test, with 0.05 level significance.
[b] in Korean *Won*, Korean currency, where 1 KRW = 0.000736 USD (November 2022).
[c] The average monthly household income at the time of survey administration was close to 5 million Won, according to Korean Statistics Information Service.

Table 2
HPV general knowledge, HPV vaccine knowledge, and HPV attitudes and beliefs: Mean scores of mothers participating in the study in Seoul, Korea, August – December 2021.

Construct/ Subscale	Cronbach alpha	Max Score	Total mean score (mean score of the items)			*F*	*P* value[1]
			No intention	Contemplating	Intention to vaccinate		
HPV knowledge							
HPV general knowledge	0.89	23	10.8	12.8	10.9	7.90	<0.001
HPV vaccine knowledge	0.71	9	5.4	5.8	4.6	3.62	0.028
HPV-related attitudes and beliefs							
Benefits	0.95	63	38.9(4.3)	47.6(5.3)	50.6(5.6)	61.60	<0.001
Barriers	0.90	56	34.9(4.4)	32.9(4.1)	32.1(4.0)	3.95	0.020
Threat	0.77	42	26.3(4.4)	29.8(5.0)	30.6(5.1)	22.70	<0.001
Influence	0.84	56	26.1(3.3)	32.0(4.0)	38.1(4.8)	35.38	<0.001
Communication	0.91	35	17.9(4.4)	17.3(4.6)	20.0(4.0)	1.69	0.186

[1] One-Way ANOVA Test.

subscales were significantly different except for communication. Item-specific scores on each subscale can be found in Supplementary Material 2.

Table 3 shows the results of the multinomial logit model, in which the independent variables are mothers' HPV-related knowledge, attitudes, and beliefs and the outcome variable is mothers' intention to vaccinate their sons (reference: no intention). In the multivariable analysis, benefits and influence were significantly associated with the mothers' vaccination intention. Mothers with higher scores pertaining to beliefs that the HPV vaccine was beneficial had three times and almost four times the odds of contemplating and intending to vaccinate their sons, respectively (OR = 3.04, 95 % CI 1.96 – 4.70; OR = 3.94, 95 % CI 1.54 – 10.04) compared to having no intention. Mothers with higher scores on influence had almost 1.5 times and almost three times the odds of being in the contemplating and intention to vaccinate groups, respectively (OR = 1.48, 95 % CI 1.03 – 2.13; OR = 2.97, 95 % CI 1.44 – 6.14) compared to having no intention. Mothers who expressed fewer concerns about barriers to vaccinating their sons were more likely to be in the contemplating group (OR = 0.92, 95 % CI 0.63 – 1.36) and the intention to vaccinate group (OR = 0.68, 95 % CI 0.33 – 1.40) compared to the no intention group, although these results were not significant. Threat showed significance only in the multivariable analysis. Mothers with HPV general knowledge had higher odds of contemplating the vaccine (OR = 1.10, 95 % CI 1.04 – 1.15) compared to having no intention in the univariable analysis. Moreover, the association between vaccine knowledge and communication was not significant in the univariable or multivariable analyses in this sample.

4. Discussion

We confirmed that knowledge levels did not reflect the mothers' vaccination intention. Although vaccine-hesitant mothers were more knowledgeable than mothers with vaccination intention, profound concerns about the less recognized HPV vaccine for boys may have caused them to contemplate the vaccine. The nonsignificant association between knowledge and vaccination intention in our study is consistent with findings of previous studies. In a study from the United Kingdom (UK), HPV knowledge and vaccine knowledge were not significant predictors of parents' approval of vaccination for boys prior to the availability of male HPV vaccination through the National Health Service (Sherman and Nailer, 2018). In Poland, a country with low HPV vaccination coverage, HPV knowledge among parents of sons and daughters was not associated with vaccine acceptance (Ganczak et al., 2018). In contrast, studies of Chinese parents found that HPV knowledge remained a significant and independent correlate of parental vaccination intentions despite suboptimal knowledge (Zhu et al., 2019). In the UK and Germany, HPV vaccination awareness increased with the introduction of publicly funded male HPV vaccine programs, resulting in stronger intention to vaccinate sons among parents (Mortensen et al., 2015). Therefore, the absence of gender-neutral HPV vaccination in Korea may have contributed to the little predictive power of knowledge in our study.

Perceived benefits of the vaccine was strongly associated with mothers' vaccination intention in our study. Previous studies in Korea identified significant associations between perceived benefits and vaccination intention, although they targeted college students, school teachers, and mothers of daughters (Jo et al., 2021; Kim et al., 2017; Choi et al., 2013; Kim and Kim, 2015; Kim and Kang, 2014; Choi and Park. 2016). Another study indicated that Thai parents who intended to vaccinate their children had higher perceived benefits of the HPV vaccine (Juntasopeepun and Thana, 2018). A Chinese study showed that parents of sons reported lower levels of perceived benefits than those of daughters even with briefing about the HPV vaccine efficacies for both genders (Wang et al., 2018). Association between perceived benefits and parental acceptability for their son's HPV vaccination was not significant in this study (Wang et al., 2018). While this result does not align with our findings, it demonstrates the need for different strategies when promoting HPV vaccination for parents of daughters and parents of sons. For example, tailored gain-framed messages such as prevention of penile cancer through on-time vaccination can help parents of boys make informed decisions (Choi and Park, 2016).

Influence was also associated with the mothers' intention to vaccinate their sons against HPV. The items receiving the highest average scores across the three groups of mothers pertained to their anticipated approval of doctors, friends, and family. This result was expected as social elements strongly influence health-seeking behaviors, particularly vaccination, in Asia (Wong et al., 2020). For example, a recent study reported a higher likelihood of Vietnamese mothers of boys to receive HPV vaccination education by providers (Minh et al., 2020) and a Chinese study explained that because physicians are seen as a "wise benevolent authority figure" in collectivist cultures, parents tend to be heavily influenced by, or even defer vaccine decision-making to physicians (Zhu et al., 2019). Studies of Filipino, Korean, and Japanese mothers mentioned that decisions about vaccinating their children against HPV were influenced by having friends with vaccinated children (Kim et al., 2015; Dela Cruz et al., 2020). Our findings also support those of a Canadian study, in which increased influence from family, friends, and providers regarding HPV vaccination was positively associated with vaccine acceptability among vaccine-hesitant parents of boys (Tatar et al., 2019).

We observed little explanatory power of HPV-related communication and threat in understanding mothers' vaccination intention. In many Asian countries including Korea, parental sexual communication is often minimal because sex is a deeply ingrained taboo subject (Kim and Ward, 2007; Grandahl and Nevéus, 2021). When parents occasionally impart sexual knowledge to children, daughters are more likely recipients than sons as health has long been considered a female responsibility (Connell, 2012). The traditional gender norms may have hindered mothers from realizing severity of HPV for males, ultimately leading mothers to postpone or forgo their sons' HPV vaccination. Overidentification of the

Table 3
Associations of HPV-related knowledge, attitudes, and beliefs with HPV vaccination intention for sons among mothers participating in the study in Seoul, Korea, August – December 2021: Results of the multinomial logistic regression analysis.

Variable	HPV vaccination intention levels			
	Reference: no intention (n = 126) Contemplating (n = 219)		Intention to vaccinate (n = 16)	
	Odds Ratio (95 % CI)	*P* value	Odds Ratio (95 % CI)	*P* value
Univariable				
HPV knowledge				
HPV general knowledge	1.10*** (1.04, 1.15)	<0.001	1.01 (0.91, 1.12)	0.893
HPV vaccine knowledge	1.11 (1.00, 1.23)	0.056	0.87 (0.58, 1.02)	0.219
HPV-related attitudes and beliefs				
Benefits	4.53*** (3.13, 6.54)	<0.001	7.66*** (3.73, 15.74)	<0.001
Barriers	0.70** (0.53, 0.91)	0.009	0.60 (0.33, 1.11)	0.102
Threat	2.54*** (1.85, 3.47)	<0.001	3.18*** (1.59, 6.37)	0.001
Influence	2.57*** (1.92, 3.44)	<0.001	5.47*** (3.08, 9.67)	<0.001
Communication	0.92 (0.77, 1.10)	0.358	1.33 (0.86, 2.05)	0.198
Multivariable†				
HPV knowledge				
HPV general knowledge	1.05 (0.98, 1.12)	0.201	0.96 (0.83, 1.12)	0.616
HPV vaccine knowledge	1.02 (0.89, 1.18)	0.770	0.88 (0.64, 1.22)	0.446
HPV-related attitudes and beliefs				
Benefits	3.04*** (1.96, 4.70)	<0.001	3.94** (1.54, 10.04)	0.004
Barriers	0.92 (0.63, 1.36)	0.674	0.68 (0.33, 1.40)	0.296
Threat	1.35 (0.90, 2.02)	0.146	1.13 (0.47, 2.73)	0.791
Influence	1.48* (1.03, 2.13)	0.033	2.97** (1.44, 6.14)	0.003
Communication	0.87 (0.68, 1.11)	0.258	1.13 (0.65, 1.95)	0.645

*p < 0.05, **p < 0.01, ***p < 0.001.
†Model fit: Likelihood ratio $X^2 = 132.84$, p < 0.001.

HPV vaccine with cervical cancer prevention may have led to mothers to misinterpret that boys are not susceptible to HPV and that the vaccine is not necessary nor safe for boys. A population-based study from China reported that parents of boys were price sensitive and had lower vaccine acceptability than parents of girls under different cost scenarios (Wang et al., 2018). This finding suggests that while parents may tolerate investing in girls' vaccination to prevent cervical cancer, parents of boys may be reluctant to pay for the HPV vaccine especially when they do not realize its importance for boys. Skepticism about the vaccine for boys may also be partly due to providers' lack of recommendation. For example, pediatricians believed that it would require more time to communicate with parents of boys compared to those of girls about the HPV vaccine than other childhood vaccines, resulting in fewer HPV vaccine recommendations for boys compared to girls (Gilkey et al., 2015). In another study examining gender-based differences in reasons for HPV vaccine refusal, parents of boys were more likely to report that the vaccine was not recommended by providers compared to those of girls (Johnson et al., 2017).

Based on our study, we present the following suggestions to increase HPV vaccine uptake among boys in Korea. Healthcare providers, particularly pediatricians, should proactively educate parents about the importance of timely HPV vaccination, debunk misinformation about male HPV vaccination, and frame the vaccine as prevention of non-cervical HPV-associated cancers for males. With their professional credibility, providers should be at the forefront to help normalize HPV vaccination as part of gender-neutral, routine adolescent healthcare (Cuccaro et al., 2023). School nurses, who are also well trusted figures by parents, should integrate HPV into sexual health curriculum and strongly encourage parent-son communication to increase boys' vaccine uptake. In a previous study, children who talked with their parents about HPV vaccination were more likely to complete the vaccine series compared with those who did not (Woodall et al., 2021). Finally, it is critical that public health researchers continue to examine psychosocial and behavioral factors underlying HPV vaccine hesitancy. Guided by this formative work and collaboration with providers, researchers can design tailored messages to increase knowledge and promote positive attitudes about HPV vaccination among parents of boys, which will be seminal in improving vaccine uptake among boys in Korea.

5. Strengths and limitations

This study has several limitations. First, we used a cross-sectional study design, from which causal inferences cannot be made between the variables of interest. Therefore, a follow-up prospective study is imperative. Second, while we conducted pretesting to verify that the psychometric properties of the original scales were valid after translation, there still may be insufficient evidence for translation accuracy. Third, the design and length of the survey may have caused response fatigue, deterring participants from providing truthful responses to lessen the burden of completing the survey. Fourth, we used non-probability sampling and did not include parents outside of social networking websites and the capital city, which may have biased the results, limiting the generalizability of the study findings. Fifth, the study lacked consideration of paternal perspectives on HPV vaccination for boys but this could be an important avenue for future research that should be conducted nationwide. Finally, the small sample size of the intention to vaccinate group warrants some caution in interpreting the results. Strengths of this study are the use of validated scales to measure HPV-related knowledge and perceptions, and the inclusion of a contemplating stage to illustrate not only the decision already reached but also uncertainty in the vaccination decision continuum.

6. Conclusions

Ensuring equity in protection from HPV-associated cancers in men is crucial, but male HPV vaccination rates remain low in Korea. Male HPV vaccination rates remain low in Korea. The majority of mothers in our study were contemplating the HPV vaccine for their sons. Perceived benefits of the vaccine and influence of others were associated with mothers' intention to vaccinate their sons. HPV knowledge was lacking among the mothers, for whom HPV was likely a feminized concept, and was not associated with vaccination intention. HPV vaccine hesitancy emanates prominently from Korean parents due to cultural sensitivity regarding sex-related issues and lack of HPV knowledge. To alleviate this hesitancy and improve vaccine uptake among boys, trusted sources of vaccine information such as healthcare professionals should provide HPV education and strongly encourage parent-son communication about the vaccine. Public health researchers should also continue to

explore public sentiments towards male HPV vaccination to craft effective vaccine-advocacy messages as preliminary work for the adoption of gender-neutral HPV vaccination in Korea.

CRediT authorship contribution statement

Jihye Choi: Writing – original draft, Writing – review & editing, Data curation, Methodology, Formal analysis, Conceptualization. **Paula Cuccaro:** Writing – review & editing, Conceptualization. **Christine Markham:** Writing – review & editing, Conceptualization. **Sooyoun Kim:** Writing – review & editing, Data curation, Conceptualization. **Irene Tamí-Maury:** Writing – review & editing, Supervision, Methodology, Conceptualization.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Data availability

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

Acknowledgements

We would like to thank all the mothers who participated in the study.

Ethics approval and consent to participate

Study protocols were reviewed and approved from the Institutional Review Board at Seoul National University (IRB No. 2106/003–013).

Funding

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

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.pmedr.2023.102566.

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