




RESEARCH PAPER



Human papillomavirus and Chinese international students in the United States: attitudes, knowledge, vaccination trends, healthcare behaviors, and sexual activity

Aaron Esagoff ^{a,b}, Samuel A. Cohen ^{b,c}, Guoxuan Chang^d, Ozlem Equils^b, and Sarah Van Orman ^d

^aThe Johns Hopkins University School of Medicine, Baltimore, MD, USA; ^bMiOra, Public Health Nonprofit, Encino, CA, USA; ^cStanford University School of Medicine, Stanford, CA, USA; ^dKeck School of Medicine of USC, USC Student Health, Los Angeles, CA, USA

ABSTRACT

Human papillomavirus (HPV) is the most common sexually transmitted infection in the world, with the ability to cause external genital warts and cancers. The HPV vaccine, first released in the United States of America (USA) in 2006, has been shown to protect against the highest risk HPV strains responsible for the majority of HPV-related cancers. In mainland China, the HPV vaccine was only recently approved in 2016 and is therefore not readily available. As a result, Chinese international students (CIS) studying in the USA continue to have low HPV vaccination rates. This study completed in person and online surveying of 396 CIS at a large Southern California university, with the goal of better understanding CIS knowledge and awareness of HPV disease, vaccination and healthcare behaviors, and sexual activity. Among participants, the reported HPV vaccination rate was 61% (females: 85%; males: 32%). HPV vaccination was significantly correlated with a past visit to the on-campus student health center, having university-sponsored student health insurance, higher self-perceived HPV knowledge, and increased willingness to pay for vaccination. A large portion of participants portrayed low levels of sexual activity, which suggests that CIS can take advantage of catch-up HPV vaccination recommendations through 26 years of age. The results of this study can be used to inform policy initiatives, particularly at the campus level, that attempt to improve HPV vaccination rates amongst CIS.

ARTICLE HISTORY

Received 26 October 2020
Revised 26 December 2020
Accepted 23 January 2021

KEYWORDS

HPV; human papillomavirus; vaccination; Chinese; international; student; healthcare; sex; sexual activity

Introduction

Human papillomavirus (HPV) is the most common sexually transmitted infection in the world; it is likely to infect nearly all sexually active, unvaccinated individuals at some point in their lives.¹ HPV is the most common cause of cervical cancer and can also lead to cancers of the oropharynx, vagina, vulva, penis, and anus.² It is estimated that 14 million Americans were newly infected with HPV in 2019, with most acquiring the disease in their late teens and early 20s, an age range that aligns with most college students in the United States of America (USA).³

Given the detrimental effects and widespread nature of the virus, the HPV vaccine has been lauded as one of the most important discoveries in cancer prevention, shown to protect against the highest risk strains, which are responsible for a majority of related cancers.⁴ Though vaccination has proven effective, vaccination in China has yet to become commonplace.^{5,6} The HPV vaccine was first approved in mainland China in 2016 and only made available in 2017.⁷ Therefore, given the lack of vaccine availability, most Chinese young adults remain unvaccinated.⁸

Universities in the USA host more than 1 million international students a year, about a third of whom are Chinese.⁹ Given that the Advisory Committee on Immunization Practices (ACIP) at the Centers for Disease Control and Prevention (CDC) recommends HPV vaccination through 26 years of age for men and women, there is a substantial

window for catch-up for previously unvaccinated Chinese international students (CIS) who attend college in the USA.¹⁰

To date, there has been limited research on HPV vaccine knowledge, beliefs, and behaviors amongst CIS in the USA. Tung et al. previously examined HPV knowledge and awareness amongst self-identified Chinese college students and discovered that students typically had low to moderate awareness and knowledge about HPV.¹¹ However, the Tung et al. study participants included all students who self-identified as Chinese college students, not solely CIS. The purpose of our study was twofold. First, we assessed knowledge and awareness of HPV disease and vaccination amongst CIS in the USA. Second, we collected data on sexual behaviors, and we identified factors, such as healthcare access and behavior, contributing to HPV vaccination practices (or lack thereof) amongst CIS. The results of this study can be used to improve vaccination rates amongst CIS in the USA and to help American healthcare providers learn more about CIS health behaviors.

Materials and methods

Ethical considerations

This study was approved by the Institutional Review Board at a large Southern California university. Participation in the survey was voluntary, and both paper and online participants were presented with an information sheet for non-medical research disclosure prior to surveying.

Survey

A self-administered survey consisting of 25 multiple choice questions was developed based on previously used HPV-related student surveys and the needs of CIS studying at American universities.^{12–16} We collected information on demographics, healthcare activity, sexual activity, HPV vaccination status, and HPV disease and vaccine knowledge and attitudes. Questions were multiple choice, with 2 to 11 possible answers, available in both paper and electronic (Survey Monkey) formats, and surveys typically took 10–15 minutes to complete. Surveys were provided in English and glossaries with Mandarin translations were available for participants. Prior to approval and use, the survey was trialed by the study team's 18 CIS volunteers to ensure clarity and understanding.

Procedure step 1 – recruiting study volunteers

Several months prior to data collection, 18 CIS were recruited via mass e-mail to academic departments to participate in a focus group. Those who were interested in volunteering for the study implementation were recruited as study-team volunteers. This group underwent educational training sessions facilitated by a team of infectious disease medical doctors regarding HPV disease, vaccination, and vaccination opportunities at the Student Health Center (SHC). Importantly, the HPV vaccine is available free of charge at SHC for university students with university-sponsored student health insurance. CIS volunteers who underwent educational training sessions were required to pass a knowledge and competency test designed by the study team by correctly answering at least 26 out of 27 true/false questions regarding HPV disease and vaccination.

Procedure step 2 – data collection and sampling

Eight tabling events were held in April of 2019: four near a popular campus crossing/landmark and four outside of SHC. The events were intended to obtain as large a sample of CIS as possible within a short time span to minimize changes in sample characteristics over time. At these survey and information dissemination events, large-print banners were used to catch the attention of CIS, and CIS who interacted with the study team were asked to participate in the study by filling out a survey. After voluntarily filling out the survey, participants were given the opportunity to share the online version of the survey with other CIS through WeChat and other social forums.

Procedure step 3 – educational infographic dissemination

The study team's volunteers provided participants an educational HPV infographic (Appendix A) after surveying. The educational infographic summarized key information regarding HPV disease, HPV-related cancers and warts, the HPV vaccine, and how to obtain the HPV vaccine at SHC. The educational infographic was double-sided, consisting of English and Mandarin translations. The decision to pursue vaccination was left to participants and there was no further

direct communication between the study team and participants.

Data analysis

Survey data were stored and analyzed using Excel, SPSS, R, and Python. Paper and online surveys were coded either numerically or categorically depending on question type. Unanswered questions were marked as “Decline to Answer.”

Pairwise crosstabs chi-squared tests were run for 18 of the 25 survey questions. Four questions were left out of crosstab analysis due to extreme result distributions: gender identity (Q#3), country/place of origin (Q#4), past personal STI diagnosis (Q#8), and witnessing an HPV/cancer diagnosis (Q#12). Three other questions were left out due to multiple valid answer possibilities: HPV-related cancer knowledge (Q#11), information sources on vaccines (Q#18), and key factors for vaccination (Q#19), as they were designed to elicit information distributions rather than explore relationships.

The following questions were grouped to ensure that at least 80% of expected frequencies were above the usually recommended minimum of 5: age (Q#1), resident years in the USA (Q#5), sexual activity in the last 12 months (Q#6), sexual contact partners in the last 12 months (Q#7), knowledge of the HPV infection rate among the general population (Q#13), perceived likelihood of personal infection (#14), feelings toward personal infection (Q#15), and theoretical willingness to pay for the HPV vaccine (Q#20). When chi-squared tests had more than 20% of expected values below 5 and no further grouping was possible, the *p*-value was found and reported; having over 20% of expected values below 5 does not lead to excess false-positives.¹⁷ For each crosstab pair, individual respondents who declined to answer either question were excluded from the chi-squared test. Given that 153 chi-squared tests were run, a false discovery rate of 5% was set according to the conservative method of Benjamini and Yekutieli.¹⁸ By this procedure, the *p*-values for individual chi-squared tests were ordered from smallest to largest, and tests with *p*-values below the calculated cutoff of 0.00282 were accepted with a false discovery rate of 5%.

Since male and female answer distributions differed greatly in terms of HPV vaccination status and self-perceived HPV knowledge, crosstab chi-squared tests for these variables were also run independently for both sexes.

Paper and online survey data were compared using chi-squared testing. Since the goal was not to reject the null hypothesis, each of the 18 comparisons from the crosstabs was tested against a criterion of $p < .05$.

Multivariate logistic regression was run to find the best combination of variables in predicting HPV vaccination status and self-perceived HPV knowledge. Categorical responses were one-hot encoded, while numeric values were ranked in order. The Synthetic Minority Oversampling Technique (SMOTE) was used to synthesize new entries for classes of output variables that did not have sufficient data.¹⁹ Ninety percent of datasets were fed into logistic regression to train models, and the remaining 10% was used for testing predictions.

Results

Demographic variables (age, sex, country of origin, resident years in USA)

In total, 396 CIS participated in the survey, 300 in paper format and 96 in online format. 212 participants were female and 184 were male (Q#2). A vast majority of participants (94%) were from mainland China (Q#4). All participants were at least 18 years of age, and 83% of survey-takers were under 25 years of age (Q#1). Just over half of the participants (55%) were residents in the USA for under 2 years (Q#5, Table 1).

Paper vs. online surveys

Chi-squared tests were run for paper vs. online surveys against the 18 crosstab variables. Consistent with the null hypothesis, only one difference yielded $p < .05$: online survey-takers were younger than paper survey-takers ($p = .0288$). Paper and online surveys were therefore combined in subsequent analyses.

HPV vaccination status

Sixty-one percent of students reported to be HPV vaccinated, with 85% vaccination among females and 32% among males (Q#9, Table 2). Several factors were correlated to HPV vaccination status in both females and males: SHC visit ($p < .0001$),

Table 1. Demographics.

	n (%)
Q#1: What is your age in years?	
18	14 (3.54)
19	34 (8.59)
20	20 (5.05)
21	30 (7.58)
22	55 (13.89)
23	84 (21.21)
24	90 (22.73)
25	33 (8.33)
26	16 (4.04)
27–32	18 (4.55)
Over 32	2 (0.51)
Q#2: What sex were you assigned at birth?	
Female	212 (53.54)
Male	184 (46.46)
Other	0 (0.00)
Q#3: What is your preferred gender identity?	
Woman	214 (54.04)
Man	181 (45.71)
Trans Man	1 (0.25)
Trans Woman	0 (0.00)
Nonbinary or Genderqueer	0 (0.00)
Questioning	0 (0.00)
Other	0 (0.00)
Q#4: What is your country or place of origin?	
China	374 (94.44)
Hong Kong	10 (2.53)
Taiwan	12 (3.03)
Other, Please Specify:	0 (0.00)
Q#5: How many years have you spent living in the United States?	
Less than 1 year	151 (38.13)
1 year	67 (16.92)
2 years	73 (18.43)
3 years	35 (8.84)
4 or more years	70 (17.68)

theoretical willingness to pay for the HPV vaccine ($p = .0007$), self-perceived HPV knowledge ($p < .0001$), and knowledge of the HPV infection rate among the general population ($p = .0005$; Table 5).

HPV knowledge – self-perceived and knowledge-based questions

Sixteen percent of students reported “no knowledge” regarding HPV, 80% “some,” and only 4% “a great deal.” There were stark differences between males and females, where 30% of males reported “no knowledge,” 67% “some,” and only 3% “a great deal.” For females, 3% reported “no knowledge,” 92% “some,” and 5% “a great deal” (Q#10, Table 2). Overall, females self-reported to have more HPV knowledge than males ($p < .0001$; Table 5).

In terms of knowledge of the HPV infection rate among the general population, 42% of participants responded that they had “no idea,” while only 29% identified that HPV is likely to infect at least half of people over a lifetime (Q#13, Table 2). Between females and males, females correctly identified higher HPV infection rates than males ($p = .0004$; Table 5).

When asked about which groups (males, females, both) are recommended for HPV vaccination, 86% of participants correctly identified that both males and females are recommended for vaccination. Five percent of males incorrectly identified “females only” for recommendation, while 11% of females did so; 10% of males selected “I have no idea” while only 2% of females did so (Q#17, Table 2).

About two-thirds of students identified at least one form of cancer related to HPV; males and females identified HPV as causing cancer at about the same rate (Females: 69%, Males: 67%) (Q#11, Table 2).

Sexual activity, partners, and STIs

Over half of participants were not sexually active in the last 12 months, with 39% of females and 49% of males having engaged in sexual activity (Q#6). Of those who were sexually active, only 5% had more than one partner in the last 12 months, and none had more than five partners (Q#7, Table 4). Sexual activity was found to be significantly correlated with increased resident years in the USA ($p = .0003$; Table 5) for both males and females, and in males only, sexual activity and HPV vaccination status were significantly positively correlated ($p = .0049$).

Ninety-seven percent of participants had no previous STI diagnosis (Q#8, Table 4), and only 7% of students knew anyone who had been diagnosed with HPV or any HPV-related cancers (Q#12, Table 2).

Healthcare interaction

Only 38% of students reported having spoken to a doctor or personal healthcare provider regarding the HPV vaccine (Q#16, Table 2). Females were more likely to have done so when compared to males ($p < .0001$; Table 5).

In terms of student health insurance rates, 77% of participants reported having the university’s student health

Table 2. HPV disease and vaccine knowledge, attitudes, and behavior.

	Male n (%)	Female n (%)	n (%)
<i>Q#9: Have you received the HPV vaccine series, or are you in the process of completing the series?</i>			
Yes	59 (32.07)	181 (85.38)	240 (60.61)
No	118 (64.13)	26 (12.26)	144 (36.36)
I don't know	7 (3.80)	5 (2.36)	12 (3.03)
<i>Q#10: Which option best describes your knowledge of Human Papillomavirus (HPV) and the HPV vaccine?</i>			
No knowledge	56 (30.43)	7 (3.30)	63 (15.91)
Some knowledge	123 (66.85)	194 (91.51)	317 (80.05)
A great deal of knowledge	5 (2.72)	11 (5.19)	16 (4.04)
<i>Q#11: Select all that apply:</i>			
HPV can't cause cancer	44 (23.91)	50 (23.58)	94 (23.74)
HPV can cause cervical cancer	93 (50.54)	108 (50.94)	201 (50.76)
HPV can cause oropharyngeal cancer	59 (32.07)	56 (26.42)	115 (29.04)
HPV can cause anal cancer	61 (33.15)	48 (22.64)	109 (27.53)
HPV can cause vulvar and penile cancers	54 (29.35)	43 (20.28)	97 (24.49)
Decline to Answer	18 (9.78)	17 (8.02)	35 (8.84)
<i>Q#12: Do you know anyone who has been diagnosed with HPV, cervical cancer, or any of the following cancers: throat, vagina, vulva, penis, anus, or rectum?</i>			
Yes	15 (8.15)	11 (5.19)	26 (6.57)
No	141 (76.63)	160 (75.47)	301 (76.01)
I don't know	28 (15.22)	40 (18.87)	68 (17.17)
Decline to Answer	0 (0.00)	1 (0.47)	1 (0.25)
<i>Q#13: How common is HPV?</i>			
So common that nearly everyone will be infected with HPV at some point in their lives	21 (11.41)	38 (17.92)	59 (14.90)
About half of all people will be infected with HPV at some point in their lives	17 (9.24)	39 (18.40)	56 (14.14)
About one-quarter of all people will be infected with HPV at some point in their lives	31 (16.85)	47 (22.17)	78 (19.70)
Less than 1%	18 (9.78)	15 (7.08)	33 (8.33)
I have no idea	95 (51.63)	73 (34.43)	168 (42.42)
Decline to Answer	2 (1.09)	0 (0.00)	2 (0.51)
<i>Q#14: How likely do you believe you are to acquire HPV?</i>			
Extremely Likely	13 (7.07)	32 (15.09)	45 (11.36)
Very Likely	12 (6.52)	21 (9.91)	33 (8.33)
Likely	42 (22.83)	51 (24.06)	93 (23.48)
Unlikely	84 (45.65)	89 (41.98)	173 (43.69)
Impossible	33 (17.93)	19 (8.96)	52 (13.13)
<i>Q#15: Which of the following best describes your feelings if you were to acquire HPV (which can lead to increased risk of cancer and genital warts)?</i>			
Worst thing that could happen	44 (23.91)	50 (23.58)	94 (23.74)
Extremely upset	69 (37.50)	98 (46.23)	167 (42.17)
Somewhat upset	52 (28.26)	41 (19.34)	93 (23.48)
Not at all upset	19 (10.33)	22 (10.38)	41 (10.35)
Decline to Answer	0 (0.00)	1 (0.47)	1 (0.25)
<i>Q#16: Has your doctor or other healthcare provider ever spoken to you about the HPV vaccine?</i>			
Yes	48 (26.09)	104 (49.06)	152 (38.38)
No	125 (67.93)	98 (46.23)	223 (56.31)
I don't know	10 (5.43)	10 (4.72)	20 (5.05)
Decline to Answer	1 (0.54)	0 (0.00)	1 (0.25)
<i>Q#17: What groups of people is the HPV vaccine recommended for?</i>			
Females only	9 (4.89)	23 (10.85)	32 (8.08)

(Continued)

Table 2. (Continued).

Males only	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)
Both females and males	156 (84.78)	185 (87.26)	341 (86.11)	341 (86.11)
I have no idea	19 (10.33)	4 (1.89)	23 (5.81)	23 (5.81)
<i>Q#20: How much money would you hypothetically be willing to pay for the HPV vaccine series (recommended as 3 doses for those older than 15 years of age, the cost is approximately \$150/dose)?</i>				
\$0	32 (17.39)	17 (8.02)	49 (12.37)	49 (12.37)
\$1 - \$150	94 (51.09)	81 (38.21)	175 (44.19)	175 (44.19)
\$150 to \$450	49 (26.63)	89 (41.98)	138 (34.85)	138 (34.85)
>\$450	9 (4.89)	25 (11.79)	34 (8.59)	34 (8.59)
<i>Q#24: If the HPV vaccine was presented to you now, would you be interested in acquiring it free of charge?</i>				
Yes	167 (90.76)	203 (95.75)	370 (93.43)	370 (93.43)
No	17 (9.24)	9 (4.25)	26 (6.57)	26 (6.57)
<i>Q#25: Did you know that you can get the HPV vaccine at the Engemann Student Health Center or Eric Cohen Student Health Center free of charge with Aetna Student Health Insurance?</i>				
Yes	148 (80.43)	195 (91.98)	343 (86.62)	343 (86.62)
No	36 (19.57)	17 (8.02)	53 (13.38)	53 (13.38)

Table 3. Healthcare and vaccination attitudes and history.

	n (%)
<i>Q#18: What is the most common information source on health and vaccines for you?</i>	
Family and Friends	209 (52.78)
Personal Healthcare Provider	66 (16.67)
Social Media	134 (33.84)
Other	11 (2.78)
Decline to Answer	0 (0.00)
<i>Q#19: Which of the following factors would most determine whether or not you were going to get a certain vaccine?</i>	
Time and Accessibility	134 (33.84)
Family Values	18 (4.55)
Cost	48 (12.12)
Safety Concerns	176 (44.44)
Vaccine Effectiveness	82 (20.71)
<i>Q#21: Have you visited a medical provider in the United States outside of the Engemann Student Health Center or Eric Cohen Student Health Center?</i>	
Yes	147 (37.12)
No	248 (62.63)
Decline to Answer	1 (0.25)
<i>Q#22: Do you have Aetna Student Health Insurance through USC?</i>	
Yes	306 (77.27)
No	90 (22.73)
<i>Q#23: Have you visited the Engemann Student Health Center or Eric Cohen Student Health Center?</i>	
Yes	334 (84.34)
No	62 (15.66)

insurance, and rates were similar between males and females (Q#22). About 85% of participants indicated that they had visited SHC at least once in the past (Q#23). On the other hand, under 40% had visited a medical provider in the USA outside of SHC (Q#21, Table 3).

Vaccination factors, willingness, payment, and acknowledgment

Forty-three percent of participants identified their perceived likelihood of personal infection as “extremely likely,” “very likely,” or “likely” (Q#14). In regard to one’s reaction to personally being infected by HPV, about two-thirds of students said that it would be the “worst thing that could happen” or that they would be “extremely upset” (Q#15, Table 2). A higher perceived likelihood of personal infection was significantly correlated to more negative feelings in regard to a personal HPV infection ($p < .0001$; Table 5).

About half of students cited “Family and Friends” as a principal source of health and vaccine information, and another 32% cited “Social Media,” while only 15% cited their “Personal Healthcare Provider” (Q#18). In terms of key factors in determining to be vaccinated, 40% of participants noted “Safety,” 31% “Time and Accessibility,” and 16% “Effectiveness”; only 10% cited “Cost” and 4% cited “Family Values” (Q#19, Table 3).

In terms of willingness to pay for the HPV vaccine, only 12% of students expressed unwillingness to pay anything, while 44% were willing to pay up to 150 USD and 43% were willing to pay more than 150 USD (Q#20, Table 2).

Eighty-seven percent of participants acknowledged that they were aware of the HPV vaccine’s availability at SHC (Q#25). Moreover, when asked regarding their theoretical willingness to receive the HPV vaccine for free at the time of surveying, 93% of students expressed their theoretical willingness to be vaccinated (Q#24, Table 2).

Table 4. Sexual activity and sexual history.

	n (%)
<i>Q#6: Select all that apply:</i>	
I have had intercourse in the last 12 months	100 (25.25)
I have had oral sex in the last 12 months	52 (13.13)
I have had anal sex in the last 12 months	8 (2.02)
I have had sexual contact in the last 12 months	100 (25.25)
I have had no sexual contact in the last 12 months	219 (55.30)
<i>Q#7: How many sexual partners have you had in the last 12 months?</i>	
0 Partners	215 (54.29)
1 Partner	158 (39.90)
2–5 Partners	21 (5.30)
More than 5 Partners	0 (0.00)
Decline to Answer/Inconsistent Responses	2 (0.51)
<i>Q#8: Have you been diagnosed with a sexually transmitted disease (STD) like chlamydia, gonorrhea, syphilis, or HPV, in the past?</i>	
Yes	9 (2.27)
No	383 (96.72)
Prefer not to say	4 (1.01)

Table 5. Significant chi-square analysis results following conservative correction.

Variable 1	Variable 2	p-value
Q#2: Sex	Q#9: HPV Vaccination Status	<0.0001
Q#2: Sex	Q#10: Self-Perceived HPV Knowledge	<0.0001
Q#2: Sex	Q#13: Knowledge of HPV Infection Rate	0.0004
Q#2: Sex	Q#16: Spoken to Doctor Regarding HPV Vaccine	<0.0001
Q#2: Sex	Q#20: Willingness to Pay for HPV Vaccine	<0.0001
Q#5: Resident Years in USA	Q#6: Sexual Activity	0.0003
Q#5: Resident Years in USA	Q#7: Number of Sex Partners in Past 12 Months	<0.0001
Q#9: HPV Vaccination Status	Q#10: Self-Perceived HPV Knowledge	<0.0001
Q#9: HPV Vaccination Status	Q#13: Knowledge of HPV Infection Rate	0.0005
Q#9: HPV Vaccination Status	Q#20: Willingness to Pay for HPV Vaccine	0.0007
Q#9: HPV Vaccination Status	Q#23: Past Student Health Center Visit	<0.0001
Q#14: Perceived Likelihood of Personal HPV Infection	Q#15: Feelings Toward Personal HPV Infection	<0.0001

Regression analysis for HPV vaccination status and self-perceived HPV knowledge

Regression analysis determined that sex, past SHC visit, and university-sponsored student health insurance status were the best factors in predicting HPV vaccination (Pseudo $R^2 = 0.335$). Females were about three times more likely than males to be vaccinated (coef. = 2.9742), CIS with a past SHC visit were about twice as likely to be vaccinated (coef. = 1.8946), and participants with student health insurance were about 75% more likely to be vaccinated. In terms of sex, a student health insured female with an SHC visit has ~90% predicted chance of vaccination, a non-student health-insured female with an SHC visit has ~81% predicted chance of vaccination, and a non-student health-insured female with no past SHC visit has only a ~39% predicted chance of HPV vaccination. Males were much less likely to be vaccinated. A student health-insured male with an SHC visit has ~31% predicted chance of vaccination, a non-student health-insured male with an SHC visit has ~18% predicted chance of vaccination, and a non-student health-insured male with no past SHC visit has only a ~3% predicted chance of HPV vaccination (Table 6).

Regression analysis used to predict self-perceived HPV knowledge found that HPV vaccination status and perceived likelihood of personal infection were the best predictors (Pseudo $R^2 = 0.283$). HPV vaccination status had more than twice as great an influence on predicting self-perceived HPV knowledge than perceived likelihood of personal infection. Those with HPV vaccination were 2.7 times more likely to have indicated “some” or “a great deal” of HPV knowledge (Table 7).

Discussion

This study is the first to quantitatively measure HPV disease and vaccination knowledge and attitudes, healthcare experience and behaviors, and sexual activity of CIS in the USA. Tung et al. studied similar topics among Chinese students in the USA, but the study did not distinguish between CIS and Chinese American students, nor did the study collect data on sexual activity and healthcare engagement and behaviors.¹¹

Since the HPV vaccine was approved in China four years ago, and due to limited vaccine availability, vaccination rates among Chinese students in China remain quite low. Even among those with high levels of healthcare access, such as Chinese medical students, rates of HPV vaccination are approximately 45% in females and 2% in males.¹⁴ In terms of self-identified Chinese students in the USA, Tung et al. reported a 38% HPV vaccination rate in the Nevada area, with a significant difference between female and male vaccination rates, 55% and 15%, respectively.¹¹ The HPV vaccination rate of 61% (Females: 85%, Males: 32%) reported in this study is much higher than that reported for both college students in China and for self-identified Chinese students in the USA, and the large difference in male and female HPV vaccination rates reflects trends in both the USA and China.^{12–15}

Regression analysis found that the optimal predictors for HPV vaccination were sex, past SHC visit, and student health insurance status. The high vaccination rate among CIS in this study is likely due in part to HPV vaccine availability at SHC,

Table 6. Multivariate regression of HPV vaccination status (Q#9) by sex (Q#2), university-sponsored student health insurance status (Q#22), and past student health center visit (Q#23).

	Coefficient	Standard Error	z-value	Pr(> z)	[95% Conf. Int.]		
Constant	-3.4291	0.4536	-7.5599	0.0000	-4.3181	-2.5400	
Q#2: Sex	2.9742	0.2735	10.8730	0.0000	2.4381	3.5104	
Q#22: University-Sponsored Student Health Insurance Status	0.7508	0.2950	2.5457	0.0109	0.1728	1.3289	
Q#23: Past Student Health Center Visit	1.8946	0.3779	5.0131	0.0000	1.1539	2.6354	
Model Summary	No. Observations	Df Model	Df Residual	Pseudo R^2	Log-Likelihood	LL Null	LLR p-value
	434	3	430	0.335	-200.17	-300.83	2.21×10^{-43}

Table 7. Multivariate regression of HPV knowledge (Q#10) by HPV vaccination status (Q#9) and perceived likelihood of personal HPV infection (Q#14).

	Coefficient	Standard Error	z-value	Pr(> z)	[95% Conf. Int.]		
Constant	1.5032	0.1585	9.4815	0.0000	1.1925	1.8140	
Q#9: HPV Vaccination Status	-2.6993	0.2172	-12.4304	0.0000	-3.1249	-2.2737	
Q#14: Perceived Likelihood of Personal HPV Infection	-1.2027	0.2201	-5.4650	0.0000	-1.6340	-0.7714	
Model Summary	No. Observations	Df Model	Df Residual	Pseudo R ²	Log-Likelihood	LL Null	LLR p-value
	592	2	589	0.283	-294.23	-410.34	3.73*10 ⁻⁵¹

which is free of charge for those with university-sponsored student health insurance. Healthcare engagement findings indicated that three-fourths of participants had university-sponsored student health insurance, and two-thirds of participants used only SHC for healthcare access, indicating the importance of SHC to CIS health and vaccination. Moreover, over 85% of participants acknowledged their awareness of the vaccine's availability at SHC, and this awareness of the vaccine's availability is likely a key factor in its high uptake rate at the university.

In both males and females, pay willingness and HPV knowledge (both self-perceived and knowledge regarding HPV infection among the general population) were significantly correlated with HPV vaccination status.

The issue of cost is noted as a central barrier to HPV vaccination in both China and the USA, and the study's findings further illustrate the trend that those with the highest willingness for vaccination also express a higher willingness to pay to acquire the HPV vaccine.^{14,20-22} Females were significantly more willing to pay than males, which likely relates to higher HPV vaccination rates among females. Moreover, when students were asked regarding their theoretical willingness to obtain the HPV vaccine if it were presented to them free of charge, over nine in ten indicated that they would opt for vaccination, conveying the draw of no-cost vaccination. Since this was one of the last questions asked on the survey, it is probable that students may have been positively influenced by the survey to receive the vaccination.

In this study, participants with higher self-perceived HPV knowledge were more likely to be vaccinated. Regression analysis found the best predictors for self-perceived HPV knowledge were HPV vaccination status and perceived likelihood of personal infection, which is similar to previous reports on the relationship between knowledge and vaccination rates.^{13,14,20,21} Moreover, the observed lower levels of self-perceived HPV knowledge among males could help explain their lower vaccination rates compared to females.

For male participants in particular, reported HPV vaccination was over three times higher for those who had discussions with a primary healthcare provider regarding HPV, further supporting the importance of strong healthcare provider recommendations for male CIS.²²⁻²⁵

Among males, self-reported sexual activity significantly correlated with HPV vaccination status. It is possible that males who are sexually active perceive their risk of contracting HPV as higher, and thus seek out vaccination; according to Liu et al., one common reason for not being vaccinated is low perceived risk due to sexual inactivity.¹⁴ Interestingly, in our study, perceived likelihood of HPV

infection did not significantly correlate with self-reported sexual activity, possibly suggesting that sexual activity may have been under-reported.

Similar to previous observations, females were more likely to identify higher personal likelihood of HPV infection. However, unlike previous studies that have shown that females have more negative feelings toward getting infected with HPV, our observations found no significant difference between males and females in this regard.^{12,24}

In our study, participants placed a large focus on "Family and Friends" and "Social Media" for health and vaccine information, and key factors influencing vaccination were "Safety," "Time and Accessibility," "Effectiveness," "Cost," and "Family Values," in that order. Cheung et al. found a similar trend of safety concerns among Chinese college students, and Liu et al. found that safety concerns were a major barrier to HPV vaccination.^{12,14} These findings support the importance of education regarding the safety and efficacy of the HPV vaccine in increasing HPV vaccination rates among CIS.

In this study, CIS reported low levels of sexual activity. Chi et al. reported that approximately 13% of university students in China reported having premarital intercourse or oral sex.²⁶ Chen et al. found that, among female college students in China, about 80% had no sexual partners in the last year, and under 10% had two or more sexual partners,²⁷ and Yan et al. found that only about 18% of Chinese female college students have had sex.²⁸ CIS sexual activity rates reported here are similar to those in China and are significantly lower than sexual activity trends among college students in the USA.²⁹

Participants also reported very low levels of STI diagnosis, with less than 3% having been diagnosed with an STI in the past. These findings are similar to those by Dangui et al. where ~3% of sexually active Chinese university students had a previous STI diagnosis but lower than those by Chen et al. who observed that 8% of Chinese females had a previous STI diagnosis.^{27,30}

The study had several limitations. Since the study took place at a well-known and large research institution, the study population may not be representative of the general CIS population in the USA. Furthermore, we did not confirm the self-reported HPV vaccination rate with that in the medical records, nor did we ask regarding the number of doses of the HPV vaccine taken. Both paper and online survey response rates were not collected and thus cannot be reported. Knowledge questions were initially planned to be indexed together to form a knowledge score; however, due to extreme answer distributions and high levels of unsure and decline to answers, this was not an effective technique to measure knowledge. Finally, it is possible that a preexisting relationship between CIS volunteers and study participants may have influenced participants'

answers to the survey; however, the survey was anonymous, which makes this less likely.

Strengths of the study include a large data set of 396 CIS at a university with a very large CIS population. Data were collected by the study team with the help of CIS volunteers, allowing peer-to-peer interaction and notably higher comfort among participants. After collecting the surveys, we provided an educational infographic on HPV disease and vaccination hoping to increase CIS knowledge and awareness; however, the effectiveness of this infographic was not a part of this research study (Appendix A).

Future studies may focus on more diverse populations of CIS and non-Chinese international students. More data may be collected on the differences in vaccination trends between universities and the influence of university health policies on CIS vaccination rates. In addition, there is a need for data on the potential effect of the COVID-19 pandemic on CIS HPV vaccination knowledge, attitudes, and uptake, as there may be a decrease in HPV vaccination due to the effects of the pandemic.

In conclusion, our findings give a clearer picture of CIS health behaviors in the USA and may inform policy decisions as well as public awareness campaigns that aim to boost HPV vaccination rates amongst CIS. Furthermore, our insights can help healthcare providers frame discussions surrounding the potential for HPV vaccine catch-up when treating CIS patients.

Acknowledgments

The authors would like to thank Dr. Eric Holman for advice in statistical analysis. The authors would also like to thank Alicia Burnett, RN., and Dr. Mildred Wenger of USC Student Health for their help in forming several aspects of the research project.

Disclosure of potential conflicts of interest

No potential conflicts of interest were disclosed.

Funding

This work was supported by MiOra public health education nonprofit and the USC Student Health Department.

ORCID

Aaron Esagoff  <http://orcid.org/0000-0001-8433-5091>
 Samuel A. Cohen  <http://orcid.org/0000-0002-8816-5015>
 Sarah Van Orman  <http://orcid.org/0000-0002-4988-9803>

References

- Centers for Disease Control and Prevention. Genital HPV infection - CDC fact sheet. Washington (DC); 2017 Jul [accessed 2020 July 15]. <https://www.cdc.gov/std/hpv/HPV-FS-July-2017.pdf>
- de Martel C, Plummer M, Vignat J, Franceschi S. Worldwide burden of cancer attributable to HPV by site, country and HPV type. *Int J Cancer*. 2017 Aug 15;141(4):664–70. doi:10.1002/ijc.30716.
- Centers for Disease Control and Prevention. STD Facts - Human papillomavirus (HPV). Washington (DC); 2019 May 24 [accessed 2020 Aug 14]. <https://www.cdc.gov/std/hpv/stdfact-hpv.htm>
- Printz C. HPV vaccination rates remain low: cancer prevention community needs to continue promoting the vaccine's safety and efficacy, say experts. *Cancer*. 2015;121(9):1341–43. doi:10.1002/cncr.28993.
- Yu Y, Xu M, Sun J, Li R, Li M, Wang J, Zhang D, Xu A. Human papillomavirus infection and vaccination: awareness and knowledge of HPV and acceptability of HPV vaccine among mothers of teenage daughters in Weihai, Shandong, China. *PLoS One*. 2016;11(1):e0146741. doi:10.1371/journal.pone.0146741.
- Chang IJ, Huang R, He W, Zhang S-K, Wang S-M, Zhao F-H, Smith JS, Qiao Y-L. 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(1):916. doi:10.1186/1471-2458-13-916.
- Yin Y. HPV vaccination in China needs to be more cost-effective. *Lancet*. 2017;390(10104):1735–36. doi:10.1016/S0140-6736(17)32606-5.
- Li SL, Lau YL, Lam TH, Yip PSF, Fan SYS, Ip P. HPV vaccination in Hong Kong: uptake and reasons for non-vaccination amongst Chinese adolescent girls. *Vaccine*. 2013;31(49):5785–88. doi:10.1016/j.vaccine.2013.10.027.
- Batalova J, Zong J Migration policy institute. International students in the United States; 2018 May 8 [accessed 2020 Aug 16]. <https://www.migrationpolicy.org/article/international-students-united-states-2017>
- Meites E, Kempe A, Markowitz LE Centers for disease control and prevention. Use of a 2-dose schedule for human papillomavirus vaccination — updated recommendations of the advisory committee on immunization practices. Washington (DC); 2016 Dec 16 [accessed 2020 Aug 10]. <https://www.cdc.gov/mmwr/volumes/65/wr/mm6549a5.htm>
- Tung W-C, Lu M, Qiu X, Ervin S. Human papillomavirus knowledge, attitudes, and vaccination among Chinese college students in the United States. *Vaccine*. 2019;37(24):3199–204. doi:10.1016/j.vaccine.2019.04.084.
- Cheung T, Lau JTF, Wang JZ, Mo PKH, Ho YS. Acceptability of HPV vaccines and associations with perceptions related to HPV and HPV vaccines among male baccalaureate students in Hong Kong. *PLoS One*. 2018;13(6):e0198615. doi:10.1371/journal.pone.0198615.
- Kellogg C, Shu J, Arroyo A, Dinh NT, Wade N, Sanchez E, Equils O. A significant portion of college students are not aware of HPV disease and HPV vaccine recommendations. *Hum Vaccin Immunother*. 2019;15:1760–66. doi:10.1080/21645515.2019.1627819.
- Liu A, Ho FK, Chan LK, Ng JY, Li SL, Chan GC, Leung TF, Ip P. Chinese medical students' knowledge, attitude and practice towards human papillomavirus vaccination and their intention to recommend the vaccine. *J Paediatr Child Health*. 2018;54(3):302–10. doi:10.1111/jpc.13693.
- Wang S-M, Zhang S-K, Pan X-F, Ren Z-F, Yang C-X, Wang -Z-Z, Gao X-H, Li M, Zheng Q-Q, Ma W, et al. Human papillomavirus vaccine awareness, acceptability, and decision-making factors among Chinese college students. *Asian Pac J Cancer Prev*. 2014;15(7):3239–45. doi:10.7314/apjcp.2014.15.7.3239.
- Thomas TL, Dalmida S, Higgins M. The student human papillomavirus survey: nurse led instrument development and psychometric testing to increase HPV vaccine series completion in young adults. *J Nurs Meas*. 2016;24(2):226–44. doi:10.1891/1061-3749.24.2.226.
- Bradley DR, Bradley TD, McGrath SG, Cutcomb SD. Type I error rate of the chi-square test in independence in R × C tables that have small expected frequencies. *Psychol Bull*. 1979;86(6):1290–97. doi:10.1037/0033-2909.86.6.1290.
- Benjamini Y, Yekutieli D. The control of the false discovery rate in multiple testing under dependency. *Ann Stat*. 2001;29(4):1165–88. doi:10.1214/aos/1013699998.
- Fernandez A, Garcia S, Herrera F, Chawla NV. SMOTE for learning from imbalanced data: progress and challenges, marking the 15-year anniversary. *J Artif Intell Res*. 2018;61:863–905. doi:10.1613/jair.1.11192.


20. Mathur MB, Mathur VS, Reichling DB. Participation in the decision to become vaccinated against human papillomavirus by California high school girls and the predictors of vaccine status. *J Pediatr Health Care*. 2010;24(1):14–24. doi:10.1016/j.pedhc.2008.11.004.
21. Kops NL, Hohenberger GF, Bessel M, Correia Horvath JD, Domingues C, Kalume Maranhão AG, Alves de Souza FM, Benzaken A, Pereira GF, Wendland EM. Knowledge about HPV and vaccination among young adult men and women: results of a national survey. *Papillomavirus Res*. 2019;7:123–28. doi:10.1016/j.pvr.2019.03.003.
22. Bynum SA, Brandt HM, Friedman DB, Annang L, Tanner A. Knowledge, beliefs, and behaviors: examining human papillomavirus-related gender differences among African American college students. *J Am Coll Health*. 2011;59(4):296–302. doi:10.1080/07448481.2010.503725.
23. Preston SM, Darrow WW. Are men being left behind (Or Catching Up)? Differences in HPV awareness, knowledge, and attitudes between diverse college men and women. *Am J Mens Health*. 2019;13(6):1557988319883776. doi:10.1177/1557988319883776.
24. Katz ML, Krieger JL, Roberto AJ. Human papillomavirus (HPV): college male's knowledge, perceived risk, sources of information, vaccine barriers and communication. *J Mens Health*. 2011;8(3):175–84. doi:10.1016/j.jomh.2011.04.002.
25. Gilkey MB, McRee A-L. Provider communication about HPV vaccination: A systematic review. *Hum Vaccin Immunother*. 2016;12:1454–68. doi:10.1080/21645515.2015.1129090.
26. Chi X, Yu L, Winter S. Prevalence and correlates of sexual behaviors among university students: a study in Hefei, China. *BMC Public Health*. 2012;12:972. doi:10.1186/1471-2458-12-972.
27. Chen M, Liao Y, Liu J, Fang W, Hong N, Ye X, Li J, Tang Q, Pan W, Liao W. Comparison of sexual knowledge, attitude, and behavior between Female Chinese college students from urban areas and rural areas: A hidden challenge for HIV/AIDS control in China. *Biomed Res Int*. 2016;8175921. doi:10.1155/2016/8175921.
28. Yan H, Chen W, Wu H, Bi Y, Zhang M, Li S, Braun KL. Multiple sex partner behavior in female undergraduate students in China: A multi-campus survey. *BMC Public Health*. 2009;9(1):305. doi:10.1186/1471-2458-9-305.
29. American College Health Association National College Health Assessment. Undergraduate reference group executive summary, Spring 2019; 2019 [accessed 2020 Aug 1]. https://www.acha.org/documents/ncha/NCHA-II_SPRING_2019_UNDERGRADUATE_REFERENCE%20GROUP_EXECUTIVE_SUMMARY.pdf
30. Dangui Z, Pan H, Cui B, Law F, Farrar J, Ba-Thein W. Sexual behaviors and awareness of sexually transmitted infections among Chinese university students. *J Infect Dev Countr*. 2013;7:966–74. doi:10.3855/jidc.3872.

Appendix A. Educational Infographic

HUMAN PAPILOMAVIRUS

USC Student Health

<h2 style="margin: 0;">HUMAN PAPILOMA-VIRUS (HPV)</h2>	<ul style="list-style-type: none"> HPV is one of the most common sexually transmitted infections in the world. HPV is a viral infection that spreads through sexual activity. HPV can be transmitted even when no symptoms are present. There are more than 100 strains of HPV.
<h2 style="margin: 0;">CANCER AND WARTS</h2>	<ul style="list-style-type: none"> Strains of HPV are associated with several types of cancer, including those of the cervix, throat, anus, vulva, and penis. Cervical cancer is the fourth most common cancer in women worldwide. HPV infections can lead to genital warts in both males and females.
<h2 style="margin: 0;">HPV VACCINE</h2>	<ul style="list-style-type: none"> The Gardasil 9 Vaccine prevents infection with 9 strains of HPV most associated with cancer and warts. The HPV vaccine is safe and efficient in both men and women. Vaccination is recommended through 21 years of age for men and through 26 years of age for women and men who have sex with men or are transgender.
<h2 style="margin: 0;">HOW TO GET YOUR VACCINE</h2>	<ul style="list-style-type: none"> The HPV vaccine is provided at Engemann Student Health Center at UPC or Eric Cohen Student Health Center at HSC. The vaccine is fully covered for students with Aetna Student Health Insurance. To schedule an appointment, call (213) 740-9355 or visit usc.edu/myshr.



USC Student Health
Keck Medicine of USC

人乳头瘤病毒

U SC 学生健康

人乳头瘤病毒 (HPV)

- HPV 是全球最常见的性传播感染之一。
- HPV 是一种通过性行为传播的病毒感染。
- HPV 甚至可以在毫无症状的情况下传播。
- 目前有超过 100 种 HPV 型别。

癌症和疣

- 有些 HPV 型别与多种癌症有关，包括宫颈癌、咽喉癌、肛门癌、外阴癌和阴茎癌。
- 宫颈癌是全球女性的第四大癌症。
- HPV 感染可导致男性和女性出现生殖器疣。

HPV 疫苗

- 佳达修 9 疫苗可预防与癌症和疣最密切相关的 9 种 HPV 型别感染。
- 该 HPV 疫苗对男性和女性均安全有效。
- 建议男性在 21 岁之前 (含)、女性以及有同性性行为的男性或者跨性别人士在 26 岁之前 (含) 进行疫苗接种。

如何获得疫苗

- HPV 疫苗在 UPC 的 Engemann 学生健康中心和 HSC 的 Eric Cohen 学生健康中心提供。
- 对于购买 Aetna 学生健康保险的学生，该疫苗属全额承保范畴。
- 如需安排预约，请致电 (213) 740-9355，或浏览 usc.edu/mySHR/

MiORA

USC Student Health
Keck Medicine of USC