Impact of Web-Based Health Education on HPV Vaccination Uptake Among College Girl Students in Western and Northern China: A Follow-Up Study

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Abstract

Objective: To investigate the knowledge of human papillomavirus (HPV) and HPV vaccines, HPV vaccination uptake, and vaccination willingness among female college students, and to explore the effect of a web-based educational intervention, immediately and at one month later, on HPV knowledge, vaccine acceptability and uptake among female college students in Western and Northern China.

Methods: A web-based interventional follow-up study was conducted at two universities in Western and Northern China between February and April 2020. Female freshmen were required to complete an online questionnaire, and then eligible students were randomized into intervention and control group. Students in the intervention group received 7-days of web-based health education regarding HPV and HPV vaccines, while the control group received educational materials unrelated to HPV prevention. All students were asked to complete post-intervention questionnaire to assess their awareness, uptake, and willingness regarding HPV vaccination at a 7 days and 30 days interval, respectively. Differences between intervention and control groups were compared using the Chi-square test. Multivariable logistic regression was used to analyze the influencing factors of vaccination intentions.

Results: A total of 967 participants were included in this study. Prior to the intervention, 63.8%, 66.3%, and 60.8% of students had heard of HPV, HPV-related diseases, and HPV vaccines, respectively. However, only 2.2% of students had reported to have been vaccinated, and 33.0% were willing to be vaccinated against HPV. After 7-days education, students in the intervention group had higher awareness and willingness of HPV vaccines than those in the control group. Major reasons that college female students do not accept HPV vaccines were the high cost (57.7%) and concerns about the adverse events (56.0%). School location, education background of parents, history of counseling about HPV vaccines, history of sexual behavior, and having heard of HPV vaccines are influencing factors on willingness to be vaccinated.

Conclusion: The female college students' HPV vaccination uptake is insufficient, and they have minimal detailed knowledge about HPV and its vaccines. Web-based health education on HPV vaccines is an easy, feasible, and effective way to improve the awareness and acceptance of HPV vaccination among female college students, but it has limited effect on improving HPV vaccination uptake.

Introduction

Cervical cancer is the fourth most frequently diagnosed malignant tumor affecting women's health worldwide, with an estimated 604,000 new cases and 342,000 deaths reported in 2020 [1]. China, the most populous country in the world, also bears the most significant global burden of cervical cancer, with 98,900 new cases and 30,500 deaths annually, according to the national cancer registry [2]. Sufficient evidence has confirmed that almost all cervical cancers are caused by carcinogenic human papillomavirus (HPV) infection. Prophylactic HPV vaccination can effectively prevent approximately 70–80% of the corresponding HPV infections and reducing the risk of cervical pre-cancer lesions, cervical cancer, and other HPV-related diseases [3, 4].

Since the first prophylactic HPV vaccine was launched in the United States in 2006, it has been commercially available in many countries around the world. As of April 2021, 112 of these countries have introduced HPV vaccines into their national immunization schedules to address cervical cancer and other HPV-related diseases

[5]. From 2016 to 2019, imported bivalent, quadrivalent, 9-valent, and the domestic-made bivalent HPV vaccine have been successively approved by the Chinese authorities for marketing in mainland China. However, due to the 10-year delay in introducing the HPV vaccine, public awareness and acceptance toward HPV vaccines are generally low, with vaccination rates of only about 3% among females aged 18–45 years [6]. If no effective measures to strengthen HPV vaccination in the next few decades, cervical cancer will remain a significant public health issue in mainland China.

College students are becoming sexually active and are prioritized as HPV vaccination catch-up group in developed countries such as the United States [7]. Previous studies have shown that women aged 15–19 are one of the peak populations of high-risk HPV infection in China, most of whom are in college [8]. However, due to the late introduction and lack of relevant education, Chinese female college students have insufficient knowledge of HPV vaccines, with less than half (44.17%) have heard of HPV vaccines [9], which was significantly lower than that in Western countries (71.4%) [10]. Even more, the uptake of HPV vaccines was only 11% in female college students [11], far below the World Health Organization (WHO) goal to eliminate cervical cancer by 2030 [12]. Therefore, it is particularly urgent to carry out health education for HPV vaccination among female college students in mainland China.

Numerous studies have shown that HPV-related health education can significantly increase their awareness of HPV and HPV vaccines, thereby increasing their willingness to get vaccinated [13–15]. However, most of the target population were general women; few studies have focused on college-aged girls. Furthermore, traditional school-based health education has encountered challenges in implementation due to the COVID-19 pandemic since 2020. Therefore, new health education models for HPV and HPV vaccines among female college students are urgently needed to be implemented and evaluated. This present study sought to (1) assess the knowledge of HPV, HPV vaccines, HPV vaccination uptake and willingness to receive HPV vaccines among female college students; (2) evaluate the effectiveness of a web-based educational intervention on changing the knowledge, willingness, and uptake towards HPV and HPV vaccines immediately and one month after among female college students; (3) explore factors that related to willingness change to receive HPV vaccination among female college students.

Methods

Study design and participants

This study was a web-based interventional follow-up study conducted in Western and Northern China from February to May 2020. In each region, one comprehensive university was selected through convenience sampling. After that, six colleges from the university in Western China and two colleges from the university in Northern China were selected using convenience sampling, stratified sampling (liberal arts or sciences), and cluster sampling. Furthermore, female freshmen aged 18 years or older with no contraindications to vaccination were invited to participate in the study.

Data collection

Since this study was conducted during the COVID-19 pandemic, all processes were conducted online, including informed consent, baseline survey, health education, and follow-up survey. Prior to enrollment, electronic

informed consent was obtained from each student, followed by an online baseline questionnaire. Furthermore, eligible students were randomly assigned to either the intervention or control group. The intervention group then received a 10-minute daily web-oriented education on HPV and HPV vaccine for one week. After the 7-day intervention, students were asked to complete a post-intervention questionnaire to assess their respective knowledge of HPV and HPV vaccine. Students in the control group received educational materials unrelated to HPV prevention and were asked to complete the same questionnaire as the intervention group. Additionally, one month after the intervention, students in both the intervention and control groups received a post-intervention questionnaire on the same day. All data were collected by a mobile application, and the 7-day intervention was administered through smart devices, such as a computer or a mobile phone. The study flowchart is presented in Figure 1, which contains more detailed information.

A self-administered electronic questionnaire in Mandarin was used throughout the study to assess socio-demographic information and knowledge and attitudes towards the HPV vaccine. This questionnaire was developed by the research team after reviewing relevant literature and conducting several rounds of panel discussions and has already been used and tested in previous studies employed with different populations. In brief, the questionnaire consisted of four sections. The first part was general information about the study participants, including the participants' HPV vaccination status, socio-demographic characteristics (date of birth, ethnicity, place of residence, parents' education level, and personal living expenses), and previously heard of HPV, HPV-related diseases, and HPV vaccines. The second section was about perceptions of sexual health education, including "Have you received sexual health education before the survey?", "Have you ever had sexual experience?" and "Are you single?" The third section was about knowledge of HPV and HPV vaccine by judging true, false, and don't know, with a statement including "Persistent HPV infection can lead to cervical cancer.", "HPV is mainly transmitted through sexual contact.", "Condoms protect against HPV infection.", "HPV infection is almost asymptomatic.", "HPV infection can cause oral cancer, anal cancer, and genital warts.", "Antibiotics can cure most HPV infections.", "HPV infection is common.", "The best time to get vaccinated is before the first debut of sex." The fourth section was about the willingness to receive the HPV vaccine, including "Are you willing to get the HPV vaccine within the next six months?", "Would you like to encourage your friends to get the HPV vaccine?", "What are your main reasons for refusing or discouraging HPV vaccination?" (Supplementary file 1). In addition, the information in the post-intervention survey was the same as that collected at baseline, except for background information.

Ethical considerations

This study was approved by the Clinical Research Ethics Committee of Peking University Cancer Hospital and the Institutional Review Board of the Chinese Center for Disease Control and Preventive and conformed to the Declaration of Helsinki. Prior to implementation, participants were well informed of the purpose, methods, expected risk, and potential benefits of this study. After that, informed consent was obtained from each participant before the baseline survey.

Statistical analysis

The social-demographic characteristics, knowledge about HPV, HPV-related disease, and HPV vaccine among female students were assessed using case counts and percentages. Differences between control and intervention groups and the awareness of HPV vaccine at baseline and post-intervention were analyzed using

the *Chi*-squared test. Univariate logistic regression was employed to explore the association of potential factors with the willingness to receive the HPV vaccine. Significant parameters found by univariate analysis ($P<0.01$) were incorporated and examined using multivariate analysis. Odds ratios (*ORs*) with corresponding 95% confidence intervals (*CI*s) were calculated and reported based on the Wald *Chi*-square statistics. SPSS statistical software version 20.0 (IBM, Corp, Armonk, New York) was used to analyze the data in this study. Statistical significance was assessed by two-tailed tests with α level of 0.05.

Results

A total of 967 female college students from two schools were surveyed between February and July 2020. Of these participants, 21 were excluded due to they had received HPV vaccination before the survey. In total, 946 eligible students were enrolled and then randomly divided into the control and the intervention group. More than half (56.2%, 532/946) of the enrolled students were in the intervention group and received online health education about HPV and HPV vaccines for seven days. Immediately after the intervention and one month later after the intervention, a total of 810 and 820 students completed the post-intervention questionnaire, respectively (Fig. 1).

Participants' characteristics

The mean age of the participants was 18.99 years, and more than half (54.5%) majored in science. The majority of the participants were ethnic Han Chinese (93.0%). 75.5% had lived in urban areas for more than one year, and 69.6% of them had monthly living expenses between 1,000 and 2,000 Chinese Yuan (CNY). 35.7% of the students had parents with junior high school or below, 29.5% with senior high school, and 34.9% with a bachelor's degree or above. Furthermore, 79.0% of students had ever received sexual education or knowledge, and 35.1% of students reported having searched or consulted for HPV vaccines. The vast majority (98.2%) of the students had not had sex, and 84.8% were single. There was no statistically significant difference in general demographic characteristics between the intervention and control groups, except for receiving sexual education or knowledge before the survey (81.8% vs. 74.9%) (Table 1).

Table 1 Demographic characteristics of female college students

Variables	All, N (%)	Control group, n (%)	Intervention group, n (%)	<i>p</i>
Total participants	967 (100)	414 (43.8)	532 (56.2)	
Research Site				
Western	453 (46.8)	177 (42.8)	260 (48.9)	0.061
Central	514 (53.2)	237 (57.2)	272 (51.1)	
Major				
Liberal art	430 (44.5)	174 (42.0)	249 (46.8)	0.143
Science	537 (55.5)	240 (58.0)	283 (53.2)	
Ethnic group				
Han Chinese	899 (93.0)	390 (94.2)	490 (92.1)	0.209
Non-Han Chinese Minority	68 (7.0)	24 (5.8)	42 (7.9)	
Permanent residence place (more than one year)				
Urban	730 (75.5)	303 (73.2)	407 (76.5)	0.242
Rural	237 (24.5)	111 (26.8)	125 (23.5)	
Education of parents				
Junior high school or below	345 (35.7)	151 (36.5)	192 (36.1)	0.976
Senior high school	285 (29.5)	121 (29.2)	159 (29.9)	
College and above	337 (34.9)	142 (34.3)	181 (34.0)	
Living expenses per month (CNY*)				
<1,000	201 (20.8)	84 (20.3)	116 (21.8)	0.851
1,000~2,000	674 (69.7)	293 (70.8)	369 (69.4)	
>2,000	92 (9.5)	37 (8.9)	47 (8.8)	
Received sexual education				

Yes	764 (79.0)	310 (74.9)	435 (81.8)	0.010
No	203 (21.0)	104 (25.1)	97 (18.2)	
Prior consultation regarding HPV vaccines				
Yes	339 (35.1)	142 (34.3)	177 (33.3)	0.740
No	628 (64.9)	272 (65.7)	355 (66.7)	
Previous sexual experience				
Yes	17 (1.8)	8 (1.9)	9 (1.7)	0.782
No	950 (98.2)	406 (98.1)	523 (98.3)	
Currently relationship				
Yes	147 (15.2)	74 (17.9)	72 (13.5)	0.067
No	820 (84.8)	340 (82.1)	460 (86.5)	

Except for the 21 students who had received HPV vaccine before the baseline survey, a total of 946 study subjects were randomly assigned into the intervention and control groups; *1 CNY=0.15 US dollar

Knowledge and awareness towards HPV and HPV vaccines before and after intervention

Table 2 showed that 63.8%, 66.3%, and 60.8% of the participants had heard of HPV, HPV-related diseases, and HPV vaccines, respectively, before the survey. Nearly 70% of the students knew that persistent HPV infection could lead to cervical cancer. However, knowledge of "HPV infection is almost asymptomatic," "HPV infection can be cured by antibiotics," and "HPV infection was very common" were relatively poor, with correct rates of 8.3%, 9.0% and 27.5%, respectively. There was no statistically significant difference in knowledge and awareness of HPV and HPV vaccine between the intervention and control group at baseline, except for correct perception of "persistent HPV infection may lead to cervical cancer" (65.7% vs. 72.9%) ($P=0.016$).

After the intervention, HPV and HPV vaccine knowledge level was significantly higher in the intervention group than that in the control group ($P<0.001$). However, the correct rates of "HPV infection is almost asymptomatic" (21.2%), and "antibiotics can cure HPV infection" (29.5%) remained low.

Table 2 Knowledge and awareness towards HPV/HPV vaccines between two groups before and immediately after the intervention

Items	Baseline				Post-intervention			Change percentage point (%)
	All	Control	Intervention	<i>p</i>	Control	Intervention	<i>p</i>	
	N (%)	n (%)	n (%)		n (%)	n (%)		
Heard of HPV								
Yes	617 (63.8)	260 (62.8)	337 (63.3)	0.863	335 (89.1)	425 (97.9)	<0.001	34.6
No	350 (36.2)	154 (37.2)	195 (36.7)		41 (10.9)	9 (2.1)		
Heard of HPV-related diseases (genital warts, cervical cancer, penile cancer)								
Yes	641 (66.3)	275 (66.4)	347 (65.2)	0.700	290 (77.1)	410 (94.5)	<0.001	29.3
No	326 (33.7)	139 (33.6)	185 (34.8)		86 (22.9)	24 (5.5)		
Heard of HPV vaccine								
Yes	588 (60.8)	237 (57.2)	330 (62.0)	0.136	311 (82.7)	413 (95.2)	<0.001	33.2
No	379 (39.2)	177 (42.8)	202 (38.0)		65 (17.3)	21 (4.8)		
Persistent HPV infection can cause cervical cancer								
Yes	678 (70.1)	272 (65.7)	388 (72.9)	0.016	270 (71.8)	423 (97.5)	<0.001	24.6
No/Unknown	289 (29.9)	142 (34.3)	144 (27.1)		106 (28.2)	11 (2.5)		
HPV is mainly transmitted through sexual contact intercourse								
Yes	516 (53.4)	205 (49.5)	301 (56.5)	0.031	197 (52.4)	348 (80.2)	<0.001	23.6
No/Unknown	451 (46.6)	209 (50.5)	231 (43.4)		179 (47.6)	86 (19.8)		
Condoms can prevent HPV infection								
Yes	345 (35.7)	139 (33.6)	196 (36.8)	0.297	117 (31.1)	210 (48.4)	<0.001	11.6
No/Unknown	622 (64.3)	275 (66.4)	336 (63.2)		259 (68.9)	224 (51.6)		

HPV infection is almost asymptomatic								
Yes	80 (8.3)	38 (9.2)	41 (7.7)	0.417	38 (10.1)	92 (21.2)	<0.001	13.5
No/Unknown	887 (91.7)	376 (90.8)	491 (92.3)		338 (89.9)	342 (78.8)		
HPV infection may result in oral cancer, anal cancer and genital warts								
Yes	547 (56.6)	231 (55.8)	300 (56.4)	0.895	222 (59.0)	393 (90.6)	<0.001	34.2
No/Unknown	420 (43.4)	183 (44.2)	232 (43.6)		154 (41.0)	41 (9.4)		
Most HPV infections can be cured by antibiotics								
Yes	87 (9.0)	35 (8.5)	48 (9.0)	0.759	46 (12.2)	128 (29.5)	<0.001	20.5
No/Unknown	880 (91.0)	379 (91.5)	484 (91.0)		330 (87.8)	306 (70.5)		
HPV infection is common								
Yes	266 (27.5)	119 (28.7)	137 (25.8)	0.304	114 (30.3)	342 (78.8)	<0.001	53.0
No/Unknown	701 (72.5)	295 (71.3)	395 (74.2)		262 (69.7)	92 (21.2)		
Ideal time for HPV vaccination is before sex debut								
Yes	483 (49.9)	192 (46.4)	275 (51.7)	0.105	209 (55.6)	417 (96.1)	<0.001	44.4
No/Unknown	484 (50.1)	222 (53.6)	257 (48.3)		167 (44.4)	17 (3.9)		

Students' willingness to receive HPV vaccine and reasons for unwillingness before and after the intervention

At baseline, only 2.2% (21/967) of students had received HPV vaccines, and 33.0% (312/946) and 68.8% (651/946) were willing to be vaccinated or willing to encourage their friends to get vaccinated. After intervention, willingness to be vaccinated and willingness to encourage others to take HPV vaccines increased from 36.3% to 45.6% and 71.2% to 84.4%, in the intervention group, respectively. However, the number of vaccinated students remained low, with only 1.6% and 1.8% of students in the control and intervention group, respectively (Fig.2).

The high cost of vaccination (57.7%) and concerns about adverse events (56.0%) were the main reasons for reluctance to be vaccinated at baseline. After the intervention, students in the intervention group had significantly fewer concerns about adverse events (45.5% vs. 60.2%, $P=0.001$), safety and efficacy of the vaccine (26.8% vs. 42.9%, $P<0.001$) than the control group, but the high price remained the main factor for students to refuse HPV vaccination (Table 3).

Table 3 Reasons for unwillingness to receive HPV vaccine between intervention and control group before and after the intervention

Reasons for against HPV vaccination	Pre-intervention				Post-intervention		
	All (n, %)	Control group (n, %)	Intervention group (n, %)	<i>p</i>	Control group (n, %)	Intervention group (n, %)	<i>p</i>
Expense of vaccines	366 (57.7)	168 (56.9)	198 (58.4)	0.711	152 (58.7)	160 (68.1)	0.031
Possible adverse events of HPV vaccine	355 (56.0)	167 (56.6)	188 (55.5)	0.771	156 (60.2)	107 (45.5)	0.001
No sexual activity	243 (38.3)	112 (38.0)	131 (38.6)	0.861	93 (35.9)	95 (40.4)	0.302
Doubts on safety and efficacy of HPV vaccine	237 (37.4)	111 (37.6)	126 (37.2)	0.905	111 (42.9)	63 (26.8)	<0.001
Fear of needling pain	133 (21.0)	68 (23.1)	65 (19.2)	0.232	59 (22.8)	50 (21.3)	0.687
Vaccination is troublesome	130 (20.5)	51 (17.3)	79 (23.3)	0.061	40 (15.4)	46 (19.6)	0.227

Factors related to the intention of HPV vaccination

At baseline, five variables were found to be associated with the intention to receive HPV vaccination, as suggested by multivariable logistic regression analysis. Female students from Western China (*AOR*: 1.51, 95% *CI*: 1.13-2.02) and students with highly educated parents (*AOR*: 1.91, 95% *CI*: 1.34-2.73) were more likely to be vaccinated against HPV. In addition, students who had consulted regarding HPV vaccines (*AOR*: 1.75, 95% *CI*: 1.27-2.41), had previous sexual experience (*AOR*: 5.04, 95% *CI*: 1.56-16.32) and had heard of HPV vaccines (*AOR*: 1.94, 95% *CI*: 1.39-2.71) were more likely to take HPV vaccination. Six factors, including residence place, living expenses, sexual education history, current relationship, heard of HPV, and HPV-related disease, were excluded from the multivariable logistic regression model (Table 4).

Table 4 Factors associated with willingness to be vaccinated with HPV vaccines among female college students at baseline

Variables	Total, n	Willing to vaccinate, n (%)	OR (95% CI)	AOR (95% CI)	P
Research Site					
Central	509	138 (27.1)	1.00	1.00	
Western	437	174 (39.8)	1.78 (1.35-2.34)	1.51 (1.13-2.02)	0.006
Permanent residence place (>one year)					
Rural	236	56 (23.7)	1.00		
Urban	710	256 (36.1)	1.81 (1.29-2.54)		
Education of parents					
Junior high school or below	343	82 (23.9)	1.00	1.00	0.001
Senior high school	280	86 (30.7)	1.41 (0.99-2.01)	1.20 (0.83-1.74)	0.331
College and above	323	144 (44.6)	2.56 (1.84-3.57)	1.91 (1.34-2.73)	<0.001
Living expenses per month (CNY*)					
<1,000	200	48 (24.0)	1.00		
1,000~2,000	662	221 (33.4)	1.59 (1.10-2.28)		
>2,000	84	43 (51.2)	3.32 (1.94-5.68)		
Received sexual education					
No	201	48 (23.9)	1.00		
Yes	745	264 (35.4)	1.75 (1.22-2.50)		
Prior consultation regarding HPV vaccines					
No	627	159 (25.4)	1.00	1.00	
Yes	319	153 (48.0)	2.71 (2.04-3.60)	1.75 (1.27-2.41)	0.001
Previous sexual experience					
No	929	299 (32.2)	1.00	1.00	
Yes	17	13 (76.5)	6.85 (2.21-21.18)	5.04 (1.56-16.32)	0.007

Currently relationship						
No	800	251 (31.4)	1.00			
Yes	146	61 (41.8)	1.57 (1.09-2.25)			
Heard of HPV						
No	349	74 (21.2)	1.00			
Yes	597	238 (39.9)	2.46 (1.82-3.34)			
Heard of HPV-related disease						
No	324	77 (23.8)	1.00			
Yes	622	235 (37.8)	1.95 (1.44-2.64)			
Heard of HPV vaccine						
No	379	76 (20.1)	1.00	1.00		
Yes	567	236 (41.6)	2.84 (2.10-3.84)	1.94 (1.39-2.71)	<0.001	

*1 CNY=0.15 US dollar; OR, odds ratio; AOR, adjusted odds ratio; CIs: confidence intervals.

Discussion

To our knowledge, this current study was the first web-based educational intervention study about HPV and HPV vaccines among female college students in mainland China. In our study, only 1.7% of female college students had sexual experience before the survey, which was significantly lower than the reported 17.8% in previous studies.¹¹ This may be because the current study participants were female freshmen, who might have more conservative sexual attitudes than upper-year students. Several studies have confirmed that HPV vaccination before sexual debut is the most effective and cost-effective measure for cervical cancer prevention [16, 17]. Moreover, compared with high school students, college students have financial independence and the ability to make decisions by themselves. Therefore, HPV-related health education for female freshmen is expected to expand the catch-up schedule of HPV vaccines. Notably, 21.0% of students reported having not received any sexual education before the survey, indicating that sexual education still needs to be strengthened in mainland China. Currently, the prevention of HIV/AIDS has been integrated into the sexual health education curriculum for high school students in mainland China [18]. As HPV is also one of the sexually transmitted infections, it is recommended to include HPV-associated health education into secondary school students' sexual health education curriculum.

It is not rare to find that more than 60% of the responder reported having heard of HPV and HPV vaccine at baseline survey, which significantly increased compared to the pre-marketing level (11.8%, 11.1%) [15]. However, there is still a huge gap with developed areas (82.4%, 78.6%) in the same period [19]. Several factors have contributed to the low HPV vaccine awareness in our study. Firstly, the study participants were female freshmen,

and their HPV-related knowledge was insufficient; Secondly, Shanxi and Sichuan provinces, where the study was conducted, are relatively less developed provinces. Their education and economic levels are relatively backward compared to those in developed areas; hence, it is essential to provide HPV-associated health education among less developed regions of China.

It is worth noting that only 2.2% of female college students had received HPV vaccination before the survey, which was much lower than female college students in Beijing (9.5%) [19], Hong Kong (13.3%) [20], and developed eastern regions of China (13.7%) [11]. Meanwhile, 33.1% of the responder reported willing to vaccinate themselves, which was much lower than the national average (53.5%) [11]. The analysis of factors influencing willingness to vaccinate showed that students with higher educated parents had a higher intention to receive HPV vaccination, which was consistent with the findings by Szilagyi et al [21]. Besides, parents are the key decision-makers for their children's HPV vaccination. Parents with a higher level of education were more concern for health and more likely to initiate HPV vaccination for their child [22]. Moreover, students who reported had sexual experience were more likely to receive HPV vaccines, consistent with previous studies [23], possibly because sexual experiences led to more knowledge and awareness of sexually transmitted diseases and their associated knowledge.

HPV vaccination is relatively expensive for most college students in our study, which leading to various affordability issues with the increasing demand for HPV vaccination. Currently, the available imported bivalent, quadrivalent, and 9-valent HPV vaccines in mainland China costs about 600 CNY, 800 CNY, and 1,300 CNY each dose, respectively, and is too expensive to afford for most college students [24]. Besides, the domestic bivalent HPV vaccine has been approved for marketing [25]. It costs 329 CNY per dose, which is much lower than the imported HPV vaccines, which made it expected to increase the vaccination rate of students. In the meantime, the authorities should also consider including HPV vaccines in the national immunization program to solve low vaccination rates due to the high price of HPV vaccines. In addition, concerns about the adverse events, safety, and efficacy of the vaccine are also reasons students are reluctant to get vaccinated. Many studies have proven the safety and efficacy of the HPV vaccine [25–27], and its adverse events have been clarified [28]. Therefore, further educations should enhance the safety, efficacy, and adverse events of HPV vaccines for female college students to eliminate their doubts and promote their vaccination against HPV.

In this study, we used a novel web-based methods to educate students about the HPV intervention information. After the intervention, the awareness of HPV, HPV-related diseases, and HPV vaccines among female college students in the intervention group reached more than 90%. The correct rate of relative knowledge about HPV prevention increased significantly compared with the pre-intervention and the control group; this scenario suggests the effectiveness of HPV-related health education in improving the awareness and knowledge among female college students, which is consistent with the findings of previous studies. However, the correct answer of "Condoms can prevent HPV infection," "HPV infection is almost asymptomatic," "Most HPV infection can be cured by antibiotics" in the intervention group remain low after the intervention. Based on these results, further studies should pay more attention to reducing the target population's concerns about vaccine safety and vaccination costs would be a cost-effective and practical way to improve HPV vaccination rates in Chinese youth.

Immediately and one month after the intervention, the intention to vaccinate was higher in the intervention group compared with the control group, but the vaccination action did not change significantly. The reason may

be that changes in knowledge do not lead to behavioral action, which is consistent with the findings of a study conducted among Africa American girls [29]. More importantly, the present study was conducted during the COVID-19 pandemic, and it was difficult for the participants to implement vaccination. Thus, many students did not receive the HPV vaccine despite their willingness to do so. Additionally, there is a need to consider the supply and accessibility issues of HPV vaccines, since HPV vaccines are not yet available in many rural areas in mainland China [30]. Finally, this study followed up for only one month, and future studies with longer follow-up are needed to observe changes in the behavior of the study subjects.

Our study has several limitations. First, this study enrolled only two universities from two cities, which cannot accommodate representative female college students in Western and Central China. Future studies with broader coverage and larger sample sizes are needed to provide evidence for HPV vaccination promotion. Second, since all questionnaires were self-reported, some results should be interpreted with caution, especially questions about sexual activities. Third, all students in the intervention group were included in the post-intervention analysis but did not assess the completion and quality of student learning, thus potentially underestimating the effect of the intervention. Last, the study was conducted during the COVID-19 outbreak, and there were barriers to HPV vaccination, resulting in no significant behavioral changes observed in this study.

Conclusion

In summary, female college students' HPV vaccination uptake is deficient, and they have minimal detailed knowledge about HPV and its vaccines. Web-based health education on HPV vaccines is an easy, feasible, and effective way to improve the awareness and acceptance of HPV vaccination among female college students but did not change vaccination behavior. Further studies are needed to explore suitable HPV vaccine intervention strategies for female college students and improve HPV vaccination rates in mainland China.

Abbreviations

AOR: adjusted odds ratio; CIs: Confidence Intervals; CNY: Chinese Yuan; HPV: Human papillomavirus; P: Probability; OR: Odds ratio; RCT: Randomized Controlled Trial; WHO: World Health Organization.

Declarations

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Availability of data and material

The dataset supporting the conclusions of this article are available from the corresponding author on reasonable request.

Authors' contributions

JL and XZ developed the protocol for the study. HC and JZ performed the statistical analysis and drafted the manuscript. QH and XF participated in the data collection and revised the manuscript. All authors read and approved the final version of the manuscript.

Ethics approval and consent to participate

The study protocol was approved by both the Clinical Research Ethics Committee of Peking University Cancer Hospital (approval number: 2019KT65) and Chinese Center for Disease Control and Preventive Institutional Review Board (approval number: 201918) prior to implementation. Informed consent was obtained from each participant prior to the baseline survey.

Consent for publication

Not applicable.

Competing interests

All authors declare that they have no competing interests.

References

1. Sung H, Ferlay J, Siegel RL, Laversanne M, Soerjomataram I, Jemal A, et al. Global Cancer Statistics 2020: GLOBOCAN Estimates of Incidence and Mortality Worldwide for 36 Cancers in 185 Countries. *CA Cancer J Clin.* 2021, 71(3):209-249.
2. Chen WQ, Zheng RS, Baade PD, Zhang SW, Zeng HM, Bray F, et al. Cancer statistics in China, 2015. *CA Cancer J Clin.* 2016, 66(2):115-132.
3. Crosbie EJ, Einstein MH, Franceschi S, Kitchener HC. Human papillomavirus and cervical cancer. *Lancet.* 2013;382(9895):889-99.
4. Walboomers JM, Jacobs MV, Manos MM, Bosch FX, Kummer JA, Shah KV, et al. Human papillomavirus is a necessary cause of invasive cervical cancer worldwide. *J Pathol.* 1999;189(1):12-9.
5. World Health Organization. Immunization, Vaccines and Biologicals-Data, statistics and graphics, 2020. <https://www.who.int/teams/immunization-vaccines-and-biologicals/data-statistics-and-graphics>. In.
6. Hu S, Xu X, Zhang Y, Liu Y, Yang C, Wang Y, et al. A nationwide post-marketing survey of knowledge, attitude and practice toward human papillomavirus vaccine in general population: Implications for vaccine roll-out in mainland China. *Vaccine.* 2021;39(1):35-44.
7. Silverberg MJ, Leyden WA, Lam JO, Gregorich SE, Huchko MJ, Kulasingam S, et al. Effectiveness of catch-up human papillomavirus vaccination on incident cervical neoplasia in a US health-care setting: a population-based case-control study. *The Lancet Child & Adolescent Health.* 2018;2(10):707-14.

8. Wang R, Guo X, Wisman GB, Schuurin E, Wang WF, Zeng ZY, et al. Nationwide prevalence of human papillomavirus infection and viral genotype distribution in 37 cities in China. *BMC Infect Dis.* 2015;15:257.
9. Yin G, Zhang YL, Chen CY, Ren HY, Guo BT, Zhang M. Have you ever heard of Human Papillomavirus (HPV) vaccine? The awareness of HPV vaccine for college students in China based on meta-analysis. *Hum Vaccin Immunother.* 2021;1-12.
10. Chido-Amajuoyi OG, Jackson I, Yu R, Shete S. Declining awareness of HPV and HPV vaccine within the general US population. *Hum Vaccin Immunother.* 2021;17(2):420-7.
11. You DY, Han LY, Li L, Hu JC, Zimet GD, Alias H, et al. Human Papillomavirus (HPV) Vaccine Uptake and the Willingness to Receive the HPV Vaccination among Female College Students in China: A Multicenter Study. *Vaccines (Basel).* 2020;8(1):31.
12. World Health Organization. Human papillomavirus (HPV) and cervical cancer. [https://www.who.int/en/news-room/fact-sheets/detail/human-papillomavirus-\(hpv\)-and-cervical-cancer](https://www.who.int/en/news-room/fact-sheets/detail/human-papillomavirus-(hpv)-and-cervical-cancer). In.
13. Chen H, Zhang X, Wang W, Zhang R, Du M, Shan L, et al. Effect of an educational intervention on human papillomavirus (HPV) knowledge and attitudes towards HPV vaccines among healthcare workers (HCWs) in Western China. *Hum Vaccin Immunother.* 2021;17(2):443-50.
14. Zhang X, Liu CR, Wang ZZ, Ren ZF, Feng XX, Ma W, et al. Effect of a school-based educational intervention on HPV and HPV vaccine knowledge and willingness to be vaccinated among Chinese adolescents: a multi-center intervention follow-up study. *Vaccine.* 2020;38(20):3665-70.
15. Chang IJ, Huang R, He W, Zhang SK, Wang SM, Zhao FH, et al. Effect of an educational intervention on HPV knowledge and vaccine attitudes among urban employed women and female undergraduate students in China: a cross-sectional study. *BMC Public Health.* 2013;13:916.
16. Castle PE, Maza M. Prophylactic HPV vaccination: past, present, and future. *Epidemiol Infect.* 2016, 144(3):449-68.
17. Datta S, Pink J, Medley GF, Petrou S, Staniszewska S, Underwood M, et al. Assessing the cost-effectiveness of HPV vaccination strategies for adolescent girls and boys in the UK. *BMC Infect Dis.* 2019;19(1):552.
18. Gao X, Wu Y, Zhang Y, Zhang N, Tang J, Qiu J, et al. Effectiveness of school-based education on HIV/AIDS knowledge, attitude, and behavior among secondary school students in Wuhan, China. *PLoS One.* 2012;7(9):e44881.
19. Liu Y, Di N, Tao X. Knowledge, practice and attitude towards HPV vaccination among college students in Beijing, China. *Hum Vaccin Immunother.* 2020;16(1):116-23.
20. Chiang VC, Wong HT, Yeung PC, Choi YK, Fok MS, Mak OI, et al. Attitude, Acceptability and Knowledge of HPV Vaccination among Local University Students in Hong Kong. *Int J Environ Res Public Health.* 2016;13(5):486.
21. Szilagyi PG, Albertin CS, Gurfinkel D, Saville AW, Vangala S, Rice JD, et al. Prevalence and characteristics of HPV vaccine hesitancy among parents of adolescents across the US. *Vaccine* 2020, 38(38):6027-37.
22. Sitaresmi MN, Rozanti NM, Simangunsong LB, Wahab A. Improvement of Parent's awareness, knowledge, perception, and acceptability of human papillomavirus vaccination after a structured-educational intervention. *BMC Public Health.* 2020;20(1):1836.
23. Cocchio S, Bertoncetto C, Baldovin T, Fonzo M, Bennici SE, Buja A, et al. Awareness of HPV and drivers of HPV vaccine uptake among university students: A quantitative, cross-sectional study. *Health Soc Care*

Comm. 2020;28(5):1514-24.

24. Siu JY. Barriers to receiving human papillomavirus vaccination among female students in a university in Hong Kong. *Cult Health Sex.* 2013;15(9):1071-84.
25. Qiao YL, Wu T, Li RC, Hu YM, Wei LH, Li CG, et al. Efficacy, Safety, and Immunogenicity of an Escherichia coli-Produced Bivalent Human Papillomavirus Vaccine: An Interim Analysis of a Randomized Clinical Trial. *J Natl Cancer Inst.* 2020;112(2):145-53.
26. Harder T, Wichmann O, Klug SJ, van der Sande MAB, Wiese-Posselt M. Efficacy, effectiveness and safety of vaccination against human papillomavirus in males: a systematic review. *BMC Med.* 2018;16(1):110.
27. Human papillomavirus vaccines: WHO position paper, May 2017–Recommendations. *Vaccine.* 2017;35(43):5753-5.
28. Martínez-Lavín M, Amezcua-Guerra L. Serious adverse events after HPV vaccination: a critical review of randomized trials and post-marketing case series. *Clin Rheumatol.* 2017;36(10):2169-78.
29. DiClemente RJ, Murray CC, Graham T, Still J. Overcoming barriers to HPV vaccination: A randomized clinical trial of a culturally-tailored, media intervention among African American girls. *Hum Vaccin Immunother.* 2015;11(12):2883-94.
30. Wong LP, Han L, Li H, Zhao J, Zhao Q, Zimet GD. Current issues facing the introduction of human papillomavirus vaccine in China and future prospects. *Hum Vaccin Immunother.* 2019;15(7-8):1533-40.

Figures

Figure 1

Study flowchart

Figure 2

Comparison of intention to vaccinate, encourage friends to get HPV vaccine, and HPV vaccination between intervention and control group at baseline, post-intervention, and one-month follow-up

Supplementary Files

This is a list of supplementary files associated with this preprint. Click to download.

- [questionnaire.pdf](#)