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Knowledge, Attitude, Willingness of HPV Vaccination and Associated Factors among Undergraduate's Students in Guangzhou, China: A Single-center Cross-sectional Study*

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Abstract: Cervical cancer and HPV-related diseases can be effectively prevented through HPV vaccination. Yet, in mainland China, there is limited understanding of the associated factors among young people who are at the optimal age for HPV vaccination. This study aimed to investigate the HPV-related knowledge, attitudes, and willingness to vaccinate among this population, analyze associated factors, and provide a basis for primary and secondary cervical cancer prevention strategies. We performed a cross-sectional questionnaire survey, recruiting 892 participants. Of these, 86.7% had heard of the HPV vaccine, and 83.3% reported their willingness to receive the HPV vaccination. Our findings suggest that the most crucial factor influencing vaccine uptake is females who had heard of the HPV vaccine, believed in their ability to self-determine vaccination, encouraged their sexual partners to get vaccinated, and were in favor of incorporating the vaccine into routine vaccinations. In conclusion, despite high willingness, Guangzhou university students have a low actual HPV vaccination rate, with internet and social media being the main, yet insufficient, sources of HPV knowledge. Enhancing vaccination coverage in China requires boosted awareness, cost regulation, and national campaign implementation.

Keywords: Willingness; Knowledge; Attitude; HPV vaccine

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1. Introduction

Human papillomavirus (HPV) infection is responsible for virtually all occurrences of cervical cancer and a substantial proportion of non-cervical malignancies, including vulvar, vaginal, penile, anal, and oropharyngeal cancers.[1] In general, more than 90% of anal and cervical cancers are believed to be caused by HPV, along with about 70% of vaginal and vulvar cancers, and more than 60% of penile cancers.[2] Cervical cancer remains one of the most prevalent malignant tumors in women worldwide, particularly in low-middle income countries.[3] For instance, in 2018, there were approximately 570,000 new cases of cervical cancer and roughly 310,000 deaths worldwide.[4] In 2020, China alone recorded 110,000 new cases of cervical cancer and 59,000 deaths, making it the country with the second-largest burden of cervical cancer in the world.[5] In addition, it has been shown in recent studies that about 70% of oropharyngeal cancers may also be linked to HPV.[6]

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1 Parkin DM, "The Global Health Burden of Infection-associated Cancers in the Year 2002," *Int J Cancer* 118.12 (2006.01): 3030-44. doi: 10.1002/ijc.21731.

2 Szymonowicz KA, Chen J, "Biological and Clinical Aspects of HPV-related Cancers," *Cancer Biol Med* 17.4 (2020.12): 864-78. doi: 10.20892/j.issn.2095-3941.2020.0370.

3 Wei M, Zhou W, Bi Y, Wang H, Liu Y, Zhang ZJ, "Rising Mortality Rate of Cervical Cancer in Younger Women in Urban China," *J Gen Intern Med*. 34.2 (2019): 281-4. doi: 10.1007/s11606-018-4732-z. PubMed PMID: 30484099; PubMed Central PMCID: PMCPMC6374275; Brisson M, Kim JJ, Canfell K, Drolet M, Gingras G, Burger EA, et al. "Impact of HPV Vaccination and Cervical Screening on Cervical Cancer Elimination: A Comparative Modelling Analysis in 78 Low-income and Lower-middle-income Countries," *Lancet* 395.10224 (2020.02): 575-90. doi: 10.1016/s0140-6736(20)30068-4. PubMed PMID: 32007141; PubMed Central PMCID: PMCPMC7043009.

4 Ferlay J, Colombet M, Soerjomataram I, Mathers C, Parkin DM, Piñeros M, et al. "Estimating the Global Cancer Incidence and Mortality in 2018: GLOBOCAN Sources and Methods," *International Journal of Cancer* 144.8 (2019.04): 1941-53. doi: 10.1002/ijc.31937. PubMed PMID: 30350310.

5 Sung H, Ferlay J, Siegel RL, Laversanne M, Soerjomataram I, Jemal A, et al. "Global Cancer Statistics 2020: GLOBOCAN Estimates of Incidence and Mortality Worldwide for 36 Cancers in 185 Countries," *CA: A Cancer Journal for Clinicians* 71.3 (2021.03): 209-49. doi: 10.3322/caac.21660. PubMed PMID: 33538338.

6 CDC, n.d. "HPV-Associated Cancer Statistics." Accessed n.d. https://www.cdc.gov/cancer/hpv/statistics/index.htm.

Another health concern associated with HPV is anogenital warts, boasting a median annual incidence rate of 137 cases per 100,000 men and 121 cases per 100,000 women.[7] Yet, the vaccination rate against HPV in China is much lower than in Western countries, with only 3.1%-11.0% of students vaccinated compared to vaccination rates of 17-81% in Western countries. [8]

The prevalence of HPV-related diseases varies based on the country and its execution of national vaccination programs, as well as the availability and quality of screening and treatment options. Persistent HPV infection is undoubtedly a major cause of cervical cancer.[9] In 2019, the World Health Organization (WHO) endorsed immunization, screening, and treatment as pivotal approaches to combat cervical cancer.[10] Currently, the HPV vaccine stand as the most effective preventive measure against cervical cancer and other HPV-related illnesses.[11] Thus, vaccination is necessary to avoid recurring infection

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7 Yanofsky VR, Patel RV, "Goldenberg G. Genital Warts: A Comprehensive Review," *J Clin Aesthet Dermatol.* 5.6 (2012.07): 25-36. PubMed PMID: 22768354; PubMed Central PMCID: PMCPMC3390234 conflicts of interest; Patel H, Wagner M, Singhal P, Kothari S, "Systematic Review of the Incidence and Prevalence of Genital Warts," *BMC Infect Dis*. 13.39 (2013.01) doi: 10.1186/1471-2334-13-39. PubMed PMID: 23347441; PubMed Central PMCID: PMCPMC3618302.

8 You D, Han L, Li L, Hu J, Zimet GD, Alias H, et al. "Human Papillomavirus (HPV) Vaccine Uptake and the Willingness to Receive the HPV Vaccination among Female College Students in China: A Multicenter Study." *Vaccines (Basel)*. 8.1 (2020): doi: 10.3390/vaccines8010031. PubMed PMID: 31963370; PubMed Central PMCID: PMCPMC7157221; Deng C, Chen X, Liu Y. "Human Papillomavirus Vaccination: Coverage Rate, Knowledge, Acceptance, and Associated Factors in College Students in Mainland China," *Hum Vaccin Immunother*. 17.3 (2021): 828-35. Epub 2020/09/03. doi: 10.1080/21645515.2020.1797368. PubMed PMID: 32873128; PubMed Central PMCID: PMCPMC7993118.

9 World Health Organization, "Human Papillomavirus Vaccines: WHO Position Paper," *Biologicals.* 37.5 (2009.06): 338-44. Epub 2009/06/16. doi: 10.1016/j.biologicals.2009.04.005. PubMed PMID: 19525124; Dong M, Yan W, Ou L, Wenchang W. "Human Papillomavirus Vaccines: WHO Position Paper, May 2017-Recommendations." *Vaccine*. 35.43 (2017.06): 5753-5. Epub 2017/06/10. doi: 10.1016/j.vaccine.2017.05.069. PubMed PMID: 28596091.

10 Gultekin M, Ramirez PT, Broutet N, Hutubessy R, "World Health Organization Call for Action to Eliminate Cervical Cancer Globally," *Int J Gynecol Cancer.* 30.4 (2020.03): 426-7. Epub 2020/03/04. doi: 10.1136/ijgc-2020-001285. PubMed PMID: 32122950.

11 Drolet M, Bénard É, Pérez N, Brisson M, "Population-level Impact and Herd Effects Following the Introduction of Human Papillomavirus Vaccination Programmes: Updated Systematic Review and Meta-analysis," *Lancet.* 394.10197 (2019): 497-509. Epub 2019/07/01. doi: 10.1016/s0140-6736(19)30298-3. PubMed PMID: 31255301; PubMed Central PMCID: PMCPMC7316527.

with high-risk HPV, effectively lowering the risk of HPV-related diseases.[12]

In the present day, more than one hundred countries have authorized the use of bivalent and quadrivalent HPV vaccines.[13] Numerous nations have integrated HPV immunization into their national vaccination strategies, and a minimum of eleven countries routinely vaccinate males with HPV vaccines.[14] Jennings and Loharikar argue that achieving high coverage among girls is a more cost-effective vaccination strategy in low-and middle-income countries than a 'gender-neutral' vaccination strategy that includes both females and males.[15] Since 2016, 2017, and 2018 respectively, the Chinese government has approved the use of bivalent, quadrivalent, and nonavalent HPV vaccines for Chinese women.[16] However, the vaccine is not part of China's routine vaccination program, rendering the vaccine self-funded and optional for Chinese citizens.

The WHO recommends that females aged 9 to 26, preferably those with no prior sexual history, be vaccinated against HPV.[17] As sexual activity presents a direct risk factor for HPV infection, undergraduates have emerged as the target population for preventive

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12 Muñoz N, Kjaer SK, Sigurdsson K, Iversen OE, Hernandez-Avila M, Wheeler CM, et al. "Impact of Human Papillomavirus (HPV)-6/11/16/18 Vaccine on All HPV-associated Genital Diseases in Young Women," *J Natl Cancer Inst.* 102.5 (2010.02): 325-39. Epub 2010/02/09. doi: 10.1093/jnci/djp534. PubMed PMID: 20139221; Lehtinen M, Paavonen J, Wheeler CM, Jaisamrarn U, Garland SM, Castellsagué X, et al. "Overall Efficacy of HPV-16/18 AS04-adjuvanted Vaccine Against Grade 3 or Greater Cervical Intraepithelial Neoplasia: 4-year End-of-study Analysis of the Randomised, Double-blind PATRICIA Trial." *Lancet Oncol.* 13.1 (2012): 89-99. Epub 2011/11/15. doi: 10.1016/s1470-2045(11)70286-8. PubMed PMID: 22075171.

13 Markowitz LE, Tsu V, Deeks SL, Cubie H, Wang SA, Vicari AS, et al. "Human Papillomavirus Vaccine Introduction: The First Five Years." *Vaccine.* 30 Suppl 5 (2012.12): F139-48. Epub 2012/12/05. doi: 10.1016/j.vaccine.2012.05.039. PubMed PMID: 23199957.

14 "Human Papillomavirus Vaccines: WHO Position Paper, May 2017." *Wkly Epidemiol Rec*. 92.19 (2017.05): 241-68. Epub 2017/05/23. PubMed PMID: 28530369.

15 Jennings MC, Loharikar A. "A Vaccine Against Cervical Cancer: Context for the Global Public Health Practitioner." *Global Health: Science and Practice*. 6.4 (2018): 629-34. doi: 10.9745/ghsp-d-18-00222.

16 China National Medical Products Administration. n.d. "HPV Vaccine and Prevention of Cervical Cancer [in Chinese]." Accessed March 31, 2022. https://www.nmpa.gov.cn/yaopin/ypjgdt/20190722080001877.html.

17 World Health Organization. "Working Group on potential contribution of Human Papillomavirus (HPV) vaccines and immunization towards cervical cancer elimination Strategic Advisory Group of Experts (SAGE) on Immunizationa" *WHO*. Accessed 2019. https://www.who.int/immunization/sage/meetings/2019/october/1_HPV_SAGE2019WG_for_SAGE.pdf.

HPV vaccination. Research suggests that factors such as knowledge of HPV and the HPV vaccine, parental education level, type of medical insurance, recommendations from healthcare providers, and whether the HPV vaccine is included in the national vaccination program are key influencers of vaccination coverage.[18] Several studies on Chinese women indicate that young women's awareness of HPV vaccination is primarily driven by their knowledge of HPV and HPV-related issues, as well as the cost and safety of the HPV vaccine, followed by the efficacy.[13]

Prior research has indicated that Chinese women have a general understanding of cervical cancer, but process limited comprehension of HPV and the HPV vaccine.[19] Since the HPV vaccine has only been available in China for a few years, some individuals remain hesitant, adopting a 'wait-and-see' stance towards it. The Chinese government has not yet included the HPV vaccine in its national vaccination program, resulting in a low vaccination rate, lack of understanding, and a negative attitude towards HPV vaccination.[20]

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[18] Mansfield LN, Silva SG, Merwin EI, Chung RJ, Gonzalez-Guarda RM. "Factors Associated With Human Papillomavirus Vaccine Series Completion Among Adolescents." *Am J Prev Med.* 61.5 (2021.07): 701-8. Epub 2021/07/15. doi: 10.1016/j.amepre.2021.04.031. PubMed PMID: 34256974.

[19] Wang X, Du T, Shi X, Wu K, "Awareness and Knowledge about Human Papilloma Virus Infection among Students at Secondary Occupational Health School in China," *Int J Environ Res Public Health.* 18.12 (2021.07). doi: 10.3390/ijerph18126321. PubMed PMID: 34207971; PubMed Central PMCID: PMCPMC8296127; Yin G, Zhang Y, Chen C, Ren H, Guo B, Zhang M, "Have You Ever Heard of Human Papillomavirus (HPV) Vaccine? The Awareness of HPV Vaccine for College Students in China Based on Meta-analysis," *Hum Vaccin Immunother*. 17.8 (2021.04): 2736-47. doi: 10.1080/21645515.2021.1899731. PubMed PMID: 33787459; PubMed Central PMCID: PMCPMC8475627; Wen Y, Pan XF, Zhao ZM, Chen F, Fu CJ, Li SQ, et al. "Knowledge of Human Ppapillomavirus (HPV) Infection, Cervical Cancer, and HPV Vaccine and Its Correlates among Medical Students in Southwest China: A Multi-center Cross-sectional Survey," *Asian Pac J Cancer Prev.* 15.14 (2014.08): 5773-9. doi: 10.7314/apjcp.2014.15.14.5773. PubMed PMID: 25081700.

[20] Zhou L, Wang J, Cheng P, Li Y, Liu G, Zhang X, "HPV Vaccine Hesitancy Among Medical Students in China: A Multicenter Survey." *Front Public Health*. 10 (2022.03): 774767. doi: 10.3389/fpubh.2022.774767. PubMed PMID: 35265570; PubMed Central PMCID: PMCPMC8900914; Xiaoxiao Z, Jinjing S, Yanyang Z, Wenzhou Y, "A Meta-analysis of Human Papillomavirus Vaccine Awareness and Vaccination Willingness of College Students in Mainland China." *China Vaccines and Immunization.* 25.03 (2019): 308-12; Jie Z, Jiayi Z, Minhui P, Jianwei Y, Xiongfei C, Xiaomei D, "Intention to Vaccinate HPV Vaccine among College Students in Guangzhou and Its Influencing Factors," *Chinese Journal of Disease Control*. 22.9 (2018.09): 965-7+71. doi: 10.16462/j.cnki.zhjbkz.2018.09.022.

Furthermore, research implies that traditional Chinese culture tends to influence more sensitive sex-related themes, leading Chinese parents and schools to employ a 'silencing' approach to the 'sexual health education'.[21]

The WHO and various studies have demonstrated that knowledge and attitudes significantly influence the willingness and vaccination rate of the HPV vaccine. [22]A survey focusing on knowledge, attitudes, and willingness can assist in identifying knowledge gaps, analyzing government policies, and understanding cultural beliefs, which in turn facilitate comprehension and action. Furthermore, it can highlight any potential issues or barriers that prevent HPV vaccination. Thus, this study investigates the willingness, HPV-related knowledge, and attitudes of undergraduates towards HPV vaccination at a university in Guangzhou. It aims to provide a theoretical framework and recommendations to promote HPV vaccine uptake among students, thereby contributing to primary and secondary cervical cancer prevention strategies.

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[21] Gao E, Zuo X, Wang L, Lou C, Cheng Y, Zabin LS. "How Does Traditional Confucian Culture Influence Adolescents' Sexual Behavior in Three Asian Cities?," *J Adolesc Health.* 50.3. (2012): S12-S7. doi: 10.1016/j.jadohealth.2011.12.002. PubMed PMID: 22340851.

[22] Leung JTC, Law CK, "Revisiting Knowledge, Attitudes and Practice (KAP) on Human Papillomavirus (HPV) Vaccination among Female University Students in Hong Kong," *Hum Vaccin Immunother*. 14.4 (2017.12): 924-30. doi: 10.1080/21645515.2017.1415685. PubMed PMID: 29232166; PubMed Central PMCID: PMCPMC5893186; Charan J, Biswas T, "How to Calculate Sample Size for Different Study Designs in Medical Research,?" *Indian J Psychol Med.* 35.2 (2013.09); 35(2): 121-6. Epub 2013/09/21. doi: 10.4103/0253-7176.116232. PubMed PMID: 24049221; PubMed Central PMCID: PMCPMC3775042; Trucchi C, Amicizia D, Tafuri S, Sticchi L, Durando P, Costantino C, et al. "Assessment of Knowledge, Attitudes, and Propensity towards HPV Vaccine of Young Adult Students in Italy." *Vaccines (Basel).* 8.1 (2020): 74. doi: 10.3390/vaccines8010074. PubMed PMID: 32046039; Kim HW, Lee EJ, Lee YJ, Kim SY, Jin YJ, Kim Y, et al. "Knowledge, Attitudes, and Perceptions Associated with HPV Vaccination among Female Korean and Chinese University Students," *BMC Women's Health.* 22.1 (2022): 51. doi: 10.1186/s12905-022-01624-1; World Health Organization & Stop TB Partnership, "Advocacy, Communication and Social Mobilization for TB Control: A Guide to Developing Knowledge, Attitude and Practice Surveys," Geneva: World Health Organization; 2008; Rui R, Chun-hwan J, Yong H, Jianxiong X, "Analysis of HPV Vaccination Willingness and Its Influencing Factors among Women in Guangzhou," *Chinese Public Health.* 37.12 (2021): 1751-5.

2. Material and Methods

2.1 Study Population

A cross-sectional questionnaire survey was conducted at Jinan University using convenience sampling between March 20th and March 26th, 2022. The team of well-trained investigators obtained verbal agreement from the participants, adhering to medical ethics guidelines, prior delivering the survey. To better inform participants about the study, a brief summary was provided at the beginning of the questionnaire.

The inclusion criteria for this study's participants were: (a) Undergraduate students studying for their first bachelor's degree at Jinan University. (b) those not having received the HPV vaccine, and (c) individuals not being diagnosed with any HPV-related disease.

The exclusion criteria for participation in the study were: (a) instances of the IP address being used repeatedly, (b) participants being diagnosed with any HPV-related disease, and (c) completing the questionnaire in less than 2 minutes (the questionnaire takes about 2-3 minutes to complete).

Recruitment of the participants took place during the week at several sites on the university's main campuses, including teaching buildings, research buildings, canteens, and library entrances. Participants could access the survey by scanning a QR code was provided on the questionnaire, using their mobile devices and the WeChat app.

To maintain anonymity, the questionnaires were kept anonymous, and participants were informed that completing the questionnaire indicated their consent to participate in the survey. Thus, participants' consent was implied by their completion of the questionnaire. We utilized the sample size formula of cross-sectional study,[23] anticipating 75% of undergraduate students in Guangzhou having the willingness to receive the HPV vaccine. [24]

[23] Charan J, Biswas T. "How to Calculate Sample Size for Different Study Designs in Medical Research?," *Indian J Psychol Med.* 2013; 35(2): 121-6. Epub 2013/09/21. doi: 10.4103/0253-7176.116232. PubMed PMID: 24049221; PubMed Central PMCID: PMCPMC3775042.

[24] Xiaoxiao Z, Jinjing S, Yanyang Z, Wenzhou Y. "A Meta-analysis of Human Papillomavirus Vaccine Awareness and Vaccination Willingness of College Students in Mainland China," *China Vaccines and*

In order to obtain a representative sample of the population with a 95% confidence and an absolute error of 5%, a sample size of 289 subjects was required.

This study was open to individuals of any gender. To ensure survey quality, we implemental the following controls: (1) All questions were made compulsory to avoid missing responses; (2) When a participant completed the questionnaire in less than two minutes, they were prompted to review their answers; and (3) IP addresses were checked to detect repeat participation.

As the questionnaires were kept anonymous, and participants were informed that completing the questionnaire implied their consent, the completion of the questionnaire indicated the participants' consent. The established inclusion and exclusion criteria for participants guided the recruitment and data analysis process.

This study has been approved by the Research Ethics Committee of the Jinan University (JNUKY-2022-027). The Ethics Committee, after a thorough review, concluded that the research content and research methods comply with the norms and requirements of medical ethics.

2.2 Measuring Instrument

The author developed a structured self-administered questionnaire drawing on insights from previous relevant studies in the literature.[25] After the initial drafting of the

Immunization. 2019;25 (03): 308-12; Jie Z, Jiayi Z, Minhui P, Jianwei Y, Xiongfei C, Xiaomei D. "Intention to Vaccinate HPV Vaccine among College Students in Guangzhou and Its Influencing Factors," *Chinese Journal of Disease Control.* 2018; 22(09): 965-7+71. doi: 10.16462/j.cnki.zhjbkz.2018.09.022; Rui R, Chun-hwan J, Yong H, Jianxiong X, "Analysis of HPV Vaccination Willingness and Its Influencing Factors among Women in Guangzhou," *Chinese Public Health.* 2021; 37(12): 1751-5; Qing L, Peach, Qiuwen L, Peiyu F, Ziwei Z, Shizhen C, "Cognitive status and Related Factors of HPV Vaccine among Some College Students in Guangdong Province." *Primary health care in China.* 36.1 (2022): 82-5.

[25] Zhou L, Wang J, Cheng P, Li Y, Liu G, Zhang X, "HPV Vaccine Hesitancy Among Medical Students in China: A Multicenter Survey." *Front Public Health*. 2022; 10: 774767. Epub 2022/03/11. doi: 10.3389/fpubh.2022.774767. PubMed PMID: 35265570; PubMed Central PMCID: PMCPMC8900914; Leung JTC, Law CK, "Revisiting Knowledge, Attitudes and Practice (KAP) on Human Papillomavirus (HPV) Vaccination among Female University Students in Hong Kong," *Hum Vaccin Immunother*. 2018;

questionnaire, an expert from Jinan University was consulted for content validation, resulting in a further review and revision of the questionnaire.

To ensure the questionnaire's validity and interpretability, it underwent a pilot test with 450 first bachelor's degree students at Jinan University. The Cronbach alpha coefficient of the questionnaire in the pilot test was 0.91, indicating a high level of internal consistency. Item-total correlation coefficients ranged from 0.50 - 0.90. Following the pilot test, no further revisions were required to the questionnaire or implementation procedures.

The final version of the questionnaire consisted of four sections, capturing demographics of the participants, as well as their knowledge, attitudes, and responses to additional questions about HPV.

The questionnaire included sections for demographic variables such as age, gender, sex experience, sexually transmitted infection experience, frequency of sex, sexual partner, and family history of cancer.

The knowledge section consisted of eight questions related to HPV, including statements such as 'cervical cancer is mainly caused by HPV infections' ; 'certain types of HPV can cause genital warts'; 'HPV is sexually transmitted'; 'HPV infection is not likely to be completely cured by clinical treatment'; 'most sexually active women are infected by HPV at some points in their lives'; 'using condoms does not prevent 100% HPV infection' ; 'it is recommended that females should receive all 3 shots of HPV vaccination within a 6-month period' ; 'male can be infected with HPV'. participants' knowledge scores were obtained by adding up the correct answers and calculating a percentage (number of correct answers/ numbers of knowledge statements * 100). A higher knowledge score indicated a greater understanding of the infection, related disease and prevention. The internal consistency reliability of Cronbach's alpha for the knowledge section was 0.687, and the Kaiser-Meyer-Olkin (KMO) value was 0.937 for the overall items.

The attitudes section consisted of five questions on participants' attitudes towards

14(4): 924-30. Epub 2017/12/13. doi: 10.1080/21645515.2017.1415685. PubMed PMID: 29232166; PubMed Central PMCID: PMCPMC5893186.

HPV vaccination, including statements such as ‘increase the availability of HPV vaccine; ‘hope the insurance company will cover the cost’; ‘looking to incorporate vaccines into routine vaccinations’ ; ‘ability to self-determine whether to get vaccinated’ ; ‘encouraged sexual partners to get HPV vaccine’ . participants’ attitudes scores were obtained by calculating the average of their responses to the statements on a five-point Likert scale, with a score ranging from 1.0 to 5.0 (1 = fully not agree, 5 = fully agree). A higher score indicated more positive attitudes towards HPV vaccination. The internal consistency reliability of Cronbach’s alpha for the attitudes section was 0.937, and the KMO value was 0.870 for the overall items. Additionally, binary logistic regression models were conducted on each item of the attitudes questions by calculating the agreement and disagreement as an independent variable.

Additional questions about HPV included seven questions, such as ‘valent of HPV vaccines are you willing to receive’ ; ‘government should provide free/ subsidized HPV vaccination to all eligible women’ ; ‘scientifically gained knowledge about HPV’ ; ‘needs for further of HPV-related knowledge’; ‘have received classroom health education on HPV’ ; ‘time to first receive HPV vaccine popularization education’ ; ‘HPV information sources’. Two questions were used to evaluate participants’ willingness to receive HPV vaccine and their willingness to recommend the HPV vaccine to others.

2.3 Statistical analysis

Statistical analyses were performed using SPSS 26.0 (IBM SPSS Statistics, New York, United States). A sample size of 450 subjects was used for AMOS 21.0 to conduct confirmatory factor analysis of the questionnaire. Exploratory factor analysis showed that the Cronbach’s αcoefficient of the total scale was 0.93, Chi-square = 6805, Degrees of freedom = 253, Probability level < 0.05. The factor loadings of the 15 items were all greater than 0.4, and the cumulative contribution rate of the variance was 61.24%. Confirmatory factor analysis showed that the model fitting evaluation was consistent with the judgement criterion. The Structural Equation Model Chi-square = 96.5, Probability level = 1.85,

Goodness of fit index (GFI) = 0.97, Root Mean Square Error of Approximation (RMSEA) = 0.017, Comparative Fit Index (CFI) = 0.996, Normed Fit Index (NFI) = 0.969, and a Tucker-Lewis Index (TLI) of 0.995 (Supplementary Table 1 to Table 2).

The mean with standard deviation and the mean with Interquartile Range (IQR) were calculated to demonstrate the distribution of knowledge scores. Descriptive statistics were employed to depict the willingness to receive HPV vaccination in relation to each potential factor. Chi-square tests, F test, Kruskal-Wallis H test, Wilcoxon-Mann-Whitney test, and univariable logistic regression analysis were conducted for bivariate analysis to assess the association between the independent predictors and the outcomes of interest: high knowledge level about HPV and HPV vaccination (with the median as a reference, correctly identifying 8 to 10 scores was considered a high knowledge level; Model 1); high attitudes level about HPV and HPV vaccination (with the median as a reference, identifying 21 to 45 scores was considered a high attitudes level; Model 2); and whether a participant was willing to receive HPV vaccination and willingness to recommend the HPV vaccination to others (Model 3).

Variables with a p-value below 0.05 in the univariate analysis were included in the multivariate logistic regression analysis model via stepwise regression to establish whether the independent variables were associated with the outcome of interest after controlling the effect of other variables. Odds ratios (ORs) and their 95% confidence intervals (CIs) from the multivariate model were illustrated to demonstrate to illustrate their statistical association. A two-sided p-value below 0.05 was considered statistically significant in this study.

3. Results

3.1 Participants' Characteristics

Of the 1,011 participants who initially participated, 119 were ultimately excluded, yielding a final sample size of 892 students, or 88.23% of the original participant pool. The

demographic breakdown of these participants is provided in Table 1. Among these participants, 62% were women, and 38% were men, with an average age of 21.3 years (standard deviation: 2.23). The majority of participants, at a percentage of 79.6%, reported a monthly consumption of 1000-3000 CNY. Additionally, a total of 264 participants (29.6%) reported having had sexual experience, with only eight of these reporting a sexually transmitted infection.

3.2 Descriptive statistics and univariate regression analyses

Table 1 outlines the characteristics of the participants and their stances on HPV vaccination. Of the total 892 participants, a substantial majority (743 or 83.3%) expressed their willingness to receive the vaccine, with 698 (78.3%) willing to recommend the HPV vaccine to others. Furthermore, a considerable proportion showed a positive attitude towards HPV-related matters (78.7%) and exhibited a robust understanding of HPV-related topics (81.0%).

Our findings reveal that women who expect the government to provide free or subsidized HPV vaccinations are significantly more likely to get vaccinated and display a more positive attitude towards vaccination. In contrast, participants who engage in sexual activity more than seven times a month may exhibit less inclination to receive HPV vaccination and have a less positive attitudes.

Significantly, participants who had previously heard about HPV vaccines (OR: 7.779, $p < 0.01$),those who received HPV vaccine education for the first time during their undergraduate years (OR: 2.526, $p < 0.01$), and those who had obtained scientifically accurate knowledge about HPV (OR: 2.881, $p < 0.01$) showed a significantly higher willingness to get vaccinated. They also demonstrated heighted levels of knowledge and positive attitudes towards HPV vaccination ($p < 0.05$). Importantly, we identified a positive correlation between knowledge and attitude concerning HPV vaccination (Table 1).

3.3 The reason for participants' vaccine willingness

Table 2 detailed the reasons participants provided for their willingness to receive HPV vaccinations. A significant proportion, approximately 98.1% of participants, maintained the belief that the HPV vaccine acts as a safeguard to individual's health. Meanwhile, 59.2% and 57.1% upheld the belief in the vaccine's safety and effectiveness, and its ability to protect the health of their family, respectively. Conversely, the leading two reasons reported by participants for their reluctance to receive the HPV vaccine were the perceived lack of evident HPV infection (43.6%) and concerns regarding the cost of the vaccine (38.3%).

3.4 The Demographic Characteristic of Participants' Knowledge Scores

Table 3 provides an overview of participants' knowledge scores and how they correspond with their demographic characteristics. The mean knowledge score was situated at 6.30 ± 1.68. Interestingly, participants whose sexual partners had received the HPV vaccine demonstrated the highest mean knowledge score (7.05 ± 1.19), in contrast to those who had never heard of the HPV vaccine, who exhibited the lowest score (5.47 ± 2.47).

Participants possessing a family history of cancer, sexual experience, a sexual partner who has received the HPV vaccine, prior knowledge of the HPV vaccine, willingness to receive and recommend the vaccine, scientifically accurate knowledge about HPV, a need for further HPV-related knowledge, and exposure to HPV vaccine popular science education during their undergraduate years demonstrated significantly greater knowledge scores ($p < 0.05$).

Worth noting is that 89.7% of participants were aware that certain types of HPV can cause genital warts, and 89.3% understood that condoms do not provide absolute protection against HPV infection. Furthermore, 86.4% were cognizant of the fact that males can be infected with HPV. However, a much smaller proportion of participants (50.6%) were aware of the fact that "HPV infection is unlikely to be totally cured with therapeutic

treatment" (Table 1). Moreover, only 82.7% of participants recognized that HPV vaccinations do not guarantee complete prevention of cervical cancer completely.

3.5 The Demographic Characteristic of Participants' Attitudes Scores

Table 3 provides an overview of the attitudes scores of the participants in relation to their demographic characteristics. The mean attitudes score was placed at 21.00 ± 3.59. Participants who demonstrated a willingness to advocate for HPV vaccination held the highest mean attitudes score (22.15 ± 2.50). Conversely, those who showed reluctance towards advocating for the vaccine had the lowest score (16.85 ± 3.87).

Significantly higher attitude scores ($p < 0.05$) were observed among female participants, those who engaged in sexual activity 0-3 times per month, those whose sexual partners had not received the HPV vaccine, those who had prior knowledge of the vaccine, those willing to receive or suggest the HPV vaccine to others, those who believed the government should provide free/subsidized HPV vaccination to all eligible women, those who had scientifically accurate knowledge about HPV, those who expressed a need for additional HPV-related knowledge, and those who received HPV vaccine popular science education during their undergraduate years.

The median score for the attitude section ranged from 3 to 5 (Table 4). Moreover, 83.2% of participants expressed a desire to incorporate vaccines into routine immunizations and to broaden the availability of the HPV vaccine. However, it is worth noting that 82.1% of participants affirmed that they would encourage their sexual partners to get the HPV vaccine.

3.6 Stepwise Multivariate Logistic Regression Analysis

Table 5 features the outcomes of the stepwise multivariate logistic regression analysis. Notably, participants who had scientifically accurate knowledge about HPV and a sexual partner who had received the HPV vaccine were found to have a higher level of HPV

vaccination knowledge. Furthermore, those who are sexually active, willing to advocate for the HPV vaccine to others, express a need for further HPV-related knowledge, and are aware that certain types of HPV can cause genital warts, are more inclined to maintain a positive attitude towards the vaccine.

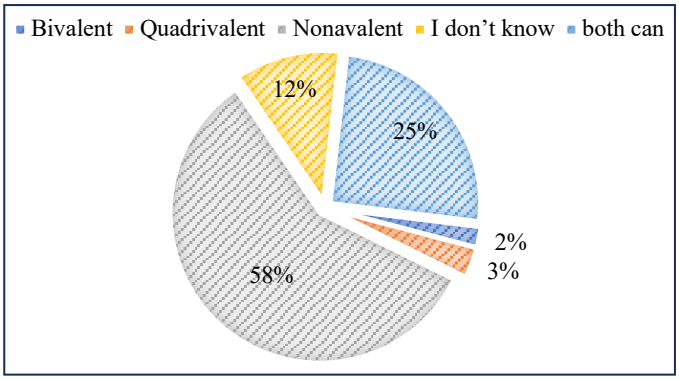
Most importantly, the factors that substantially predict a positive attitude towards HPV vaccination were identified as follow: being a female participants, possessing prior knowledge of the HPV vaccine, knowing that "it is recommended that females receive all 3 shots of HPV vaccination within 6 months", believing in their personal capacity to decide whether to get vaccinated, encouraging their sexual partners to receive the HPV vaccine, and expressing a desire to incorporate vaccines into routine immunizations as demonstrated by their willingness to receive the HPV vaccine.

3.7 Preferred HPV Vaccine of Willing Participants

When it comes to the specific types of HPV vaccines that participants preferred, the nonavalent vaccine emerged as the first choice for 58.1% of the participants, while multiple vaccines (including the bivalent, quadrivalent, and nonavalent vaccines) were chosen by 25.2% of the participants. Nonetheless, 11.3% of participants remained uncertain about which type of HPV vaccine to opt for (Figure 1).

Figure 1. Participant's willing to vaccine valent of HPV (n =743)

Items	N	%
Bivalent	16	2.2
Quadrivalent	24	3.2
Nonavalent	432	58.1
I don't know	84	11.3
Both can	187	25.2

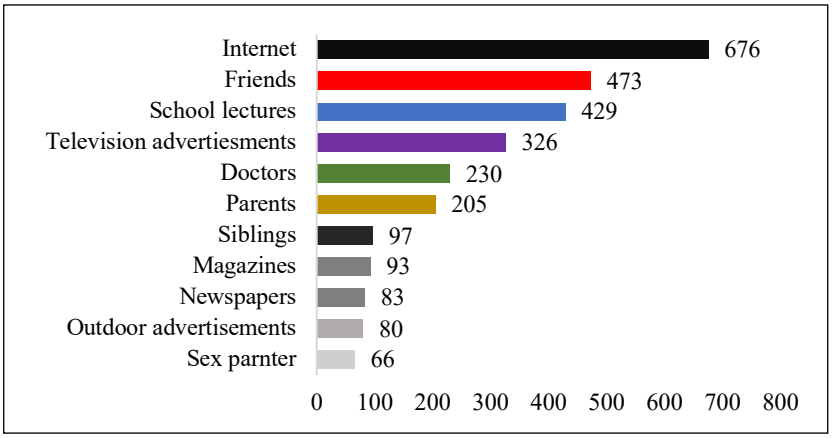


3.8 HPV Information Sources

The participants reported their primary sources of information regarding HPV to be the internet, followed by friends, and then school lectures. Other information channels included television advertisements, consultations with doctors, and discussion with parents. Interestingly, participants highlighted that their sexual partners contributed minimally to their knowledge HPV and its related vaccine (Figure 2).

Figure 2. Sources of knowledge of HPV and HPV vaccination (n = 892)

Sources of Knowledge	N	%
Sex partner	66	7.4
Outdoor advertisements	80	9.0
Newspapers	83	9.3
Magazines	93	10.4
Siblings	97	10.9
Parents	205	23.0
Doctors	230	25.8
Television advertisements	326	36.5
School lectures	429	48.1
Friends	473	53.0
Internet	676	75.8



4. Discussion

Cervical cancer, the second leading cause of cancer-related deaths among women globally, imposes a significant socioeconomic burden, especially in developing nations like China.[26]Chinese undergraduate students typically have their first sexual encounters before the age of 20,[27] and the peak prevalence of HPV infection is seen among Chinese females aged between 20 to 24.[28] Thus, providing timely vaccination of undergraduate students can substantially contribute to public health measures and prevent the onset of cervical cancer. Our study explored the factors influencing undergraduate students' willingness to receive the HPV vaccine and offers strategic suggestions to boost future vaccination rates.

Between 2016 and 2018, bivalent, quadrivalent, and nonavalent vaccines were successively introduced in mainland China. However, the overall three-dose HPV vaccine coverage rate among Guangzhou residents from October 2017 to March 2019 was extremely low, with only 0.7% of the population receiving the vaccine. Contrarily, the current study [29]found that a large majority of undergraduate students (83.2%) were open to getting the HPV vaccine, despite more than 63.3% of them expressing a need for additional information on HPV and its vaccines.

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[26] Wei M, Zhou W, Bi Y, Wang H, Liu Y, Zhang ZJ. "Rising Mortality Rate of Cervical Cancer in Younger Women in Urban China." *J Gen Intern Med*. 2019; 34(2): 281-4. Epub 2018/11/30. doi: 10.1007/s11606-018-4732-z. PubMed PMID: 30484099; PubMed Central PMCID: PMCPMC6374275; Brisson M, Kim JJ, Canfell K, Drolet M, Gingras G, Burger EA, et al. "Impact of HPV Vaccination and Cervical Screening on Cervical Cancer Elimination: A Comparative Modelling Analysis in 78 Low-income and Lower-middle-income Countries." *Lancet*. 2020; 395(10224): 575-90. Epub 2020/02/03. doi: 10.1016/s0140-6736(20)30068-4. PubMed PMID: 32007141; PubMed Central PMCID: PMCPMC7043009; Sung H, Ferlay J, Siegel RL, Laversanne M, Soerjomataram I, Jemal A, et al. "Global Cancer Statistics 2020: GLOBOCAN Estimates of Incidence and Mortality Worldwide for 36 Cancers in 185 Countries." *CA Cancer J Clin*. 2021; 71(3): 209-49. Epub 2021/02/05. doi: 10.3322/caac.21660. PubMed PMID: 33538338.

[27] Jung-kun C. "Investigation and Research on College Students' Sexual Cognition and Sexual Behavior." *Chinese Sex Science.* 27.1 (2018): 137-40.

[28] Chenchen T, Xiaoxin W, Zhe M. "Investigation on Infection of High-risk HPV in All Age Groups in Jilin Area." *Journal of Beihua University (Natural Science Edition).* 19.3 (2018): 386-8.

[29] Dai Z, Si M, Su X, Wang W, Zhang X, Gu X, et al. "Willingness to Human Papillomavirus (HPV) Vaccination and Influencing Factors among Male and Female University Students in China." *Journal of Medical Virology.* (2021). doi: 10.1002/jmv.27478.

Moreover, our research revealed a significant dependency of HPV vaccination on knowledge about HPV and its vaccines, highlighting that scientific literacy and awareness about HPV vaccines among undergraduate students are positive correlated with vaccine uptake. Interestingly, the study found carrying HPV vaccination rates among different demographic groups, with a mere 41.7% of undergraduates receiving formal HPV education. Those who were educated about HPV-related knowledge demonstrated significantly higher awareness and intent to get the HPV vaccine compared to their uneducated counterparts.[30] In addition, students with prior sexual experience exhibited a higher willingness to receive the HPV vaccine, cognizant of the fact that the vaccine's effectiveness diminishes post exposure to any HPV infection.[31] However, female undergraduate students who have not had sexual encounters should be made aware that the HPV vaccine is potentially most effective prior to exposure to any HPV infection.[32]

Amplifying health education about HPV-related information has been associated with an increase in vaccination intent among students. Hence, it is critical to underscore the importance of HPV vaccination, particularly among those who have not received HPV-related education. Enhancing the spread of relevant knowledge and information could potentially bolster vaccines popularity, ultimately leading to higher vaccination rates.

Our study found that a majority of undergraduates wish for governmental regulation on HPV vaccine pricing and for it to be included in routine vaccinations. Reducing the cost of vaccines could significantly boost vaccination rates since cost was a primary factor

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30 Xi Z, Shiyu Y, Liying S, Xiangxian F, Mingyu S, Xiaoyou S, et al. "Intervention Effect Evaluation of Health Education Based on Mobile Phone Application Software on Female College Students' Awareness of HPV Vaccine and Willingness to Vaccinate." *Modern Preventive Medicine.* 48.5 (2021): 888-92+934.

31 Chiang VC, Wong HT, Yeung PC, Choi YK, Fok MS, Mak OI, et al. "Attitude, Acceptability and Knowledge of HPV Vaccination among Local University Students in Hong Kong." *Int J Environ Res Public Health.* 13.5 (2016.05) Epub 2016/05/18. doi: 10.3390/ijerph13050486. PubMed PMID: 27187424; PubMed Central PMCID: PMCPMC4881111.

32 Meites E, Szilagyi PG, Chesson HW, Unger ER, Romero JR, Markowitz LE. "Human Papillomavirus Vaccination for Adults: Updated Recommendations of the Advisory Committee on Immunization Practices." *MMWR Morb Mortal Wkly Rep.* 68.32 (2019): 698-702. Epub 2019/08/16. doi: 10.15585/mmwr.mm6832a3. PubMed PMID: 31415491; PubMed Central PMCID: PMCPMC6818701

dissuading vaccination uptake. However, unlike many other nations, China is not a member of The Vaccine Alliance (GAVI), which could limit the financial support it receives for sustaining HPV vaccine supply.[33] Additionally, the cost of a compete three-dose immunization course in China ranges between 2500 and 3000 CNY, significantly higher than what most students, as an economically dependent group with a monthly consumption ranging between 1,000 to 1,999 CNY, can afford. Interestingly, the study found that undergraduate students who have personally received the HPV vaccinations are more likely to advocate for the vaccine among friends or sexual partners. Also, studies have shown that government-led school-based vaccinations programs achieve higher vaccination rates compared to organizations that offer free vaccinations to eligible individuals.[34] Given these findings, we recommend that China considers offering free HPV vaccines in government schools, positioning schools as optimal vaccination sites. This approach could not only increase vaccination rates but also ensure accessibility for a broader student who might otherwise not afford the vaccine.

Our study data reveals that women are statistically more inclined than men to receive HPV vaccinations. Despite a satisfactory level of HPV-related expertise demonstrated by the female population, the fact remains that most HPV-related death education is primarily aimed at women. This results in a noteworthy cognitive discrepancy between male and female students. However, it is critical to underscore the fact that in the United States, the

[33] Ma Y, Wang C, Liu F, Lian G, Li S, He Q, et al. "Human Papillomavirus Vaccination Coverage and Knowledge, Perceptions and Influencing Factors among University Students in Guangzhou, China." *Hum Vaccin Immunother.* 17.10 (2021.06): 3603-12. Epub 2021/06/23. doi: 10.1080/21645515.2021.1927411. PubMed PMID: 34156312; PubMed Central PMCID: PMCPMC8437546.

[34] Fujiwara H, Takei Y, Ishikawa Y, Saga Y, Machida S, Taneichi A, et al. "Community-based Interventions to Improve HPV Vaccination Coverage among 13- to 15-year-old Females: Measures Implemented by Local Governments in Japan." *PLoS One.* 8.12 (2013.12): e84126. Epub 2013/12/21. doi: 10.1371/journal.pone.0084126. PubMed PMID: 24358333; PubMed Central PMCID: PMCPMC3865286; Brotherton J, Gertig D, Chappell G, Rowlands L, Saville M. "Catching up with the Catch-up: HPV Vaccination Coverage Data for Australian Women Aged 18-26 Years from the National HPV Vaccination Program Register." *Commun Dis Intell Q Rep.* 35.2 (2011): 197-201. Epub 2011/10/21. PubMed PMID: 22010515.

clinical and economic toll of HPV-related oral cancer has exceeded its impact on females.[35] Regrettably, no standardized screening is exclusively directed towards females.[36] As such, it becomes imperative for China's relevant authorities to give priority to health education and policy support pertaining to male HPV infection and vaccination. The systematic abolition of gender restrictions on vaccination could contribute to elevating vaccination rates in both men and women. Broadly, efforts should be intensified to direct more HPV and its vaccine-related education and awareness towards men to ensure a balanced approach in HPV prevention and control.

The study further indicates that among participants open to receiving the HPV vaccine, the nonavalent vaccine was the preferred choice for 58.1% of students, while only a minor fraction, 2.2% and 3.2%, opted for the bivalent and quadrivalent vaccines respectively. It was also found that 28.2% of individuals were disinclined to receive the HPV vaccine due to the challenges associated with scheduling appointments. It was evident that while some individuals were not averse to vaccination, their preference leaned towards the nonavalent vaccine. However, the study suggests that the indiscriminate preference for nonavalent vaccines contributes to China's lagging HPV vaccination rate, even though bivalent and tetravalent vaccinations are domestically available. Additionally, it's estimated that every year of delay result in eight million women in China missing the optimal timeframe to receive the HPV vaccine.[37] Therefore, the authors recommend that the Chinese government and pertinent health organizations undertake initiatives to eligible population that the two-dose HPV vaccination program for young females generates the same immune

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35 Deng C, Chen X, Liu Y. Human Papillomavirus Vaccination: Coverage Rate, Knowledge, Acceptance, and Associated Factors in College Students in Mainland China. *Hum Vaccin Immunother.* 2021; 17(3): 828-35. Epub 2020/09/03. doi: 10.1080/21645515.2020.1797368. PubMed PMID: 32873128; PubMed Central PMCID: PMCPMC7993118.

36 Napolitano F, Napolitano P, Liguori G, Angelillo IF. "Human Papillomavirus Infection and Vaccination: Knowledge and Attitudes among Young Males in Italy." *Hum Vaccin Immunother.* 12.6 (2016): 1504-10. Epub 2016/04/14. doi: 10.1080/21645515.2016.1156271. PubMed PMID: 27070042; PubMed Central PMCID: PMCPMC4964675.

37 Meng Z, Konkasun, Lumiao J, Huiying L. "Investigation and Research on the Status quo of HPV Vaccine Awareness among Rural Women in Henan Province." *Health Professions Education.* 37.18 (2019): 108-10.

response as the three-dose program. The two-dose HPV vaccination regimen is also presents a more convenient than the three-dose scheme, which could positively increase vaccine uptake and enhance vaccination rates.[38]

According to the study, vaccine safety concerns are making some undergraduate students in Guangzhou apprehensive, thus influencing their unwillingness to get vaccinated, potentially a reflection of vaccine conspiracy theories influence.[39] This finding corroborates earlier research which associated vaccine conspiracy beliefs with reluctance towards the COVID-19 vaccine, a phenomenon not limited to newly approved vaccines designed to combat the pandemic.[40] Furthermore, it is important to note the impact of the internet and social media platforms on shaping the HPV vaccination attitudes among undergraduate students. Massey et al. [41]in a prior study highlighted how anti-vaccination advocates may exploit social media platforms like Instagram and YouTube to disseminate misinformation and disinformation. Therefore, emphasizing robust fact-checking and ensuring the provision of accurate, authoritative information on HPV vaccines becomes a critical measure in preventing the spread of false information.[42]

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38 Bergman H, Buckley BS, Villanueva G, Petkovic J, Garritty C, Lutje V, et al. "Comparison of Different Human Papillomavirus (HPV) Vaccine Types and Dose Schedules for Prevention of HPV-related Disease in Females and Males." *Cochrane Database of Systematic Reviews*. 11 (2019). doi: 10.1002/14651858.CD013479. PubMed PMID: CD013479.

39 Sallam M, Al-Mahzoum K, Eid H, Assaf AM, Abdaljaleel M, Al-Abbadi M, et al. "Attitude towards HPV Vaccination and the Intention to Get Vaccinated among Female University Students in Health Schools in Jordan." *Vaccines (Basel).* 9.12 (2021.12) Epub 2021/12/29. doi: 10.3390/vaccines9121432. PubMed PMID: 34960177; PubMed Central PMCID: PMCPMC8707789.

40 Sallam M, Dababseh D, Eid H, Hasan H, Taim D, Al-Mahzoum K, et al. "Low COVID-19 Vaccine Acceptance Is Correlated with Conspiracy Beliefs among University Students in Jordan." *Int J Environ Res Public Health.* 18.5 (2021.04) Epub 2021/04/04. doi: 10.3390/ijerph18052407. PubMed PMID: 33804558; PubMed Central PMCID: PMCPMC7967761.

41 Andrade G. "Covid-19 Vaccine Hesitancy, Conspiracist Beliefs, Paranoid Ideation and Perceived Ethnic Discrimination in a Sample of University Students in Venezuela." *Vaccine.* 39.47 (2021.10): 6837-42. Epub 2021/10/30. doi: 10.1016/j.vaccine.2021.10.037. PubMed PMID: 34711439; PubMed Central PMCID: PMCPMC8531467.

42 Canfell K, Kim JJ, Brisson M, Keane A, Simms KT, Caruana M, et al. "Mortality Impact of Achieving WHO Cervical Cancer Elimination Targets: A Comparative Modelling Analysis in 78 Low-income and Lower-middle-income Countries." *The Lancet*. 395.10224 (2020): 591-603. doi: 10.1016/s0140-6736(20)30157-4.

In 2018, the WHO Director-General put forth a call to action aiming at eliminating cervical cancer as a global public health problem. It was projected that a rapid expansion of immunization through a broad-spectrum HPV vaccine to achieve a global coverage of 80-100% could prevent 6.7-7.7 million HPV cases by 2020, with over half of these cases prevented beyond 2060.[43] A recent study indicated that the implementation of a triple intervention approach - vaccination, screening, and therapy - could avert 620 million deaths and reduce mortality by 99%, as compared to a 90% reduction (45.8 million deaths) with immunization.[44] Consequently, it becomes of utmost importance to thoroughly examine the actual circumstances of undergraduate students, heighten the publicity and intervention efforts for the HPV vaccine, and provide the public with accurate and authoritative information on HPV vaccines. The authors recommend including the HPV vaccine in the national vaccination program, or exploring options such as incorporating the vaccine into medical insurance and investigating a feasible cost-sharing mechanism. Furthermore, formulating HPV vaccination policies tailored to China's unique conditions and amplifying the HPV vaccination rate and willingness among students is crucial. By taking these steps, China can significantly alleviate the burden of HPV-related diseases and make a significant contribution to the WHO's objective of eradicating cervical cancer as a public health issue.

5. Limitations and Strengths

This study bears several limitations worth acknowledging. Given its cross-sectional design, certain items may be susceptible to recall bias, and despite efforts to minimize it

[43] Simms KT, Steinberg J, Caruana M, Smith MA, Lew JB, Soerjomataram I, et al. "Impact of Scaled up Human Papillomavirus Vaccination and Cervical Screening and the Potential for Global Elimination of Cervical Cancer in 181 Countries, 2020-99: A Modelling Study." *Lancet Oncol*. 20.3 (2019.02): 394-407. Epub 2019/02/24. doi: 10.1016/s1470-2045(18)30836-2. PubMed PMID: 30795950.

[44] Canfell K, Kim JJ, Brisson M, Keane A, Simms KT, Caruana M, et al. "Mortality Impact of Achieving WHO Cervical Cancer Elimination Targets: A Comparative Modelling Analysis in 78 Low-income and Lower-middle-income Countries." *The Lancet*. 2020;395 (10224): 591-603. doi: 10.1016/s0140-6736(20)30157-4.

through self-administration of the questionnaire, the existence of social desirability bias cannot be ruled out. Furthermore, due to time and manpower constraints, a single-center convenience sample was utilized for data collection, potentially leading to selection bias. The study's sample size was also relatively small, encompassing merely 892 participants. Also noteworthy is the fact that ethical restrictions on maintaining anonymity and confidentiality barred the collection of participants' contact information and personal data, thereby ultimately hindered the ability to conduct a prospective study that could underpin a targeted public health strategy with empirical evidence.

Despite these limitations, this study nonetheless marks significant contributions to the existing body of literature on HPV vaccination in China. It uniquely identified the payment of vaccine costs by insurance companies as a determinant influencing students' willingness to receive the HPV vaccination, an aspect hitherto unexplored by previous Chinese studies. Besides, the study considered a variety of factors that could affect student knowledge, attitudes, and willingness towards HPV vaccination, including sexual experience, past history of sexually transmitted infection, relationship status, frequency of sexual activity, and the vaccination status of sexual partners. Thus, while acknowledging its limitations, this study undeniably provides valuable insights into strategies for promoting HPV vaccination among undergraduate students in China.

6. Conclusion

In our survey of 892 undergraduate students in China, we assessed their knowledge and attitudes towards HPV, as well as their willingness to receive vaccination. Although a substantial majority, 83.3%, expressed willingness to receive the vaccine, the actual vaccination rate remained starkly low, indicating a crucial need for more extensive promotion of knowledge. Importantly, we found that those who were aware of the HPV vaccine and encouraged their partners to receive it displayed a higher willingness to receive the vaccine. Based on these findings, we advocate for the amplification of awareness campaigns, effective regulation of vaccine costs, and the comprehensive implementation

of immunization programs. These measures could considerably improve vaccination rates and thereby contribute towards the prevention of cervical cancer in China.

Bibliography (Reference to table 1-2)

[1] Parkin DM. "The Global Health Burden of Infection-associated Cancers in the Year 2002." *Int J Cancer* 118.12 (2006.01): 3030-44. doi: 10.1002/ijc.21731.

[2] Szymonowicz KA, Chen J. "Biological and Clinical Aspects of HPV-related Cancers." *Cancer Biol Med* 17.4 (2020.12): 864-78. doi: 10.20892/j.issn.2095-3941.2020.0370.

[3] Wei M, Zhou W, Bi Y, Wang H, Liu Y, Zhang ZJ. "Rising Mortality Rate of Cervical Cancer in Younger Women in Urban China." *J Gen Intern Med*. 34.2 (2019): 281-4. Epub 2018/11/30. doi: 10.1007/s11606-018-4732-z. PubMed PMID: 30484099; PubMed Central PMCID: PMCPMC6374275.

[4] Brisson M, Kim JJ, Canfell K, Drolet M, Gingras G, Burger EA, et al. "Impact of HPV Vaccination and Cervical Screening on Cervical Cancer Elimination: A Comparative Modelling Analysis in 78 Low-income and Lower-middle-income Countries," *Lancet* 395.10224 (2020.02): 575-90. Epub 2020/02/03. doi: 10.1016/s0140-6736(20)30068-4. PubMed PMID: 32007141; PubMed Central PMCID: PMCPMC7043009.

[5] Ferlay J, Colombet M, Soerjomataram I, Mathers C, Parkin DM, Piñeros M, et al. "Estimating the global cancer incidence and mortality in 2018: GLOBOCAN sources and methods," *International Journal of Cancer* 144.8 (2019.04): 1941-53. Epub 2018/10/24. doi: 10.1002/ijc.31937. PubMed PMID: 30350310.

[6] Sung H, Ferlay J, Siegel RL, Laversanne M, Soerjomataram I, Jemal A, et al. "Global Cancer Statistics 2020: GLOBOCAN Estimates of Incidence and Mortality Worldwide for 36 Cancers in 185 Countries," *CA: A Cancer Journal for Clinicians* 71.3 (2021.03): 209-49. Epub 2021/02/05. doi: 10.3322/caac.21660. PubMed PMID: 33538338.

[7] CDC, n.d. "HPV-Associated Cancer Statistics." Accessed n.d. https://www.cdc.gov/cancer/hpv/statistics/index.htm.

[8] Yanofsky VR, Patel RV, "Goldenberg G. Genital Warts: A Comprehensive Review." *J*

Clin Aesthet Dermatol. 5.6 (2012.07): 25-36. PubMed PMID: 22768354; PubMed Central PMCID: PMCPMC3390234 conflicts of interest.

[9] Patel H, Wagner M, Singhal P, Kothari S. "Systematic Review of the Incidence and Prevalence of Genital Warts." *BMC Infect Dis.* 13.39 (2013.01) doi: 10.1186/1471-2334-13-39. PubMed PMID: 23347441; PubMed Central PMCID: PMCPMC3618302.

[10] You D, Han L, Li L, Hu J, Zimet GD, Alias H, et al. "Human Papillomavirus (HPV) Vaccine Uptake and the Willingness to Receive the HPV Vaccination among Female College Students in China: A Multicenter Study." *Vaccines (Basel)*. 8.1 (2020): doi: 10.3390/vaccines8010031. PubMed PMID: 31963370; PubMed Central PMCID: PMCPMC7157221.

[11] Deng C, Chen X, Liu Y. "Human Papillomavirus Vaccination: Coverage Rate, Knowledge, Acceptance, and Associated Factors in College Students in Mainland China." *Hum Vaccin Immunother*. 17.3 (2021): 828-35. Epub 2020/09/03. doi: 10.1080/21645515.2020.1797368. PubMed PMID: 32873128; PubMed Central PMCID: PMCPMC7993118.

[12] World Health Organization. "Human Papillomavirus Vaccines: WHO Position Paper." *Biologicals.* 37.5 (2009.06): 338-44. Epub 2009/06/16. doi: 10.1016/j.biologicals.2009.04.005. PubMed PMID: 19525124.

[13] Dong M, Yan W, Ou L, Wenchang W. "Human Papillomavirus Vaccines: WHO Position Paper, May 2017-Recommendations." *Vaccine*. 35.43 (2017.06): 5753-5. Epub 2017/06/10. doi: 10.1016/j.vaccine.2017.05.069. PubMed PMID: 28596091.

[14] Gultekin M, Ramirez PT, Broutet N, Hutubessy R. "World Health Organization Call for Action to Eliminate Cervical Cancer Globally." *Int J Gynecol Cancer*. 30.4 (2020.03): 426-7. Epub 2020/03/04. doi: 10.1136/ijgc-2020-001285. PubMed PMID: 32122950.

[15] Drolet M, Bénard É, Pérez N, Brisson M. "Population-level Impact and Herd Effects Following the Introduction of Human Papillomavirus Vaccination Programmes:

Updated Systematic Review and Meta-analysis." *Lancet.* 394.10197 (2019): 497-509. Epub 2019/07/01. doi: 10.1016/s0140-6736(19)30298-3. PubMed PMID: 31255301; PubMed Central PMCID: PMCPMC7316527.

[16] Muñoz N, Kjaer SK, Sigurdsson K, Iversen OE, Hernandez-Avila M, Wheeler CM, et al. "Impact of Human Papillomavirus (HPV)-6/11/16/18 vaccine on all HPV-associated Genital Diseases in Young Women." *J Natl Cancer Inst*. 102.5 (2010.02): 325-39. Epub 2010/02/09. doi: 10.1093/jnci/djp534. PubMed PMID: 20139221.

[17] Lehtinen M, Paavonen J, Wheeler CM, Jaisamrarn U, Garland SM, Castellsagué X, et al. "Overall Efficacy of HPV-16/18 AS04-adjuvanted Vaccine Against Grade 3 or Greater Cervical Intraepithelial Neoplasia: 4-year End-of-study Analysis of the Randomised, Double-blind PATRICIA Trial." *Lancet Oncol*. 13.1 (2012): 89-99. Epub 2011/11/15. doi: 10.1016/s1470-2045(11)70286-8. PubMed PMID: 22075171.

[18] Markowitz LE, Tsu V, Deeks SL, Cubie H, Wang SA, Vicari AS, et al. "Human Papillomavirus Vaccine Introduction–the First Five Years." *Vaccine.* 30 Suppl 5 (2012.12): F139-48. Epub 2012/12/05. doi: 10.1016/j.vaccine.2012.05.039. PubMed PMID: 23199957.

[19] "Human papillomavirus vaccines: WHO position paper, May 2017." *Wkly Epidemiol Rec*. 92.19 (2017.05): 241-68. Epub 2017/05/23. PubMed PMID: 28530369.

[20] Jennings MC, Loharikar A. "A Vaccine Against Cervical Cancer: Context for the Global Public Health Practitioner." *Global Health: Science and Practice*. 6.4 (2018): 629-34. doi: 10.9745/ghsp-d-18-00222.

[21] China National Medical Products Administration. n.d "HPV Vaccine and Prevention of Cervical Cancer [in Chinese]." Accessed March 31, 2022. https://www.nmpa.gov.cn/yaopin/ypjgdt/20190722080001877.html.

[22] World Health Organization. "Working Group on Potential Contribution of Human Papillomavirus (HPV) Vaccines and Immunization towards Cervical Cancer Elimination Strategic Advisory Group of Experts (SAGE) on Immunizationa" *WHO*. Accessed 2019.

https://www.who.int/immunization/sage/meetings/2019/october/1_HPV_SAGE2019WG_for_SAGE.pdf.

[23] Mansfield LN, Silva SG, Merwin EI, Chung RJ, Gonzalez-Guarda RM. "Factors Associated with Human Papillomavirus Vaccine Series Completion among Adolescents." *Am J Prev Med*. 61.5 (2021.07): 701-8. Epub 2021/07/15. doi: 10.1016/j.amepre.2021.04.031. PubMed PMID: 34256974.

[24] Wang X, Du T, Shi X, Wu K. "Awareness and Knowledge about Human Papilloma Virus Infection among Students at Secondary Occupational Health School in China." *Int J Environ Res Public Health.* 18.12 (2021.07). Epub 2021/07/03. doi: 10.3390/ijerph18126321. PubMed PMID: 34207971; PubMed Central PMCID: PMCPMC8296127.

[25] Yin G, Zhang Y, Chen C, Ren H, Guo B, Zhang M. "Have You Ever Heard of Human Papillomavirus (HPV) Vaccine? The Awareness of HPV Vaccine for College Students in China Based on Meta-analysis." *Hum Vaccin Immunother*. 17.8 (2021.04): 2736-47. Epub 2021/04/01. doi: 10.1080/21645515.2021.1899731. PubMed PMID: 33787459; PubMed Central PMCID: PMCPMC8475627.

[26] Wen Y, Pan XF, Zhao ZM, Chen F, Fu CJ, Li SQ, et al. "Knowledge of Human Papillomavirus (HPV) Infection, Cervical Cancer, and HPV Vaccine and its Correlates among Medical Students in Southwest China: A Multi-center Cross-sectional Survey." *Asian Pac J Cancer Prev.* 15.14 (2014): 5773-9. Epub 2014/08/02. doi: 10.7314/apjcp.2014.15.14.5773. PubMed PMID: 25081700.

[27] Zhou L, Wang J, Cheng P, Li Y, Liu G, Zhang X. "HPV Vaccine Hesitancy among Medical Students in China: A Multicenter Survey." *Front Public Health*. 10 (2022.03): 774767. Epub 2022/03/11. doi: 10.3389/fpubh.2022.774767. PubMed PMID: 35265570; PubMed Central PMCID: PMCPMC8900914.

[28] Xiaoxiao Z, Jinjing S, Yanyang Z, Wenzhou Y."A Meta-analysis of Human Papillomavirus Vaccine Awareness and Vaccination Willingness of College Students in Mainland China." China Vaccines and Immunization. 25.3 (2019): 308-12.

[29] Jie Z, Jiayi Z, Minhui P, Jianwei Y, Xiongfei C, Xiaomei D. "Intention to Vaccinate HPV Vaccine among College Students in Guangzhou and Its Influencing Factors." *Chinese Journal of Disease Control.* 22.9 (2018.09): 965-7+71. doi: 10.16462/j.cnki.zhjbkz.2018.09.022.

[30] Gao E, Zuo X, Wang L, Lou C, Cheng Y, Zabin LS. "How Does Traditional Confucian Culture Influence Adolescents' Sexual Behavior in Three Asian Cities? " *J Adolesc Health.* 50.3 (2012): S12-S7. doi: 10.1016/j.jadohealth.2011.12.002. PubMed PMID: 22340851.

[31] Leung JTC, Law CK. "Revisiting Knowledge, Attitudes and Practice (KAP) on Human Papillomavirus (HPV) Vaccination among Female University Students in Hong Kong." *Hum Vaccin Immunother.* 14.4 (2018): 924-30. Epub 2017/12/13. doi: 10.1080/21645515.2017.1415685. PubMed PMID: 29232166; PubMed Central PMCID: PMCPMC5893186.

[32] Trucchi C, Amicizia D, Tafuri S, Sticchi L, Durando P, Costantino C, et al. "Assessment of Knowledge, Attitudes, and Propensity towards HPV Vaccine of Young Adult Students in Italy." *Vaccines (Basel)*. 8.1 (2020): 74. doi: 10.3390/vaccines8010074. PubMed PMID: 32046039.

[33] Kim HW, Lee EJ, Lee YJ, Kim SY, Jin YJ, Kim Y, et al. "Knowledge, Attitudes, and Perceptions Associated with HPV Vaccination among Female Korean and Chinese University Students." *BMC Women's Health.* 22.1 (2022): 51. doi: 10.1186/s12905-022-01624-1.

[34] World Health Organization & Stop TB Partnership. "Advocacy, Communication and Social Mobilization for TB control: A Guide to Developing Knowledge, Attitude and Practice Surveys." *Geneva: World Health Organization*; 2008.

[35] Rui R, Chun-hwan J, Yong H, Jianxiong X. "Analysis of HPV Vaccination Willingness and Its Influencing Factors among Women in Guangzhou." *Chinese Public Health.* 37.12 (2021): 1751-5.

[36] Charan J, Biswas T. "How to Calculate Sample Size for Different Study Designs in

Medical Research?" *Indian J Psychol Med.* 35.2 (2013.09): 121-6. Epub 2013/09/21. doi: 10.4103/0253-7176.116232. PubMed PMID: 24049221; PubMed Central PMCID: PMCPMC3775042.

[37] Qing L, Peach, Qiuwen L, Peiyu F, Ziwei Z, Shizhen C. "Cognitive Status and Related Factors of HPV Vaccine among Some College Students in Guangdong Province." *Primary health care in China.* 36.1 (2022): 82-5.

[38] Jung-kun C. "Investigation and Research on College Students' Sexual Cognition and Sexual Behavior." *Chinese Sex Science.* 27.1 (2018): 137-40.

[39] Chenchen T, Xiaoxin W, Zhe M. "Investigation on Iinfection of High-risk HPV in All Age Groups in Jilin Area." *Journal of Beihua University (Natural Science Edition).* 19.3 (2018): 386-8.

[40] Dai Z, Si M, Su X, Wang W, Zhang X, Gu X, et al. "Willingness to Human Papillomavirus (HPV) Vaccination and Influencing Factors among Male and Female University Students in China." *Journal of Medical Virology.* (2021). doi: 10.1002/jmv.27478.

[41] Xi Z, Shiyu Y, Liying S, Xiangxian F, Mingyu S, Xiaoyou S, et al. "Intervention Effect Evaluation of Health Education Based on Mobile Phone Application Software on Female College Students' Awareness of HPV Vaccine and Willingness to Vaccinate." *Modern Preventive Medicine.* 48.5 (2021): 888-92+934.

[42] Chiang VC, Wong HT, Yeung PC, Choi YK, Fok MS, Mak OI, et al. "Attitude, Acceptability and Knowledge of HPV Vaccination among Local University Students in Hong Kong." *Int J Environ Res Public Health.* 13.5 (2016.05) Epub 2016/05/18. doi: 10.3390/ijerph13050486. PubMed PMID: 27187424; PubMed Central PMCID: PMCPMC4881111.

[43] Meites E, Szilagyi PG, Chesson HW, Unger ER, Romero JR, Markowitz LE. "Human Papillomavirus Vaccination for Adults: Updated Recommendations of the Advisory Committee on Immunization Practices." *MMWR Morb Mortal Wkly Rep.* 68.32 (2019): 698-702. Epub 2019/08/16. doi: 10.15585/mmwr.mm6832a3. PubMed

PMID: 31415491; PubMed Central PMCID: PMCPMC6818701 potential conflicts of interest. No potential conflicts of interest were disclosed.

[44] Ma Y, Wang C, Liu F, Lian G, Li S, He Q, et al. "Human Papillomavirus Vaccination Coverage and Knowledge, Perceptions and Influencing Factors among University Students in Guangzhou, China." *Hum Vaccin Immunother.* 17.10 (2021.06): 3603-12. Epub 2021/06/23. doi: 10.1080/21645515.2021.1927411. PubMed PMID: 34156312; PubMed Central PMCID: PMCPMC8437546.

[45] Fujiwara H, Takei Y, Ishikawa Y, Saga Y, Machida S, Taneichi A, et al. "Community-based Interventions to Improve HPV Vaccination Coverage among 13- to 15-year-old Females: Measures Implemented by Local Governments in Japan." *PLoS One.* 8.12 (2013.12):e84126. Epub 2013/12/21. doi: 10.1371/journal.pone.0084126. PubMed PMID: 24358333; PubMed Central PMCID: PMCPMC3865286.

[46] Brotherton J, Gertig D, Chappell G, Rowlands L, Saville M. "Catching up with the Catch-up: HPV Vaccination Coverage Data for Australian Women Aged 18-26 Years from the National HPV Vaccination Program Register." *Commun Dis Intell Q Rep.* 35.2 (2011): 197-201. Epub 2011/10/21. PubMed PMID: 22010515.

[47] Napolitano F, Napolitano P, Liguori G, Angelillo IF. "Human Papillomavirus Infection and Vaccination: Knowledge and Attitudes among Young Males in Italy." *Hum Vaccin Immunother.* 12.6 (2016): 1504-10. Epub 2016/04/14. doi: 10.1080/21645515.2016.1156271. PubMed PMID: 27070042; PubMed Central PMCID: PMCPMC4964675.

[48] Meng Z, Konkasun, Lumiao J, Huiying L. "Investigation and Research on the Status quo of HPV Vaccine Awareness among Rural Women in Henan Province." *Health Professions Education.* 37.18 (2019): 108-10.

[49] Bergman H, Buckley BS, Villanueva G, Petkovic J, Garritty C, Lutje V, et al. Comparison of Different Human Papillomavirus (HPV) Vaccine Types and Dose Schedules for Prevention of HPV-related Disease in Females and Males. Cochrane Database of Systematic Reviews. 11 (2019). doi: 10.1002/14651858.CD013479.

PubMed PMID: CD013479.

[50] Sallam M, Al-Mahzoum K, Eid H, Assaf AM, Abdaljaleel M, Al-Abbadi M, et al. "Attitude towards HPV Vaccination and the Intention to Get Vaccinated among Female University Students in Health Schools in Jordan." *Vaccines (Basel).* 9.12 (2021.12) Epub 2021/12/29. doi: 10.3390/vaccines9121432. PubMed PMID: 34960177; PubMed Central PMCID: PMCPMC8707789.

[51] Sallam M, Dababseh D, Eid H, Hasan H, Taim D, Al-Mahzoum K, et al. "Low COVID-19 Vaccine Acceptance Is Correlated with Conspiracy Beliefs among University Students in Jordan." *Int J Environ Res Public Health.* 18.5 (2021.04) Epub 2021/04/04. doi: 10.3390/ijerph18052407. PubMed PMID: 33804558; PubMed Central PMCID: PMCPMC7967761.

[52] Andrade G. "Covid-19 Vaccine Hesitancy, Conspiracist Beliefs, Paranoid Ideation and Perceived Ethnic Discrimination in a Sample of University Students in Venezuela." *Vaccine.* 39.47(2021.10):6837-42. Epub 2021/10/30. doi: 10.1016/j.vaccine.2021.10.037. PubMed PMID: 34711439; PubMed Central PMCID: PMCPMC8531467.

[53] Simms KT, Steinberg J, Caruana M, Smith MA, Lew JB, Soerjomataram I, et al. "Impact of Scaled up Human Papillomavirus Vaccination and Cervical Screening and the Potential for Global Elimination of Cervical Cancer in 181 Countries, 2020-99: A Modelling Study." *Lancet Oncol.* 20.3 (2019.02): 394-407. Epub 2019/02/24. doi: 10.1016/s1470-2045(18)30836-2. PubMed PMID: 30795950.

[54] Canfell K, Kim JJ, Brisson M, Keane A, Simms KT, Caruana M, et al. "Mortality Impact of Achieving WHO Cervical Cancer Elimination Targets: A Comparative Modelling Analysis in 78 Low-income and Lower-middle-income Countries." *The Lancet.* 395.10224 (2020): 591-603. doi: 10.1016/s0140-6736(20)30157-4.

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Disclaimer

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Informed consent and patient details

The study was conducted following the principles of the Declaration of Helsinki. Ethical permission was obtained from the local ethic committee.

Authors' Contributions

Conceptualization: CC and SX. Data curation, methodology, formal analysis validation and visualization: CC, WC, XW, SX. Investigation: WC and CC. Project administration and Resources: CC, WC, XW, SX. Writing – original draft: CC, WC, XW. Supervision and Writing – review & editing: CC and SX.

Supplementary Material

Table 1. Results of descriptive statistics and univariate regression analyses.				
	% (Unless specified)	Model 1	Model 2	Model 3
		OR (95% CI)		
Basic profile				
Female	62.0	0.875 (0.667-1.147)	2.398 (1.818-3.163) **	5.361 (3.931-7.313) **
Age (years)	21.3	1.079 (1.015-1.147) *	1.038 (0.978-1.102)	1.051 (0.982-1.124)
Have sex experience (Ref. don't have)	29.6	1.129 (0.846-1.506)	1.119 (0.838-1.493)	1.049 (0.764-1.440)
Uncommon sexual acts experience# (Ref. don't have)	3.4	0.482 (0.113-2.058)	0.829 (0.203-3.386)	1.220 (0.241-6.182)
Have sexual partner (Ref. don't have)	65.9	1.446 (0.867-2.412)	0.579 (0.344-0.972) *	1.185 (0.680-2.068)
Frequency of sex (monthly) (Ref. 0-3 times)				
3-6 times	13.8	1.262 (0.513-3.104)	0.620 (0.257-1.493)	0.469 (0.185-1.188)
over 7 times	15.5	1.101 (0.472-2.568)	0.166 (0.059-0.469) **	0.352 (0.147-0.840) *
The sexual partner has been received the HPV vaccine (Ref. Yes)				
No	22.4	0.285 (0.121-0.671) **	1.203 (0.584-2.479)	2.054 (0.949-4.442)
Don't know	69.0	0.226 (0.063-0.810) *	0.383 (0.104-1.412)	1.250 (0.357-4.374)
Had heard HPV vaccine previously (Ref. No)	86.7	1.607 (1.017-2.539) *	3.678 (1.982-6.825) **	7.779 (4.230-14.306) **
Have Family history of cancer (ref. don't have)	9.8	1.468 (0.855-2.520)	1.123 (0.720-1.751)	1.041 (0.639-1.697)
Believed that government should provide free/ subsidized HPV vaccination to all eligible women (Ref. don't believed)	93.6	1.262 (0.737-2.160)	4.534 (2.364-8.695) **	3.912 (2.256-6.784) **

Scientifically gained knowledge about HPV (Ref. No)	72.4	1.566 (1.165-2.104) **	1.619 (1.204-2.176) **	2.881 (2.112-3.929) **
Needs for further HPV-related knowledge (Ref. don't need)	63.3	1.408 (1.071-1.851) *	1.501 (1.141-1.973) **	2.143 (1.596-2.878) **
Have received classroom health education on HPV (Ref. don't have)	41.7	1.286 (0.984-1.681)	0.885 (0.678-1.156)	1.270 (0.946-1.706)
Time to first receive HPV vaccine popularization education (Ref. Never had)				
Primary school	5.4	1.631 (0.848-3.137)	0.561 (0.282-1.118)	0.834 (0.435-1.599)
Junior school	11.2	1.269 (0.765-2.105)	1.187 (0.716-1.968)	1.490 (0.883-2.515)
High school	28.4	1.597 (1.065-2.395) *	1.413 (0.944-2.117)	2.416 (1.570-3.717) **
University	38.0	1.542 (1.049-2.267) *	1.821 (1.238-2.680) **	2.526 (1.680-3.797) **
Willingness receive HPV vaccination (Ref. unwillingness)	83.3	1.507 (1.058-2.147) *	3.443 (2.342-5.061) **	-
Willingness to recommend the HPV vaccine to others	78.3	1.916 (1.386-2.649) **	7.783 (5.215-11.618) **	-
Knowledge				
Know that "cervical cancer is mainly caused by HPV infections"	86.2	-	1.748 (1.187-2.573) **	2.655 (1.801-3.915) **
Know that "certain types of HPV can cause genital warts"	89.7	-	3.150 (1.959-5.064) **	3.818 (2.453-5.943) **
Know that "HPV is sexually transmitted"	79.6	-	1.237 (0.893-1.714)	1.674 (1.190-2.355)**
Know that "HPV infection is not likely to be completely cured by clinical treatment"	50.6	-	0.962 (0.740-1.252)	1.044 (0.782-1.392)
Know that "most	77.1	-	1.402 (1.025-1.918*	1.883 (1.357-2.612) **

sexually active women are infected by HPV at some points in their lives"				
Know that "Using condoms does not prevent 100% HPV infection"	89.3	-	2.519 (1.604-3.954) **	2.902 (1.884-4.469) **
Know that "it is recommended that females should receive all 3 shots of HPV vaccination within a 6-month period"	70.7	-	1.454 (1.089-1.943) *	1.657 (1.218-2.253) **
Know that "Male can be infected with HPV"	86.4	-	1.904 (1.286-2.818) **	2.542 (1.720-3.757) **
Attitudes				
Agree that "Increase the availability of HPV vaccine"	84.2	1.577 (1.097-2.266) *	-	61.431 (31.438-120.040) **
Agree that "Hope the insurance company will cover the cost"	73.3	1.852 (1.371-2.502) **	-	8.646 (6.190-12.076) **
Agree that "Looking to incorporate vaccines into routine vaccinations"	83.2	1.580 (1.109-2.251) *	-	31.862 (19.007-53.412) **
Agree that "Ability to self-determine whether to get vaccinated"	82.1	1.710 (1.209-2.417) *	-	24.091 (15.192-38.202) **
Agree that "Encouraged sexual partners to get HPV vaccine"	82.1	2.066 (1.455-2.935) **	-	28.648 (17.700-46.369) **
Remark: * = p<0.05; ** = p<0.01; # = prostitution, multiple sexual partners, threesomes, orgy etc.; CNY: Chinese Yuan.				

Table 2. Reasons for willingness or NOT willingness HPV vaccination				
Reasons for willingness against HPV vaccination N = (743)	**Yes**		**No**	
	n	**(%)**	**n**	**(%)**
Protect personal health	729	98.1	18	2.4
The HPV vaccine is safe and effective	440	59.2	303	15.5
Protect the health of family	424	57.1	319	16.4
Suggestions from family/friends	228	30.7	515	26.4
Publicity	221	29.7	522	26.8
Recommended by doctor	140	18.8	603	30.9
Reasons for NOT willingness against HPV vaccination N = (149)	**Yes**		**No**	
	n	**(%)**	**n**	**(%)**
HPV infection is not present	65	43.6	84	56.4
Expensive	57	38.3	92	61.7
Difficulty making an appointment	42	28.2	107	71.8
Worry about safety and side effects	42	28.2	107	71.8
No time / inconvenient for vaccination	26	17.4	123	82.6
Vaccines have not been widely promoted	24	16.1	125	83.9
Need to be vaccinated in batches, which is very troublesome	23	15.4	126	84.6
Physical reasons	17	11.4	132	88.6
Fear of injections	17	11.4	132	88.6
Do not trust the preventive effect of vaccines	10	6.7	139	93.3
Have adverse physical and psychological reactions to other vaccines	3	2.0	146	98.0

Table 3. Demographic characteristics of participants' knowledge and attitudes scores

Characteristics	Knowledge			Attitudes		
	Mean (SD)	Statistics	P-value	Mean (SD)	Statistics	P-value
Sex		-1.169	0.243		-7.109	<0.001
Male	6.21 (1.87)			19.86 (4.14)		
Female	6.35 (1.55)			21.69 (3.01)		
Family history of cancer		2.241	0.027		0.739	0.462
No	6.26 (1.71)			20.97 (3.58)		
Yes	6.62 (1.38)			21.28 (3.74)		
Have sex experience		1.975	0.049		1.373	0.170
No	6.23 (1.74)			20.89 (3.55)		
Yes	6.46 (1.51)			21.25 (3.68)		
Uncommon sexual acts experience		-1.192	0.271		0.099	0.924
No	6.49 (1.47)			21.25 (3.69)		
Yes	5.50 (2.33)			21.38 (3.50)		
Sexual partner		1.165	0.246		-1.481	0.140
No partner	6.30 (1.67)			21.71 (3.54)		
Have a partner	6.54 (1.41)			21.02 (3.74)		
Frequency of sex (monthly)		0.462	0.631		8.311	<0.001
0-3 times	6.55 (1.30)			21.62 (3.29)		
3-6 times	6.71 (1.23)			20.75 (3.27)		
7-9 times	6.33 (1.98)			18.52 (4.96)		
Sexual partner has been received the HPV vaccine		4.082	0.019		3.749	0.026
Yes	7.05 (1.19)			21.15 (4.19)		
No	6.44 (1.41)			21.28 (3.34)		
I don't know	6.00 (1.65)			18.53 (4.84)		
Had heard HPV vaccine		2.649	0.01		5.291	<0.001

previously						
No	5.47 (2.47)			18.14 (4.26)		
Yes	6.35 (1.60)			21.19 (3.46)		
Received HPV vaccination		3.638	<0.001			<0.001
Not willing	5.75 (2.08)			18.46 (4.22)	8.339	
Willing	6.41 (1.56)			21.50 (3.22)		
Willingness to recommend the HPV vaccine to others		-5.771	<0.001		-18.064	<0.001
Not willing	5.52 (2.30)			16.85 (3.87)		
Willing	6.51 (1.39)			22.15 (2.50)		
Government should provide free/ subsidized HPV vaccination to all eligible women		1.823	0.073		7.195	<0.001
No	5.81 (2.13)			17.89 (3.35)		
Yes	6.33 (1.64)			21.21 (3.51)		
Scientifically gained knowledge about HPV		2.454	0.015		4.442	<0.001
No	6.07 (1.78)			20.09 (3.01)		
Yes	6.38 (1.63)			21.34 (3.40)		
Needs for further of HPV-related knowledge		2.885	0.004		3.359	0.001
No	6.08 (1.77)			20.47 (3.57)		
Yes	6.42 (1.61)			21.30 (3.57)		
Have received classroom health education on HPV		1.178	0.239		-0.194	0.846
No	6.24 (1.63)			21.02 (3.53)		
Yes	6.38 (1.75)			20.97 (3.68)		
Time to first receive HPV vaccine popularization education		3.038	0.017		6.917	<0.001
Never had	5.93 (1.93)			20.36 (3.77)		
Primary school	6.08 (2.29)			19.02 (4.37)		
Junior school	6.22 (1.77)			20.71 (3.93)		
High school	6.37 (1.64)			21.22 (3.33)		
University	6.46 (1.42)			21.48 (3.35)		

Table 4. Attitudes of statement on HPV and HPV vaccination

Items	N (%)					Mean (SD)	Median (IQR)
	Strongly disagree	Disagree	Neutral	Agree	Strongly agree		
Increase the availability of HPV vaccine	7 (0.8)	8 (0.9)	126 (14.1)	337 (37.8)	414 (46.4)	4.28 (0.80)	5 (4,5)
Hope the insurance company will cover the cost	12 (1.3)	18 (2.0)	208 (23.3)	357 (40.0)	297 (33.3)	4.02 (0.88)	4 (4,5)
Looking to incorporate vaccines into routine vaccinations	8 (0.9)	10 (1.1)	132 (14.8)	339 (38.0)	403 (45.2)	4.25 (0.81)	4 (4,5)
Ability to self-determine whether to get vaccinated	7 (0.8)	9 (1.0)	144 (16.1)	362 (40.6)	370 (41.5)	4.21 (0.80)	4 (4,5)
Encouraged sexual partners to get HPV vaccine	6 (0.7)	9 (1.0)	145 (16.3)	345 (38.7)	387 (43.4)	4.23 (0.80)	4 (4,5)

Remark: SD: standard deviation; IQR; inter quartile range.

Table 5. Multivariate logistic regression analyses between independent predictors and different outcomes of interest.						
Characteristics	**Model 1**		**Model 2**		**Model 3**	
	Log likelihood = -215.999, $X^2 = 20.690$, $P < 0.001$		Log likelihood = -328.253, $X^2 = 51.301$, $P < 0.001$		Log likelihood = -634.699, $X^2 = 447.175$, $P < 0.001$	
	OR *(95%CI)*	***p-value***	**OR *(95%CI)***	***P-value***	**OR *(95%CI)***	***p-value***
Female *(Ref. male)*	-	-	-	-	4.824 (3.179-7.319)	<0.001
Had heard HPV vaccine previously *(Ref. No)*	-	-	-	-	3.773 (1.672-8.516)	0.001
Scientifically gained knowledge about HPV *(Ref. No)*	3.193 (1.551-6.573)	0.002	-	-	2.462 (1.611-3.764)	<0.001
Know that "it is recommended that females should receive all 3 shots of HPV vaccination within a 6-month period"	-	-	-	-	1.657 (1.069-2.568)	0.024
Agree that "Looking to incorporate vaccines into routine vaccinations"	-	-	-	-	4.092 (1.978-8.462)	<0.001
Agree that "Ability to self-determine whether to get vaccinated"	-	-	-	-	4.487 (2.309-8.720)	<0.001
Agree that "Encouraged sexual partners to get HPV vaccine"	-	-	-	-	5.196 (2.554-10.573)	<0.001
Have sexual partner *(Ref. don't have)*	-	-	0.510 (0.284-0.916)	0.024	-	-
Needs for further HPV-related knowledge *(Ref. don't need)*	-	-	1.858 (1.041-3.315)	0.036	-	-
Willingness to recommend the HPV vaccine to others	-	-	7.172 (3.330-15.448)	<0.001	-	-
Know that "certain types of HPV can cause genital warts"	-	-	2.956 (1.117-7.820)	0.029	-	-
The sexual partner has been received the HPV vaccine *(Ref. Yes)*	-	-	-	-	-	-
No	0.289 (0.120-0.696)	0.006	-	-	-	-
Don't know	0.241 (0.065-0.902)	0.035	-	-	-	-

Supplementary Table 1. KMO and Bartlett's Test

Kaiser-Meyer-Olkin Measure of Sampling Adequacy		0.939
Bartlett's Test of Sphericity	*Appropriate Chi-square*	6805.259
	Degrees of freedom	253
	significance probability	0

Supplementary Table 2. Total Variance Explained

	Initial eigenvalue			Extract the sum of squared loads			Sum of squares of rotational loads		
component	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	9.313	40.491	40.491	9.313	40.491	40.491	8.668	37.685	37.685
2	2.629	11.432	51.923	2.629	11.432	51.923	2.853	12.404	50.089
3	1.001	4.351	61.244	1.001	4.351	61.244	1.165	5.067	61.2445
4	1.212	4.97	56.894						
5	0.962	4.182	65.426						
6	0.858	3.73	69.156						
7	0.809	3.518	72.673						
8	0.762	3.313	75.986						
9	0.747	3.247	79.233						
10	0.673	2.924	82.157						
11	0.613	2.667	84.825						
12	0.572	2.486	87.311						
13	0.544	2.365	89.676						
14	0.51	2.218	91.893						
15	0.391	1.702	93.595						
16	0.334	1.451	95.046						
17	0.227	0.985	96.031						
18	0.219	0.951	96.982						
19	0.178	0.773	97.755						
20	0.169	0.734	98.489						
21	0.144	0.628	99.118						
22	0.084	0.364	100						