



Associations of mothers' decisional conflicts and satisfaction with governmental health promotion materials with their daughters' HPV vaccination uptake in China: A cross-sectional survey

Zian Lin ^{a,1}, Siyu Chen ^{b,1}, Lixian Su ^{c,1}, He Cao ^{d,1}, Hongbiao Chen ^d, Yuan Fang ^e, Xue Liang ^b, Jianan Chen ^a, Biyun Luo ^a, Chuanan Wu ^a, Zixin Wang ^{b,*}

^a Shenzhen Longhua District Maternity and Child Healthcare Hospital, Shenzhen, China

^b Centre for Health Behaviours Research, JC School of Public Health and Primary Care, Faculty of Medicine, the Chinese University of Hong Kong, Hong Kong SAR, China

^c Shenzhen Futian District Maternity and Child Healthcare Hospital, Shenzhen, China

^d Department of Epidemiology and Infectious Disease Control, Longhua Key Discipline of Public Health for the Prevention and Control of Infectious Diseases, Longhua Centre for Disease Control and Prevention, Shenzhen, China

^e Department of Health and Physical Education, the Education University of Hong Kong, Hong Kong SAR, China

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ABSTRACT

Background: China started to implement the HPV vaccination program for females in 2016. This study investigated associations between mothers' decisional conflicts, satisfaction with governmental health promotion materials, and their daughters' HPV vaccination uptake.

Methods: A cross-sectional online survey was conducted between July and October 2023 among mothers of girls aged 9–17 years in Shenzhen, China. Participants were mothers having a daughter aged 9–17 years at the survey date and a smartphone with internet access. About 3 % of all primary and secondary schools in Shenzhen were randomly selected by the research team (11 primary schools and 13 secondary schools). Teachers at the selected schools invited mothers of female students aged 9–17 years to complete an anonymous online questionnaire. Multivariate logistic regression was fitted.

Results: Among 11,728 mothers who completed the survey, 18.9% of their index daughters received at least one dose of HPV vaccination. In multivariate analysis, less decisional conflict about the choice of HPV vaccines for their daughters (AOR: 1.07, 95%CI: 1.05, 1.10), more satisfaction with the government's health promotional materials related to HPV vaccines (AOR: 1.15, 95%CI: 1.12, 1.19), receiving more cue to action from significant others (AOR: 1.23, 95%CI: 1.19, 1.27), and perceived higher self-efficacy related to HPV vaccines (AOR: 1.79, 95%CI: 1.67, 1.92) were associated with a higher uptake of HPV vaccines. Perceived susceptibility to HPV (AOR: 0.79, 95%CI: 0.74, 0.85), perceived barriers to having the index daughter receive HPV vaccines (AOR: 0.82, 95%CI: 0.80, 0.84), and mothers who were hesitant to receive HPV vaccination (AOR: 0.75, 95%CI: 0.68, 0.84) were associated with a lower uptake.

Conclusion: HPV vaccination uptake was low among girls in China. Future health promotion should address mothers' decisional conflicts about the choice of HPV vaccines for their daughters and improve the health promotional materials. School-based HPV vaccination programs might be useful.

Introduction

The disease burden caused by human papillomavirus (HPV) infection

remains heavy in China. The country has a high and increasing incidence and mortality rate of HPV-related cancers [1–3]. According to the latest global cancer burden study, China has the second highest incidence and

* Corresponding author at: Room 508, School of Public Health, Prince of Wales Hospital, Shatin, N.T., Hong Kong

E-mail addresses: linzian@lhfywork.com (Z. Lin), chensiyu@link.cuhk.edu.hk (S. Chen), xiandansumei@163.com (L. Su), yun003@sina.com (H. Cao), gesila2021@163.com (H. Chen), lunajoef@gmail.com (Y. Fang), liangx77@link.cuhk.edu.hk (X. Liang), chenjianan@lhfywork.com (J. Chen), luobiyun@lhfywork.com (B. Luo), 1509625509@qq.com (C. Wu), wangzx@cuhk.edu.hk (Z. Wang).

¹ These authors contributed equally to this manuscript.

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mortality rate of cervical cancer worldwide [4]. HPV vaccination has a promising efficacy in preventing infections and cancers caused by vaccine types of HPV in females without safety concerns [5,6]. The main scheme of the HPV vaccination program in China started in 2016 and has been providing bivalent, quadrivalent, and 9-valent HPV vaccines to females aged 9–45 years [7]. To receive the HPV vaccination, females need to settle the payment first. Those who choose to receive bivalent and quadrivalent HPV vaccines would receive reimbursement from the Basic Health Insurance in China, which covers 80 % of the out-of-pocket cost for these two types of vaccines [8]. However, those who choose to receive a 9-valent HPV vaccine cannot get the reimbursement. A pilot scheme under the national HPV vaccination program started in 2022 in Guangdong and Jiangsu provinces offering free bivalent vaccines to girls aged 13–15 years [9]. Shenzhen, the study site, is a city in the Guangdong province, and girls aged 13–15 years can benefit from the pilot scheme. However, the pilot scheme did not cover quadrivalent or 9-valent vaccines.

HPV vaccination could offer the best protection if administered prior to the onset of sexual activities [10]. Studies in Western countries consistently reported that vaccinating girls in the younger cohort (aged 9–12 years) is crucial, as the median age for the sexual debut is around 15 [11–13]. In China, the age of the first sexual intercourse among women was 19.3 to 23.1 years [14,15]. Therefore, data on HPV vaccination uptake and its determinants among girls aged 9–17 years is important to inform service planning and health promotion. Our literature review identified three studies investigating HPV vaccination uptake among girls of this age group in China. One study reported that only 4.5 % of Chinese girls aged 9–14 years received an HPV vaccination or had made an appointment to receive it [16]. Two other studies showed that over 50 % of parents or guardians were hesitant to vaccinate girls 9–17 years against HPV [17,18]. Parents are key decision-makers in children's HPV vaccination [19]. Significant determinants of daughters' HPV vaccination uptake found by previous studies in China included background characteristics of the parents (i.e., education and income, history of HPV-related diseases), age of the daughters, knowledge and perceptions related to HPV vaccination (i.e., concerns about safety, perceived consequences of HPV infection, physicians' recommendations, and perceived self-efficacy) [17,18,20–22]. In addition, parents/guardians who were hesitant to receive HPV vaccination were less likely to vaccinate their girls against HPV [17,18]. These factors were considered in this study.

There are five types of HPV vaccines available for females in China, including three bivalent vaccines (Cervarix, Cecolin, and Walrinvax), one quadrivalent vaccine (Gardasil 4), and one 9-valent vaccine (Gardasil 9) [4,23]. Significant variations exist in the efficacy, cost, and delivery models for different HPV vaccines. For example, the cost of these HPV vaccines (3 doses) ranged from ¥1,080 (US\$148 for the Cecolin) to ¥3,993 (US\$547 for the Gardasil 9). The basic health insurance in China covers the cost of bivalent and quadrivalent vaccines but not the 9-valent vaccine. Therefore, mothers in China may experience “choice overload” and find it difficult to select one HPV vaccine for their daughters [24]. Decisional conflicts refer to the uncertainty about which option to take when there are competing options [25]. Previous studies showed that decisional conflicts in choosing one type of vaccine was a barrier for Chinese people to receive primary series and booster doses of COVID-19 vaccination [26,27]. This study tested whether decisional conflicts in choosing a vaccine could be a barrier for mothers to vaccinate their daughters against HPV in China.

The Chinese government has actively promoted HPV vaccines through various mass media channels [28]. These governmental materials provide similar and standard information. Their contents included the harms of HPV infection, the benefits of HPV vaccination, and the locations for obtaining HPV vaccination [28]. There were concerns that the governmental health promotion materials related to HPV vaccines might not adequately address parental concerns or provide sufficient information to facilitate vaccination decisions [4,29]. Previous studies

have demonstrated a positive correlation between higher satisfaction with government-produced vaccination materials and a higher COVID-19 vaccination uptake [26,30]. However, no study investigated the associations between mothers' satisfaction with governmental health promotion materials and HPV vaccination uptake among their daughters.

To address the knowledge gaps, an online survey was conducted among mothers with daughters aged 9–17 years in Shenzhen, China. This study investigated HPV vaccination uptake among their daughters aged 9–17 years and the associations of mothers' decisional conflicts and satisfaction with governmental health promotion materials with their daughters' HPV vaccination uptake.

Methods

Study design

A cross-sectional online survey was implemented from July to October 2023 among 11,728 mothers of girls aged 9–17 years in Shenzhen, China.

Participants and data collection

Participants were: 1) mothers aged ≥ 18 years old, 2) able to read simplified Chinese, 3) had a daughter aged 9–17 years who was currently attending a primary or secondary school in Shenzhen at the time of the survey, and 4) owned a smartphone with internet access. If a participant had more than one eligible daughter aged 9–17 years, she would be asked to refer to the one whose birthday was closest to the survey date (the index daughter) when answering questions. The sample for this study was confined to mothers, as they are the primary decision-makers for children's vaccination in China [31].

In 2022, there are a total of 343 primary schools and 475 secondary schools in Shenzhen, China, accommodating over 1.7 million students. The research team created two separate Excel files, including the names of all primary and secondary schools. Using the “select random cells” function, 3 % of the primary and secondary schools were randomly selected by the research team (11 primary schools and 13 secondary schools). These selected schools have established WeChat groups to facilitate communication between parents and teachers for school announcements. In this study, the research team created an online questionnaire using the common survey platform (Questionnaire Star) in China. The selected school teachers shared the study information and a QR code to access the online questionnaire in the WeChat groups. They specifically invited the mothers of female students to participate and sent reminders twice during the study period. The survey link was not to be shared with individuals outside of the WeChat groups by the teachers and participants. Before commencing the online survey, participants read a statement indicating that participation was voluntary and refusal would have no consequences. The survey would not collect any personal contact or identifying information to ensure anonymity. Electronic informed consent was obtained from each participant after the nature and possible consequences of the study had been fully explained to the subjects. Each WeChat account was granted access to the online survey only once. The questionnaire consisted of 90 items, with approximately 15 items per page for six pages, and took about 15 min to complete. The online survey platform performed a completeness check before the submission of each questionnaire. Participants could review and change their responses before submission. No incentive was given to the participants. The data was stored on the server of the survey platform and protected by a password. Only the corresponding author had access to the database. A total of 11,728 mothers completed the survey with a response rate of 83.8 % (there were about 14,000 female students aged 9–17 years in the participating schools). Ethics approval was obtained from the Shenzhen Longhua District Maternity and Child Healthcare Hospital (ref: 2022122201).

Sample size planning

The target sample size was 10,000. Assuming the HPV vaccination uptake rate in the reference group (with a facilitating condition of HPV vaccination) to be 10–50 %, the sample size could detect the smallest odds ratio of 1.12 between mothers with and without the facilitating conditions, with a power of 0.80 and an alpha of 0.05 (PASS 11.0, NCSS LLC). We assumed the response rate to be 70 % and aimed to invite 14,000 mothers to join the study. In 2022, the median number of students in primary/secondary schools was about 800. Assuming half of these students were female, the median number of eligible female students was around 400 in primary school and 800 in secondary school. The number of eligible female students in the 24 participating primary and secondary schools should be sufficient to meet the target sample size.

Measurements

Questionnaire development

A panel of experts, including epidemiologists, clinicians, and CDC employees, developed a questionnaire for the current investigation. To assess the clarity and readability, the questionnaire was piloted among 10 mothers. All mothers believed the questionnaire was easy to understand and the length was acceptable. These 10 participants did not participate in the actual survey.

Background characteristics

Information collected included sociodemographic characteristics of the mothers (age, socio-economic status), mothers' self-reported history of HPV-related diseases, and the age of their index daughters.

HPV vaccination uptake among index daughters

Mothers reported the number of doses of HPV vaccination received by their index daughters. For those whose index daughters had received at least one dose, some details related to the HPV vaccination were collected (types of vaccines, location of vaccination).

HPV vaccination hesitancy among mothers

We first asked mothers whether they had received an HPV vaccination. For unvaccinated mothers, we further asked about their likelihood of receiving an HPV vaccination in the next year (response categories: 1 = very unlikely, 2 = unlikely, 3 = neutral, 4 = likely, and 5 = very likely). Vaccine hesitancy was defined as “very unlikely”, “unlikely” or “neutral”. The same definition was commonly used in published studies [32,33].

Decisional conflict

The measurement of decisional conflict was adapted from the validated Chinese version of the SURE test version of the Decisional Conflict Scale [34,35]. The Cronbach's alpha for this scale was 0.88. Higher scores on the scale indicated less decisional conflict.

Satisfaction with HPV vaccine health promotional materials

We modified validated questions in the Chinese population to evaluate the satisfaction with government-produced HPV vaccination health promotional materials (i.e., advertisements, posters, and others) [35]. The Cronbach's alpha for this scale was 0.91. Participants were asked whether the information presented by the health promotional materials was helpful for them to understand the policy and arrangement of HPV vaccination, address concerns related to HPV vaccination, and facilitate

their decision to vaccinate their daughters against HPV (response categories: 1 = disagree, 2 = neutral, 3 = agree). Higher scores on the scale indicated higher satisfaction with the health promotional materials.

Perceptions related to HPV vaccination

We adapted the four validated scales from a published study targeting Chinese parents to measure mothers' perceptions related to HPV vaccines for their daughters [19]. The 2-item Perceived Susceptibility Scale measured the perceived chance of having HPV infection and HPV-related cancers for the index daughters (response categories: 1 = low, 2 = moderate, and 3 = high). Three other scales included the 3-item Perceived Benefit Scale, the 5-item Perceived Barrier Scale, and the 2-item Cue to Action Scale (response categories: 1 = disagree, 2 = neutral, and 3 = agree). The Cronbach's alpha of these scales were between 0.66 and 0.92. In addition, We adapted a validated item to measure the perceived self-efficacy of having the index daughters vaccinated against HPV [35].

Statistical analysis

Descriptive statistics were presented. Using the uptake of at least one dose of HPV vaccination among index daughters as the dependent variable, univariate logistic regression models were employed to assess the significance of associations between background characteristics and the dependent variable. A single logistic regression model was then fitted, involving all significant background characteristics and one independent variable of interest (i.e., decisional conflicts, satisfaction with health promotional materials, and perceptions related to HPV vaccination) at a time. Crude odds ratio (OR), adjusted odds ratios (AOR), and their 95 % confidence intervals (CI) were reported. The analyses were performed using SPSS (version 26.0; IBM, Armonk, NY, USA). A significance level of $P < 0.05$ was used.

Results

Background Characteristics.

The majority of the mothers were aged over 35 years (73.0 %), married (95.8 %), did not attend university (81.3 %), and had a monthly household income of more than ¥5,000 (USD 685) (83.3 %). Over half of them had a daughter aged 9–12 years (61.0 %). Only 4.1 % and 2.2 % self-reported a history of HPV infection and HPV-related diseases (Table 1).

HPV vaccination uptake among index daughters

Among all participants, 18.9 % of the mothers ($n = 2213$) reported that their index daughters had received at least one dose of HPV vaccination. The most common type of HPV vaccine received by their index daughters was domestic bivalent vaccines (1120/2213, 50.6 %), followed by the 9-valent vaccine (Gardasil 9) (436/2213, 19.7 %). The common venues for their daughters to receive HPV vaccination included public hospitals and community health centers in Shenzhen (2032/2213, 91.8 %) (Table 2).

Descriptive statistics of independent variables of interest

Among the mothers, 36.9 % of them were hesitant to receive an HPV vaccination. Regarding the different types of HPV vaccines available for girls, very few mothers knew the benefits and risks of each choice (17.5 %), or which benefit and risk mattered most for their daughter (20.5 %), had enough support and advice to make a choice (16.4 %), or felt sure about the best choice for their daughters (17.5 %). Less than half of the mothers found the health promotional materials related to HPV vaccines were helpful for them to understand the policy and arrangement of HPV

Table 1
Background characteristics of the participants (n = 11,728).

	n	%
Age group, years		
18–35	3175	27.0
36–40	4863	41.5
>40	3690	31.5
Had attended university		
No	9537	81.3
Yes	2191	18.7
Relationship status		
Married	11,236	95.8
Currently single	492	4.2
Employment status		
Full time	4881	41.6
Part-time/self-employed/unemployed/retired/student/ housewife	6847	58.4
Monthly household income, ¥ (US\$)		
<3000 (421)	535	4.6
3000–6999 (421–982)	3158	26.9
7000–9999 (982–1403)	1827	15.6
10,000–15,000 (1403–2104)	1910	16.3
>15,000 (2104)	3123	26.6
Refuse to disclose	1175	10.0
Self-reported history of HPV infection		
No	11,247	95.9
Yes	481	4.1
Self-reported history of HPV-related diseases (e.g., genital warts, cervical/anus/vagina cancers, and precancerous lesions)		
No	11,467	97.8
Yes	261	2.2
Age of the index daughter, years		
9–12	7154	61.0
13–17	4574	39.0

vaccination (42.8 %), address their concerns related to HPV vaccination (39.2 %), and make decisions on whether to have their daughter received HPV vaccines (42.3 %). The mean score and standard deviation (SD) of scales or items representing perceptions related to HPV vaccination were presented in Table 2.

Factors associated with HPV vaccination uptake among the index daughters

In the univariate analysis, the older age of the mothers and their index daughters were associated with higher HPV vaccine uptake (Table 3). After adjusting for these background characteristics, less decisional conflict about the choice of HPV vaccines for their daughters (AOR: 1.07, 95 %CI: 1.05, 1.10) and more satisfaction with the government’s health promotional materials related to HPV vaccines (AOR: 1.15, 95 %CI: 1.12, 1.19) were associated with a higher uptake of HPV vaccines among the index daughters. Regarding perceptions related to HPV vaccines, receiving more cues to action from significant others (AOR: 1.23, 95 %CI: 1.19, 1.27) and perceived higher self-efficacy related to HPV vaccines (AOR: 1.79, 95 %CI: 1.67, 1.92) were associated with a higher uptake of HPV vaccines. Perceived susceptibility to HPV (AOR: 0.79, 95 %CI: 0.74, 0.85) and perceived barriers to having the index daughter receive HPV vaccines (AOR: 0.82, 95 %CI: 0.80, 0.84) were associated with lower uptake. In addition, mothers who were hesitant to receive HPV vaccination were less likely to have their index daughters vaccinated against HPV (AOR: 0.75, 95 %CI: 0.68, 0.84) (Table 4).

Discussion

Our findings represented the latest estimate of HPV vaccine coverage among girls aged 9–17 years in Shenzhen, China. We extended the existing literature by investigating the associations between mothers’ decisional conflict and satisfaction with health promotional materials and their daughters’ HPV vaccination uptake with a relatively large

Table 2
HPV vaccine hesitancy and uptake, decisional conflict, satisfaction with health promotional materials, and perceptions related to HPV vaccines.

	n	%
HPV vaccine uptake among the index daughters		
The index daughter had received at least one dose of HPV vaccine		
No	9515	81.1
Yes	2213	18.9
Number dose of HPV vaccination uptake among the index daughters (Among 2213 participants whose index daughters had received at least one dose of HPV vaccine)		
1 dose	380	17.2
2 doses	1495	67.6
3 doses	221	10.0
Uncertain	117	5.2
Type of HPV vaccination uptake among the index daughters (Among 2213 participants whose index daughters had received at least one dose of HPV vaccine)		
Domestic bivalent vaccines	1120	50.6
Imported bivalent vaccines	83	3.8
Quadrivalent vaccine (Gardasil 4)	53	2.4
9-valent vaccine (Gardasil 9)	436	19.7
Uncertain	521	23.5
Venues of vaccination uptake among the index daughters (Among 2213 participants whose index daughters had received at least one dose of HPV vaccine)		
Public hospitals or community health centers in Shenzhen	2032	91.8
Private hospitals in Shenzhen	166	7.5
Other provinces or cities	53	2.4
Hong Kong, Macao or other countries	51	2.3
Mothers’ HPV vaccine hesitancy		
HPV vaccine hesitancy among mothers		
No	7396	63.1
Yes	4332	36.9
Decisional conflict		
There are different choices of a HPV vaccine for your daughter ...,		
Yes		
Do you know the benefits and risks of each option?	2052	17.5
Are you clear about which benefits and risks matter most to your daughter?	2404	20.5
Do you have enough support and advice to make a choice?	1925	16.4
Do you feel sure about the best choice for your daughter?	2051	17.5
The SURE test version of Decisional Conflict Scale ^a , mean (SD)	8.1	2.0
Satisfaction of HPV vaccine health promotional materials		
Satisfaction of HPV vaccine health promotional materials (e.g., advertisement, poster, and others) produced by the government,		
Yes		
Helpful for you to understand the policy and arrangement of HPV vaccination	5022	42.8
Can address your concerns related to HPV vaccination	4592	39.2
Helpful for you to make decision on whether to have your daughter received HPV vaccines	4962	42.3
Satisfaction with Health Promotional Materials Scale ^b , mean (SD)	7.1	1.6
Perceptions related to HPV vaccines		
Perceived susceptibility to HPV, moderate/high		
The index daughter’s chance of contracting HPV in lifetime	1819	15.5
The index daughter’s chance of having cervical, anal or vulvar cancer in lifetime	1666	14.2
Perceived Susceptibility Scale ^c , mean (SD)		
2.3		0.8
Perceived benefits of HPV vaccines for the index daughter, agree		
HPV vaccines are highly effective in preventing your daughter from HPV infection	9691	82.6
HPV vaccines are highly effective in preventing your daughter from cervical, anal or vulvar cancers	9194	78.4
HPV vaccines have a long duration of protection	6909	58.9
Perceived Benefit Scale ^d , mean (SD)		
8.1		1.3
Perceived barriers to have the index daughter received HPV vaccines, agree		
Your daughter would have severe side effects after receiving HPV vaccines	2121	18.1
It’s difficult to explain the reason for HPV vaccination to your daughter	2741	23.4
Do not have time to take the child for HPV vaccination	1852	15.8
It is not necessary to have your daughter received HPV vaccines because she is still young	1667	14.2
Receiving HPV vaccination would increase the child’s risk of having juvenile sexual acts	794	6.8

(continued on next page)

Table 2 (continued)

	n	%
Perceived Barrier Scale ^e , mean (SD)	8.2	2.3
Cue to action related to HPV vaccines, agree		
School teachers suggested you to vaccinate your daughter against HPV	6753	57.6
Health care providers suggest you to vaccinate your daughter against HPV	6912	58.9
Family members and friends suggest you to vaccinate your daughter against HPV	7584	64.7
Cue to Action Scale ^f , mean (SD)	7.6	1.7
Perceived self-efficacy related to HPV vaccines, agree		
It is easy for you to vaccinate your daughter against HPV if you want to	6262	53.4
Item score, mean (SD)	2.3	0.8

^a The SURE test version of Decisional Conflict Scale, 4 items, Cronbach's alpha: 0.88; one factor was identified by exploratory factor analysis, explaining for 74.0 % of total variance.

^b Satisfaction with Health Promotional Materials Scale, 3 items, Cronbach's alpha: 0.91; one factor was identified by exploratory factor analysis, explaining for 84.6 % of total variance.

^c Perceived Susceptibility Scale, 2 items, Cronbach's alpha: 0.92; one factor was identified by exploratory factor analysis, explaining for 92.7 % of total variance.

^d Perceived Benefit Scale, 3 items, Cronbach's alpha: 0.77; one factor was identified by exploratory factor analysis, explaining for 71.0 % of total variance.

^e Perceived Barrier Scale, 5 items, Cronbach's alpha: 0.66; one factor was identified by exploratory factor analysis, explaining for 42.6 % of total variance.

^f Cue to Action Scale, 3 items, Cronbach's alpha: 0.87; one factor was identified by exploratory factor analysis, explaining for 78.7 % of total variance.

sample size. Our study could provide a knowledge basis to inform health promotion programs and service planning.

Only 18.9 % of girls aged 9–17 years in this study received at least one dose of HPV vaccination. Such uptake was much lower than in some developed countries (i.e., 76.9 % in the United States and 83.0 % in Australia) and developing countries (i.e., 44.4–61.2 % in Ethiopia) [36–40]. Some reasons may contribute to the low HPV vaccination uptake rate in this age group in China. On the one hand, the rollout of HPV vaccination programs was about 10 years later than in these countries. It takes time for members of a social system to adopt an innovation (i.e., HPV vaccination for girls) [41,42]. In China, the diffusion of HPV vaccination has not yet reached critical mass, the point at which enough mothers have adopted it so that the further rate of adopting HPV vaccination became self-sustaining. On the other hand, mothers in China might consider HPV vaccination optional and less important as it was not yet included in the childhood vaccination scheme [43,44]. Our findings suggested that the implementation of a free HPV vaccination program in Shenzhen has not yet resulted in a surge in HPV coverage among girls aged under 18 years.

The HPV vaccination uptake among girls aged 13–17 years was significantly higher than that of their younger counterparts. Since the free HPV vaccination program only covers girls aged over 12 years in Shenzhen, mothers with daughters aged under 13 years may decide to wait until their daughters become eligible for the free vaccination. Cost is a known barrier for parents to vaccinate their daughters against HPV [45]. Since the median age of sexual debut among Chinese women is around 18 years [14,15], the target group of the free pilot scheme of the HPV vaccination program (i.e., girls aged 13–15 years) is appropriate. However, a trend of earlier sexual debut was observed among Chinese women [46,47]. Therefore, in the future, the health authorities should consider expanding the free pilot scheme to cover younger girls when more resources are available [48,49]. In this study, older mothers aged over 36 years showed a higher likelihood of vaccinating their daughters against HPV, aligning with a previous study in China [50]. Older mothers typically possess greater health literacy [51,52]. To address the disparity, future HPV vaccination promotion programs should pay more attention to younger mothers.

Table 3

Associations between background characteristics and HPV vaccine uptake among the index daughters.

	OR (95 %CI)	P values
Age group, years		
18–35	Reference	
36–40	1.74 (1.53, 1.98)	<0.001
>40	2.50 (2.19, 2.84)	<0.001
Had attended university		
No	Reference	
Yes	0.89 (0.78, 1.01)	0.06
Relationship status		
Married	Reference	
Currently single	1.10 (0.88, 1.38)	0.40
Employment status		
Full time	Reference	
Part-time/self-employed/unemployed/retired/student/housewife	1.04 (0.95, 1.14)	0.42
Monthly household income, ¥ (US\$)		
<3000 (421)	Reference	
3000–6999 (421–982)	1.08 (0.86, 1.35)	0.53
7000–9999 (982–1403)	0.83 (0.65, 1.07)	0.15
10,000–15,000 (1403–2104)	0.82 (0.65, 1.05)	0.12
>15,000 (2104)	0.94 (0.74, 1.18)	0.57
Refuse to disclose	0.95 (0.73, 1.23)	0.69
Self-reported history of HPV infection		
No	Reference	
Yes	1.24 (0.99, 1.55)	0.06
Self-reported history of HPV-related diseases (e.g., genital warts, cervical/anus/vagina cancers, and precancerous lesions)		
No	Reference	
Yes	1.24 (0.92, 1.66)	0.16
Age of the index daughter, years		
9–12	Reference	
13–17	10.85 (9.66, 12.19)	<0.001

OR: crude odds ratios.

CI: confidence interval.

Our results also suggested that there is a need to improve the existing health promotional materials related to HPV vaccination, as less than half of the mothers believed such materials were helpful. Satisfaction with these health promotional materials was associated with higher HPV vaccination uptake among their index daughters. Health promotional materials should address mothers' barriers to vaccinating their daughters against HPV, such as the concerns about side effects and difficulties in explaining reasons for vaccination. These barriers were associated with lower HPV vaccination uptake among girls. Currently, most health promotional materials are developed using a top-down approach by academics or healthcare professionals with limited input from the end users [53]. These materials are standardized without fully considering the needs of the end-users from their own perspectives [54]. Making use of co-creation, a collaborative development by both academics and end-users, may help improve health promotional materials [55,56]. Such an approach effectively addresses complex issues and facilitates behavioral changes [55]. The phenomenon of "choice overload" might have existed among mothers, as only 20 % were sure about the choice of HPV vaccines for their daughters or had sufficient support or advice to make such a choice. Less decisional conflicts among mothers were associated with higher HPV vaccination uptake among their daughters. Efficacies, side

Table 4

Associations of decisional conflict, satisfaction with health promotional materials, and perceptions of HPV vaccine uptake among the index daughters.

	AOR (95 %CI)	P values
HPV vaccine hesitancy among mothers		
No	Reference	
Yes	0.75 (0.68, 0.84)	<0.001
Decisional conflicts		
The SURE test version of Decisional Conflict Scale	1.07 (1.05, 1.10)	<0.001
Satisfaction of HPV vaccine health promotional materials		
Satisfaction with Health Promotional Materials Scale	1.15 (1.12, 1.19)	<0.001
Perceptions related to HPV vaccines		
Perceived Susceptibility Scale	0.79 (0.74, 0.85)	<0.001
Perceived Benefit Scale	0.99 (0.95, 1.03)	0.60
Perceived Barrier Scale	0.82 (0.80, 0.84)	<0.001
Cue to Action Scale	1.23 (1.19, 1.27)	<0.001
Perceived self-efficacy	1.79 (1.67, 1.92)	<0.001

AOR: adjusted odds ratios, odds ratios adjusted for significant background characteristics listed in Table 3.

CI: confidence interval.

effects, cost, duration of protection, and supply of different HPV vaccines available in China can be compared in a table, which makes it easier for mothers to compare features across products [24].

Future programs promoting HPV vaccination for girls should involve school teachers, healthcare providers, and family members, as receiving more suggestions from these significant others was associated with higher HPV vaccination uptake among the index daughters. School-based HPV vaccination programs, which were shown to be effective in the Hong Kong Special Administrative Region of China, may be useful in increasing the HPV vaccination uptake among girls of this age group [57]. The school-based programs could address mothers' concerns about the lack of time to vaccinate their daughters and hence increase the self-efficacy of the mothers related to daughters' HPV vaccination. Moreover, the perceived higher risk of HPV and HPV-related cancers was associated with lower HPV vaccination uptake. The seemingly paradoxical finding that mothers with vaccinated daughters had a lower perceived risk for their daughters' developing HPV disease may result from their confidence in the protection from the vaccine. This was a cross-sectional study and could not establish causal relationships.

This study has several limitations. First, we only recruited participants from Shenzhen, where the free HPV vaccination program for girls aged 13 years or above was implemented. Therefore, our findings could not be generalized to other Chinese cities without the free program. The HPV vaccination uptake rate among girls in other Chinese cities is expected to be lower in the absence of free HPV vaccination programs. As compared to mothers of girls aged 9–17 in Shenzhen and other Chinese provinces (i.e., Fujian province), our participants had higher income and education, and more of them had full-time employment [45,58]. Therefore, our findings might not be generalizable to all mothers of girls aged 9–17 in China or in provinces where the pilot scheme of the HPV vaccination program was implemented. Second, we were not able to validate the HPV vaccination status. Mothers might over-report their daughters' HPV vaccination uptake due to social desirability [59]. Third, selection bias existed. This was an anonymous survey, and we could not collect information from mothers who refused to answer the online questionnaire. Furthermore, this was a cross-sectional study and could not establish causality.

Conclusion

In conclusion, the HPV vaccination uptake rate was very low among girls aged 9–17 years, especially among those under 13 years who could benefit most from HPV vaccination. Health promotional materials produced by the government might not adequately address mothers' concerns and facilitate their decisions related to daughters' HPV vaccination. Co-creating the materials with mothers and addressing their choice overload might be useful approaches to improve health promotional materials. Future programs promoting HPV vaccination for girls should involve significant others of mothers such as school teachers, healthcare providers, and other family members. School-based HPV vaccination programs should be considered.

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Ethical approval.

This study was conducted following the guidelines of the Declaration of Helsinki. Ethics approval was obtained from the Shenzhen Longhua District Maternity and Child Healthcare Hospital (ref: 2022122201).

Informed Consent Statement.

Electronic informed consent was obtained from each participant after the nature and possible consequences of the study had been fully explained to the subjects.

CRedit authorship contribution statement

Zian Lin: Writing – original draft, Project administration, Methodology, Data curation, Conceptualization. **Siyu Chen:** Writing – review & editing, Writing – original draft, Methodology, Conceptualization. **Lixian Su:** Writing – original draft, Project administration, Methodology, Data curation, Conceptualization. **He Cao:** Writing – original draft, Project administration, Methodology, Data curation, Conceptualization. **Hongbiao Chen:** Writing – review & editing, Project administration, Methodology, Data curation. **Yuan Fang:** Writing – review & editing, Writing – original draft, Methodology. **Xue Liang:** Writing – review & editing, Writing – original draft, Methodology. **Jianan Chen:** Writing – review & editing, Project administration, Data curation. **Biyun Luo:** Writing – review & editing, Project administration, Data curation. **Chuanan Wu:** Writing – review & editing, Project administration, Data curation. **Zixin Wang:** Writing – review & editing, Writing – original draft, 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

Data will be made available on request.

The datasets generated and/or analyzed during the current study are not publicly available as they contain sensitive personal behaviors but are available from the corresponding author on reasonable request.

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