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Human papillomavirus knowledge, attitudes, and vaccination among Chinese college students in the United States

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ABSTRACT

Human papilloma virus (HPV) is the most common sexually transmitted infection in the USA with some strains increasing the risk of certain cancers. The HPV vaccine, introduced in 2006, has reduced the infection rate, although racial/ethnic disparities in vaccination exist. Asian college students are among those with the lowest vaccination rates, however there has been little exploration as to why. The purposes of this study were to assess (a) knowledge and attitudes regarding HPV and its vaccine, (b) HPV vaccination practices, and (c) factors associated with HPV-related knowledge and attitudes, and vaccination among Chinese college students in the USA. This cross-sectional quantitative survey collected data face-to-face and online from 449 participants. The mean scores for HPV knowledge and attitudes were 40.87 and 2.36 indicating a low-to-moderate level of knowledge but a moderately positive attitude regrading HPV transmission and vaccination. Only half (50.8%) knew that the vaccination could be received after the age of 18 years. Only 38.3% reported having receiving at least one dose of the vaccine, with 92.4% receiving their first HPV vaccines in the USA. Multiple logistic regression showed that men and non-health sciences majors had lower knowledge about HPV. Older students, those without a primary care provider, and those who completed the survey in English had more negative attitudes about the HPV and vaccine. Participants who were younger, female, had a higher level of knowledge, had more positive attitudes, and completed the survey online were associated with better vaccination status. Findings from this study provide insight into Chinese college students' knowledge and attitudes about HPV and HPV vaccination and may be used to develop culturally sensitive programs that address the risk of HPV and the benefits of HPV vaccine.

1. Introduction

Human papillomavirus (HPV) is mainly transmitted through sexual contact and most people are infected with HPV shortly after the onset of sexual activity [1]. In the United States of America (USA), HPV is the most common sexually transmitted infection. It is estimated that 79 million Americans have been infected with HPV and most become infected in their late teens and early 20 s, which is an age demographic similar to that of college students [2]. The latest data from 2013 to 2014 also report that prevalence of genital infections from any kind of HPV was 45.2% among adults ages 18–59 in the USA [3].

The first HPV vaccine was introduced in 2006 in the USA to protect against HPV infections that can cause certain types of cancers. The national guidelines for HPV vaccination are recommended for young women beginning at age 9 through 26 and for young men through age 21 [2]. Catch-up vaccination to age 26 is recommended for men who have sex with men, young adults who are transgender, and young adults who are immunocompromised. There has been a 64% reduction in vaccine-type HPV infections among teen girls ages 14 to 19 in the USA since it was available in 2006 [4]. One *meta*-analysis study has shown that HPV vaccines reduced the risk of cervical pre-cancer associated with HPV16/18 from 341 to 157 per 10,000 among women aged 15 to 26 [5]. Despite the benefits of HPV vaccines, racial/ethnic disparities in HPV vaccination exist among college students. Data from the National College Health Assessment (NCHA) (fall 2012, N = 18,919) found that Asian American and Pacific Islander (AAPI) college students were less likely to receive HPV vaccination [6]. Similarly, the Fall 2009 to 2013 data from the NCHA (N = 153,276) showed that Asian female college students (2009:

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27.95%, 2010: 48.35%, 2011: 50.110%, 2012: 58.18%, 2013: 61.86%) had lower rates of HPV vaccination compared to Non-Hispanic white female students (2009: 46.88%, 2010: 58.04%, 2011: 62.90%, 2012: 67.75%, 2013: 70.58%) [7]. Another study conducted at a large public university in the Midwest reported that 38.6% of AAPI college women received all recommended doses compared to 60.7% of non-Latina white college women [8]. Moreover, the National Immunization Survey estimated that 47.2% of Asian teens were fully vaccinated against HPV in the USA [9]. These rates are far below the 2020 Healthy People goal of 80% [10].

This study specifically focused on college students in the USA who self-identified as Chinese due to a significant number of Chinese students enrolled in U.S. colleges. National data of college enrollment specific for the entire Chinese students is unavailable, but students from China make up the largest group of international students in the US college campuses, 363,341 in the academic year 2017–2018 [11]. To date, only one qualitative study has assessed knowledge and beliefs about HPV vaccination among international Chinese college students in the USA. This study found participants had little knowledge about cervical cancer, genital warts, and the HPV vaccine [12]. Participants believed Chinese students started having sex later than American students so did not need to be vaccinated at a young age, a vaccine developed in Western countries would not be appropriate for Chinese individuals, and the vaccine was not necessary if they were only dating Chinese individuals [12]. These data suggest that more research and education efforts are needed to improve HPV knowledge among Chinese college students in the USA in order to develop culturally sensitive HPV programs. The purposes of the study were to (a) assess knowledge and attitudes regarding HPV and its vaccine, (b) examine HPV vaccination practices, and (c) identify factors associated with HPV-related knowledge and attitudes, and vaccination. Results from this study have potential to increase vaccination rates.

2. Methods

2.1. Study design, participants, and settings

A cross-sectional quantitative survey of a convenience sample of Chinese college students was conducted via paper and online between February and May 2018. To recruit participants, multiple strategies were employed including snowball sampling, personal contacts, referrals, and in-person recruitment at libraries, Chinese student organizations, grocery stores, and churches. Participants were screened to ensure eligibility, including self-identification as Chinese college students, age 18 or older, and able to read Chinese or English. Participants were compensated for their time with a $5 gift card. After participants completed the questionnaire, investigators asked if they knew other students who met study criteria and were willing to participate. Hard copy surveys, the online survey link, and the letter of information were provided if participants were willing to recruit more students. Participants were instructed to return completed hardcopy surveys to the principal investigator.

This study took place at several public, medium to large-size universities in the Western United States. These universities were initially selected because of professional relationships between the investigators and previous students of the investigators.

2.2. Ethical considerations

The Institutional Review Board at the University of Nevada, Reno approved this study (No. 1203881–3). The recruiting investigators explained the study to potential participants using an informational letter. After providing verbal informed consent, participants were asked to complete an anonymous self-administered questionnaire described below.

2.3. Measurements

The survey instruments were available in English, Simple Chinese, and Traditional Chinese. Participants could choose their preferred language. Participants were also given a choice of a paper or online survey method. The online questionnaire was administrated using WJX survey software.

The questionnaire consisted of four sections, including (a) demographics, (b) Knowledge about Human papillomavirus and its Vaccine, (c) Attitudes towards Human papillomavirus Vaccination, and (d) HPV Vaccination. Demographics collected from each participant included age, gender, grade, major, and if they had health insurance and a primary care provider.

2.3.1. Knowledge about Human papillomavirus and its vaccine

Knowledge about HPV and its vaccine was measured using 13 questions developed by Dany and colleagues [13]. This instrument was selected after expert review and determination of content validity. Three items related to the links among HPV vaccine, cancers, and Pap smears were added. Participants were asked to answer 16 questions as true or false to assess knowledge about HPV and the HPV vaccine [13]. For each correct response, one point was given. Points were totaled with higher scores correlating with more knowledge of HPV and the HPV vaccine. The range of scores is 0–100 with higher scores indicating better knowledge.

2.3.2. Attitudes towards Human papillomavirus vaccination

Seven 5-point Likert-scale questions were included in the questionnaire to assess attitude about HPV vaccination [13]. Responses varied from 1-Strongly agree, 2-Agree, 3-Neutral, 4-Disagree, to 5-Strongly disagree. Scores from each participant were averaged (range 1–5), and higher scores represented more negative attitudes about HPV vaccination.

2.3.3. HPV vaccination

Each participant was asked how many HPV vaccinations they had received, and at what age and in what country they received their first HPV vaccine. Vaccination records were not reviewed.

2.4. Translation process

Both translation and back-translation methods were performed to translate the English version of the instruments into Simple and Traditional Chinese. A committee fluent in Chinese and English translated the original questionnaire into Chinese. Two bilingual and bicultural individuals back-translated the Chinese instruments into English. The Chinese version of the questionnaire was pilot tested in Chinese college students prior to data collection. Some modifications were made to make questions clearer and more understandable.

2.5. Statistical analysis

SAS version 9.4 and SPSS version 25 for Windows was applied for data management and analysis. Summary statistics such as sample average, standard deviation, count, and percentage were utilized to describe demographics, HPV related knowledge, attitudes, and vaccination. Multiple logistic regression models were performed to identify the significant predictors for HPV knowledge, attitudes, and vaccination. P-value < 0.05 was considered as statistically significant.

3. Results

3.1. Participants' characteristics

A total of 449 surveys were fully completed. The participants' mean age was 23.3 years (SD = 3.4, range 18–57). As presented in Table 1, the majority of participants were female, enrolled in undergraduate programs, and not in a health-related major. The majority reported they had health insurance, but no primary care provider. Most participants completed the survey in Chinese, and on paper.

3.2. Knowledge about HPV and its vaccine

The mean score for this knowledge section was 40.87 (SD = 26.60, range 0–87.50). The percentages of participants answering each question correctly and incorrectly are shown in Table 2. It should be noted the majority did not realize that genital warts are caused by HPV and less than half knew the infected partner may not show symptoms. Most did not know that, despite a normal Pap smear, a woman may still have HPV infection. The majority did not know that the vaccination could be received after the age of 18 years. Only one-third knew a woman still needs to get Pap smear after receiving HPV vaccination

Table 1
Demographic variables (N = 449).

	n (%)
Gender	
Male	186 (41.4)
Female	263 (58.6)
Academic Year	
Undergraduate	293 (65.3)
Graduate	156 (34.7)
Major	
Health-related	44 (9.8)
Non Health-related	405 (90.2)
Having Health Insurance	
Yes	447 (95.1)
No	22 (4.9)
Having a Primary Care Provider	
Yes	162 (36.1)
No	287 (63.9)
Selected Survey Language	
English	132 (29.4)
Chinese	317 (70.6)
Selected Survey Method	
Online-based	142 (31.6)
Paper-based	307 (68.4)

3.3. Attitudes regarding the HPV and its vaccine

The mean score for this attitude section was 2.36 (SD = 0.57, range 1–5). Table 3 shows the percentages of participants who indicated their responses on seven attitudes items. It is important to note that less than one-fifth agreed that they are susceptible to HPV infection. The results demonstrated a positive attitude regarding the HPV vaccines' capability to protect against cervical cancer, which goes along with the result that most would consider the cost of the vaccine reasonable and would recommend HPV vaccines to their friends. Finally, most agreed that gynecologists and primary care providers should advocate for HPV vaccination.

3.4. Vaccination

The majority reported that they have never received HPV vaccines (n = 259, 57.7%) or were unsure of their HPV vaccination status (n = 18, 4%). Only 38.3% (n = 172) had received one to three of the vaccine [n = 36 (8%) for one dose; n = 37 (8.3%) for two doses; n = 99 (22%) for three doses]. Among 172 students who were vaccinated, the mean age was 19.76 years (SD = 3.39, range 9–32). Most received their first dose of HPV vaccine in the USA (n = 159, 92.4%). Very few students received their first dose in Hong Kong (n = 7, 4.1%) and China (n = 6, 3.5%).

3.5. Factors associated with HPV-related knowledge and attitudes, and vaccination

As displayed in Tables 4 and 5, males demonstrated significantly lower HPV knowledge compared with females, 36.6% vs. 49.4%, AOR = 0.59, 95% C.I. (0.39, 0.88). Participants majoring in health sciences understood more about HPV than those majoring in non-health disciplines, 61.4% vs. 42.2%, AOR = 1.95, 95% C.I. (1.01, 3.78).

Regarding attitudes toward HPV and HPV vaccine, older participants showed significantly more negative attitudes than younger

Table 2
Participants knowledge about human papilloma virus and its vaccine (N = 449).

Knowledge statement	Correct answer	True *n* (%)	False *n* (%)	Do not know *n* (%)
The type of cancer highly associated with HPV infection is cervical cancer	True	229 (51.0%)*	50 (11.1%)	170 (37.9%)
Human papilloma virus can cause herpes	False	98 (21.8%)	44 (9.8%)*	307 (68.4%)
Human Papilloma virus can lead to genital warts (growths on the genitals)	True	149 (33.2%)*	32 (7.1%)	268 (59.7%)
HPV can be transmitted through vaginal, anal, and oral sex as well as genital to genital contact	True	244 (54.3%)*	22 (4.9%)	183 (40.8%)
In most cases, HPV infected persons do not show symptoms	True	156 (34.7%)*	66 (14.7%)	227 (50.6%)
All HPV infections are caused by the same type of virus	False	31 (6.9%)	206 (45.9%)*	212 (47.2%)
Only females can be infected with HPV and show symptoms	False	46 (10.2%)	244 (54.3%)*	159 (35.4%)
HPV can be transmitted from a carrier to his/her partner only if the carrier shows symptoms	False	28 (6.2%)	222 (49.4%)*	199 (44.3%)
A normal Pap smear implies that the woman is free of HPV	False	65 (14.5%)	108 (24.1%)*	276 (61.5%)
There is no current cure or therapy for HPV infection	True	90 (20.0%)*	99 (22.0%)	260 (57.9%)
HPV vaccines have the same effect whether the female takes it before or after being infected with HPV	False	24 (5.3%)	211 (47.0%)*	214 (47.7%)
HPV vaccine is best taken before starting to have sexual activities	True	268 (59.7%)*	22 (4.9%)	159 (35.4%)
HPV vaccine can only be taken after the age of 18 years	False	44 (9.8%)	228 (50.8%)*	177 (39.4%)
HPV vaccines protect against cervical cancer	True	247 (55.0%)*	35 (7.8%)	167 (37.2%)
HPV vaccines do not protect against all HPV infections that cause cancer	True	189 (42.1%)*	37 (8.2%)	223 (49.7%)
Women who receive HPV vaccine still have to get Pap smear	True	160 (35.6%)*	29 (6.5%)	260 (57.9%)

* Answered correctly.

Table 3
Participants' attitudes toward HPV and vaccination (N = 449).

Attitude assessing statement	Strongly Agree *n* (%)	Agree *n* (%)	Neutral *n* (%)	Disagree *n* (%)	Strongly Disagree *n* (%)
Based on my lifestyle, I believe that I am susceptible for the HPV infection and must get the vaccine	35 (7.8%)	49 (10.9%)	199 (44.3%)	133 (29.6%)	33 (7.3%)
I believe that contracting HPV virus is serious and life threatening	107 (23.8%)	199 (44.3%)	119 (26.5%)	22 (4.9%)	2 (0.4%)
I believe that the current HPV vaccine is capable of preventing the occurrence of cervical cancer	67 (14.9%)	197 (43.9%)	168 (37.4%)	15 (3.3%)	2 (0.4%)
I believe that the price of the vaccine is affordable given the benefits it offers	88 (19.6%)	184 (41.0%)	160 (35.6%)	14 (3.1%)	3 (0.7%)
I believe that the side effects of the vaccine are reasonable and will not deter me from taking the vaccine	74 (16.5%)	174 (38.8%)	178 (39.6%)	22 (4.9%)	1 (0.2%)
I would recommend this vaccine for my friends whether or not they come from conservative families	116 (25.8%)	163 (36.3%)	155 (34.5%)	12 (2.7%)	3 (0.7%)
I believe that all gynecologists and primary care providers should recommend the vaccine to their patients, whether or not they come from conservative families	121 (26.9%)	170 (37.9%)	141 (31.4%)	15 (3.3%)	2 (0.4%)

students, 55.2% vs. 47.6%, AOR = 1.82, 95% C.I. (1.08, 3.07). Participants without a primary care provider demonstrated more negative attitudes compared with those with a primary care provider, 54.7% vs. 43.2%, AOR = 0.53, 95% C.I. (0.35, 0.82). Participants using English to complete the survey were more likely to have significantly more negative attitudes than those who completed the survey in Chinese, 58.3% vs. 47.3%, AOR = 1.78, 95% C.I. (1.09, 2.93).

With regard to HPV vaccination, older participants were less likely to receive HPV vaccine (29.7%) compared with younger participants (43.7%) with AOR = 0.46, 95% C.I. (0.25, 0.88). Other significant differences observed in receiving HPV vaccine included between gender [males 14.5% vs. females 55.1%, AOR = 0.13, 95% C.I. (0.08, 0.22)], knowledge level [high 52.0% vs. low 27.5%, AOR = 2.36, 95% C.I. (1.47, 3.79)], attitude score [high 22.5% vs. low 54.5%, AOR = 0.28, 95% C.I. (0.17, 0.46)], and survey method selection [online 48.6% vs. paper-based 33.6%, AOR = 2.22, 95% C.I. (1.22, 4.04)].

Table 4
Participants' HPV knowledge scores, attitude scores, and vaccination stratified by demographics.

	High Knowledge Scores n (%)[a]	High Attitude Scores n (%)[b]	Have Been Vaccinated n (%)
Age[c]			
18–23	113 (40.8)	132 (47.6)	121(43.7)
24–57	85 (49.4)	95 (55.2)	51 (29.7)
Gender			
Male	68 (36.6)	107 (57.5)	27 (14.5)
Female	130 (49.4)	102 (45.6)	145 (55.1)
Academic Year			
Undergraduate	116 (39.6)	150 (51.2)	113 (38.6)
Graduate	82 (52.6)	77 (49.4)	59 (37.8)
Major			
Health	27 (61.4)	16 (36.4)	21 (47.7)
Non-health	171 (42.2)	211 (52.1)	151 (37.3)
Having Health Insurance			
Yes	191 (44.7)	213 (49.9)	170 (39.8)
No	7 (31.8)	14 (63.6)	2 (9.1)
Having a Primary Care Provider			
Yes	70 (43.2)	70 (43.2)	66 (40.7)
No	128 (44.6)	157 (54.7)	106 (36.9)
Selected Survey Language			
Chinese	144 (45.4)	150 (47.3)	133 (42.0)
English	54 (40.9)	77 (58.3)	39 (29.6)
Selected Survey Method			
Online-based	69 (48.6)	62 (43.7)	69 (48.6)
Paper-based	129 (42.0)	165 (53.8)	103 (33.6)

[a] Respondents received one point if they selected the correct answer for each HPV knowledge item. The total points were added and a percentage was computed ([total points earned/16 items] × 100). We used median score (43.75) as a cut-off point to decide on low and high knowledge, with a higher score indicating greater HPV knowledge. N and % represent the frequencies and percentages of high knowledge scores stratified by each of variables.

[b] For attitude scores, we used median score (2.43) as a cut-off point to decide on low and high attitude scores. Higher scores indicate more negative attitudes toward HPV and its vaccine. N and % represent the frequencies and percentages of high attitude scores stratified by each of variables.

[c] The median age of 23 years was used as a cut-off point.

4. Discussion

This is the first quantitative study to explore HPV knowledge and attitudes, HPV vaccination rates, and associated factors among 449 Chinese college students in the USA. Participants had a mean knowledge score of 40.87, indicating a low-to-moderate level of knowledge regarding HPV transmission and vaccination. About half of the participants were unaware of the recommended age for HPV vaccine or the relationship among HPV, HPV vaccine, and cervical cancer. These results concurred with previous qualitative research among Chinese international students in the USA which also reported a low to moderate awareness and knowledge level about HPV [12]. It underscores the importance of education related to HPV, HPV vaccine, and cancers.

Although study participants exhibited a moderately positive attitude towards HPV and its vaccines, it is worth noting that they had low perceptions of their susceptibility to contract HPV infection, consistent with a study conducted among 383 undergraduate students in Mississippi, USA [14]. The possible reasons may be due to the lack of HPV knowledge and a large proportion of the study participants majoring in non-health related programs, which emphasizes a need for HPV education addressing HPV severity and susceptibility.

Only 38.3% in our study reported having received at least one dose of the vaccine, similar to the 38.6% who reported completing all three doses of HPV vaccine among 341 AAPI female undergraduate students in Minnesota, USA [8]. Our study rate was lower than the rate of 47.9% reported having received HPV vaccine among 18,919 college students in the USA [6]. Given that 95.1% of the participants had insurance coverage, campus student health centers have an opportunity to educate students that the costs of HPV vaccine are covered fully or partially by their insurers. Additionally, 92.4% of participants who received HPV vaccination got their first dose in the USA. This finding can be attributed to the fact that HPV vaccine was approved by the China Food and Drug Administration in 2016 [15] and HPV vaccine was not available when participants lived in China. Another explanation is that there is a lack of comprehensive education regarding HPV in their home country; as a result, participants might be exposed to HPV vaccination knowledge for the first time when they came to the USA [12]. Thus, a large percentage of participants received the first dose of HPV vaccine in the USA.

Table 5
Multivariate analysis for predicting HPV knowledge, attitudes, and vaccination.

	OR (95% C.I)	p
Knowledge Score[a]		
Male vs. Female (Ref.)	0.59 (0.39, 0.88)	0.009
Health-related major vs. Non health-related (Ref.)	1.95 (1.01, 3.78)	0.049
Attitude Score[b]		
Age: 24–57 vs 18–23 (Ref.)	1.82 (1.08, 3.07)	0.026
Having a primary care provider vs. No care provider (Ref.)	0.53 (0.35, 0.82)	0.004
Selected English survey vs. Selected Chinese survey (Ref.)	1.78 (1.09, 2.93)	0.02
Have Been Vaccinated		
Age: 24–57 vs 18–23 (Ref.)	0.46 (0.25, 0.88)	0.019
Male vs. Female (Ref.)	0.13 (0.08, 0.22)	<0.0001
Higher knowledge scores vs. Lower knowledge scores (Ref.)	2.36 (1.47, 3.79)	0.0004
Higher attitude scores vs. Lower attitude scores (Ref.)	0.28 (0.17, 0.46)	<0.0001
Selected online-based survey vs. Paper-based survey (Ref.)	2.22 (1.22, 4.04)	0.007

[a] Respondents received one point if they selected the correct answer for each HPV knowledge item. The total points were added and a percentage was computed ([total points earned/16 items] × 100). We used median score (43.75) as a cut-off point to decide on low and high knowledge, with a higher score indicating greater HPV knowledge.
[b] For attitude scores, we used median score (2.43) as a cut-off point to decide on low and high attitude scores. Higher scores indicate more negative attitudes toward HPV and its vaccine.

We found significant associations between HPV knowledge and gender and student majors, with males and participants majoring in non-health related programs more likely to have a lower level of HPV knowledge. Among the few available studies, mixed results with respect to gender-differences in HPV knowledge levels have been reported, with one indicating no differences in HPV knowledge between US female and male college students [14], and another stating lower levels of HPV knowledge in male students in China [16]. One possible explanation for this difference is different study populations, suggesting more research is needed about HPV knowledge between genders before developing gender-specific HPV programs. It is not surprising that having a health-related major was associated with higher level of HPV knowledge. This finding may simply reflect that health education courses at colleges increased participants' knowledge about HPV.

Results from multiple logistic regression analyses showed that younger participants displayed more positive attitudes towards HPV compared to older participants. A similar finding has been reported among Chinese international students studying in the USA and suggested that older students who relocated to the USA later in their life were likely to have adopted the traditional conservative belief that considered sexually transmitted infections, including HPV, as taboos [12]. Such beliefs could potentially affect older participants' attitudes towards HPV and vaccination. On the contrary, younger students might receive early education in the USA and could be more liberal towards HPV.

Having a primary care provider was also related to positive attitudes towards HPV and vaccination. This finding is consistent with prior studies, which described the recommendations and information delivered by healthcare professionals (i.e., personal physicians, gynecologists, and nurses) played vital roles in promoting HPV awareness and vaccination uptake [6,16–19]. Therefore, future interventions targeted at raising HPV awareness among Chinese college students should include healthcare professionals.

Interestingly, participants completing the survey in Chinese had more positive attitudes toward HPV. Perhaps participants who completed the Chinese version of the survey were China-born students. The first HPV vaccine (Cervarix) officially licensed for use in Mainland China had only been available one year, since 2017 [20]. Some of our participants may have been exposed to information regarding the availability of HPV vaccination in China and USA. During data collection, several participants stated that a shortage of HPV vaccine in China has led to medical tourists to Hong Kong for the vaccine. The relatively lower cost and increased availability of vaccines in the USA could contribute to more positive HPV attitudes among China-born participants.

Several factors were found to be associated with vaccination status in the present study, including age, gender, HPV knowledge and attitudes, and completing the survey online. Similar to prior research conducted among US college students [7,21], older participants were less likely to have gotten HPV vaccine than younger participants. Older Chinese students may hold a conservative attitude toward HPV vaccine practice [12]. It is also possible that the vaccines were not available for older participants prior coming to the USA given that the HPV vaccine was approved just recently in Mainland China. It is therefore possible that these participants missed the opportunity to obtain the vaccine in China.

Our study results indicated that male participants were less likely to receive HPV vaccine compared with females, consistent with prior studies of college students in the USA [7,14] and China [16,22]. Misconceptions regarding gender-specific HPV vaccination were found in the literature and during our data collection among Chinese college students. For instance, male college students and Chinese communities believed that only girls need to be vaccinated [12,22]. Male college students also had a higher tendency to deny risk due to misperceptions and low awareness [14,23] and they were less likely to receive HPV vaccine recommendations from healthcare providers [14]. This could be explained by the fact that HPV vaccines, licensed in China in 2016, were only recommended for females. Finally, guidelines for HPV vaccination differ among countries and across international organizations. For example, World Health Organization guidelines recommend HPV vaccination for men only if resources are not diverted from vaccinations for women [24]. Men especially experience health disparities in relation to HPV vaccination. These facts reveal the need for education of both men and women about the efficacy of HPV vaccine and policy change that addresses the inclusion of men in recommendations for vaccination in Chinese communities.

Finally, higher levels of HPV knowledge and a more positive attitude towards HPV vaccine were associated with greater odds of having been vaccinated. While there was no association between HPV knowledge and attitudes in the present study, improving both variables may be likely to promote vaccination among this study population.

5. Limitations

There were some limitations in this study. First, the sample of this study was limited to college students primarily studying at public universities in the Western United States, which may not be generalizable to other groups of Chinese college students. Second, convenience sampling method was used which may over-represent participants with larger networks of friends, limiting representativeness of overall Chinese college students in the USA. This method does not allow for calculation of a response rate. Third, the study design did not use a comparison group. Therefore, there was no comparison of Chinese students with other student populations in relation to the study variables. The cross-sectional data also limits the ability to make causal inferences about the relationship among study variables. Additionally, we were unable to distinguish between international Chinese students and Chinese American students. The proportion of international students was

unknown in this convenience sample of Chinese students. Moreover, we did not include some variables such as knowledge related to different types of HPV-associated cancers (e.g., oropharyngeal cancer) and number of HPV vaccine doses needed, barriers such as pain and concern about needles, sexual behaviors, parent's education levels and attitudes towards HPV vaccination. Future study should examine these factors to provide more comprehensive information for intervention development. Finally, HPV vaccination data was self-reported which may be inaccurate or subject to socially desirable response biases, recall biases, or self-selection biases.

6. Conclusions

Findings from this study support the need for educational programs on college campuses that address HPV and HPV vaccination, and increased access for students to the HPV vaccine. Of greatest concern is the fact that a majority of participants in this study indicated they had not received the HPV vaccine. College campuses provide an environment that supports both education and access to the vaccine. Educational resources should be available through multiple avenues on campuses. The health sciences majors, international student organizations, and student health services can all contribute to education and increased vaccination rates. College students in the health related programs, for example, often have health fairs that focus on issues pertaining to their peers. This is an ideal milieu for development and distribution of educational materials related to HPV. International student organizations on campus can advocate for access to care, for instance, working with student health services to create access. Student health services can facilitate administration of the vaccine at reasonable cost, especially for those students who may not have insurance or a primary care provider. They can also create and distribute educational materials and ensure that those students with insurance are aware that the cost of the vaccine is covered. In conclusion, collaborative efforts among multidisciplinary teams are needed to reduce disparities in HPV vaccination rates. Given that little research has focused on HPV studies among Chinese college students in the USA, it is important to continue investigations and therefore develop evidence-based approaches.

Conflict of interest

The authors have no conflict of interest to declare.

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