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Application of the Health Belief Model to Understand the Factors Associated with Chinese International Students' HPV Vaccine Uptake

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Abstract: Guided by the Health Belief Model (HBM), this cross-sectional quantitative study investigated the relationship between key factors and HPV vaccine uptake among Chinese international students (CISs). The sample consisted of 105 CISs attending a southwestern U.S. public university. Participants completed English or Chinese surveys consisting of questions about HPV vaccination status, sociodemographics, perceived risks, facilitators, barriers, knowledge, and cultural beliefs about HPV and HPV vaccination. Findings showed that being female, receiving HPV education, and perceiving higher risks of contracting HPV were associated with receiving at least one dose of HPV vaccination among CISs. Given the current suboptimal HPV vaccination rate among CISs, universities might consider enhancing accessibility to HPV education, making it more inclusive and sex-neutral, and addressing the high risks of HPV infection to encourage their vaccination.

Keywords: HPV; vaccination; Chinese international students; health belief model

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1. Introduction

The papillomavirus (HPV) can cause several health problems, including genital warts and cancer of the cervix, vulva, vagina, penis, anus, and oropharynx (Centers for Disease Control and Prevention, 2023). Significantly, an estimated 91% of cervical cancers, over 70% of vaginal and vulvar cancers and penile cancers are caused by HPV (Centers for Disease Control and Prevention, 2022). China reported 110,000 new cases of cervical cancer and 59,000 related deaths, making it the country with the second-highest burden of cervical cancer globally (Sung et al., 2021). HPV vaccines have been one of the most important approaches to preventing HPV-related diseases, including cervical cancer (World Health Organization, 2022). Mainland China first approved the use of Cervarix and Gardasil-9 vaccines (Merck) in 2016 and 2017, respectively (Yuan & Qiu, 2018). Women in China between the ages of 9 and 45 have access to the bivalent vaccine (Cervarix), and Gardasil 9 is only available for women aged 16–26 (Bai et al., 2022). Currently, HPV vaccine distribution faces several challenges in China, including the age and sex restrictions to HPV vaccination indicated above, the severe shortage of domestically produced HPV vaccines, and the high prices of imported vaccines (Wong et al., 2019).

To date, Chinese international students (CISs) make up the largest international student body in the U. S. (Institute of International Education, 2021). Being in the U.S., where the cost of HPV vaccination is fully covered by most insurance, and the supply of HPV vaccine is relatively sufficient, provides CISs with a great opportunity to catch

up on HPV vaccination. CISs, however, face multiple complex and unique challenges. Many international students have limited knowledge of their health insurance options, limited access to healthcare services, or even intentionally delayed healthcare (Adegboyega et al., 2020; Jang, 2021). Only 38.3% of CISs in the U.S. received at least one dose of the HPV vaccine due to a low-to-moderate level of awareness and knowledge of HPV and the vaccine and low susceptibility to contracting HPV (Tung et al., 2019). Factors contributing to CIS' HPV vaccine uptake included cultural identity, stigma, and concerns about safety. For example, CISs with higher Asian identification were less likely to receive an HPV vaccine than those with high Western identification, possibly due to the higher fear of communicating with U.S. healthcare providers, uncertainty about whether a "western-developed" vaccine would be suitable for Chinese people (Tung et al., 2021), and stigma about HPV infection (Gao et al., 2016). Given the high incidence rate of cervical cancer, the low vaccination rate in the Chinese population, and the big presence of CISs in American colleges, it is imperative to empirically examine the key factors associated with CISs' HPV vaccine uptake to develop effective, evidence-based strategies to increase their vaccination rates and reduce the burden of HPV-related diseases including cancers.

Originally developed to predict health-related behaviors (Rosenstock, 1974), the Health Belief Model (HBM) incorporates constructs like perceived risks, which assess an individual's belief about their susceptibility to a health issue; perceived facilitators, which involve external cues and resources encouraging health actions; and perceived barriers, which represent obstacles to taking recommended actions. The model also accounts for sociodemographic and structural factors, such as sex and culture, which can shape perceptions of risks and benefits. A wealth of research has explored factors influencing HPV vaccination decisions using different theoretical models. Among these, the HBM has emerged as the most commonly applied model to investigate HPV vaccination behaviors (Sacca et al., 2023). A study conducted among young women suggested that constructs within the HBM (perceived susceptibility, severity, benefits, barriers, facilitators) can explain 43% of the variance in HPV vaccine uptake through increased HPV vaccination intention (Gerend & Shepherd, 2012). A scoping review suggested that in the HBM, high perceived risks of contracting HPV infection and HPV vaccines' protection from cancer are the most influential factors associated with HPV vaccine uptake among adults under the age of 45 (Oyedeji et al., 2024). A systematic review of studies exploring the relationship between HBM constructs and HPV vaccine acceptability indicated that, among young adults, a higher perceived likelihood of contracting HPV (i.e., perceived risk), greater perceived effectiveness of HPV vaccines, and obtaining recommendations from physicians (i.e., cues to action) were associated with higher HPV vaccine acceptability (Brewer & Fazekas, 2007). While extensively used to study HPV preventative behaviors, limited research has applied the HBM to investigate factors associated with the HPV vaccination among Chinese international students (CISs). Given CISs' unique experiences and challenges, it is likely that the relationships between HBM constructs, and HPV vaccine uptake differ for this population.

2. Current Research

This cross-sectional quantitative study aimed to (1) examine how constructs in the HBM and other key factors (biological sex, prior HPV education, knowledge, cultural beliefs) are associated with HPV vaccination uptake among CISs and (2) investigate whether the effect of CISs' perceived risks of obtaining HPV is moderated by prior HPV education or biological sex. We hypothesized that female CISs who had received HPV education and perceived higher risks of contracting HPV infection were more likely to receive the HPV vaccine. Additionally, we hypothesized that the effect of perceived risks of contracting

HPV is moderated by HPV education or biological sex. The findings of this study can help identify the most influential factors in CISs' vaccine uptake, allowing for targeted interventions.

3. Methods

3.1. Design, Participants, and Sampling

This study was approved by the institutional review board of the hosting university. This study involved a nonexperimental, cross-sectional design. Purposive sampling was used to recruit eligible participants from a southwestern U.S. public university through flyers distributed by the Chinese Students and Scholars Association (CSSA). Chinese international students who (1) were 18 and over; (2) read and wrote in English or Chinese; and (3) provided consent were eligible to participate. Individuals were excluded if they did not meet the inclusion criteria listed above.

3.2. Data Collection

Individuals interested in participating could access a screening form via a QR code and a survey link included on the flyer. Eligible participants were redirected to a separate, external link leading to an online survey on REDCap (Harris et al., 2009) after providing consent. The survey included questions on sociodemographic characteristics, HPV vaccination status, prior HPV education, HPV-related knowledge, perceived risks, perceived facilitators, perceived barriers, and cultural beliefs about HPV. Each participant received a USD 10 e-gift card as compensation sent to their email address after completion. All study materials were available in both Chinese and English.

3.3. Measures

All measures in this study were adapted from prior research (A. C. C. Chen et al., 2017, 2019, 2021; Rambout et al., 2014) and found to be reliable and valid (see Supplementary Materials).

Sociodemographic. sociodemographic characteristics, including age, biological sex (male and female), college program (undergraduate and graduate), and major (nursing, health-related but not nursing, non-health related), were used to describe the sample characteristics.

HPV vaccine uptake. HPV vaccine uptake was measured with one item (yes/no), "Have you received any HPV vaccines?". Those who received at least one dose of HPV vaccines responded yes to the item.

Prior HPV education. Prior HPV education was measured with one yes/no item: "Have you received any HPV-related education?". Those who had received HPV education prior to the survey responded yes to this item.

Lower perceived risks of contracting HPV. Participants responded whether they agreed or disagreed with five statements about personal characteristics or situations that put them at lower risk of obtaining HPV using nine true/false items (i.e., "I am not sexually active, so I do not need HPV vaccine"). "True" responses were coded as 1, and "False" responses were coded as 0. Perceived risk scores were calculated using the sum of responses (range: 0–5). A higher score indicated a lower perceived likelihood of contracting HPV ($\alpha = 0.74$).

Perceived facilitators. Perceived facilitators include 2 yes/no questions reflecting resources shown to promote vaccination decisions ("I will do it if I know where to get HPV vaccine"; "I will do it if I can afford it"). "Yes" responses were coded 1, and "No" responses were coded 0. The perceived facilitators' score was calculated using the sum

of the responses (range: 0–2). Higher scores indicated higher perceived facilitators for vaccination.

Perceived barriers. Barriers to receiving HPV vaccines were measured using 7 yes/no questions associated with concerns about stigma (i.e., "Because people will think I already had sex"), vaccine safety (i.e., "Because HPV vaccines can cause cancers"), and vaccine effectiveness (i.e., "Because I don't know if it works"). "Yes" responses were coded 1, and "No" responses were coded 0. Sum scores were calculated, and higher scores indicated perceiving more barriers to being vaccinated (range: 0–7; $\alpha = 0.79$).

Knowledge. HPV-related knowledge was measured by 10-item true/false questions about HPV developed using the CDC recommendation (Centers for Disease Control and Prevention, 2019). Questions included diseases associated with HPV infection and HPV vaccination (i.e., "HPV is a very common virus that is spread during any type of sexual activity with another person"). Correct responses were coded 1, and incorrect responses were coded 0. Knowledge scores were calculated using the sum of correct answers (range: 1–10). Higher sum scores indicate a higher level of HPV-related knowledge.

Cultural beliefs. Participants responded to three questions on the extent to which they agreed or disagreed with statements on how cultural/religious beliefs are related to the risk of being infected with HPV. The three items reflected "locus of control" in the context of health, as they related to beliefs about what factors can influence health outcomes. There are three dimensions in the health locus of control: internal (e.g., the belief that health is determined by internal factors and personal efforts), external in the form of powerful others (i.e., health is determined by other persons, especially healthcare providers and family members), and the chance dimension (i.e., health is determined by God or destiny). The items included in the current measure align with Chinese culture in relation to the external locus of control (Wallston et al., 1978; West et al., 2018; Pisl et al., 2021). Responses were recorded on a five-point Likert scale (1 = *strongly disagree*, 5 = *strongly agree*). Average scores were calculated based on responses, and higher scores indicated *lower* perceived needs to receive HPV vaccines due to cultural/religious beliefs ($\alpha = 0.80$).

3.4. Data Analysis

SPSS 27.0 was used for analysis (IBM Corp., 2020). We conducted univariate analysis (means, frequencies, standard deviations) to describe the characteristics of the sample. Chi-square and independent sample *t*-tests were used to compare the means between vaccinated and unvaccinated CISs. Three logistic regression models were used to examine the key factors associated with vaccination status and potential moderating effects. Continuous variables, such as perceived risks, facilitators, barriers, knowledge, and cultural beliefs, were included as the main predictors in the models. To account for nonnormality, the perceived risk variables was square-rooted before being included in the logistic regression models. Dichotomized vaccination status (yes vs. no) was included as the outcome variable. Given the potential moderating effect of sex and prior HPV education on perceived risks (Rosenstock, 1974), the interaction between biological sex (male vs. female) and perceived risks and the interaction between prior HPV education (yes vs. no) and perceived risks were also included as predictors in the models. Due to the small sample size, a *p*-value less than 0.1 was used to indicate significance.

4. Results

4.1. Descriptive Statistics

One hundred and five CISs participated in the study; the mean age was 23.44 years (*SD* = 3.82 years). Fifty-nine (56.2%) of them were males, 59 (56.2%) were undergraduate students, and 87 (82.9%) were from non-health disciplines. Thirty-five (33.3%) of them had

not received prior HPV education. Regarding theoretical constructs, CISs reported a mean lower perceived risks score of 0.19, facilitator score of 1.9, perceived barriers score of 0.82, knowledge score of 8.19, and cultural beliefs score of 1.23 (Table 1).

Table 1. Sample characteristics.

Variables	All Participants (N = 105)		Unvaccinated (N = 33)		Vaccinated (N = 72)		Test Statistics (df) [b]	*p*
	n/Mean	%/*SD* [a]	n/Mean	%/SD	n/Mean	%/SD		
Vaccination Status			33	31.43%	72	68.57%		
Predictors								
Lower perceived risks	0.19	0.66	0.48	1.09	0.06	0.23	−2.23 (33.31)	0.016
Perceived facilitators	1.94	0.30	1.90	0.38	1.95	0.26	0.77 (103)	0.445
Perceived barriers	0.82	1.41	1.15	1.58	0.67	1.31	−1.65 (103)	0.103
Knowledge level	8.11	1.35	7.81	1.86	8.25	1.02	1.25 (41.02)	0.128
Cultural beliefs	1.23	0.51	1.34	0.63	1.17	0.43	−1.42 (46.07)	0.162
Demographics								
Age	23.44	3.82	23.8	4.41	23.29	3.54	−0.62 (103)	0.539
Biological sex							16.35 (1)	<0.001
Male	46	43.8%	24	72.7%	22	30.6%		
Female	59	56.2%	9	27.3%	50	69.4%		
Program							0.53 (1)	0.835
Undergraduate	59	56.2%	18	54.5%	41	56.9%		
Graduate	46	43.8%	15	45.5%	31	43.1%		
Major							3.48 (2)	0.176
Nursing	2	1.9%	1	3%	1	1.4%		
Health-related (Non nursing)	16	15.2%	8	24.2%	8	11.1%		
Not health-related discipline	87	82.9%	24	72.7%	63	87.5%		
Have you received HPV education?							12.73 (1)	<0.001
No	35	33.3%	19	57.6%	16	22.2%		
Yes	70	66.7%	14	42.4%	56	77.8%		

Note: SD = standard deviation; df = degrees of freedom. [a] mean/*SD* if variables were continuous, n/% if variables were categorical. [b] t statistic for a numeric variable and Chi-square statistic for a categorical variable.

Among the CISs, 72 (68.57%) of them received at least one dose of the HPV vaccine. Female CISs ($X^2(1) = 16.348$, $p < 0.01$) and CISs that received HPV education in the past ($X^2(1) = 12.73$, $p < 0.01$) were more likely to have received at least one dose of HPV vaccination. Compared to unvaccinated CISs, those who received one dose of the HPV vaccine reported higher perceived risks ($M = 0.06$, $SD = 0.23$ vs. M = 0.48, $SD = 1.09$; $t(33.31) = -2.23$, $p = 0.03$) (see Table 1).

4.2. Logistic Regression Models

Three binary logistic regression models were used to examine the associations between key factors and receiving at least one dose of the HPV vaccine and potential moderating effects (Tables 2 and 3).

Model 1 tested the main effects of perceived risks, facilitators, barriers, knowledge, and cultural beliefs on vaccination status, controlling for age, biological sex, and prior HPV education. This model had a Nagelkerke R^2 of 0.37 and showed that perceiving higher risks of infection (OR = 0.29, $p = 0.09$) was significantly associated with the increased likelihood of HPV vaccine uptake. Model 2 tested the interaction between prior HPV education and perceived risks while holding all other variables constant. This model had a Nagelkerke R^2 of 0.38; however, the interaction effect was not significant (OR = 139,026,480, $p = 0.99$).

Model 3 tested the interaction between biological sex and perceived risks while holding all other variables constant. This model had a Nagelkerke R^2 of 0.28; however, the interaction effect was not significant (OR = 0.09, $p = 0.12$).

Table 2. Logistic regression models of factors associated with HPV vaccine uptake (N = 105).

Variable	OR	S.E.	*p*	Nagelkerke R^2
Model 1				0.37
Perceived risks	0.29	0.73	0.09	
Perceived facilitator	2.22	0.72	0.28	
Perceived barriers	0.96	0.22	0.85	
Knowledge level	1.35	0.21	0.14	
Cultural beliefs	0.90	0.50	0.82	
Age	0.99	0.06	0.86	
Biological sex (reference: male)	4.24	0.54	0.01	
HPV education (reference: no HPV education)	3.98	0.53	0.01	
Model 2				0.38
HPV education X perceived risks	139,026,480	13,429.429	0.99	
Perceived risks	0	13,429.43	0.99	
Perceived facilitator	2.12	0.72	0.30	
Perceived barriers	0.98	0.22	0.93	
Knowledge level	1.37	0.20	0.12	
Cultural beliefs	0.93	0.51	0.89	
Age	0.99	0.07	0.89	
Biological sex (reference: male)	4.14	0.54	0.01	
HPV education (reference: no HPV education)	3.51	0.55	0.02	
Model 3				0.28
Biological sex X perceived risks	0.09	1.56	0.12	
Perceived risks	0.64	0.79	0.58	
Perceived facilitator	2.21	0.74	0.29	
Perceived barriers	0.92	0.21	0.68	
Knowledge level	1.37	0.20	0.12	
Cultural beliefs	0.91	0.49	0.85	
Age	1	0.07	0.1	
Biological sex (reference: male)	5.71	0.58	0.003	
HPV education (reference: no HPV education)	4.41	0.54	0.01	

Note: OR = odds ratio; S.E. = standard error.

Table 3. Classification table for model 1.

Observed		Predicted		Percentage Correct
HPV vaccination status		No	Yes	60.6
	No	20	13	86.1
	Yes	10	62	
	Overall Percentage			78.1

5. Discussion

Using the HBM as a framework, this cross-sectional quantitative study examined the relationship between key factors and HPV vaccine uptake among CISs. Partially supporting the HBM, our results showed that being female, having received prior HPV education, and having higher perceived risks of contracting HPV were associated with receiving at least one dose of the HPV vaccine. The statistical models tested in the current study were able to explain 37%, 38%, and 28% of the variance, respectively, which indicates a decent fit

of the data (Carpenter, 2010). Statistical models 1 and 2 in our study showed improved fit compared to the study conducted among CISs that were not guided by the HBM. A study conducted by Esagoff et al. (2021) suggested that sex, school health center visits, and university-sponsored insurance were the best predictors of HPV vaccination among CISs, and this model explained 33.5% of the variance.

Consistent with prior research (Tung et al., 2019), being female (versus male) was associated with a significantly higher likelihood of receiving HPV vaccination. The feminization of the HPV vaccination due to its causal relationship with cervical cancer and the lack of healthcare provider recommendation for males to receive HPV vaccination have been identified as possible factors that contribute to the sex disparity (Grandahl & Nevéus, 2021; Siu et al., 2019). According to the China Centers for Disease Control and Prevention (CCDC), current HPV vaccination promotion efforts in China mainly target young females to reduce the occurrence of cervical cancer (J. Chen et al., 2024). It is possible that female-focused HPV vaccination campaigns and policies in China contribute to the gender disparities in HPV vaccination uptake among CISs. Recognizing the risks of contracting HPV and the associated cancers and illnesses stemming from it, the U.S. CDC recommends HPV vaccination for both males and females (Centers for Disease Control and Prevention, 2019). A sex-neutral HPV vaccination education campaign is needed to increase HPV vaccine uptake and decrease the occurrence of associated health consequences. The results from this study suggested that similar sex disparities regarding HPV vaccination exist among CISs and reaffirmed the need for sex-neutralizing HPV vaccine promotion and education.

Compared to previous research conducted among CISs in the Nevada area, which reported 38% HPV vaccine uptake, low-to-moderate levels of knowledge, and low perceived risks (Tung et al., 2021), our participants showed higher rates of HPV vaccine uptake and higher levels of knowledge and perceived risks. It is possible that, with the recent introduction of HPV vaccines in mainland China, CISs were exposed to more information about HPV and HPV vaccination, which increased their knowledge and perceived risks. However, these differences could also be due to differences in measurements and sample characteristics in these two studies. Notably, in our study, those who received at least one dose of the HPV vaccine were more likely to have received prior HPV education and perceived higher risks of infection than unvaccinated CISs. These results are aligned with the HBM (Rosenstock, 1974) and suggest the importance of HPV education in increasing HPV vaccine uptake. This result also suggests the need to highlight the high prevalence and severe health consequences of HPV infection in both sexes for future education efforts among CISs.

Although our results showed that prior HPV education, being female, and perceived risks of contracting HPV are associated with vaccine receipt, there is no significant interaction effect between HPV education and perceived risks, nor between biological sex and perceived risks. These findings indicate that the relationship between perceived risks of contracting HPV infection and vaccine uptake did not differ based on CISs' prior HPV education or biological sex. The relationship between perceived risks and the decision to receive the HPV vaccine aligns with previous research conducted among male college students in Hong Kong (Cheung et al., 2018). Cheung et al. (2018) found that male college students with higher perceived susceptibility to HPV infection reported higher HPV vaccination acceptability. Our findings further emphasize the important role that perceived risk plays in CISs' decisions to receive the HPV vaccine. The high risks of HPV infection and the associated health concerns should be incorporated and emphasized in education efforts.

It is important to note that several constructs in the HBM were not significantly associated with HPV vaccine uptake among CISs in the current study. Although past research has identified sociocultural factors as being associated with one's HPV vaccination decision, especially in Asian countries (Wong et al., 2019; You et al., 2020), cultural beliefs did not emerge as a significant factor contributing to CISs' HPV vaccination uptake in our study. Our sample consisted of CISs who had been studying and living in the U.S. for varying lengths of time; therefore, they might have different levels of acculturation, which, in turn, could affect their vaccination decisions. Inconsistent with a previous study conducted among female college students in China (You et al., 2020), knowledge, perceived barriers, and perceived facilitators were not significantly associated with HPV vaccination among CISs in our study. This difference could possibly be attributed to the sample differences. Our CIS sample possessed relatively high knowledge about HPV and HPV vaccination, greater awareness of the benefits of HPV vaccination, and easier access to the HPV vaccine. However, when deciding whether or not to receive HPV vaccination, CISs' perceived risks of contracting HPV appeared to outweigh their knowledge, perceived benefits, and perceived barriers to receiving HPV vaccination. This suggests that future intervention efforts targeting CISs should focus on addressing their perceived risks of contracting HPV.

5.1. Limitations

There are several limitations to this study. First, the current study had a relatively small sample recruited from one single public university in the U.S., which could reduce the ability to detect significant relationships between variables with limited generalizability. The cross-sectional design limited the ability to establish clear causal relationships among variables. All measures were self-reported by participants, which may be subject to social desirability and recall bias. The study did not measure other potential variables, such as self-efficacy, acculturation, or time in the U.S., which may be related to CISs' HPV vaccine uptake. Furthermore, data on HPV vaccination, such as when, where, and the number of doses received by our sample, could provide a more in-depth understanding of vaccination patterns and the variables associated with these patterns. Although HBM has been widely used and has shown strong relevance in research investigating HPV vaccine uptake, other health behavioral theories, such as the Theory of Planned Behavior (TPB), may provide useful insights into the factors influencing HPV vaccination decisions and help identify effective frameworks for intervention design (Gerend & Shepherd, 2012). Future research should consider utilizing a longitudinal design, recruiting a larger and more representative sample of CISs, applying other models to the CIS population, and including additional important information mentioned above to inform intervention development.

5.2. Implications and Conclusions

Unvaccinated CISs have a great catch-up window to receive the HPV vaccine for cancer prevention when in the U.S., particularly if they lack access to affordable HPV vaccines in their home country. Therefore, it is vital to provide culturally and linguistically appropriate interventions to increase HPV vaccine uptake among CISs. Establishing pre-departure health education orientation programs for CISs before they leave for the U.S. could be beneficial. These programs could introduce them to the U.S. healthcare system and their insurance policies, encourage them to utilize healthcare services, and help them connect with healthcare resources on campus and in the community to promote HPV and HPV vaccination knowledge, increasing their awareness. To increase accessibility, universities in the U.S. could collaborate with student health centers and local health departments to provide vaccine campaigns to CISs. Information about the risks of HPV infection,

the timeline of HPV vaccine administration, and where CISs can receive HPV vaccines could be provided in both English and Chinese. Other possible interventions, such as posting information on the university health center's social media pages, sending text messages to students, conducting webinars, providing bilingual health interpreters, and implementing campus-based marketing strategies, could be used to enhance knowledge about HPV-related issues and improve HPV vaccination rates (Liu et al., 2024). Our study also shows the urgent need to address the sex disparities in male students' HPV vaccination and highlight the high risks, high prevalence of HPV infection, and the severity of associated health consequences in both males and females.

Supplementary Materials: The following supporting information can be downloaded at: https://www.mdpi.com/article/10.3390/youth5010009/s1.

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