

RESEARCH ARTICLE



HPV vaccination willingness among 3,081 secondary school parents in China's capital

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ABSTRACT

Assessing knowledge of HPV and HPV vaccine and vaccine willingness among Beijing secondary school parents, and identifying decision-influencing factors. Selected via multi-stage stratified sampling, 3,081 Chaoyang secondary school students' parents participated in a June–August 2024 study. They completed a questionnaire assessing HPV knowledge, vaccine awareness, and vaccination willingness. Although 56.4% of parents showed a high awareness of HPV and its vaccine, only 13.7% had actually vaccinated their children, indicating a low vaccination rate. Moreover, 59.9% of parents indicated a willingness to vaccinate their children against HPV. Factors influencing this willingness included having daughters (OR: 2.873, 95% CI: 2.403–3.436), the school's street location (OR: 1.279, 95% CI: 1.056–1.550), personal HPV vaccination (OR: 2.153, 95% CI: 1.726–2.686), comprehensive knowledge about HPV and its vaccine (OR: 1.956, 95% CI: 1.595–2.398), awareness of vaccine price (OR: 1.500, 95% CI: 1.143–1.968), perceiving the price as reasonable (OR: 1.265, 95% CI: 1.029–1.533), and challenges in scheduling HPV vaccine appointments (OR: 3.909, 95% CI: 2.692–5.675). Notably, there was a negative correlation between parents' education levels and their willingness to vaccinate their children: junior college (OR: 0.690, 95% CI: 0.527–0.902), undergraduate (OR: 0.626, 95% CI: 0.482–0.813), postgraduate and above (OR: 0.686, 95% CI: 0.475–0.989). Therefore, relevant sectors must implement varied health campaigns, focusing on parental health needs, particularly HPV education for men, and advocate for HPV vaccines in immunization programs to boost secondary school students' vaccination rates.

ARTICLE HISTORY

Received 24 December 2024
Revised 11 February 2025
Accepted 6 March 2025

KEYWORDS

HPV vaccine; secondary school parents; awareness; willingness; China's capital



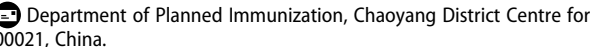
Introduction

Cervical cancer (CCa) is a significant global health threat to women. The “Global Cancer Statistics 2022” reports 662,000 new cases and 349,000 deaths due to CCa among women worldwide, ranking it as the fourth most common cancer in terms of female morbidity and mortality, and the leading cause of cancer-related deaths among women in 37 countries.¹ Although the incidence of CCa has decreased in high-income countries, in China, there is a notable annual increase, with a trend toward affecting younger populations. Imposing a severe disease burden on the nation.² Human papillomavirus (HPV) infects both men and women. Persistent high-risk HPV infection is the primary etiological factor for CCa and other anogenital cancers.³ Men are more susceptible to HPV infection,^{4,5} and their infections can substantially increase the risk of HPV infection in women.⁶ Therefore, preventing HPV infection in men is also crucial.

HPV vaccination is the most important primary prevention measure against HPV-related diseases. In 2020, the World Health Organization (WHO) launched a “Global Strategy to Accelerate the Elimination of Cervical Cancer,” recommending that all countries incorporate the HPV vaccine into their National Immunization Program (NIP).³ The strategy aims for a 90% vaccination rate among girls under 15 by 2030.³ As of 2020, 125 countries had included female HPV vaccination in their NIP, with 47 countries extending coverage to males.³ “China's Action Plan for Accelerating the Elimination of

Cervical Cancer (2023–2030)” emphasizes the importance of promoting pilot exercise for HPV vaccination among girls of the appropriate age.⁷ In China, the HPV vaccine is currently available only to women and is not included in the NIP. Chinese expert consensus indicates that the median age of sexual debut in China is 21 to 22 years, and more than 10% aged 15 to 19 have already engaged in sexual activity. The benefits of HPV vaccination are maximized for women aged 13 to 15 years, prior to sexual debut. According to various studies, Chinese experts recommend HPV vaccination for women aged 9 to 26 years, particularly for those under 17.⁸ A total of five HPV vaccines have been approved for use in China, including two domestic bivalent vaccines and three imported vaccines. All of these vaccines demonstrate effective prevention against the common high-risk strains of HPV 16 and HPV 18. HPV vaccination is available to females in the age range of 9–45 years old.⁸

From 2018 to 2020, we estimated the full (3-dose) HPV vaccination rate for females aged 9 to 45 years, both nationally and within each province. The vaccination rate was calculated as follows: (Estimated number of recipients in the population/total population) × 100%. The estimated number of HPV vaccine recipients was derived from the total number of doses administered divided by three. This analysis showed a vaccination rate of 2.24% for women aged 9 to 45 and 0.83% for the WHO-recommended population.⁹

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At the time of the study, China's HPV vaccine was administered exclusively to women aged 9 to 45 years and was not included in the national immunization program. To date, only a few provinces and cities, including Ordos, Chengdu, Fujian, and Jiangxi, have implemented pilot programs offering free domestic bivalent HPV vaccines. In Beijing, which has a permanent population of more than 20 million people, no pilot programs have been established; instead, a reservation-free vaccination policy has been established in certain areas, with the vaccine unavailable for men during the study period. The limited number of pilot districts, small coverage of the pilot population, and restricted variety of pilot vaccines highlight significant gaps between government supply and public demand. Additionally, male HPV vaccination has not yet attracted sufficient attention, and there may be a significant awareness gap regarding HPV vaccination for men. Therefore, there is a long way to go to improve the level of awareness and vaccination rate of HPV vaccine in China.

Typically, Chinese secondary school students are between 12 and 18 years old, which falls within the recommended age range for vaccination. Most of the secondary school students are in the recommended age group for vaccination, and given the transmission route of HPV and the fact that the age of initial sexual intercourse for females in China is generally 17 years old,¹⁰ secondary school students are an appropriate population for HPV vaccination in China. Parents, as guardians of secondary school students, play a crucial role in their children's HPV vaccination status through their cognition and attitudes. In recent years, there has been a notable lack of data on the willingness of parents of secondary school students to receive the HPV vaccine in Beijing. With the approval of the 9-valent HPV vaccine for females aged 9–45 years in August 2022 and the introduction of a two-dose immunization schedule for females aged 9–14 years in January 2024, the effectiveness of these new policies and public perception have not been assessed. Given this, it is particularly necessary to conduct a survey on HPV vaccine awareness and the willingness of secondary school parents to vaccinate their children with HPV vaccine in the capital area, especially in Chaoyang District, which has one of the largest populations and student numbers and is a leader in economic and cultural development. This survey will provide key baseline data for government decision-making to increase HPV vaccination rates among secondary school students and fill the gap in data following the implementation of new policies.

Methods

Study design and sampling method

This cross-sectional study employed a multi-stage stratified cluster random sampling design to select 3081 samples from target school in Chaoyang district from June to August 2024. The sample size was calculated using the formula:

$$n = \left(\frac{Z_{1-\alpha/2}}{\delta} \right)^2 \times P(1 - P) \times \text{deff}(\alpha = 0.05, \quad Z_{1-\alpha/2} = 1.96, \delta = 0.1P, \text{deff} = 2.5).$$

Here, P represents the anticipated probability of vaccination intentions. According to the literature, the HPV vaccination willingness of parents of secondary school

student populations (including boys) in China ranges from 41% to 87%.^{11–14} A pre-survey was conducted with 68 respondents from two classes in a middle school, revealing an HPV vaccination willingness of 47%. Therefore, we set the expected willingness to vaccinate at $p = 50\%$. Considering stratified sampling and a 20% loss to follow-up, the sample size was calculated to be 2400. Based on the division of streets and areas in Chaoyang District, we first randomly selected 10 streets or areas out of the total 43. Subsequently, stratified random sampling was conducted within each selected street or area based on the level of education (junior high school (JHS) and senior high school (SHS)). A total of 5 junior high schools and 5 senior high schools were sampled, with one or two classes randomly selected from each grade. All parents (both fathers and mothers) of students in the sampled classes were surveyed.

Questionnaire survey

Based on both domestic and international research and related expert consultations, the study questionnaire consists of three parts. The first part collects basic information about the study subjects, including the children's grade, educational stage, parents' identities, ages, education levels, industries in which they are engaged, and monthly family income. The second part addresses HPV vaccination status, such as whether the parents and their children have received the HPV vaccine and the type of HPV vaccine chosen. The third part assesses knowledge related to HPV and its vaccine, covering topics such as the target populations for HPV infection, transmission routes, common diseases caused by HPV, and the optimal vaccination period and duration of protection provided by the HPV vaccine. Parents' knowledge about HPV and its vaccine was assessed using a series of routine questions. These questions covered various topics, including the transmission routes of HPV, susceptible groups, major diseases caused by the virus, the degree of harm it can inflict, the optimal age for HPV vaccination, the duration of protection offered by the vaccine, and relevant policy changes. Each correct answer was awarded 1 point, while incorrect answers received 0 points. The assessment consisted of a total of 10 questions, with a maximum possible score of 10 points. Referring to similar studies.¹⁵ In this study, the median cognitive score was 7. Therefore, scores below 7 were recorded as low cognition, and scores of 7 or above were recorded as high cognition.

The assessment of parents' willingness to vaccinate their children was based on their responses to a question about their willingness to vaccinate their children against HPV, without considering the cost of the vaccine. Parents who selected "very willing" or "willing" were classified as willing to vaccinate. Conversely, those who chose other options were categorized as exhibiting vaccine hesitancy. The formula for calculating willingness to vaccinate is as follows: (number of willing and very willing parents/total number of parents participating in the study) $\times 100\%$.

Data collection

Data collection was conducted using an online questionnaire on Wenjuanxing (www.wjx.cn). An online anonymous self-administered questionnaire was used. All investigators

receiving a uniform and standardized training. A detailed presentation of the study was then given to the sampled secondary schools to obtain permission and support from the school authorities. The questionnaires were distributed through a WeChat group with the assistance of the schools, and parents completed the questionnaire by scanning a QR code. Informed consent was obtained from all respondents prior to the start of the survey. All questionnaires were completed anonymously, and participants had the option to withdraw at any point during the process.

Data analysis

Statistical analysis was performed using IBM SPSS 29.0. Qualitative data were summarized using frequencies and percentages, while measurement data were expressed as medians and Inter-Quartile Range (IQR). The Chi-square test and Mann-Whitney U test were used to conduct univariate analysis of knowledge related to HPV and the HPV vaccine, as well as parents' willingness to vaccinate their children with HPV vaccine. Factors found to be statistically significant in the univariate analysis were included as independent variables in the multivariate analysis. The inclusion criteria were set at a significance level of 0.05, and adjusted odds ratios (OR) and 95% confidence intervals (CI) were calculated for each variable.

Results

Study sample characteristics

A total of 3,081 valid questionnaires were collected. Questionnaires are all completed by parents. Information provided by parents regarding their children includes the following: the youngest child was 11 years old, and the oldest was 20 years old; 1,982 (64.3%) were girls, 2,010 (65.2%) attended schools located in districts, 1,624 (52.7%) were junior high school students (JHS), and 2,749 (89.2%) were of Beijing household registration. Among the surveyed parents: the youngest was 31 years old, and the oldest was 63 years old; 2,640 (85.7%) of them were mothers; 2,892 (93.9%) were Han ethnicity; 777 (25.2%) had an associate degree, 1,386 (45.0%) had a undergraduate degree, 336 (10.9%) had a postgraduate degree or higher; 235 (7.6%) were engaged in the medical and health industry; and 930 (30.2%) had a per monthly household income of 5001-10000RMB. Notably, the survey revealed that 56.3% (1,736 out of 3,081) of parents exhibited a high level of awareness regarding HPV and HPV vaccines.

Current status of HPV vaccination

Among the surveyed parents, 29.4% (907 out of 3,081) had received the HPV vaccine. Among these parents, 29.8% chose the 9-valent HPV vaccine, 47.4% chose the 4-valent vaccine, and 17.1% chose the 2-valent vaccine. According to the parents' answers, 13.7% (271 out of 1,982) female students had received the HPV vaccine. Among these students, 84.1% had received the 9-valent HPV vaccine, 1.85% received the 4-valent vaccine, and 10.0% received the 2-valent vaccine. Reasons for

vaccination included disease prevention (91.5%), recommendations from medical personnel (25.1%), and suggestions from teachers (23.6%). Conversely, the primary reasons for not vaccinating their children were: concerns about adverse reactions following vaccination (36.4%), concerns that vaccination might affect growth and development (22.9%), and lack of time to schedule the vaccination (28.3%). Additional reasons included difficulties in making an appointment for the HPV vaccine (22.8%) and the belief that the child was too young to be at risk (15.9%) and so on.

Parental willingness toward HPV vaccine

Excluding survey respondents who had already vaccinated their children against HPV, 59.9% (1,682 out of 2,810) of the remaining parents expressed a willingness to vaccinate their children against HPV. Univariate analysis identified several factors that significantly influenced this willingness ($p < .05$), including the child's gender, school's geographical location, grade level, and educational phase, as well as the parents' gender, age, monthly income, educational level, vaccination history, knowledge about HPV and its vaccine, awareness of vaccine cost, and challenges in scheduling appointments.

Further multivariate analysis revealed that parents with daughters (OR: 2.873, 95% CI: 2.403–3.436), those with children attending street-located schools (OR: 1.279, 95% CI: 1.056–1.550), parents who had previously been vaccinated against HPV (OR: 2.153, 95% CI: 1.726–2.686), and parents with greater awareness of HPV and its vaccine (OR: 1.956, 95% CI: 1.595–2.398) were significantly more likely to vaccinate their children. This inclination increased with awareness of the vaccine price (OR: 1.500, 95% CI: 1.143–1.968) and a perception that the price was reasonable (OR: 1.265, 95% CI: 1.029–1.533). While the parents' gender and monthly income were not found to be statistically significant.

Conversely, higher parental education levels were negatively associated with the willingness to vaccinate.

Compared to parents with a senior high school education or less (serving as the control group), those with a college degree were 31.0% less likely to vaccinate their children (OR: 0.690, 95% CI: 0.527–0.902). This decrease was 37.4% for parents with a bachelor's degree (OR: 0.626, 95% CI: 0.482–0.813) and 31.4% for those with postgraduate education or higher (OR: 0.686, 95% CI: 0.475–0.989). Interestingly, parents who reported difficulties in booking the HPV vaccine were paradoxically 3.909 times more likely to vaccinate their children compared to those who found the booking process easy (OR: 3.909, 95% CI: 2.692–5.675). This suggests that perceived difficulty may not be a significant barrier to vaccination. The results are detailed in Table 1.

Health needs of parents regarding HPV and its vaccine

Our survey explored strategies to improve HPV vaccination rates and parental acceptance. The most popular strategy was incorporating the HPV vaccine into the NIP, supported by 82.6% of parents. Other effective strategies included educational initiatives through schools and related organizations (57.3% support) and organized vaccination

Table 1. Analysis of factors influencing the willingness of parents to receive HPV vaccination.

Variant	Willingness to vaccinate		Uni-variate analysis		Multivariate analysis	
	Hesitation/reluctance	Willing	Statistical value	P-value	OR	95% CI
Children						
Gender						
Male	620 (56.4%)	479 (43.6%)	198.904 ^a	<.001	1	
Female	508 (29.7%)	1203 (70.3%)			2.873	2.403–3.436
School's location						
Streets	789 (42.6%)	1063 (57.4%)	13.684 ^a	<.001	1	
Town	339 (35.4%)	619 (64.6%)			1.279	1.056–1.550
Educational stage						
JHS	654 (41.9%)	906 (58.1%)	4.628 ^a	.033	1	
SHS	474 (37.9%)	776 (62.1%)			1.176	0.970–1.427
Household registration						
Beijing	135 (42.9%)	180 (57.1%)	1.088 ^a	.300		
Others	993 (39.8%)	1502 (60.2%)				
Parents						
Parenthood						
Mother	923 (38.6%)	1470 (61.4%)	16.574 ^a	<.001	1	
Father	205 (49.2%)	212 (50.8%)			1.265	0.982–1.630
Ethnicity						
Han ethnicity	1060 (40.1%)	1582 (59.9%)	0.008 ^a	.935		
Others	68 (40.5%)	100 (59.5%)				
Industry field						
Others	903 (41.2%)	1288 (58.8%)	5.146 ^a	.077		
Pharmaceutical and Healthcare industry	72 (34.6%)	136 (65.4%)				
Recreation, Science and Education industry	153 (37.2%)	258 (62.8%)				
Monthly income (RMB)						
≤5000	217 (48.4%)	231 (51.6%)	25.648 ^a	<.001	1	
5001–10000	372 (42.8%)	497 (57.2%)			1.040	0.794–1.363
10001–20000	298 (36.5%)	519 (63.5%)			1.313	0.983–1.753
>20000	241 (35.7%)	435 (64.3%)			1.315	0.962–1.797
Educational attainment						
Senior High school and below	237 (41.6%)	317 (58.4%)	9.212 ^a	.027	1	
Junior college	306 (43.6%)	396 (56.4%)			0.690	0.527–0.902
Undergraduate	473 (37.8%)	777 (62.2%)			0.626	0.482–0.813
Postgraduate and above	112 (36.8%)	192 (63.2%)			0.686	0.475–0.989
HPV vaccination						
No	943 (46.1%)	1103 (53.9%)	110.784 ^a	<.001	1	
Yes	185 (24.2%)	579 (75.8%)			2.153	1.726–2.686
Awareness						
Low cognition	716 (54.5%)	597 (45.5%)	212.375 ^a	<.001	1	
High cognition	412 (27.5%)	1085 (72.5%)			1.956	1.595–2.398
Level of knowledge of vaccine prices						
Not realize	473 (59.6%)	321 (40.4%)	213.483 ^a	<.001	1	
General	386 (39.6%)	589 (72.5%)			1.099	0.868–1.392
Realize	269 (25.8%)	772 (74.2%)			1.500	1.143–1.968
Feelings about vaccine's prices						
Expensive	845 (42.7%)	1134 (57.3%)	23.637 ^a	<.001	1	
Reasonably	276 (33.6%)	545 (66.4%)			1.265	1.029–1.533
Inexpensive	7 (70.0%)	3 (30.0%)			0.391	0.076–2.005
Understanding of difficulty in booking						
Easy	76 (48.4%)	81 (51.6%)	360.652 ^a	<.001	1	
General	295 (45.0%)	361 (55.0%)			1.444	0.984–2.121
Difficult	357 (25.0%)	1070 (75.0%)			3.909	2.692–5.675
Unknown	400 (70.2%)	170 (29.8%)			0.839	0.554–1.272
Age of children	15(13,16) ^c	15(14,16) ^c	–1.408 ^b	.159		
Age of parents	44 (42, 47) ^c	44 (41, 47) ^c	–2.775 ^b	.006	1.018	0.996–1.040

^aIndicates a chi-square test; ^bindicates a Mann-Whitney U test; ^cMedian (IQR).

campaigns (50.4% support). Increasing the production or introduction of vaccines was also seen as a way to boost vaccination rates, though it had a lower support rate of 34.5%. Regarding the health needs of parents, 59.2% wanted to know the transmission routes of HPV, 66.6% were interested in HPV prevention methods, and 72.5% sought detailed safety information on the vaccine. Additionally, 55.0% sought effectiveness data, and 49.6% inquired about the target population. Practical information, such as appointment scheduling, vaccination locations, and manufacturer qualifications, was also highly desired.

Discussion

The survey revealed that only 29.4% of parents and 13.7% of their daughters had received the HPV vaccine. Although this vaccination rate is higher than the national estimated cumulative vaccination rate of 0.83% in 2020,⁹ the rates in Beijing (1.87%)¹⁶ and Chongqing (12.5%),¹⁴ it remains significantly lower than the rates observed in Australia (girls: 84%, boys: 81%), Brazil (girls: 72.4%, boys: 20.2%), and Canada (girls: 86%, boys: 81%).^{17,18} Despite favorable pricing and availability of the 2-valent in the domestic market, the majority of parents still opt for the 9-valent vaccine for their children. This

suggests that parents are still inclined to select higher-valent vaccines while demonstrating limited knowledge and trust in domestically produced bivalent vaccines. A global meta-analysis¹⁹ indicated that parents primarily decided to vaccinate their children to protect them from cancer and because their doctors recommended it, which aligns with our study results.

The major causes of vaccine hesitancy among parents, both domestically and internationally, align closely with those identified in our study.^{19–21} Our study found that the reasons for vaccine hesitancy include fears of adverse effects (36.4%), belief in low infection risk due to youth (15.9%), and doubts about vaccine efficacy (12.9%). A small group (4.9%) worried the vaccine might encourage teen sexual activity. The survey found that parents primarily focus on safety issues and often overlook awareness of HPV and the vaccine. Therefore, it is important for the government and society to enhance the health education efforts to strengthen parents' understanding and perceptions regarding vaccination. Unique to Chaoyang District, parents' reluctance stems from fears of growth harm (22.9%), lack of time (28.3%), and difficulty securing appointments (22.8%). Authorities should expand vaccination sites, streamline the appointment process, increase vaccine accessibility, and launch diverse health education campaigns to address and correct parents' misconceptions about HPV and the vaccine.

Our study revealed that 56.3% of parents showed a high level of awareness regarding HPV and its vaccine. Additionally, a national study found that 35.9% of parents exhibited a high level of awareness.²² This discrepancy may be due to Beijing's ongoing efforts to promote HPV vaccination, strengthen related health education, and implement pilot vaccination programs. Although awareness levels in Chaoyang district are above average, there is still significant room for improvement. Therefore, it is essential for the government and society to enhance health education regarding HPV and the HPV vaccine, particularly for low awareness groups. Furthermore, efforts should be made to increase the dissemination of relevant information to improve the overall situation.

The HPV vaccination rate is far below the WHO goal. Understanding parental willingness to vaccinate is crucial for improving children's vaccination rates. In Chaoyang District, 59.9% (1,682 out of 2,810) of parents expressed a willingness to vaccinate their children against HPV. This rate is notably lower than those observed in Zhejiang (71.65%),²³ Zunyi (73.9%),²⁴ Africa (79.6%),¹⁹ and the United States (75%–96%).²⁵ Given that this survey was conducted after the COVID-19 pandemic, the observed differences might be linked to a decline in public trust in vaccines after the pandemic.²⁶ The pandemic's information has heightened risk perception and potentially fueled vaccine hesitancy. Beijing serves as the political, economic, and cultural center of China, where various types of information flow rapidly. Parents are frequently exposed to a mix of accurate and negative vaccine information, which may influence their intentions to vaccinate.

In summary, the current status of parental vaccination for children in Beijing is characterized by a low vaccination rate (13.7%) coupled with a high willingness to vaccinate (59.9%). This aligns with previous studies conducted in Hangzhou²⁷

and Chongqing,²⁸ which identified the primary reasons for this discrepancy as concerns regarding vaccine safety and efficacy, the belief that children are not of the appropriate age for vaccination, and the challenges associated with the vaccination process. This indicates that greater emphasis should be placed on addressing key issues such as age and vaccine safety when educating parents. Additionally, increasing the availability of vaccines and streamlining the vaccination process could help translate parents' willingness to vaccinate into action, thereby improving vaccination rates and reducing vaccine hesitancy.

Only 43.6% of participants expressed a willingness to vaccinate their boys, indicating a lower willingness compared to parents of girls. This finding aligns with the results of the previous study.²⁹ The lower willingness may stem from the fact that the HPV vaccine for boys is not yet approved. Additionally, campaigns mostly focus on school-age females, neglecting men's health needs. In the developed countries, men are increasingly recognized as the target population for HPV vaccination. The current rates of HPV infection and related cancer incidence among men are rising,³⁰ with studies indicating higher infection rate in men than in women (91.3% vs. 84.6% in foreign countries³¹ and 42.15% vs. 21.66% in China.⁵ This increase in HPV infections among men could significantly impact women's infection rates in the same regions. Controlling HPV in males is key for reproductive health and reducing HPV6 disease burden. The study highlights the need to boost parental acceptance of HPV vaccines for boys and expand vaccination efforts post-approval. Trials for a 9-valent male vaccine are ongoing in Hunan, Shanxi, and Sichuan, with an expected near-future approval.⁶

An Indonesian study found that the higher level of knowledge of the HPV and HPV vaccine significantly increased parents' willingness to vaccinate their children.³² The present study also concluded that high awareness of HPV and its vaccine is pivotal for increasing parental acceptance of the HPV vaccine. Parents with high awareness were 1.956 times more likely to accept the vaccine than those with low awareness. The survey revealed that parents whose children's school was located on street exhibited a higher willingness to vaccinate, potentially due to disparities in the level of economic development between different streets and towns.

Higher parental education levels were associated with lower willingness to vaccinate their children. This phenomenon may stem from their enhanced ability to gather and understand health information. They may accumulate more knowledge about vaccines, leading to increased scrutiny regarding the effectiveness and safety of the HPV vaccine, which in turn contributes to higher vaccine hesitancy.^{33–36} These findings suggest that practitioners should provide robust empirical data to clarify the safety and efficacy of the HPV vaccine, stress the importance of vaccination, and utilize this information to bolster parents' trust and acceptance of the HPV vaccine.

Interestingly, parents who struggled to book HPV vaccines were 3.909 times more eager to vaccinate their kids than those who found it easy. This might be due to vaccine scarcity and booking complexity. The 'scarcity effect' could explain why harder bookings increase vaccination willingness, where the perception of 'scarcity increases value' leads to heightened consumer behavior. The challenge in securing an appointment

for the HPV vaccine seems to enhance its appeal, creating a sense of urgency for vaccination.^{37,38} Despite some areas in Beijing implementing walk-in vaccinations and streamlining the booking process, over half of the parents still report difficulties in making appointments, indicating that these measures are insufficient to boost the low HPV vaccination rates. Authorities should enhance vaccination policies and intensify health education regarding the safety, efficacy, and significance of HPV vaccines. This initiative will help parents better understand and trust vaccines, with the goal of raising vaccination rates. Parents who had received HPV vaccine were more likely to vaccinate their children, indicating that targeted promotion could increase child vaccination rates.

In the univariate analysis, we found that mothers were more willing to vaccinate their children than fathers (61.4% vs. 50.8%), and that higher family income was associated with greater willingness to vaccinate. However, after adjusting for other factors, neither parental gender nor family income had a statistically significant effect on vaccination willingness. This indicates that, when other confounding factors were controlled for, there was no significant difference between fathers and mothers in their willingness to vaccinate. Additionally, family income level directly influenced the acceptance of vaccine prices. With the development of society and the improvement of family economic levels, vaccine prices no longer emerged as a key factor in the decision to vaccinate. Instead, people appeared to be more concerned about the safety and effectiveness of vaccines. This suggests that vaccine prices were no longer a primary consideration in the decision to vaccinate, at least in first-tier developed cities like Beijing.

Parents believe that incorporating the HPV vaccine into the NIP and increasing educational initiatives in schools and organizations will effectively promote the HPV vaccination rates. In countries where the HPV vaccine is part of the national plans, up to 71% to 86% of children get vaccinated.¹⁷ Health education interventions are also crucial for increasing both HPV vaccination coverage and the willingness to vaccinate.^{39,40} Parents need detailed information on HPV infection, prevention, vaccine safety, target groups, and how to book vaccines. It is essential to thoroughly consider the opinions and needs of parents to effectively increase the HPV vaccination rate. This can be achieved through multifaceted approaches, including immunization planning, enhanced education, organized vaccination efforts, and increased vaccine supply. Sharing in-depth HPV vaccine information will foster parents' trust and acceptance, and health education on these topics will help reduce hesitancy and boost their vaccination willingness and rates.

Limitation

This study has several limitations. First, the cross-sectional design restricts our ability to infer causality, allowing only the analysis of correlations between variables. Second, the study did not sufficiently consider the child's willingness, which may influence parental decisions. Future research should incorporate this factor to achieve a more comprehensive survey. Lastly,

although using online platforms to distribute surveys made the process faster, it may have resulted in incomplete or inattentive responses. This could affect the representativeness of the data and the accuracy of the findings. Future studies should employ a variety of data collection methods to mitigate survey bias.

Conclusion

The survey revealed that the vaccination rate was lower than expected, indicating a significant opportunity to enhance parental awareness and intention, particularly for boys' parents. The survey underlined that children's gender, parental educational levels, vaccination history of parents, and their knowledge of HPV and HPV vaccine are critical factors influencing HPV vaccination rates among children. These results provide important recommendations: First, governments and societies should launch health campaigns to highlight HPV dangers, prevention, and vaccine safety and efficacy, aiming to boost vaccination acceptance, particularly among parents of boys. Second, it is essential to highlight the risks of HPV in males and the necessity of vaccination. This approach aims to eliminate gender bias and promote equitable vaccination. Furthermore, it is recommended that the HPV vaccine should be included in the NIP, and its inclusion would enhance the convenience and accessibility of vaccination through policy support and health education. Lastly, building public trust in the vaccine is essential for reducing hesitancy, increasing uptake, and preventing HPV-related diseases.

Acknowledgments

We thank all the participants for their cooperation, and thank all the participating schools and the Chaoyang District Center for Disease Control and Prevention for their support.

Disclosure statement

No potential conflict of interest was reported by the author(s).

Funding

The author(s) reported there is no funding associated with the work featured in this article.

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Ethical approval

The Medical Ethics Committee of the Chaoyang District Center for Disease Prevention and Control in Beijing believes that: since this study uses an anonymous questionnaire survey method, and it has been stated before the survey that participation is voluntary and personal identity information will not be disclosed, ethical review can be exempted.

Abbreviations

CCa	Cervical cancer
HPV	Human papillomavirus
NIP	National Immunization Program
JHS	Junior High School
SHS	Senior High School
IQR	Inter-Quartile Range
WHO	World Health Organization
OR	Odds Ratio
CI	Confidence Intervals.

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