The effectiveness of promotion of human papillomavirus vaccination program among female medical students in Hubei province, China

Huan Yang

A Thesis Submitted in Partial Fulfillment of Requirements for
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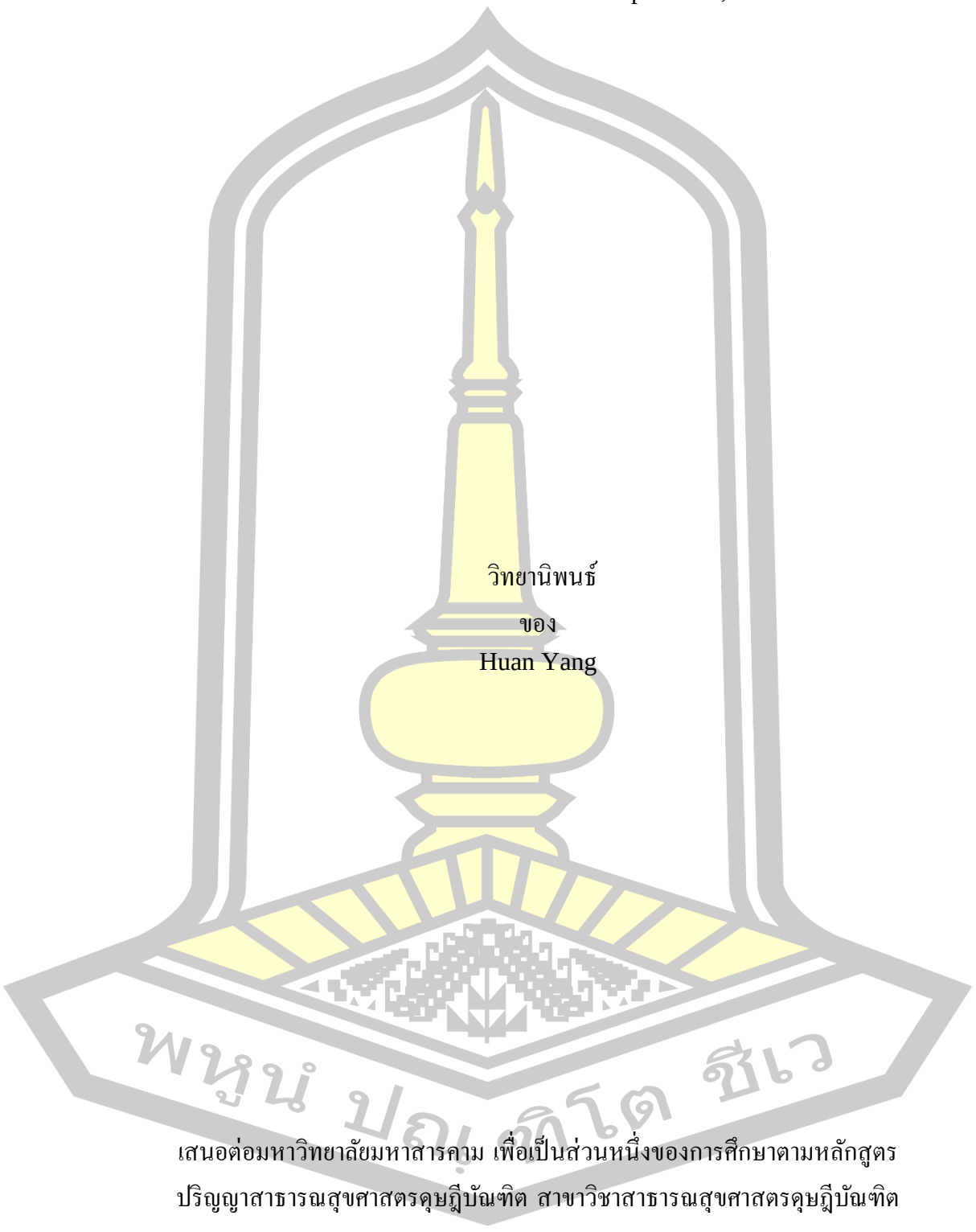

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ของ

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The examining committee has unanimously approved this Thesis, submitted by Ms. Huan Yang , as a partial fulfillment of the requirements for the Doctor of Public Health Doctor of Public Health at Mahasarakham University

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ABSTRACT

Background: Human papillomavirus (HPV) is the most common sexually transmitted infection worldwide, with the highest incidence occurring shortly after initial sexual contact. Emerging evidence underscores the heightened vulnerability of college-year students to HPV infection. However, intention to initiate HPV vaccination among college-year students is not high in China, posing a significant challenge to the goal of eliminating cervical cancer as a public health problem. Protection Motivation Theory (PMT), a widely applied model of motivation to respond to threats. Thus, this study aim to explore the intention and the factors associated with intention to initiate HPV vaccination among medical college students; and to develop a HPV vaccination program to promote intention to initiate HPV vaccination.

Method: In phase I, both quantitative and qualitative methods were used in this study. In quantitative study, a cross-sectional study was conducted on 1148 female medical college students from six colleges in Hubei Province with a multistage sampling method. The data were collected by web-based online software. Multiple logistic regression was applied to explore the intention to initiate HPV vaccination and factors associated with it. Also, an in-depth interviewing was conducted with 24 participants including 10 medical college students, 8 healthcare providers from the college clinics, and 6 teachers of college. The qualitative data was analyzed using the 7-step method proposed by Colaizzi's.

In phase II, a promotion of the HPV vaccination program based on the significance variables from Phase I and the PMT theory was developed. Then, a total of 204 medical college students were randomly assigned to intervention group (n = 102) and control group (n = 102) to explore the effect of this program. The intervention group received a PMT-based HPV vaccination online education program, while the control group received regular vaccine education program. Data were collected through an online software with a structured questionnaire. The chi-square test, independent samples t-test, repeated measure ANOVA, Cochran’s Q test, were

applied for data analyses.

Results: In phase I, the quantitative study found that (1) 85.5% of female medical college students posed a high intention for HPV vaccination in Hubei province. (2) Factors associated with the intention to initiate HPV vaccination among female medical college students, including social demographic factors (willingness to pay for HPV vaccine), knowledge and information received about HPV and HPV vaccine, and three PMT scale factors (including perceived severity, perceived response efficacy, and perceived self-efficacy).Three themes were generated from content analysis after interview, which were perception toward HPV vaccine based on PMT model, barriers to receiving HPV vaccine, and how to promote HPV vaccination.

In phase II, a PMT-based HPV vaccination online health program were develop. The results revealed that in the intervention group, HPV vaccine intention, the knowledge of HPV and HPV vaccine scores, and HPV vaccine communication competency scores were significantly higher than those before intervention ($P<0.05$). The results also showed that after intervention completion, and at three-month follow-up, HPV vaccine intention, knowledge of HPV and HPV vaccine scores, and HPV vaccine communication competency scores in the intervention groups increased compared to the control group with statistical significance ($P<0.05$).

Conclusion: Intention to initiate HPV vaccination was high but the HPV vaccination coverage was low among female medical students in Hubei province. The intention to initiate HPV vaccination was influenced by the knowledge of HPV and HPV vaccine, PMT scale factors, and willingness to pay for HPV vaccine. The PMT-based HPV vaccination online education program was effectives in improving HPV vaccine intention. Therefore, this study suggests that a PMT-based HPV vaccination online health program should be cited in HPV vaccine health education to change the mindset of the public and help promote HPV vaccine intention and vaccination nationally.

Keyword : papillomavirus vaccination program, female medical students, Hubei province, China

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Huan Yang

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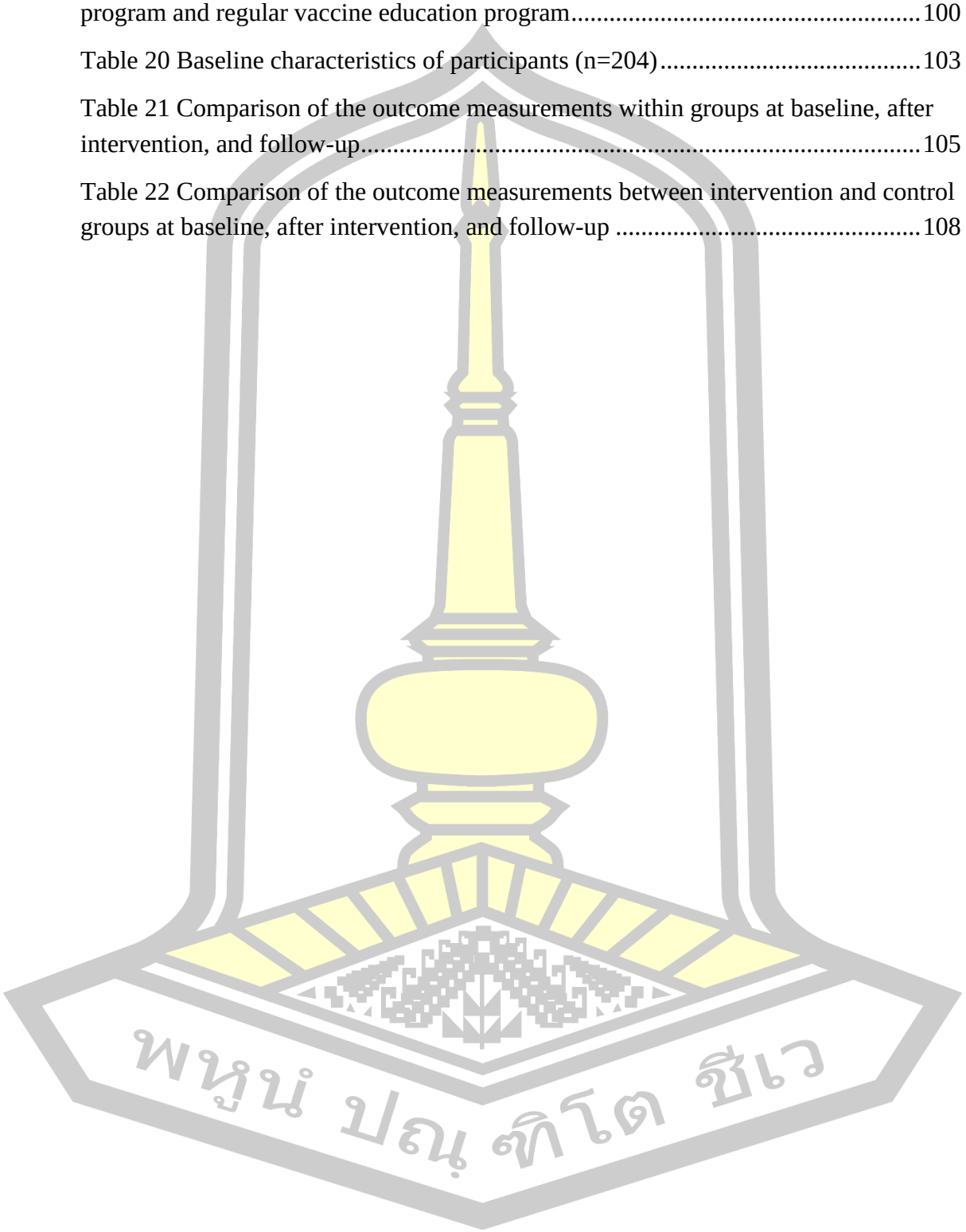

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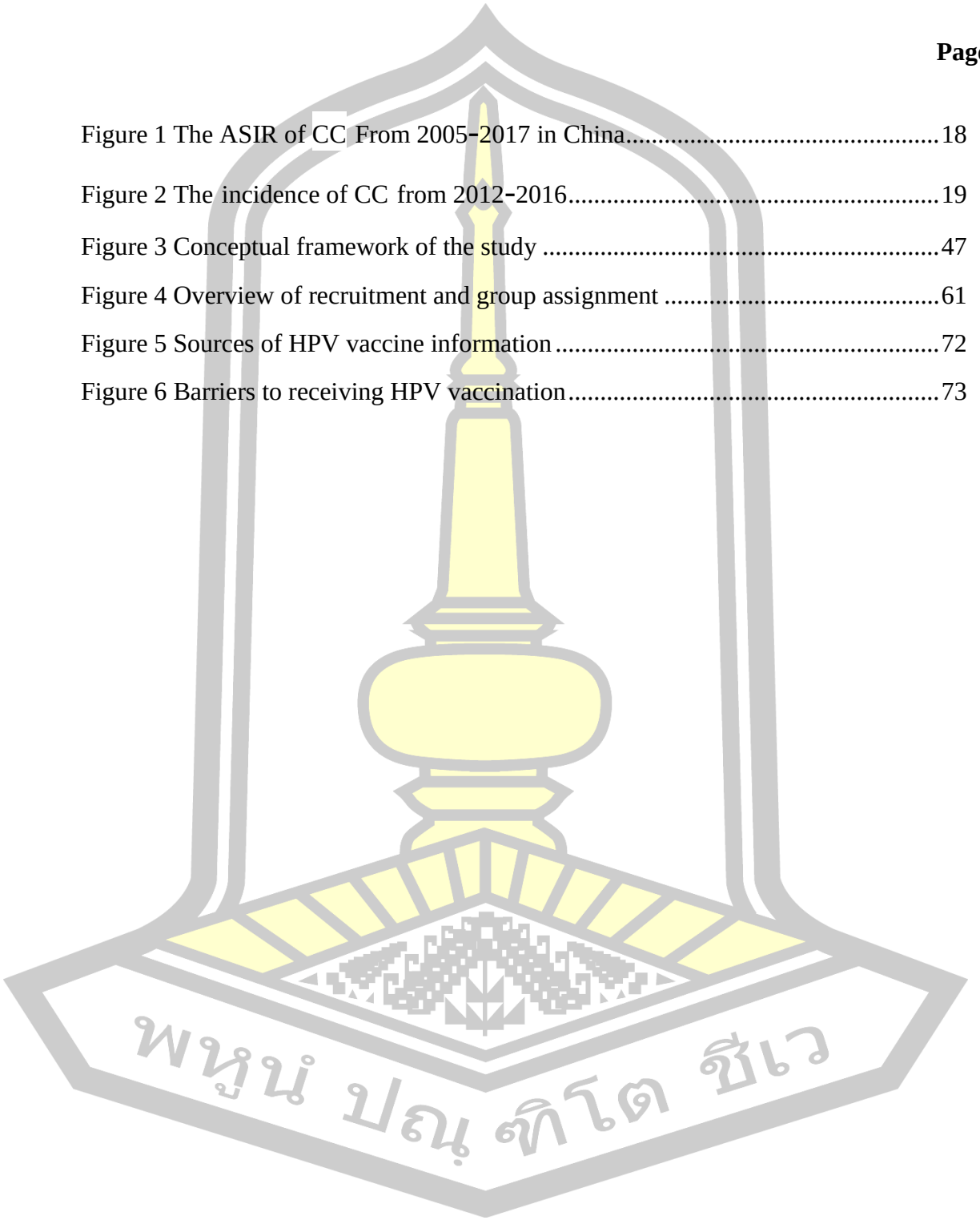


CHAPTER 1
INTRODUCTION

1.1 Background

Human papillomavirus (HPV) is a small group of double-stranded DNA viruses from the Papillomavirus family affects only human (Brianti et al. , 2017). HPV infection is one of the most common sexually transmitted infection in both sexes globally (Ntanasis-Stathopoulos et al., 2020), strongly implicated in some of the most frequent and most burdensome cancers worldwide (Boda et al., 2018).To date, 450 subtypes of HPV have been identified worldwide(Manini & Montomoli, 2018) ,and globally, more than 600,000 cancers are attributed to HPV infection (Brianti et al. , 2017). According to oncogenic potential, the International Agency for Research on Cancer(IARC) categorized HPV as low-risk and high-risk viruses (IARC, 2021). The low-risk types, also called warts causing virus, such as HPV 6 and 11, cause 90% of anogenital warts (Serrano et al. , 2018). The high-risk type, also called cancer causing virus, the last IARC classification defined 12 HPV types as high-risk type, namely HPVs 16, 18, 31, 33, 35, 39, 45, 51, 52, 56, 58, and 59(IARC,2021). In Eurogin, high-risk HPV type associated nearly 100 % of cervical cancer (CC), as well as 25% of head and neck, and 70% of vaginal cancer (Giuliano et al., 2015).

China accounts for about a fifth of the global burden of cervical cancer, with about 109,741 new cases of cervical cancer in 2020(Wang et al., 2022). Data indicated that the numbers of new CC cases are increasing constantly among young women in recent years, the age-specific incidence rate of cervical cancer starts rising after the age of 25 years (Arbyn et al., 2020). Although many factors contribute to the cervical cancer, the genesis of CC depends essentially on an infection with HPV (Petry, 2014, Patti et al., 2019). Among cervical cancer patient, the HPV infected rate reached to 97%, HPV 52, HPV 16 and HPV 58 ranked as the top 3 most common subtypes among women in China (Yan et al., 2021).

Despite the fact that HPV is known to be responsible for the development of CC, HPV infections often without being aware and not presenting any symptoms. The peak time acquiring the HPV infection is being shortly after becoming sexually active

(Boda et al., 2018), the highest HPV infection prevalence was found in the young women less than 25 years old worldwide (Bruni et al., 2010). In Germany, the highest prevalence of High risk (HR)-HPV was found in 20-26 years old women (Petry et al., 2013). In Brazil, HPV prevalence among adolescent aged 16 - 25 years old was 53.6% (Wendland et al. 2020). In China, 13.3% of the healthy participants were tested HPV positive(Yan et al., 2021), the highest HPV prevalence also observed in the young age group, with infection rates of 55.7% among women under 20 years old and 37.6% in the 20-25 years old age group(Zhang et al. 2023). Hence, the traditional college-age students were facing a high chance of infecting HPV.

The college students are the peak populations of HPV infection (Natipagon-Shah, Lee, & Lee, 2021). In US, an estimated 14 million new HPV infections occur every year among persons aged 15–59 years. Approximately half of new infections occur among persons aged 15–24 years (Markowitz et al., 2014). Creek et al., (2013) estimated that 32% of freshman female students tested positive for HPV, HPV16 infection was the most common infection (18%). Similarly, college women from Honduras have an HPV prevalence of 45% (Ferrera et al., 2011). In England, among the female students age at 16-27, 18.5% were positive for HR-HPV (Oakeshott et al., 2012). In Australia, 24.8% of the female students were tested HPV positive among the college students aged 18-25 (Osborne et al., 2015). In the less developed countries, the HPV infection prevalence in young age group is even higher (Bosch et al., 2008). In Mexico, The prevalence of vaginal HPV infection was 74.42% among female university. The HR-HPV prevalence was 22.2%, type 18 (13.95%), 31 (10.85%), and 16 (9.3%) were the most predominant high-risk HPV types (Pedroza-Gonzalez et al., 2022). In China, about 11.3% of college students had sexual intercourse (Song & Ji, 2010), the average age of sexual debut among the college students was 18.39 years (Shi et al., 2021), moreover, more than half of young Chinese college students reported having unprotected sexual intercourse (Song & Ji, 2010), the college students are facing a high chance of infecting HPV. The peak prevalence of detectable HPV infection was found in the below 20 years group which was about 37.0% (Zhu et al., 2021). This also confirmed in other study, HPV infection among Chinese female peak at the age of 20 -24 when they are in the college study. Prevention of HPV infection among college-age students in China need to take priority.

Two HPV vaccines (Cervarix and Gardasil) had been licensed for use in United States since 2006 to prevent HPV infection and HPV related disease (Markowitz et al., 2012). Since then, the Advisory Committee on Immunization Practices (ACIP) recommended routine vaccination with HPV vaccine for females aged 11 or 12 years, it can be given starting at age 9 years (Markowitz et al., 2014). In 2019, ACIP has recommended catch-up HPV vaccination for everyone through age 26 years for those who missed HPV vaccine at their routine year of getting HPV vaccine (Meites, 2019). Study has demonstrated that the HPV vaccines are approximately 98% effective at preventing strain-specific, HPV-related, high-grade cervical intraepithelial neoplasia when given before exposure of sexual activity (Cheng et.al., 2020). A systematic review of up to 8 years of follow-up data showed that there was a 31% reduction of HPV infection in women aged 20-24 years (Drolet et al., 2019). Recent study from Japan showed results from women aged 20-24 years who received HPV vaccination, and had significantly lower rates of abnormal cervical cytology results when compared to those who did not receive the vaccine (Tanaka et al., 2017). Since its effective protectiveness for HPV infection, many countries have implemented publicly-funded HPV immunization programs since then 2006. In 2019, approximately 98 countries (51%) have introduced HPV vaccinations into their immunization programs (WHO 2020). College age students were in the catch-up immunization group. In US, HPV vaccination coverage among 19–26 years old females reach to 52.8% (P.-J. Lu et al., 2021). Vaccinating college women students with HPV vaccines can boost waning immunity to prevent HPV infection (Abdullahi, et al., 2020).

In China, the Food and Drug Administration has approved HPV vaccines (Cervarix®) for marketing in the Chinese mainland in 2016. Gardasil® and Gardasil9 ® has also been successively approved by the Chinese authorities later in 2017 and 2018, respectively. In 2019, first Chinese domestic bivalent HPV vaccine (Innovax, Xiamen, China) was also licensed by the Chinese Food and Drug Administration. It has similar efficacy to the imported bivalent HPV to against HPV 16 and 18. Since the 10 years late after the license of the first HPV vaccine, and the national policy that these four HPV vaccines were not included in the routine free national immunization program, the HPV vaccination rate is low in China. The proportion of women aged 9–

45 in China who had received a complete HPV vaccination was only 3% in 2019 (Wang et al., 2021), was significantly lower than the average world level (WHO, 2022). The awareness and knowledge rates about HPV vaccination among general population were only 15.95 % and 17.55 %, respectively(Zhang et al., 2016).

Since college students were at a high rates of HPV prevalence in China, but the HPV vaccination rate was low among them. Chinese female college students have insufficient knowledge of HPV vaccines, even 29% of the college students not hear about HPV vaccine(Chen et al., 2021), 55.57% of the college students were hesitant about vaccination(Ma et al., 2021), and only 7.1% of medical students attending Dalian University in China knew that the HPV vaccination was available for both males and females (Mpemba, 2013). Moreover, only 11.0% of college students have been vaccinated against HPV nationwide, students residing in eastern, western, central part of China had a HPV vaccine uptake rate of 13.7%, 8.6%, 10.6% , respectively(You et al., 2020). The vaccination rate in college students were far behand the goal of WHO to reach 80% of females to receive HPV vaccine.

Factors effect to HPV vaccination among college students including (1) lack of knowledge about the vaccine (Chanprasertpinyo & Rerkswattavorn, 2020). Even in the US, 65% of male and 51.6% female college students did not know that the HPV vaccine recommended age (Kellogg et al., 2019). HPV knowledge levels were significantly associated with vaccination status; (2) Lack of self-perceived risks for an HPV infection was other predicator of HPV vaccine status (Natipagon-Shah et al., 2021). Perceived higher susceptibility of HPV infection indicate a higher HPV vaccine uptake (You et al., 2020); (3) Costs was a predicator of HPV vaccination. Students with lower family income were less likely to be vaccinated against HPV (Kellogg et al., 2019). In US, higher vaccination was found in the group with lower worry about vaccine cost and having health insurance (Cohen & Legg, 2014). Students with a lower level of education in the immediate family also correlated with HPV vaccine status (Kellogg et al., 2019). (4) Perceived susceptibility, response efficacy and subjective norms would predict intentions to initiate HPV vaccination among college students. Gainforth et al., (2012) found these three theoretical

determinants accounted for 50 % of the variance in HPV vaccination intentions among college students.

A growing body of literature suggests that HPV-related health education focusing on the logistics of receiving the HPV vaccine, the susceptibility of HPV infection and HPV vaccine catch-up eligibility for college students can greatly increase awareness of HPV and HPV vaccines, potentially increasing their intention to receive the HPV vaccine (Fu et al., 2014). The Protective Motivation Theory (PMT), developed and revised by Rogers and his colleagues, has been widely used as an education framework for predicting and influencing health-related behaviors. PMT has been a common tool to explore motivation and behaviors of individuals and to predict prevention outcomes in health-related fields, like to predict the skin cancer protective behavior(Sotoudeh et al., 2020), and assess intention to undertake colorectal cancer screening (Wei et al., 2022). Previous studies showed that PMT had been applied in many researches to understand the underlying reasons for individuals' intention or acceptance to get a vaccination. Studies indicated that PMT predict intentions for HPV vaccination and perceived knowledge, attitude, coping appraisal and perceived severity of HPV-related disease all had significant and direct effects on the intention to obtain HPV vaccine (Gainforth et al., 2012; Huang et al., 2021; Mupandawana et al., 2016) Also, the PMT can be predicts the self-protective motivation of individuals towards a perceived threat and determine protective motivation would be engendered through the mutual interaction of threat appraisal and coping appraisal, further leading to the enacting of a protective behavior (Ferrer et al., 2015; Gainforth et al., 2012). PMT theory predicts that the intention to protect depends upon two process, that were treat appraisal and coping appraisal process, to see whether people go for protective behaviors or high-risk behaviors. The first process is an initial cognitive process which involves appraising perceived severity and susceptibility to current threat and rewards for current activities, and may inhibit risk protective behaviors. Perceived severity and susceptibility deal more with the promotion of behavior, while perceived external and internal rewards tend more to prevent the protective behavior. The second cognitive process (i.e. coping appraisal) involves appraising perceived self-efficacy, perceived response efficacy and perceived costs of the preventive act. The higher perceived self-efficacy and response

efficacy and the lower the perceived costs, most likely promote the higher chances of protective behavior against threat(Roger, 1975). Within the context of HPV vaccination, perceived risk is comprised of a person's belief that an HPV infection is likely to occur (perceived vulnerability) and that an HPV infection will result in serious negative consequences for health and well-being (perceived severity). Perceived effectiveness represents a person's belief that the HPV vaccine will reduce the perceived severity or vulnerability of HPV (response efficacy), and cues to action refers to situational factors such as a doctor's recommendation that may prompt a person to be vaccinated(Gainforth et al., 2012). Reviews indicated that perceived susceptibility to HPV and response efficacy of the HPV vaccine are key determinants of intention to initiate HPV vaccine among adults considering vaccination for themselves (Brewer & Fazekas, 2007). Hence, our study adopt four factors of PMT theory: perceived susceptibility, perceived severity, perceive response efficacy, and perceived self-efficacy to find out whether these factor effect intention to initiate HPV vaccination in Hubei province.

Hubei province, located in the central of China, the average incidence and mortality of CC was in the high-high cluster area (He et al., 2021). Study show that the prevalence of cervical cancer in young women has been increasing steadily in Hubei, from 2.8% to 15.7% for the past 30 years (Cai et al., 2010). The overall HPV infection prevalence in Wuhan, Yichang, Huangshi, Shiyan was about 22.06%, 35.51%, 43.92%, 37.15%, respectively.(Zhang et al., 2012). The HPV infection prevalence is much higher than other province like in Chongqing (Yan et al., 2021), Jiangsu Province (Ge et al., 2019). Peak prevalence of HPV infection was found in the below 25 years group (47.56%) (Zhang et al., 2012). Hence, the college-age students are at a high risk of HPV infection. However, in Yichang city, only 58.7% of the college students have heard HPV vaccine, 39.87% thought HPV could cause related diseases, 34.7% considered to take HPV vaccine (Zhao et al., 2020). Female college students are facing a high chance of HPV infection but lack of knowledge about HPV vaccine and HPV-related disease, with a low intention to initiate HPV vaccination.

Meidical students, as the next generations of healthcare providers, equip with knowledge and pose a positive attitude towards the vaccine indicate a favorable

outlook for their future actions as health service providers in vaccination programs. It is critical for them to be appropriately educated about HPV, and HPV associated diseases, the importance of HPV vaccination, and how to deliver effective vaccine recommendations. However, a systematic review found that the HPV vaccination intention among Chinese female medical college students was 30.4% (Bai et al., 2022), which may have contributed to the low HPV vaccination rates among this group. In Hubei province, there is no data about the HPV vaccine status of female medical college students and the limited data on female medical college students' intention to initiate HPV vacciantion, and knowledge of HPV disease and its consequences. Therefore, it is important to identify intention and acceptance of HPV vaccine among this population in order to initiate beneficial vaccination behavior and promote them to uptake the vaccine. It may be useful for healthcare providers and policymakers for improving the promotion towards vaccine uptake intention and vaccine acceptance in adolescent.

1.2 Research question

What should the patterns of the promotion HPV vaccination program among college students be?

1.3 Research objectives

This study consists of 5 objectives.

1) To explore the intention and the factors associated with intention to initiate HPV vaccination among medical college students.

2) To assess the HPV vaccination coverage, sources of HPV vaccine information and HPV infection prevention awareness among medical college students.

3) To explore the perception toward HPV vaccine based on the PMT, barriers to receiving the HPV vaccine, and how to promote HPV vaccination

4) To develop the promotion of HPV vaccination program.

5) To evaluate the effectiveness of the promotion of HPV vaccination program.

1.4 Research hypothesis

In phase 1:

Social demographic factors, knowledge of HPV and HPV vaccine, HPV infection prevention awareness, and PMT scale factors are associated with the intention to initiate HPV vaccination among female medical college students.

In phase II:

1) The PMT-based HPV vaccination online education program can increase the HPV vaccine intention among first-year medical college students.

2) The PMT-based HPV vaccination online education program can increase knowledge of HPV and HPV vaccine scores, HPV infection prevention awareness scores, PMT scores, and HPV vaccine communication competency scores among first-year medical college students.

1.5 The importance of research

This study shows the HPV vaccination rate in Hubei Province, which better understands the current status of HPV vaccination. The study also aims to determine factors related to the intention to initiate HPV vaccination. Also, assess HPV infection prevention awareness, and sources of HPV vaccine information which may be used to develop the promotion of HPV vaccination programs to increase awareness and acceptance of HPV vaccination and expand HPV vaccination among college students.

1.6. Scope of research

1.6.1 Scope of contents

The study design in this research is a mixed-methods design, including two phases as follows: In phase I, we integrated both quantitative and qualitative methods into a study. In the quantitative method, we focus on determining the factors related to intention to initiate HPV vaccination, assessing HPV vaccination coverage, sources of HPV vaccine information, and HPV infection prevention awareness. Also, we used a qualitative method to explore the perception toward the HPV vaccine based on the PMT, barriers to receiving the HPV vaccine, and how to promote HPV vaccination. In phase II, we focus on developing the promotion of the HPV vaccination program based on the significance variables from Phase I and the PMT theory and evaluating the effectiveness of this program.

1.6.2 Scope of population

In phase 1, we integrated both of quantitative and qualitative method in a study.

1) The quantitative method, we focused on assessment of HPV vaccination coverage, sources of HPV vaccine information, HPV infection prevention awareness, and determine the factors related to intention to initiate HPV vaccination. The population in this phase is 1148 female college students aged 18-26 years who studied in 6 colleges including 1) Wuhan City College, 2) Wuhan College of Foreign Language and Affairs, 3) Huanggang Polytechnic College, 4) Jingzhou Institute of Technology, 5) Hubei University of Arts and Science, and 6) Hubei Engineering Vocational and Technical College in Hubei province. These 6 colleges were chosen according to their location in Hubei province, with two colleges in the central part of the province, and other four colleges were located at the south, north, east and west part of the province, separately.

2) The qualitative method, we focus on perceptions toward HPV vaccine based on the PMT model, explore barriers to receiving the HPV vaccine, and how to promote HPV vaccination. The key informants or stakeholders including medical students (n=10), healthcare providers from the college clinic (n=8), teachers of the colleges (n=6). A purposive sampling was used to recruit participant. The research will explore the following themes: perception toward HPV vaccine based on the PMT model, barriers to receiving the HPV vaccine, and how to promote HPV vaccination

In phase II, this research focused on the development of PMT based promotion HPV vaccination program and evaluates the effectiveness of this program. The population in this phase is the first year medical college students. The total sample size is 204, which will be divided into 2 group as experimental group with 102 students and control group with 102 students.

1.6.3 Scope of research setting

In phase I, the research will conduct in 6 colleges including 1) Wuhan City College, 2) Wuhan College of Foreign Language and Affairs, 3) Huanggang Polytechnic College, 4) Jingzhou Institute of Technology, 5) Hubei University of Arts and Science, and 6) Hubei Engineering Vocational and Technical College in Hubei province.

In phase II, the research will conduct at 2 colleges, Wuhan City College for experimental group and Wuhan College of Foreign Language and Affairs for control group.

1.6.4 Scope of study period.

In phase I, the research conduction was start from 1st April 2023 to 30th June 2023.

In phase II, this research conduction was start from 1st August 2023 to 4th February 2024.

1.7 Operational definition

1) Cervical cancer refers to the tumor that occurs in cervix, the lower part of the uterus. This causes abnormal vaginal discharge, pelvic pain, vaginal bleeding, and painful sex.

2) Human papillomavirus infection(HPV) refers to a group of viruses that commonly infects human cells of the epithelium through skin-to-skin contact or sexual contact. Most infections caused by HPVs are asymptomatic and inconspicuous unless the immune system is compromised. To date, more than 450 types of HPVs have been isolated and sequenced. Persistent infection with certain HPV types is associated with the development of precancer or cancer.

3) HPV Vaccine refers to vaccines protect against infection with HPV. HPV preventive vaccine was firstly introduced in 2006, there are three prophylactic HPV vaccines targeting high-risk HPV types that are 2-, 4- and 9-valent vaccines. The bivalent vaccine (adsorbed vaccine) for HPV-16/18 (GlaxoSmithKline, UK), the quadrivalent vaccine for HPV6/11/16/18 (Merck Sharp & Dohme, USA) and the HPV vaccine (Gardasil). (Merck & Co., USA) and the nine-valent HPV vaccine for HPV-6/11/16/18/31/33/45/52/58 (Merck & Co., USA). China has made the first bivalent vaccine (E. coli) with independent intellectual property rights against HPV-16/18 by Xiamen Wantai Canghai Biotechnology Co., Ltd. at the end of 2019, and now is the fourth HPV vaccine listed globally.

4) Intention to initiate HPV vaccination refers to determination to receive the HPV vaccine injection.

5) HPV vaccination coverage refers to the percentage of eligible fully-immunized people compared to the total number of the target population. The equation to calculate immunization coverage rate = number receiving all doses/one dose ÷ number in the target population x 100%. Methods used to monitor coverage including electronic vaccination registries, routine paper reports of vaccinations delivered, and surveys.

6) The promotion of HPV vaccination program refers to the program for promote the intention to HPV vaccination among college students. In this study we will apply a PMT based online health education through WeChat, which namely, "a PMT-based HPV vaccination online education program."

7) The Protective Motivation Theory (PMT) serves as a conceptual framework for comprehending how individuals respond to stimuli that prompt them to perceive potential threats. It consists of two independent appraisal processes: threat appraisal and coping appraisal. Threat appraisal focusing on perceived severity, perceived vulnerability, perceived rewards and coping appraisal focusing on perceived response efficacy, self-efficacy and perceived response costs. In this study we will apply 4 dimensions of PMT theory such as perceived susceptibility, perceived severity, perceive response efficacy, and perceived self-efficacy.

8) HPV infection prevention awareness refers to awareness against HPV infection. The awareness of HPV infection prevention include receiving prophylactic HPV vaccine, use of barrier methods such as condoms to reduce HPV infection. Abstinence from sexual activity or monogamy with an uninfected partner is also the best method to prevent infection since risk factors for HPV infection include: early onset of sexual activity, multiple sexual partners, or partners with multiple sexual partners.

9) The knowledge of HPV vaccine refers to general HPV knowledge include: target group for HPV vaccination, benefits of HPV vaccination, and the best age for vaccination.

10) The knowledge of HPV refers to general HPV knowledge include: 1) health consequences of HPV infection; 2) causes, risk factors and transmission of HPV; 3) symptoms of HPV infection ; 4) prevention and treatment of HPV infection; 6) prevalence of HPV infection.

11) HPV vaccine communication competency refers to competent to use language and skill to recommend HPV vaccine and improve HPV vaccination uptake to current and future patients.

12) The effectiveness of promotion of human papillomavirus vaccination program refers to the successful or achieving the results of programs to improve the intention to obtain HPV vaccination among female medical student. In this study, we also measure the effectiveness promotion of human papillomavirus vaccination program by using the score of the knowledge of HPV and HPV vaccine, HPV infection prevention awareness, and HPV vaccine communication competency, the Protection Motivation Theory Scale scores.

13) Sources of HPV vaccine information refer to sources providing information and helping people construct knowledge about the vaccine including individual sources and media sources. Individual sources refer to healthcare provider (doctor or nurse), parents, teacher, and friend. Media sources include TV, Internet, and others like newspapers, magazines.

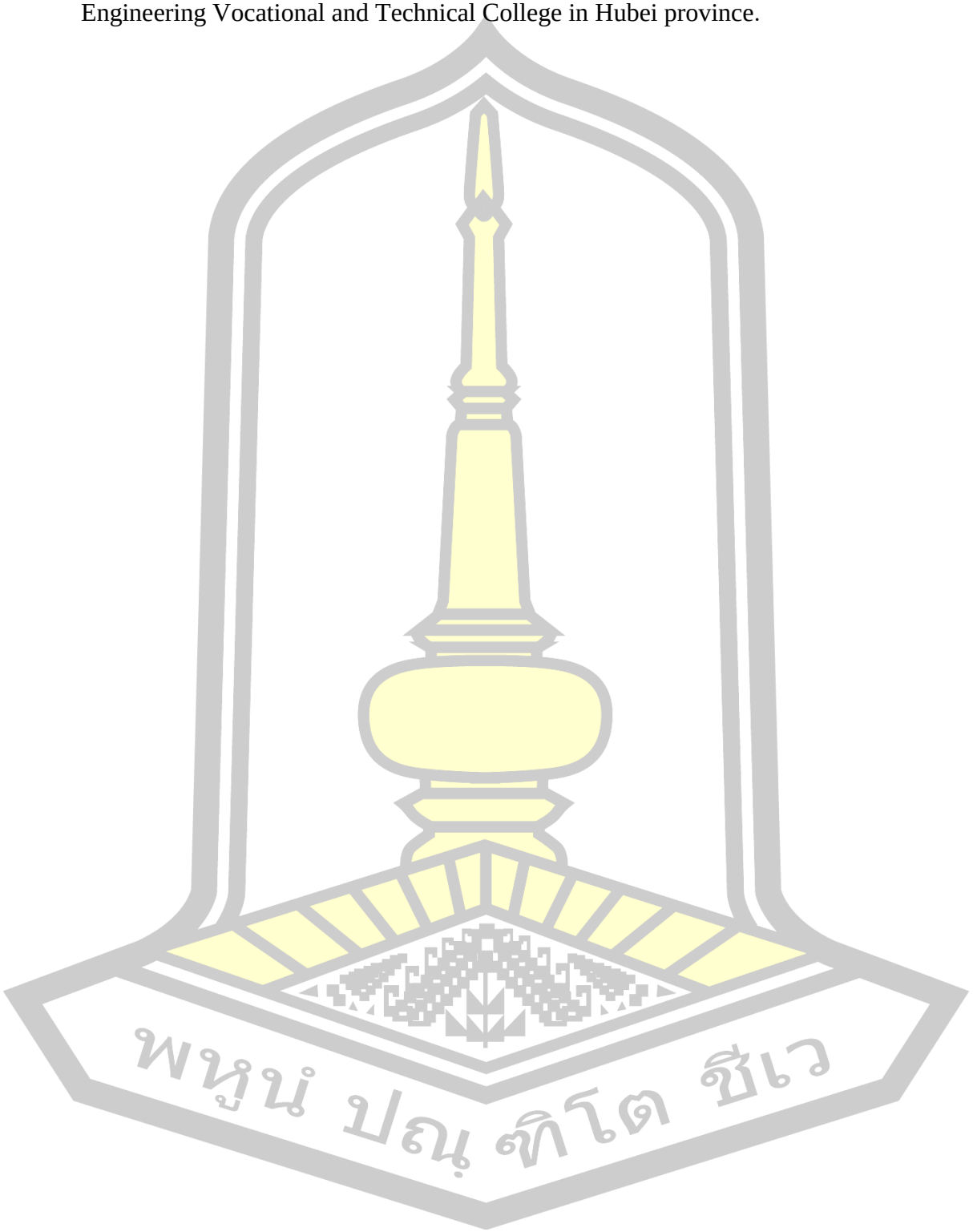
14) Barriers to receiving the HPV vaccine refer to difficulties of receiving HPV vaccine. Barriers to HPV vaccination can be divided into three levels, including patient level, provider level, and health policy level.

15) Online health education refers to the process of imparting knowledge about HPV and HPV vaccines through the internet and web-based applications. In this study, we used social media, such as WeChat, as the platform to perform the online health education.

16) WeChat refers to an online social media communication app. It is the most popular social media platform in China. At present, there are 902 million active users every day, and each user spends an average of 66 minutes on the platform every day. WeChat has many different functions, such as private or group texts or voice messages, video calls or meetings, electronic document transmission, subscription and browsing of public accounts, and information publishing.

17) College student refers to an individual who is enrolled in college with the age of 18-26. In this study, college students are the students who study in medical majors from 6 colleges including 1) Wuhan City College, 2) Wuhan College of Foreign Language and Affairs, 3) Huanggang Polytechnic College, 4) Jingzhou

Institute of Technology, 5) Hubei University of Arts and Science, and 6) Hubei Engineering Vocational and Technical College in Hubei province.



CHAPTER 2
LITERATURE REVIEW

The study of the effectiveness of the promotion of the HPV vaccination program among female medical students in Hubei Province, China. This study aims to determine factors associated with the intention to initiate HPV vaccination, assess HPV coverage, and evaluate the effectiveness of promoting the HPV vaccination program among medical students. The researcher reviewed literature, concepts, theories, and relevant research as follows:

2.1 Human papillomavirus (HPV)

2.1.1 HPV and Cervical cancer in China

2.1. 2 HPV and Cervical cancer in Hubei

2.2 Epidemiology of HPV

2.2.1 Epidemiology of HPV in China

2.2.2 Epidemiology of HPV in Hubei

2.3 Prevention of HPV infection

2.3.1 HPV vaccine

2.3.1.1 HPV vaccination program worldwide

2.3.1.2 HPV vaccination program in China

2.3.2 Protective sex

2.4 Factors related to acceptance of HPV vaccination

2.4.1 Lack of awareness and knowledge regarding HPV

2.4.2 Underestimate of personal risk of getting HPV

2.4.3 Lack of knowledge about protective practices and behaviors

2.4.4 Lack of conviction

2.4.5 Cost of HPV vaccine

2.4.6 Lack of recommendation

2.4.7 Shortage in HPV vaccine supply

2.5 PMT theory

2.6 Relevant researches

2.6.1 Researches related the intention to initiate HPV vaccination

2.6.2 Researches related HPV vaccination coverage

2.6.3 Researches related sources of HPV vaccine information and HPV infection prevention awareness

2.6.4 Researches related barriers to HPV vaccination, and how to promote HPV vaccination

2.6.5 Researches related PMT for HPV intention intervention

2.7 Conceptual framework of the study

2.1 Human papillomavirus (HPV)

Worldwide, HPV is the second most prominent infectious agents associated cancers in both men and women (Kombe et al., 2020). The Center for Disease Control affirms that 80% of women and 90% of sexually active men, would be infected with at least one HPV type (Petca et al., 2020). The overall HPV prevalence world-wide with normal cervical cytology was estimated to be 10.4%, 22.1% in Africa, 20.4% in Central America and Mexico, 11.3% in Northern America, 8.1% in Europe, and 8.0% in Asia (Bruni et al., 2010). The 12 most common HPV types, in order of decreasing prevalence, were HPV16, 18, 58, 33, 45, 31, 52, 35, 59, 39,51,56 (Li et al., 2011).

HPV can cause cancer in six different anatomical sites in the body: includes the cervix, vagina, vulva, penis, anus, and oropharynx (Szymonowicz & Chen, 2020). Today, more than 200 HPV types have been identified(Pastrana et al., 2018). They can be classified into two categories: low-risk HPV (LR-HPV) and high-risk HPV (HR-HPV). LR-HPV including HPV6, HPV11, HPV42, HPV43, and HPV44 are the causative agents for benign or low-grade changes in cervical cells, such as genital warts(Villiers et al., 2004). HR-HPV including HPV16, HPV1 ,HPV31, HPV33, HPV35, HPV39, HPV45, HPV51, HPV52, HPV56, HPV58, HPV59, HPV68, HPV69, and HPV 82 are responsible for oropharyngeal (oral, tonsil, and throat areas) cancers and anogenital cancers, including cervical, anal, vulvar, vaginal, and penile cancers. HR-HPV associate nearly 100 % of cervical cancer, as well as 25% of head and neck, 70% of vaginal, 88% of anal, 43% of vulvar and 50% of penile cancer (Giuliano et al., 2015). Globally, more than 600,000 cancers are attributed to HPV infection (Brianti et al. , 2017). Most of the HPV infections are asymptomatic and can

be cleared spontaneously by the host's immune system, but a few can persist and eventually cause cancer. Persistent infection with high-risk HPV types is strongly associated with the development of cervical cancer and other HPV related diseases(Pešut et al., 2021). Cervical carcinogenesis is represented by 4 causal stages: HPV acquisition; HPV persistence (vs. clearance); Progression to precancerous lesions; Invasive cancer.

The route of HPV transmission is primarily through skin-to-skin or skin-to-mucosa contact. Sexual transmission is the most documented, but there have been studies suggesting non-sexual ways. HPV can also been transmitted by fomites, fingers, and mouth, skin contact (other than sexual)(Petca et al., 2020). HPVs are very steady viruses, repellant to heat, and drying (they show 30% infectivity after seven days of dehydration)(Casalegno et al., 2012). The viruses are apt to live for days on surfaces, clothing, frequently used gynecological equipment, and fomites. Many studies have collected HPV DNA samples to assess these concerns. Most individuals are not aware they are infected because they are asymptomatic. Two different studies, one held in a university and one in a hospital, have revealed an abundance of HPV DNA on the fingers of infected persons, highlighting inadequate or non-existing hand hygiene (Ryndock & Meyers, 2014)). Studies demonstrated DNA HPV under fingernails of individuals with genital warts, as well as in their underwear (Gallay, 2015). The estimated crude and adjusted HPV prevalences among women with normal cytological findings worldwide were 7.2% and 11.7%, respectively(Bruni et al., 2010). HPV infection rate varies in different regions, it was estimated that the HPV infection rates was 24.0% in Sub-Saharan African regions, 16.1% in Latin America and the Caribbean, 14.2% in Eastern Europe, and 14.% in Southeastern Asia (Bruni et al., 2010). Although the HPV infection rate was low in Asia, in Kazakhstan, one country of Asia, the prevalence of HPV infection ranged from 43.8% to 55.8%(Aimagambetova & Azizan, 2018). So it is necessary to take measure to prevent HPV infection since it's susceptibility to infect and severity after infected.

2.1.1 HPV and cervical cancer

2.1.1.1 HPV and cervical cancer in China

The causal relationship between HPV infection and cancer was first established for cervical cancer (CC). CC is the 6th leading HPV-associated cancer in China(Sung et al., 2021). In 2020, China reported 109,741 new CC cases and 59060 deaths, corresponding to 18.16% of diagnoses and 17.28% of deaths from CC worldwide (Sung et al., 2021). The difference CC incidence in rural and urban area, Eastern areas, Central areas and Western areas was shown in table 1. The incidence rate of CC in Central areas was higher than the Western areas and the Eastern areas. From 2005-2017, the ASIR China of CC in women increased from 7.4 to 11.4 per 100,000 (Figer 1) and the Age-standardized incidence rate (ASMR) China increased from 1.7 to 3.4 per 100,000 (Wang et al., 2022). There was an overall upward trend both in of CC incidence and mortality in China.

Table 1 Incidence of cervical cancer in the registration areas of China, 2017

Area	**NO. cases**	**Crude rate/100 000^{-1}**	**Freq./%**	**ASIR World/ 100 100^{-1}**
All	36 740	17.07	6.45	11.35
Urban areas	17 558	16.53	5.68	10.80
Rural areas	19 182	17.60	7.35	11.91
Eastern areas	15 191	15.44	4.99	9.92
Central areas	11 180	19.87	8.33	13.86
Western areas	10 369	17.13	7.92	11.72

ASIR World: Age-standardized incidence rate by the world standard population (Segi population).

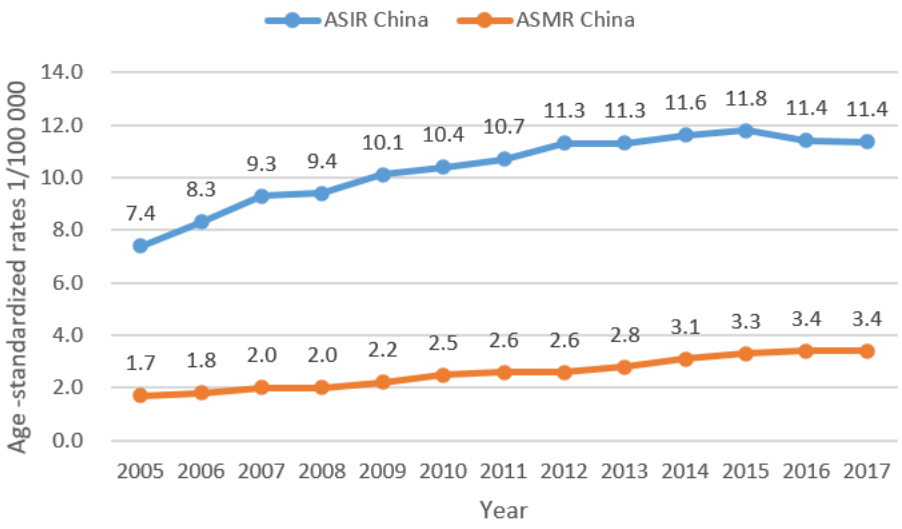


Figure 1 The ASIR of CC From 2005-2017 in China

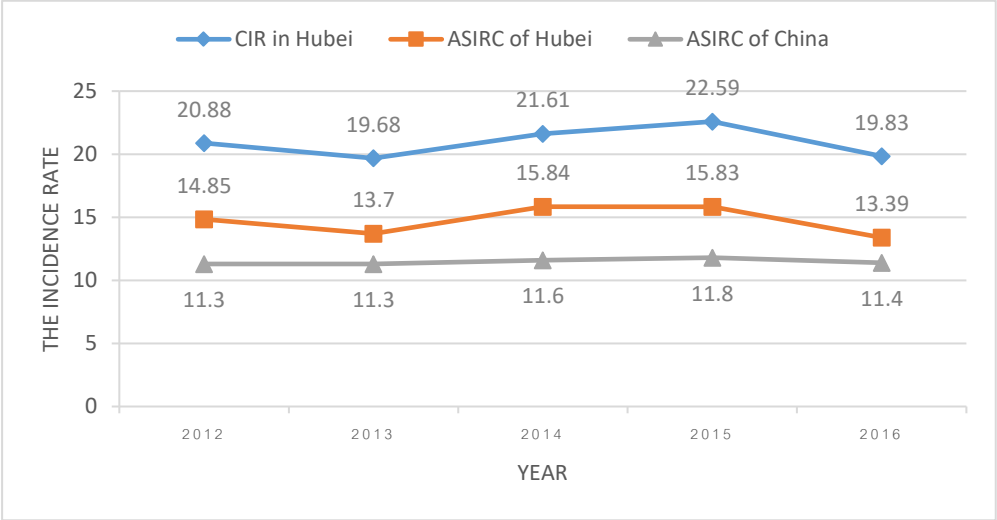
Across China , the overall HPV infection estimated at 97.6% among the cervical cancer cases(Chen et al., 2009). In western area of China, 90.87% of the cervical cancer cases were HPV positive(Li et al., 2017), lower than the national infection level. The 5 most common HPV subtypes in China were HPV 16 (78.70%), HPV 18 (9.87%), HPV 58(4.16), HPV 53(2.51%) and HPV 33(2,21%), a little various was seen in other research (Chen et al., 2009). The incidence of CC starts rising after the age of 25 years(Arbyn et al., 2020).An increasing trend was also seen in age-group < 25 year. A worse survival rate was related to younger patients (Santos et al., 2019). It's necessary for the Chinese women in young age group to have an awareness of how to prevent cervical cancer.

2.1.1.2 HPV and Cervical Cancer in Hubei province

Hubei province, located in the central areas of China. The prevalence of cervical cancer in young women has been increasing steadily. According to a retrospective study, the prevalence of young (≤ 35 years old) patients steadily increased from 2.8% to 15.7% from 1975 to 2009 (Cai et al., 2010).

In Hubei province, according to cancer registry center data from the Hubei Cancer Registry Annual Report (CRAR) (Hubei Cancer Center, 2019; 2018; 2017; 2016; 2015), the ASIR of CC in Hubei was higher than the domestic average level

across year 2012 to 2016. In 2016, the ASIRC of CC in China was $11.4*10^{-5}$, but in Hubei province, the ARIRC rate of CC was $19.8*10^{-5}$.



(ASIRC: Age-standardized incidence rate by the Chinese standard population).

Figure 2 The incidence of CC from 2012-2016

According to the cancer registry center in Hubei, due to the regional and socio-economic disparities, there were great disparity exist of crude incidence rate of CC in Hubei province(Table 2). The incidence of CC in Wufeng county and Gongan district were $34.57*10^{-5}$ and $36.55*10^{-5}$, with the highest incidence rate of CC in Hubei province in 2016 (Zhang et al., 2012).

Table 2 Incidence rate of cervical cancer in Hubei，2013—2017

	2012 ($1/10^{-5}$)	**2013 ($1/10^{-5}$)**	**2014 ($1/10^{-5}$)**	**2015 ($1/10^{-5}$)**	**2016 ($1/10^{-5}$)**
Hubei province	20.88	19.68	19.86	22.59	19.83
Wuhan city	17.77	18.49	16.86	20.39	19.73
Yichang city	\	12.47	16.36	11.71	24.36
Wufeng county	58.14	35.02	48.14	22.79	34.57
Xiangyang city	\	\	\	\	9.89
Yicheng city	\	\	11.72	\	11.49

Table 3 Incidence rate of cervical cancer in Hubei，2013—2017 (cont.)

	2012 ($1/10^{-5}$)	**2013 ($1/10^{-5}$)**	**2014 ($1/10^{-5}$)**	**2015 ($1/10^{-5}$)**	**2016 ($1/10^{-5}$)**
Zhongxiang city	13.10	13.90	21.19	31.09	23.19
Jingshan city	\	\	20.37	19.07	16.33
Yumen district	10.48	10.85	24.31	29.50	7.04
Gongan district	51.41	41.32	40.04	43.07	36.55
Honghu district	\	16.61	18.07	22.96	16.21
Macheng city	15.07	22.80	15.90	14.96	14.09
Daye city	\	\	\	26.05	23.88
Jiayu district	15.15	22.95	17.95	27.49	16.91
Enshi city	\	\	27.86	27.10	31.06
Tianmen city	\	\	\	12.34	17.36

In Hubei, study indicated the trend of cervical cancer incidence in young women is rising, too. The youngest patient diagnosed with cervical cancer is at the age of 15 . Data showed women with cervical cancer aged < 35 increased significantly from 2.8% during 1975-1979 to 15.7% during 2005-2009 (Cai et al., 2010). The proportion of adenocarcinoma in young women (17%) was higher than that of older women (7.1%), too. It's necessary for the females in Hubei province in young age group to have an awareness of how to prevent cervical cancer.

2.2 Epidemiology of HPV

2.2.1 Epidemiology of HPV in China

In China, a retrospective study of 3568 cervical cancer patients found 90.87% of the cervical cancer cases were HPV DNA positive (Li et al., 2017). A study of 37 cities found the overall HPV prevalence was 21.07 %, ranging from 18.42 % (Nanchang) to 31.94 % (Haikou) (Wang et al., 2015). Overall, the six most prevalent genotypes of HPV were HPV16 (4.82 %) , HPV52 (4.52 %), HPV58 (2.74 %), HPV 59(1.64%), HPV 39(1.60%) and HPV 18 (1.48%) (Wang et al., 2015). WHO data indicate that the five most frequent HPV types in Chinese women with cervical cancer

are HPV 16, HPV 18, HPV 58, HPV 33 and HPV 52 while HPV16, HPV 52, HPV 18, HPV 51 and HPV 58 are the most common in the general population of Chinese women (Petry, 2014).

The overall prevalence of HPV was highest in the youngest 15–19 year age group, presenting the infection rate of 30.55 % (Wang et al., 2015). The peak age varied little in different studies. In Henan province, one of the province in central areas of China, HPV positive were estimated to infect 38.1% of the local people, the first peak of HPV infection also found in the youngest group <25 year with an infection rate of 55.6%, HR-HPV infections and LR-HPV infections also peak at the same age group (Zhao et al., 2016). In Guangzhou, a retrospective study also found that the highest prevalence of HPV was found in women <25 years old with infection rate at 31.65% (Zeng et al., 2016). In Chongqing, the HPV infection prevalence peaks were even observed in women under 20 years of age (Yan et al., 2021). In Jiangsu province, the overall HPV prevalence was 10.6% , the highest HPV infection also found in the young age group < 20 years (Ge et al., 2019). In China, the highest HPV prevalence also observed in the young age group, with infection rates of 55.7% among women under 20 years old and 37.6% in the 20-25 years old age group(Zhang et al. 2023). Hence, traditional college-age students within the ages of 18–25 are at an increased risk of acquiring HPV in China.

2.2.2 Epidemiology of HPV in Hubei province

Hubei, in the central mainland China, HPV positive was detected in 93.75% patients with cervical cancer (Cai et al,. 2009). The prevalence of HPV was estimated about 8.6% among the health women (CHIMUST team et al., 2021).

Wuhan, the capital city of Hubei province, the HPV infection rate was 17.68%,

which is consistent with that of the national level, the highest prevalence of HPV infection was found in women <25 years old with a rate of 22.65% , the HR-HPV infection and LR-HPV infection pattern was also peak at the same year group (Xiang et al., 2018). The same results were also observed in Chen's (2019) study, the HPV infection rate was among 18-24 year group with an infection rate of 30.8% in Wuhan. Same results were found in Wufeng County, located in the southwest of Hubei

Province, the prevalence of HR HPV infections also observed peak in women 20–24 years with a HR HPV infection rate of 21.43% (Zhang et al., 2012). The five most common HPV genotypes in younger women <25 years of age were HPV-52, -16, -81, -58, -39 (Xiang et al., 2018).

In Hubei province, the college-age students were at a high rates of HPV prevalence and posed a high risk of getting HPV.

2.3 HPV infection prevention behavior

2.3.1 HPV vaccination

HPV vaccine, which has been available since 2006, is the most effective primary preventive method for HPV infection. In China, There are four prophylactic HPV vaccines: Cervarix, Gardasil, Gardasil 9, and Cecolin which are effective in preventing HPV-related cancers. All four vaccines are protective against HPV types 16 and 18. Gardasil also prevents HPV 6 and 11 which cause genital warts, Gardasil 9 prevents HPV 31, 33, 45, 52, and 58. The World Health Organization recommends two doses of vaccines for youths between 9 and 14 years old. The doses should be administered every 1-2 months. For males and females ages 15-26 who were not previously vaccinated, they recommend three doses administered 6 months apart (WHO, 2017).

Previous study has demonstrated that, when administered before exposure sex, these vaccines are approximately 98% effective at preventing strain-specific HPV infection (Cheng et.al., 2020). A systematic review of up to 8 years of follow-up data showed that it was 70% reduction in HPV-16 and 18 infections among screened women after vaccination, and 51% reduction in cervical intraepithelial neoplasia grade 2 among women aged 15-19 years and a 31% reduction in women aged 20-24 years (Drolet et al., 2019). There was also a significant reduction in colposcopy referrals associated with screening and procedures of cervical excision treatment. Also, the introduction of HPV vaccine immunization programs, continued reduction of cervical intraepithelial neoplasia diagnose, and related treatments was found (Cruickshank et al., 2017). In 2018, the WHO recommended the coverage rate of HPV vaccination to be cover 90% of the girls (WHO, 2018).

2.3.1.1 HPV vaccination in worldwide

A growing body of literature suggests HPV vaccines can prevent and control HPV infection and its complication. High rate of HPV vaccination coverage has the potential to reduce substantially cervical cancer incidence and mortality and HPV-related disease (Liu et al., 2022).

In 2019, approximately 98 countries (51%) have introduced HPV vaccinations into their immunization programs (WHO 2020), and 11 countries (6%) also for boys (Bigaard & Franceschi, 2021). The worldwide HPV vaccination coverage in 2018 was estimated at only 12.2%, with 51.5 in High income counties and 7.6 in LAMICs (Spayne & Hesketh, 2021). In High income counties, like in United states, HPV vaccination coverage among females (reported receipt of at least 1 dose of HPV vaccine) by age group was 52.8% (19–26 years), 53.3% (19–21 years), and 52.5% (22–26 years) in 2018 (Lu et al., 2021). In Australia, 1 dose coverage of HPV vaccine was 86% among females and 79% among males, and in the United Kingdom, three-dose coverage reach to 86% among females (Ragan et al., 2018). And Gallagher (Gallagher et al., 2017) reported that three doses coverage was over 50% in 45 LAMICs in 2007-2016. For example, in Africa, the country South Africa and Rwanda reached ≥ 80% of HPV vaccine coverage (Bigaard & Franceschi, 2021). In Asia, countries like Bhutan, Malaysia and South Korea, the HPV vaccination coverage is with ≥ 80% coverage, but in some of the most populous countries including Indian and China, since no national vaccination program available yet, HPV vaccination rate is low. In the future, attention should be paid to ensure more countries nationally introduce the HPV vaccine into their immunization programs, especially for countries with high cervical cancer burden, to further improve program performance globally.

2.3.1.2 HPV vaccination in China

In China, until 2016, bivalent and quadrivalent HPV vaccines had been successively approved by the Chinese authorities for marketing in the Chinese mainland. Later on April 2018, the 9-valent HPV vaccines was also been approved by the Chinese authorities for marketing in the Chinese mainland. The availability of the first HPV vaccine in Chinese mainland has been delayed by almost 10 years, resulting in approximately 114 million 9–14 years old girls missing out on the best

opportunity to protect them from cervical cancers and precancers (National Medical Products Administrition.2022). It was estimated that 783,000 cervical cancer cases and 435,000 related deaths could be preventable in this population by implementing a national HPV vaccination program targeting 9–14 years old girls (90% vaccination coverage with bivalent HPV vaccine), between 2006 and 2015(National Bureau of Statistics,2020; Colombara & Wang, 2013) Moreover, these three HPV vaccine have fall into the second category of vaccines (vaccines that citizens pay by their own expense and voluntarily) based on the Regulations on the Circulation and Vaccination of vaccines, has not yet included the HPV vaccine in the national immunization program (NIP). In 2019, first Chinese domestic bivalent HPV vaccine (Innovax, Xiamen, China) was licensed by the Chinese Food and Drug Administration released. It has similar efficacy to the imported bivalent HPV to against HPV 16 and 18, which also falls into the second category of vaccines. (Table 3).

Table 4 Comparison of the four vaccines available in the China market.

HPV Vaccines		Cervarix	Gardasil	Gardasil 9	Cecolin
Time of Approval		2009	2006	2014	2019
Time introduced to mainland China		2016.6	2017.5	2018	2019
Year		9 to 45	20 to 45	9 to 45	9 to 45
Manufacture		GSK	Merk&Co	Merk&Co	Innovax
HPV type	6		√	√	
	11		√	√	
	16	√	√	√	√
	18	√	√	√	√
	31			√	
	33			√	
	45			√	
	52			√	
	58			√	
Expression system		Baculovirus-Insect Cell	Yeast	Yeast	E coli-produced
Dose		0.5 ml/dose	0.5 ml/dose	0.5 ml/dose	
Injection schedule		0, 1, 6 months	0, 2, 6 months	0, 2, 6 months	0, 1, 6 months
CC Protection rate		70%	70–75%	90%	
Price		$262 for three doses	$360 for three doses	$586 for three doses	$144 for three doses

China has not yet included the HPV vaccine in the national immunization program, the vaccination rate for women of the right age in China is still at a low level. It is estimated that during 2022–2030, each year of delay in the initiation of the NIP could result in the occurrence of more than 119 thousand new cases and 42 thousand deaths of cervical cancer (Gao et al., 2023). Although the total number of HPV vaccinations increased from 3.417 million doses in 2018 to 12.279 million doses in 2020 (Li, & Gu, 2022). The proportion of women aged 9–45 in China who had received a complete HPV vaccination was only 3%(Wang et al., 2021). Guangzhou, a city in the eastern China, the 3-dose HPV vaccine coverage rate in was only 0.73% in 2019 (Ran et al., 2021), lower than the worldwide HPV vaccination coverage 12.2%, even lower than the average rate of Low and Middle income countries which was 7.6 (Spayne & Hesketh, 2021). Shanghai, the biggest cities in China, located in the eastern division of China, the first and full dose rates of HPV vaccine administered to women aged 9-45 were only 4.19% and 2.83% respectively in 2019 (Liu et al., 2020). In addition, among college student nationwide, only 3.1% of the sample had been vaccinated against HPV, and 36.9% of female students indicated that they would choose to initiate HPV vaccine (Deng, Chen, & Liu, 2021), even the awareness rate of HPV vaccine was 40.27%, no more than 50% (Yin et al., 2021). In other nation-wide study, researcher found only 12.9% and 17.1% of the enrolled students reported having heard of HPV and HPV vaccines before the research (Zhang et al., 2021). A multicenter study of 4220 university students nationwide reported that only 11.0% of them having been vaccinated against HPV, students residing in eastern China had a HPV vaccine uptake rate of 13.7%, higher than west China (8.6%), Central China (10.6%) (You et al., 2020). In Sanxia city, a city located in the west of Hubei province, only 34.0% of the college students had considered HPV vaccination (Zhao et al., 2020). The HPV vaccination rate is still lower than the world average level, far behind the 90% coverage goal proposed by WHO.

To compensate for the costly delay and to accelerate the full roll-out of the HPV vaccination program, China has made aggressive efforts to develop domestic HPV vaccines, provide local evidence, explore tailored strategies, initiate free vaccination, and launch a national action plan for steps forward (Zhao et al., 2023). In March

2021, the National Health Commission launched the Healthy City Innovation Pilot Program focusing on cervical cancer comprehensive prevention and control, involving the following targets by 2025: having 90% of girls vaccinated by age 15 years, improving screening coverage of the women aged 35–64 (particularly over 70% of women screened by age 35 years and again by age 45 years), and having 90% of women with cervical cancer and precancerous treated. Under such an initiative, several pilot cities with adequate resources have first initiated local government funded HPV vaccination programs targeted at young adolescents, providing a promising start for free HPV vaccination in China(Zhao et al., 2023). Several flexible funding approaches have been set up for HPV vaccination, including (1) free charge for a certain type of HPV vaccine, or (2) fixed financial compensation whichever types of HPV vaccines, or (3) free charge for one certain type of HPV vaccine combined with fixed financial compensation for other types of HPV vaccines(Zhao et al., 2023). In 2020, Erdos, Wuxi, Xiamen, Jinan, Shenzhen and Chengdu, these 6 cities in China firstly launch a free HPV vaccination program for adolescent girls, becoming the pilot forerunner prevention of HPV immunization planning in China. China is at the stage of transition from the start of cervical cancer immunization prevention to the development of herd immunization planning. But in Hubei province, there is no financial support for HPV vaccine, people have to pay the full price for each dose of HPV vaccine. In the next step, China should take full advantage of existing opportunities to make strides towards a transition from a regional to a national HPV vaccination program and to accelerate the achievement of the 90% coverage target of HPV vaccination.

2.3.2 Protective sex behavior

HPV infection is transmitted primarily by genital contact, usually through sexual intercourse but also through other intimate contact (e.g., oral-genital or genital-genital). Nonsexual routes of HPV transmission are less common and can include intrapartum transmission from mother to infant (Markowitz et al., 2014). Epidemiologic studies have reported number of recent lifetime sexual partners and age at sexual debut to be among the risk factors for HPV infection (Tota et al., 2011). The CDC of US affirms that 80% of women and 90% of sexually active men, would

be infected with at least one HPV type (Petca et al., 2020). In Japan, study indicated that the more sexual partners the more chance of getting HPV infection. Prevalence of HR-HPV peaked in women who had ≥ 10 lifetime sexual partners (25.1%), followed by a gradual decline in prevalence at 20.2%, 9.0% and 3.6% in women who had 6–9, 2–5 and one, respectively (Yamaguchi et al., 2021). Abstaining from sexual activity (i.e., refraining from any genital contact with another person) is the surest way to prevent genital HPV infection. Persons also can lower their chances of becoming infected with HPV by being in a monogamous relationship with one partner, limiting their number of sex partners, and choosing a partner who has had no or few previous sex partners. However, even persons with only one lifetime sex partner can be infected with HPV(Markowitz et al., 2014)..

HPV can be transmitted by skin contacted, consistent and correct condom use was reported to reduce the risk for HPV and HPV-associated diseases (e.g., genital warts and cervical cancer). By 2006, two longitudinal studies had been published showing a protective effect of condoms on HPV infections. Women whose partners used condoms for all instances were 70% less likely to acquire a new infection than were women whose partners used condoms less than 5 percent of the time(Lam et al., 2014). Even women whose partners used condoms more than half the time had a 50 percent risk reduction of HPV induction (Winer et al., 2006). However, in China, 11.3% of college students had sexual intercourse in their college study (Song & Ji, 2010), the rate is on a rising trend. And the average age of sexual debut among the college students was 18.4 years(Shi et al., 2021), almost at the first year of college student. Study showed that more than half of young Chinese college students reported having unprotected sexual intercourse(Song & Ji, 2010), which put them at a high risk of contracting sexual transmitted diseases, and facing a high chance of infecting HPV. So sex protection education like the use of condom were also needed for college students.

Since the trend of unprotected sexual intercourse among Chinese young college age students was increasing, which put them at a high risk of contracting sexual transmitted diseases, including HPV infection, it’s urgently to educate them

with correct protective sex behavior knowledge and receive HPV vaccine to protect themselves.

2.4 Factors related to intention to initiate HPV vaccination

2.4.1 Lack of awareness and knowledge regarding HPV

Despite the established effectiveness of HPV vaccines, a lack of awareness about HPV and HPV vaccine remains the primary and most common barrier to adequate HPV vaccination today in the person level. Studies indicate that adolescents and young people often lack sufficient knowledge about HPV and its vaccine. In Turkey, Turhan et al., (2019) indicated that overall 27.0% and 23.2% of the 18-year-old and older women and men participant reported having heard of HPV infection and HPV vaccine and the level of knowledge of the participants about HPV infection and HPV vaccine was found to be very low. In Vietnam, Mean knowledge scores for HPV vaccination were 1.53±1.35 out of 5 among women aged 18 to 49 years (Phuong et al., 2020). Natipagon-Shah et al. (2021) reported the strongest predictor for having received vaccination was the extent of knowledge related to HPV infection. The deficit of related knowledge was closely associated with perceived low risk of HPV and modest intention to get HPV vaccinated among college students (Xu et al., 2021). In China, a nation-wide study reported that only 16.83% of 4,062 students have heard of HPV between year 2015-2016 (Zhang et al., 2021). In 2018, 72.6% of the university students had previously heard of but had insufficient knowledge about HPV. Even at Peking University, only 9.5% have received the HPV vaccine (Liu et al., 2020). A study with 256 college students in South Carolina showed that those who were vaccinated, had higher levels of HPV knowledge (Kasymova, Harrison, & Pascal, 2019). Only 19% of the college students identify behaviors associated with an increased risk of contracting HPV, such as having multiple sex partners and having sex without condom (Nkwonta, Dawson, & Adegboyega, 2022). Lin's study also found significant factors influence on intent to obtain HPV vaccination were high knowledge score, perceived high risk of HPV infection, and mass media exposure to HPV vaccination information (Lin et al., 2019). Limited knowledge about the HPV infection become the primary and most common reason for refusing vaccination and not recommending the vaccine to others (Liu et al., 2020). Zhao et al. (2016) pointed

that increasing women's awareness of the relationship between HPV infection and cervical cancer is the most important recommendation to reduce cervical cancer and improve HPV vaccination. This result confirms the need for further education about HPV for college students.

2.4.2 Underestimate of personal risk of getting HPV

70% of the college students perceived they were not at risk for contracting HPV or believed that they were not at risk of developing any HPV-related cancers (Nkwonta et al., 2022). Since they thought being in monogamous relationships, having a healthy lifestyle, having no family history of cancer, and the perceived rarity of HPV related cancer, they will have a low risk of getting HPV. Individuals who perceive a low risk of HPV infection may have a false sense of safety, which in turn may lead to more risky sexual behaviors. Even in Italy, although 93.8% of young adults are aware that HPV can cause serious diseases, 49.7% consider themselves at risk of exposure to HPV (Trucchi et al., 2020). Studies conducted in Hong Kong(Liu et al., 2018) and Malaysia(Lin et al., 2019) , higher HPV-related knowledge levels were the important factors predicting vaccine uptake and intention to recommend vaccination. In a study conducted in Turkish college students, 37.5% of the medical students cited lack of adequate knowledge as the foremost reason for not getting vaccinated(Koç, 2015). In India, 48.3% nursing students expressed insufficient knowledge as their primary deterrent(Ganju et al., 2017). One meta-analysis also pointed out that female college students should receive standard, and unbiased HPV vaccination advice, including adequate knowledge about the risks of cervical cancer and HPV infection-related diseases, as well as unbiased information about HPV vaccine coverage (Bai et al., 2022). Underestimate the personal risk of getting HPV among college students also put them facing a high chance of infecting HPV.

2.4.3 Lack of knowledge about protective practices and behaviors

Adolescents and young people often lack sufficient knowledge about protective practices and behaviors. Studies in China reported a low level of knowledge and awareness toward protective practices and behaviors. In a nation-wide study, researcher found only 17.1% of the enrolled college students reported having heard of HPV vaccines before the research (Zhang et al., 2021). Same results had also be

observed in study conducted by Yin et al. (2021). In addition, only 36.9% of Chinese female students indicated that they would choose to initiate HPV vaccine (Deng et al., 2021). In Sanxia city, a city located in the west of Hubei province, only 34.0% of the college students had considered HPV vaccination (Zhao et al., 2020). Lack of knowledge of who needed preventive services, and where to access them, were other common challenges for HPV vaccine (Nkwonta et al., 2022). This result confirms the need for further education about HPV vaccine among college students to reduce the chance of infecting HPV.

2.4.4 Lack of conviction

Lack of conviction that the vaccine was efficient and safe were also the concerns for unwillingness to vaccinate in China (Zhang et al., 2016). For the college students who did not intend to receive HPV vaccine, 59.5% offered the reasons they worry about the side effects of the HPV vaccine, 44.1% feel uncertainty about the effectiveness of the HPV vaccine (Xu et al., 2021). A system review of 22 studies including 8079 females aged 9–26 years in North America reported the second barrier for HPV vaccine is the feelings that vaccination was unnecessary (Rambout et al., 2014). Moreover, a study done in Turkey reported that there were deficiency and mistakes even in teachers' attitude and behaviors towards HPV and its vaccine(Keten et al., 2021). For the college students who did not intend to receive HPV vaccine, 54.8% offered the reasons they are believing no likelihood of being infected with HPV(Xu et al., 2021). Lin's study also found significant factors influence on intent to obtain HPV vaccination were perception of no serious side effects, and mass media exposure to HPV vaccination information (Lin et al., 2019). This result confirms the need for further education about effectiveness about HPV vaccine among college students to increase the intention of HPV vaccination.

2.4.5 Cost of HPV vaccine

Cost of HPV vaccine is also an important factor that will effect to HPV vaccination. A system review of 22 studies including 8079 females aged 9–26 years in North America reported cost was the most frequently reported barrier for HPV vaccine (Rambout et al., 2014). In China, study report that only 4.8% parents were

willing to pay more than US$148 to have the HPV vaccine, 40.1% believed less than US$14.8 would be the affordable price (Wang et al., 2015). A similar result was observed in a study of Chinese college student, 32.1% of student thought it cost too much (Xu et al., 2021), a qualitative study among college students also found the same result, they proposed a fully government-funded, population-based HPV vaccination program to offset financial burden (Chen et al., 2021). In an Vietnam study, 86.6% of the respondents were willing to pay for the HPV vaccine, and willing to pay an average amount of US$49.3 (Tran et al., 2018), that was two thirds of the actual price in the vaccination clinic. However, in the U.S. , mothers of girls aged 13-17 years would like to pay an average of US$663 for the three-dose course (Brown et al., 2010). In other studies in Thailand and Mexico, people were willing to pay US$200 for three doses (Fesenfeld, Hutubessy, & Jit, 2013). In addition, financial incentives may improve HPV vaccine uptake compared to usual practice(Abdullahi et al., 2020b). In China, 23.3% parents expected the cost of HPV vaccination to be covered by National Medical Insurance , and if HPV vaccine is to be included in the expand plan immunization, 81.0% parents were willing to accept HPV vaccination for their children (Wang et al., 2015). Future studies associated with the optimum price of the vaccine, combined with price negotiation with manufacturers are encouraged. Meanwhile, the approval process of the domestically produced HPV vaccines, especially the new-generation vaccines against more HPV types, should be expedited to force producers to cut prices effectively.

2.4.6 Lack of recommendation

Healthcare provider's positive recommendation of the vaccine is also one of the strongest factors in vaccine acceptance (Malo et al., 2013). Doctors' recommendation were found to be important determinants of HPV vaccination intentions among college-aged women, parents of daughter, parents of sons (Gainforth et al. 2012). D'Errico et al. (2020) found that the most commonly reported barrier to HPV vaccine for college students was the lack of a health care provider's recommendation. A qualitative study indicated that, when offering the vaccine to patients, health care professionals offered little information about the vaccine, treating it like other recommended adolescent vaccines, or provided detailed information about the risks, highlighting it as optional (Goff et al., 2011). Encouraging conversations with doctors

were identified as one of the most influential factors to increase vaccine uptake. Anon (2018) pointed that among students who received encouragement from a doctor, 95.8% received the vaccine (Regan et al., 2018). Nkwonta et al., (2022) indicated college campus clinics have a role to play in providing targeted sexual education to reduce college students risky behaviors. The decision for the healthcare professional to recommend vaccination included providers' beliefs that HPV vaccine was safe and would provide important great health benefits (Perkins & Clark, 2012). Low knowledge about the relationship between HPV infection and genital warts or the relationship between HPV and noncervical cancers were also barriers for HPV vaccination recommendation for physician. After receiving recommendation from the healthcare provider in the college clinic, HPV vaccine initiation rates increased from 5.2% to 25.1% (Martin et al., 2018). Meidical students, as the next generations of healthcare providers, equip with knowledge and pose a positive attitude towards the vaccine indicate a favorable outlook for their future actions as health service providers in vaccination programs. It is critical for them to be appropriately educated about HPV, and HPV associated diseases, the importance of HPV vaccination, and how to deliver effective vaccine recommendations.

2.4.7 Shortage in HPV vaccine supply

Moreover, the issues that China face include shortage in HPV vaccine supply, trouble to schedule appointments. In China, for students who did not intend to receive HPV vaccine, 41.7% offered the reason that HPV vaccine is limited availability. According to the data derived from the National Bureau of Statistics of China, approximately 80 million doses of HPV vaccines would be needed to cover 90% of the entire cohort of girls aged 9–14(Zhao et al., 2023). However, data showed that there were only about 30 million bivalent vaccine doses, 14 million quadrivalent vaccine doses, and 15 million nonvalent vaccine doses available on the market in China in 2022(Zhao et al., 2023). To date, China has approved five types of HPV vaccines against cervical cancer, making it the country with the most types of HPV vaccines. Presently, at least 13 types of HPV vaccines are undergoing clinical trials in China, and more products are in the pipeline to be approved in years ahead. The rapid development of the Chinese HPV vaccines could provide more possibilities to

alleviate the supply and financial constraints of HPV vaccines in China. Currently, under the supply-constrained scenario, domestically manufactured HPV vaccine Cecolin™ vaccination would be preferred for larger and faster health and economic gains with college students being the optimal age for vaccination, rather than just waiting for Gardasil 9. Shortage in HPV vaccine supply may be an obstacle for college students to pose an intention and initiate HPV vaccines.

2.5 Protective Motivation Theory (PMT)

There is growing evidence that interventions developed with an explicit theoretical foundation are more effective and more likely to induce positive behavior change (Ferrer et al., 2015). Among the various theories that are frequently used to guide behavior research, the Protection Motivation Theory may be particularly well-suited for understanding and improving intention to initiate HPV vaccination. Protection Motivation Theory (PMT), originally developed by Rogers (1975) to explain the effects of fear appeals on health attitudes and behaviors, has been widely used in recent decades as a framework for explaining harmful behaviors or predicting protective behaviors. The PMT explained the intrinsic mechanism and process of behavior transformation, which contains two process that match the cognitive processes that people use in evaluating threats and in selecting among coping alternatives(Floyd, Prentice-Dunn, & Rogers, 2000).

According to the assumptions of PMT, to adopt protective behaviors in response to health problems, people consider threats and benefits. Therefore two processes are included in this theory, cognitive threat appraisal and coping appraisal. Threat appraisal, focusing on threat and factors that increase or decrease the probability of maladaptive responses, consisting of intrinsic and extrinsic rewards, severity and vulnerability, has a significant impact on the selection of behaviors. Coping appraisal, focusing on threat and factors that increase or decrease the probability of adaptive response, consisting of response efficacy, self-efficacy and response costs, is an important agent in motivational, cognitive, and affective process. Minimizing threat appraisal while maximizing the coping appraisal helps develop the intention to initiate protective actions, which facilitates actual protective behaviors(Rogers, 1983).

As mentioned previously, PMT is organized along two cognitive processes: the threat appraisal process and the coping appraisal process. The threat appraisal process consisted of two 2 constructs: (1) Perceived vulnerability: a person's estimate of the chances of being affected by the disease; (2) Perceived severity: a person's beliefs about the severity of the threat Thus, the greater the perceived threat, the more likely an individual is to be motivated to protect themselves and adopt the recommended behavior. The coping appraisal process consists of two constructs: (1) Response efficacy: how well a person determines the efficacy of an adaptive response to a perceived health threat, (2) Self-efficacy a person's own assessment of their ability to successfully initiate and complete an adaptive response. In the coping appraisal process, belief in the efficacy of the response, and perceived self-efficacy in carrying out the response, was seen as increasing protection motivation. (Floyd, Prentice-Dunn, & Rogers, 2000). The threat-appraisal process is addressed first, because once a threat is be perceived or identified by an idividual, there can be an evaluation of coping options. Rewards will increase the probability of selecting the maladaptive response, whereas threat will decrease the probability of selecting the maladaptive response. If the threat appraisal was stronger than the coping solution, individuals often had maladaptive responses which included nonaction, or just ignoring the threat. If the coping appraisal was stronger than the threat appraisal, then the adaptive response was embraced (Floyd et al., 2000). (Table 4)

An extensive narrative review of literature and research on PMT, indicated that PMT has been applied to a diverse array of topics to explore motivation and behaviors of individuals and to predict prevention outcomes in health-related fields, including pregnancy exercise (Gaston & Prapavessis, 2014), cancer protective behaviors (Romli et al., 2023), Chronic disease control (Brooks & Bubela, 2020), Vaccination (Hedayati et al., 2023) and adolescent somking behavior (Thrul et al., 2013). As an integrative conceptual framework, PMT has also been used in predicating intention to initiate vaccine. Li et al. (2021)used PMT to analysis people’s intention to receive COVID-19 in China, showing that PMT factors, especially coping assessment factors, were significant correlate to respondents’ intention to COVID-19 vaccination. Education about the safety and efficacy of COVID-19 vaccines to improve perception of the vaccine’s safety, external reward and response efficacy would improve the

vaccination intention, which will be the key to increasing the vaccination rate. Huang et al. (2021) used PMT model to explain the intention for COVID-19 vaccination uptake among university students in Taiwan, which also indicated that perceived knowledge was significantly related to coping appraisal, and intention of vaccination. In other words, coping appraisal of PMT model may have a positive effect on protective behavior which could affect intention of individuals. The use of PMT can shaping university students' intention to get a vaccination and subsequently increase the coverage of vaccination. Severity, susceptibility, maladaptive response costs, and self-efficacy, four PMT constructs emerged as significant predictors of COVID-19 vaccination intention (Eberhardt & Ling, 2021). Ling, Kothe, & Mullan (2019) found among the constructs of PMT factor were predictors of intention to predict people's intention to obtain the seasonal influenza vaccine. PMT also used to predicate people's intention to get hepatitis B vaccine(R. Liu et al., 2016).

The reason why PMT can be used to guide study to motivated individuals to protect themselves and adopt the recommended behavior to receive HPV vaccine may because this theory can balance threat appraisal and coping appraisal. The balance between the two appraisal process determines the likelihood for a protective behavior, intention to initiate HPV vaccination, to occur. After equip with enough knowledge of HPV and HPV vaccine, individuals might weigh the protective effects of receiving prophylactic HPV vaccine against the effects that HPV infection would cause, like cervical cancer, genital warts and other diseases (potential severity of HPV infection-related risk) and concern that HPV infection prevalence can transmitted by skin to skin and peak in young age group (<25 years) (potential susceptibility to HPV infection related risk). If individuals consider there will be big health benefits of receiving HPV vaccine (perceived response efficacy of receiving HPV vaccine) and how well they think they could manage the barriers toward HPV vaccination (self-efficacy for receiving HPV vaccine), they will be motivated to protect themselves and adopt the recommended behavior to receive the HPV vaccine(Shillair, 2020).

Since the PMT was widely used to guide study to motivated individuals to protect themselves and adopt the recommended behavior, this reseach would used PMT as a guide to predicate the intention to initiate HPV vaccine among college students (<25 years) which were the peak age group of infecting HPV, by analysis

their knowledge of threat appraisal and coping appraisal toward HPV, and to motivated them to protect themselves and adopt the recommended behavior to receive HPV vaccine.

Table 5 Revised Protection Motivation Theory

Construct	**Definition**
Perceived susceptibility	Estimation of the probability of a threat occurring. In this study, it meant participants' assessment for the level of susceptibility of infection with HPV.
Perceived severity	Estimation of the seriousness of a threat In this study it meant to evaluate the perceived likelihood of adverse consequences if infected with HPV
Response efficacy	Expectancy that carrying out recommendations can remove the threat In this study it represented individuals' evaluation about the perceived effectiveness of getting the HPV vaccine
Self-efficacy	Belief in one's ability to execute the recommendations successfully In this study , it was used to assess one's belief of the ability in one's own confidence to get the first dose and complete all three doses of HPV vaccine

2.6 Relevant researches

2.6.1 Researches related the intention to initiate HPV vaccination

The HPV vaccine uptake could be illustrated through intention. Study indicated that intention accounts for considerable 0.5 to actual behavior (Steel & Ovalle, 1984). Studies in Thailand showed that perceived susceptibility and cost have appeared as predictors of intention regarding vaccination, Thai college women gave the lack of perceived susceptibility and cost as reasons for not being vaccinated. (Juntasopeepun et al., 2011; Chunuan et al., 2021). A survey conducted in the US showed that perceived susceptibility to HPV, perceived benefits of the vaccine, and self-efficacy to obtain the vaccine were significant predictors for college women intend to obtain HPV vaccination(Bennett et al., 2012). Response efficacy was found to be the most

important determinant on the part of Canadian college women's intentions(Gainforth et al., 2012. The perception of vaccine effectiveness refers to the recognition by the woman of her ability to protect her health status specifically against genital warts, cervical cancer and HPV infection if she obtained HPV vaccination. Chunuan et al. (2021) show that cost of HPV vaccination, knowledge of HPV and cervical cancer, Subjective norms to obtain the HPV vaccination, attitudes to obtain HPV vaccination, perceived susceptibility, perceived behavioral control and perceived effectiveness all seven predictor variables explain 38% of variance in intention to initiate HPV vaccination among college students. Therefore, education and the promotion of HPV vaccine awareness should be implemented for all college women. It should focus on their confidence about obtaining the HPV vaccine.

In China A study investigated 7335 university students from seven university, and found that 60.1% of them were with the intention to initiate HPV vaccination, while only 32.1% of the female students, the target population of HPV vaccination, indicated that they would be willing to get vaccinated in the following 6 months (Dai et al., 2021). Other study explore the male's intention of HPV vaccination was low in mainland China with only 3.4 point with highest willingness was 10 point (Huang et al., 2021). Dai et al. (2021) found that among the variables affecting intention to initiate HPV vaccination, the level of knowledge and having ever received sex education were both the indicators of the willingness. This indicated that students who have a good knowledge or had ever received education in some aspects tend to pay more attention to potential sexually transmitted diseases and take measures to cope with these infections. This suggests that improving attitudes and knowledge of HPV, as well as relative education, is an effective way to enhance college students' intention to initiate HPV vaccination. Also, study found that perceived severity, perceived vulnerability and self-efficacy affect the intention to initiate HPV vaccination (Huang et al., 2021). Future HPV vaccination strategies should improving the knowledge of perceived severity, perceived susceptibility and self-efficacy toward HPV vaccine to enhance college students intention to initiate HPV vaccination.

2.6.2 Researches related HPV vaccination coverage

As of 2023, 134 (69%) of the 194 WHO member states have introduced HPV vaccination in the national immunization program. It was estimated that the worldwide HPV vaccination coverage in 2018 was 12.2%, with 51.5% in High income counties and 7.6% in LAMICs (Spayne & Hesketh, 2021). In 2022, it was estimated that the global coverage of the first dose of HPV vaccination in females was 21% (WHO, 2023). The HPV vaccination coverage rate worldwide is increasing, but still far behind the 2030 elimination target of 90% (WHO, 2018). The completion HPV vaccination coverage rate varies among counties and districts. Australia and New Zealand, and Latin America achieved the highest HPV coverages (77% and 61% respectively), followed by Europe and North America (35%). In contrast, Northern Africa (1%), Asia (1%) and Oceania (excluding Australia and New Zealand)(4%) all had very low coverage rates in 2019. This is explained by the fact that 7 of the 10 top most populous countries in Asia have not yet introduced or only at sub-national level, including China, India, Nigeria, Pakistan, Indonesia, Bangladesh, and Russia. This dramatically affects the Asia HPV vaccination coverage estimates only 1% in 2019, and global coverage estimates which reached only 15% in 2019(Bruni, et al., 2021).

In China, since there is no national vaccination program available yet, HPV vaccination rate is low. The proportion of women aged 9–45 in China who had received a complete HPV vaccination was only 3% in 2020(Wang et al., 2021). A multicenter study of 4220 college students nationwide reported that only 11.0% of them having been vaccinated against HPV(You et al., 2020). There is far behind the WHO Cervical Cancer Elimination strategy goal that 90% of all adolescent girls receive HPV vaccination by 2030 (WHO, 2018). To compensate for the costly delay and to accelerate the full roll-out of the HPV vaccination program, China should made aggressive efforts to explore tailored strategies, initiate free vaccination, and launch a national action plan for steps forward to improve the HPV vaccination coverage rate.

2.6.3 Researches related sources of HPV vaccine information and HPV infection prevention awareness

Using different sources of information has been found to have differential impacts on HPV vaccine uptake across various populations. Vaccine uptake was positively related with relying on various vaccination information sources including healthcare providers, newspapers, brochures, family, and friends (Kim, 2018). The growth in internet use and increase in health information available on the web is changing the sources of health information. According to findings from the Health Tracking Household Survey, half of individuals seeking health information made subsequent lifestyle changes based on the gathered information (Tu and Cohen, 2008). The survey revealed that participants utilized various sources, such as the internet, television, newspapers, radio, and input from friends or relatives, to collect health-related information (Tu and Cohen, 2008). Notably, the internet emerged as a powerful influence, with 73 percent of those who sought information online reporting that they used it to make health-related decisions since 2006 (Liszka et al., 2006). The main advantages and attractions for health information seeking online have been found to include access, anonymity, potential for interactivity, and social support. College students mirrored this trend, as Escoffery et al. (2005) discovered that over 70 percent of a sample of 743 college students identified the internet as a primary source of health information. When it comes to information about HPV, individuals exposed to such information may exhibit a heightened inclination to plan on getting vaccinated. This potential impact of information leads us to the second research question, aiming to delve deeper into whether information-seeking behavior correlates with intentions to receive the HPV vaccine. Kim (2018) found that hearing about HPV vaccine from different information sources did not influence the perceived benefits, perceived vaccine safety barriers, and perceived logistic barriers. Using the Internet would decrease perceived barriers to talking with others regarding the HPV vaccine.

In United States, even though 86% of the population are connected online, studies have found that individuals with less internet skill are prefer to use friends, family or healthcare professionals as their primary source of health

information(Jacobs et al., 2017). Interpersonal health communication will also affect. people's risk perception and affective responses to influence health-protective behaviors such as health information seeking and adherence to protective measures. Study found that Doctors and nurses were the most commonly reported individual source of information about HPV vaccines and the individual source associated with the highest number of scales measuring knowledge and perceptions. Kim (2018) found that hearing about HPV from health care providers increased perceived susceptibility to HPV. Adolescents who indicated that doctors or nurses were sources of information had higher knowledge scores toward HPV and HPV vaccine (Rosen et al., 2017).

Awareness of HPV infection prevention among college students have also showed variable results. In one study of college-aged women, the cumulative incidence of any HPV infection at 1 year after sexual debut was 28.5 % and increased to almost 50 % by 3 years (Winer et al., 2003). Lack of HPV infection prevention awareness would led to a situation that the person would perceive a low risk of infection. This were proved by Chanprasertpinyo & Rerkswattavorn(2020) and Kasymova et al., (2019)'s study, which highlight that college students pose a median level knowledge of about HPV infection turn out to perceived a low-risk awareness toward HPV infection. Previous study conducted in the United States with college students found a large part of female college students who believe themselves to be "not at risk" for HPV infection but actually test HPV positive, with a 35% HPV prevalence rate (Ramirez et al., 1997).

2.6.4 Researches related barriers to HPV vaccination, and how to promote HPV vaccination

Barriers to HPV vaccination can be divided into three levels, which were individual level, provider level, and health policy level (Cartmell et al., 2018; Tron et al., 2024).

High cost of HPV vaccine: A survey conducted in the US showed that one of several common reasons mentioned by college women who did not intend to obtain HPV vaccination was the high cost that had to be paid, a cost that involved using their

own money (Bennett et al., 2012).. In 2015, Ratanasiripong pointed out that Thai college women point out cost as the primary reason for not being vaccinated (Ratanasiripong et al., 2018). The cost of HPV vaccination refers to the woman's estimation of the cost which prevents college students from obtaining HPV vaccination. Notably, the 9-valent HPV vaccine in China costs as high as USD 187 per dose, beyond the reach of most eligible women and the government funded program. In Hongkong, one study showed that if the vaccine was at a market price, acceptability of HPV vaccine would dropped from 51.6%–63.0% to 14.9%–27.4% (Wang et al., 2018). Without universal healthcare coverage, the financial costs of the HPV vaccine appear to prevent uptake of the vaccine by most disadvantaged families(Batista Ferrer, Audrey, Trotter, & Hickman, 2015). A high level of uptake (43%) has been reported in countries where the HPV vaccine is free-of-charge under a government-mandated immunization schedule. The gap between the acceptable price and the real cost-effective price highlights the need for strategies to reduce the HPV vaccine cost, particularly in rural areas and less resourced provinces. Future studies associated with the optimum price of the vaccine, combined with price negotiation with manufacturers are encouraged. Meanwhile, the approval process of the domestically produced HPV vaccines, especially the new-generation vaccines against more HPV types, should be expedited to force producers to cut prices effectively.

Short of supply: HPV vaccine supply in China could hardly meet the current demand, which causes the limited availability of HPV vaccine. In China, for students who did not intend to receive HPV vaccine, 41.7% offered the reason that HPV vaccine is limited availability. According to the data derived from the National Bureau of Statistics of China, approximately 80 million doses of HPV vaccines would be needed to cover 90% of the entire cohort of girls aged 9–14(Zhao et al., 2023). However, data showed that there were only about 30 million bivalent vaccine doses, 14 million quadrivalent vaccine doses, and 15 million nonvalent vaccine doses available on the market in China in 2022(Zhao et al., 2023). Currently, under the supply-constrained scenario, domestically manufactured HPV vaccine Cecolin™ vaccination would be preferred for larger and faster health and economic gains with

college students being the optimal age for vaccination, rather than just waiting for Gardasil 9.

Limited knowledge for HPV vaccine: Despite the established effectiveness of HPV vaccines, a lack of awareness about HPV and HPV vaccine remains the primary and most common barrier to adequate HPV vaccination today in the person level. Studies indicate that adolescents and young people often lack sufficient knowledge about HPV and its vaccine. In Turkey, Turhan et al., (2019) indicated that overall 27.0% and 23.2% of the 18-year-old and older women and men participant reported having heard of HPV infection and HPV vaccine and the level of knowledge of the participants about HPV infection and HPV vaccine was found to be very low. In Vietnam, Mean knowledge scores for HPV vaccination were 1.53±1.35 out of 5 among women aged 18 to 49 years (Phuong et al., 2020). Previous studies conducted in Hong Kong(Liu et al., 2018) and Malaysia(Lin et al., 2019) , higher HPV-related knowledge levels were the important factors predicting vaccine uptake and intention to recommend vaccination. In a study conducted in Turkish college students, 37.5% of the medical students cited lack of adequate knowledge as the foremost reason for not getting vaccinated(Koç, 2015). In India, 48.3% nursing students expressed insufficient knowledge as their primary deterrent(Ganju et al., 2017). One meta-analysis also pointed out that female college students should receive standard, and unbiased HPV vaccination advice, including adequate knowledge about the risks of cervical cancer and HPV infection-related diseases, as well as unbiased information about HPV vaccine coverage (Bai et al., 2022). This study also found information about where to get the vaccine, how to make a reservation and vaccine's effectiveness has been a consideration for female college students, too. Even in urban areas of Wuhan, only a few community health service centers provide HPV vaccination service. The knowledge HPV and HPV-related disease, and HPV vaccine refers to the understanding the their chance of infecting HPV and then develop to genital HPV, cervical cancer and genital warts if they did not obtain HPV vaccination. Future study should find out effective education strategies to improve knowledge level about HPV and HPV vaccine among college students.

Worldwide, interventions to promote HPV vaccination have typically targeted parents, adolescents, young adults, and providers. A systematic review of 79 articles worldwide found that HPV vaccination interventions can be targeted various socio-ecological levels that influence HPV vaccination to ultimately effect change. intervention to improve HPV vaccination can be divided to focus only on the individual level (e.g., via education such as informational text included with reminders), and changes to policy (e.g., via formalized requirements, such as school mandates)(Escoffery et al., 2023). Among them, health educating about HPV epidemiology and vaccine-related issues play an important role in improving the vaccine's uptake among college students(Boom et al., 2005; Berenson et al., 2015). Berenson et al.(2015) found that inadequate levels of knowledge about HPV disease and prevention among medical students. Deficits in HPV knowledge may also be associated with lower rates of vaccine intention. Besides, web-based education intervention were also very common to improve intention to initiate HPV vaccination. Dempsey et al., (2019) conducted a randomized controlled trail found that web-based education changed college students attitudes toward HPV vaccination in US. Esposito et al., (2018) use the website plus the lesson significantly increased the overall knowledge of various aspects of vaccine-preventable disease, reduced the fear of vaccines, and also significantly the HPV vaccination coverage. Other intervention like provider-focused education and feedback, group-based brief (5-10min) education can also increase HPV vaccine initiation in 18-26 college students, when compared to control group(Perkins et al., 2015; Kester et al., 2014). A systematic review found that multicomponent interventions were more effective than single-focus interventions to improve intention to initiate HPV vaccination among college students(Escoffery et al., 2023). So research multicomponent intervention including health education about HPV related information and HPV vaccine can be adopted in the future intervention development.

2.6.5 Researches related PMT for HPV intention intervention

PMT has been frequently used in recent years to explain people's intention and behaviors toward HPV vaccination. Review findings indicated that perceived vulnerability to HPV and response efficacy of the HPV vaccine are key determinants

of HPV vaccine acceptability among parents considering vaccination for their child and adults considering HPV vaccination (Brewer & Fazekas, 2007). Huang et al., (2021) used PMT to explain men's intention to get HPV vaccine, found that the four factors of PMT including perceived severity, perceived vulnerability, response efficacy and self-efficacy would also affect individual's intention to get HPV vaccine. Same results were also can been seen in the college students Crosby et al., (2012). Wang et al. (2022) using PMT to investigate mothers' intention to vaccinate their daughters against HPV found that perceptions of HPV severity, HPV susceptibility, vaccine response efficacy, and secondary risks would affect their intention to vaccinate their daughters. The perceived self-efficacy in carrying out the response and belief in response efficacy are frequently demonstrated as key to improving protection motivation (Milne, Sheeran, & Orbell, 2000). But, some articles' result found that perceived severity of HPV was not related to vaccine acceptance (Gainforth et al., 2012). Muturi (2020) also used PMT theory to examine the association between eHealth literacy and HPV prevention among young adults. Muturi (2020) pointed that young adults had a relatively low risk perception and did not believe they were vulnerable although a majority reported risky behaviors such as a high number of sexual partners. With low knowledge and low risk perception, young adults would be unlikely to evaluate HPV as a threat and consequently take preventive measures. Olagoke et al.(2021) also indicated perceived self-efficacy and perceived response efficacy to vaccinate a child with HPV vaccine had with HPV vaccination intention among religious parents of unvaccinated adolescents. Olagoke et al.(2021) offered the information that only provide knowledge on the threat appraisal of HPV may not increase vaccination intention if it is not provide information on coping appraisal. Presenting information regarding vulnerability to HPV without addressing their perceived self-efficacy to vaccinate may not change their vaccination decision. Perceived severity, perceived susceptibility and response efficacy of the HPV vaccine, found to be important determinants of HPV vaccination intentions in college age group students in Canada (Gainforth et al. 2012).

PMT can be used to increase understanding what factors will influence individuals to take the necessary steps to keep themselves safe from particular health

concern. It focused on understanding the cognitive aspects of health decisions and health protection decisions are finalized while assessing the severity of the threat against the ability and cope ability toward the threat (Brooks & Bubela, 2020). Future HPV vaccination strategies can use PMT as framework to address low HPV vaccination problems among college students. First, to make college students feel that the HPV threat is real and that they are at the highest risk of get it. After they realize that they are in danger and they have the ability to coping the danger they may perform the recommended action.

2.7 Conceptual framework of the study

The four aspects to be solved in this study are

1) The intention and the factors associated with intention to initiate HPV vaccine among medical college students.

2) The HPV vaccination coverage, sources of HPV vaccine information and HPV infection prevention awareness among medical college students.

3) The perception toward HPV vaccine based on the PMT, barriers to receiving the HPV vaccine, and how to promote HPV vaccination

4) The promotion of the HPV vaccination program was developed from four aspects of PMT theory: hypotheses were put forward, and the effectiveness of the intervention was verified.

Finally, the main purpose of this study is “evaluation of the effectiveness of the promotion of HPV vaccination program (or a PMT-based HPV vaccination online education program) on HPV vaccination intention among medical college students in Hubei province, China. The results of this study can provide evidence for medical college students’ HPV vaccine education to improve HPV vaccination intention and provide evidence for health decision-makers to plan or carry out effective strategies to optimize uptake of the HPV vaccine. The researcher can summarize the conceptual framework as follows:

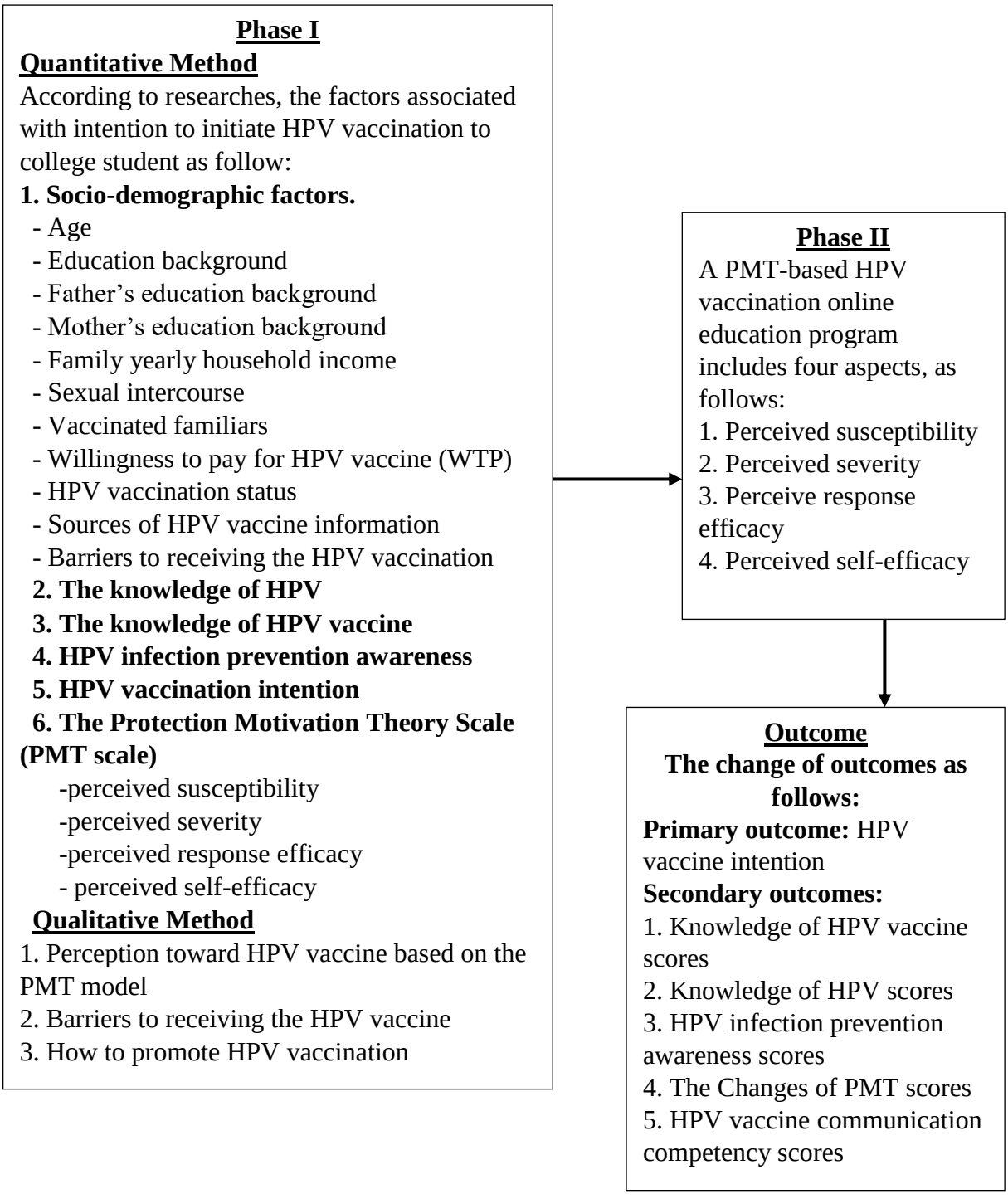


Figure 3 Conceptual framework of the study

CHAPTER 3
METHODOLOGY

This was a mixed-methods study, divided into two phases. In phase I, we integrated both quantitative and qualitative methods in a study to determine factors associated with the intention to initiate HPV vaccination, assess HPV vaccination coverage, HPV infection prevention awareness, and sources of HPV vaccine information, explore perceptions toward HPV vaccine based on the PMT model, explore barriers to receiving HPV vaccine, and learn how to promote HPV vaccination. In phase II, a cluster randomized controlled trial was used to evaluate the effectiveness of promotion the HPV vaccination program among medical students, which simulated the Protective Motivation Theory (PMT). The study procedure for each phase is as follows:

3.1 In phase I

Both of quantitative and qualitative methods were used in the study.

3.1.1 Study design

3.1.1.1 We used the quantitative method in the cross-sectional study to explore the HPV vaccination intention and determine the factors related to the HPV vaccination intention among medical students. Also, we assessed HPV vaccination coverage, sources of HPV vaccine information, and HPV infection prevention awareness.

3.1.1.2 The qualitative method, we conducted a qualitative method as in-depth interview of key informants to explore the perception toward HPV vaccine based on PMT, barriers to receiving the HPV vaccine, and how to promote HPV vaccination.

3.1.2 Study population and samples

3.1.2.1 The quantitative method

Study population

The study population in this phase was female college students aged at 18-26 years who studied in 6 colleges including 1) Wuhan City College, 2) Wuhan

College of Foreign Language and Affairs, 3) Huanggang Polytechnic College, 4) Jingzhou Institute of Technology, 5) Hubei University of Arts and Science, and 6) Hubei Engineering Vocational and Technical College in Hubei province.

Sample size

The sample size estimation was calculated using Daniel's formula(Daniel，1995) as follows:

$$n = \frac{NZ^2P(1-P)}{d^2(N-1)+Z^2P(1-P)}$$

Where:

n=Sample size

N=Number of female students population (N=38700)

Z=Confidence intervals (set as 95%CI, Z=1.96)

P=Proportion of college female students intention to initiate HPV vaccination in central part of China (P=46.2%) (You et al., 2020)

d=Maximum allowable error (d=0.03)

When

$$n = \frac{38700 * 1.96^2 * 0.462(1-0.462)}{0.03^2(38700-1)+1.96^2 * 0.462 * (1-0.462)}$$

$$n = 1032.6 \sim 1033$$

Considering there would be a 10% dropout rate in practice, so more subjects should enroll into the study. The adjusted sample size can be calculated by the formula as follows:

$$N_1 = n/(1-d)$$

Where:

N_1=The adjusted sample size

n = the sample size required as per formula

d = the dropout rate (10%)

When:

N1=1033/(1-0.1)

=1147.77~1148

Therefore, the researcher should collect at least 1148 cases.

Inclusion criteria

1. Currently college students who were freshman, sophomores, or juniors in Hubei province.

2. Being a female aged 18–26 years.

3. Able to read and understand Chinese mandarin independently.

4. Able to use smart phone and have the WeChat app on the phone.

5. Willing to participate.

Exclusion criteria

1. Student who refused to answer the questionnaire

2. Student who provided an incomplete response

Sampling method

In this study, the researcher selected a sample from each college according to the proportion of size as shown in Table 5. In each college, the students who met the eligible criteria were selected by the stratified sampling method. First, the researcher divided subjects into subgroups by college years (strata), including freshmen, sophomores, and juniors. In the second, the researcher made a sampling frame for each strata, which included a list of all students who could be sampled. In the third, the researcher selected a sample from each strata. The data collection would continue without interruption until the required number of samples was collected for each college.

Table 6 The proportion to size of sample in each college

College	Number of female students	Number of Sample
1. Hubei University of Arts and Science	8, 100	241
2. Huanggang Polytechnic College	8, 000	238
3. Jingzhou Institute of Technology	8, 000	238
4. Hubei Engineering Vocational and Technical College	5, 600	166
5. Wuhan City College	5, 000	147
6.Wuhan College of Foreign Language and Affairs	4, 000	118
Total	**38, 700**	**1, 148**

3.1.2.1 The qualitative method

In the qualitative method, we focused on perceptions toward the HPV vaccine based on PMT, explored barriers to receiving the HPV vaccine, and discussed how to promote HPV vaccination. The target group consisted of medical students (n = 10), healthcare providers from the college clinic (n = 8), and teachers of the colleges (n = 6). Purposive sampling was used to recruit participants.

Inclusion criteria

1. The healthcare providers who worked in college clinics have had experience in their work for at least 3 years.
2. The teachers who worked in college have had experience in their work for at least one year.
3. The medical students who study in college both students who either get or do not get HPV vaccinated.
4. Willing to participate

Exclusion criteria

1. The participants did not live in a research setting during the research.
2. The participants who want to cancel their research participation during research conduct
3. The participants who have a sudden illness

3.1.3 Research instruments in phase I

3.1.3.1 Quantitative instruments

The self-administered questionnaire was developed based on a literature review which consisted of six parts as follows:

Part 1 Demographic factors

Sociodemographic factors including age, education background, father's education background, mother's education background, family yearly household income, sexual intercourse, vaccinated familiars, willingness to pay for HPV vaccine (WTP), and HPV vaccination status were collected. All variables were categorized as dichotomous variables, except for the age variable, which was a continuous variable.

In terms of sources of HPV vaccine information, and barriers to receiving the HPV vaccine, this was the multiple choice question.

Part 2 — Knowledge about HPV

A 15-item HPV knowledge scale was adapted from existing published measures (Chunuan et al., 2021; Kasymova et al., 2019; You et al., 2020), with all items judged as true, or false. Participants received one point for a correct response; points were summed to create a total knowledge score (range of 0–15), with a higher total score indicating a greater level of knowledge of HPV. A standard score was also calculated: standard score points=actual score * 6.67. The HPV-Knowledge 15 (HPV-K15) had good internal consistency (KR-20 was 0.90). The knowledge of HPV including 1) the health consequences of HPV infection; 2) risk factor and transmission of HPV;3) symptom of HPV infection; (4) prevention and treatment of HPV.

Part 3 —The knowledge of HPV vaccine.

The scale utilized for this study was modified from the student HPV survey (Thomas, Dalmida, & Higgins, 2016). Knowledge of the HPV vaccine (11 items) was also gained by judging true or false. Participants received one point for a correct response; points were summed to create a total knowledge score (range of 0–11). A standard score was also calculated: standard score points=actual score * 9.10. The HPV-Knowledge 11 yielded strong internal consistency (KR-20 was 0.90). The knowledge of HPV vaccine including the benefits of HPV vaccine, the best time to take vaccine, the effects toward types of HPV infection, the dose of HPV vaccine.

Part 4 —Intention to initiate HPV vaccination

Intention to initiate HPV vaccination was assessed using one item from Huang et al. (2021). If the participants had not received any dose of HPV vaccine, they would be asked to “please rate your intention to get HPV vaccination in the future from 1 (totally unwilling to) to 10 (extremely willing to). A higher score on the item indicates a higher willingness to receive vaccinations afterwards. This variable was also dichotomized for analysis by median: participants were coded as having low intention if they responded 5 or less; otherwise, they were coded as having high intention.

Part 5 — The Protection Motivation Theory Scale (PMT scale)

The PMT to predict the intention always depends upon four factors: perceived susceptibility, perceived severity, perceive response efficacy, and perceived self-efficacy (Ferrer et.al, 2015).

1) Perceived Susceptibility

To assess the participants' beliefs about their susceptibility to HPV, a 3-item adapted from Neuwirth and colleagues (Huang et al., 2021) was used. The scale use a 5-point Likert scale ranging from 1 (No chance at all) to 5 (Very high chance). Items included (a) The risk of getting HPV by not practicing safer sex and (b) The risk of infection HPV in your lifetime? (c) The risk of infecting HPV in your lifetime .The total score ranges from 3 to 15, with a higher score indicating a higher probability of being infected. This subscales had high internal consistency (Cronbach's alpha was 0.94).

2) Perceived Severity

To assess the participants' beliefs about the severity of HPV, a 4-item scale rated on a 5-point Likert scale adapted from Huang et al. (2021) was used. The perceived severity scale ranges from 1 (not at all) to 5 (extremely high). This part of the scale asked about how contracting HPV would impact their daily lives, long-term health, and the possibility of getting cervical cancer and genital warts. The total score ranges from 4 to 20, with a higher score indicating a higher consideration of severity. This subscale had high internal consistency (Cronbach's alpha was 0.95).

3) Perceived Response Efficacy

To assesses the participants' perceptions of the potential health-promoting effects of HPV vaccination. A 4-item measure adapted from Muturi (2020) as well as Huang et al. (2021). The scale uses a 5-point Likert scale ranging from 1 (strongly disagree) to 5 (strongly agree). The total score ranges from 4 to 20, with a higher score indicating a higher response efficacy. This subscale had high internal consistency (Cronbach's alpha was 0.97).

4) Perceived Self-efficacy

To assess the participants' confidence in their ability to obtain the HPV vaccine in the next 6 months, a 5-item measure adapted from Li (2019) was used. Items were rated on a 5-point Likert scale ranging from 1 (strongly disagree) to 5 (strongly agree). The total score ranges from 5 to 25, with a higher score indicating

higher self-efficacy. This subscale had high internal consistency (Cronbach's alpha was 0.96).

Part 6 — HPV infection prevention awareness

HPV prevention awareness was adapted from the Cocchio et al. (2020) and Kuznetsov et al. (2013) study, which consisted of three subscales, including HPV infection risk factors (6 items), transmitted ways (3 items), and prevention of HPV infection (7 items). With all items judged as agree or disagree. Participants received one point for a correct response, points were summed to create a total awareness score (range of 0–16), with a higher total score indicating a greater level of awareness of HPV infection prevention. A standard score was also calculated: standard score points=actual score * 6.25. The scale had high internal consistency (KR-20 was 0.83).

3.1.3.2 Qualitative instruments

The researcher prepared the guidelines for the question with in-depth interviewing about perceptions toward the HPV vaccine based on the PMT model, explored barriers to receiving the HPV vaccine, and learned how to promote HPV vaccination.

The interview guide covered three main components. First, the researcher asked the participants to fill out the basic demographic information; after that, the researcher asked the participant to describe a typical working day. The aim of this question was to put them at ease. Second, the researcher will inquire about HPV and HPV vaccine awareness, as well as vaccination status (for students). Finally, we broached the topic to assess perceptions regarding the HPV vaccine based on PMT, the barriers to receiving the HPV vaccine, and how to promote HPV vaccination.

The guidelines questions were as follows:

1.In your opinion, should college students get HPV vaccinated or not? Why? How likely are college students to get infected with HPV? How severe would the HPV infection be if one got infected? What are the benefits of getting the HPV vaccine?

2.Have you ever had an HPV vaccination? What is your reason for getting or not getting the HPV vaccine? (For student)

3. Could you describe the barriers to receiving the HPV vaccine??

4.In your opinion, how do you promote HPV vaccination among college

students?

Closing: Thank you for taking the time out of your busy schedules to participate in this focus group session. All the feedback that was provided will help us greatly. We hope you have a great remainder of your day!

3.1.4 The evaluation of research instruments quality in phase I

Content validity: The questionnaires were checked for deficiencies by 3 expert who expertise in related field, including:

1. Xionghong Fan, Deputy nurse of Renmin hospital of Hubei Province, expert in health promotion.

2. Yanqun Liu, Deputy dean of Nursing faculty in Wuhan University, expert in women's health education

3. Qixiong Li, healthcare provider in Wuhan city college, expert in vaccine effects.

Then, the researcher re-corrected it and re-checked it for completing before implement. The content validity of measurement was used the Index of Item Objective Congruence (IOC). The range of the index score for an item was -1 to 1. Accordingly, an expert evaluates each item by giving a rating of 1 for clearly measuring objective, -1 for not clearly measuring, or 0 for the unclear objective. After the experts rated the items, the results were calculated to create the indices of IOC for each item on each objective. If the index of the IOC was between 0.5 and 1.00, it suggested that the item was acceptable, but if IOC filled below 0.5, it was mean that the item was not fitting and must be removed or reviewed (Ismail & Zubairi, 2022). The results showed that the IOC of each part of questionnaires as follow as:

1. Part 1-Socio-demographic factors, IOC was 0.80-1.00
2. Part 2-The knowledge of HPV, IOC was 0.90-1.00
3. Part 3-The knowledge of HPV vaccine, IOC was 0.70-1.00
4. Part 4-Intention to initiate HPV vaccine, IOC was 0.90-1.00
5. Part5-The Protection Motivation Theory Scale (PMT scale), IOC was 0.80-1.00
6. Part 6- HPV infection prevention awareness, IOC was 0.70-1.00

Reliability: A pilot study was conducted randomly among 50 medical students who study in college similar to our setting as Wuhan Vocational College of Commerce. The 50 students had not been included in the final sample. The Cronbach's alpha coefficient was used to measure the internal consistency of the questionnaire. High Cronbach's alpha values indicate that response values for each participant across a set of questions are consistent. The acceptable value of alpha was 0.70 or above. Additionally, the Kuder-Richardson Formula 20 (KR-20) is used to measure the internal consistency reliability of a test in which each question only has two answers: right or wrong(Tavakol & Dennick, 2011) such as the knowledge of HPV and HPV vaccine. The Cronbach's alpha coefficient and KR-20 were calculated for the different parts of it and obtained the results as follow as:

1. Part 2 — The knowledge of HPV, KR-20 was 0.90.
2. Part 3 —The knowledge of HPV vaccine, KR-20 was 0.90.
3. Part 5 — The Protection Motivation Theory Scale (PMT scale), Cronbach's alpha for subscale perceived susceptibility, perceived severity, perceived response efficacy and perceived self-efficacy were 0.94, 0.95, 0.97, and 0.96, respectively.
4. Part 6 — HPV infection prevention awareness, KR-20 was 0.83

3.1.5 Data collection in phase I

3.1.5.1 Quantitative data collection

Due to the COVID-19 pandemic, a web-based online survey was conducted to reduce face-to-face interaction. First, the questionnaire was uploaded to Wenjuanxing (https://www.wjx.cn/), an online questionnaire system, and Wenjuanxing created a link and QR code for it. Then, we contacted the administrative faculty from six universities across Hubei province via WeChat and told them the purpose of the research. Within their agreement, the questionnaire link and QR code were subsequently forwarded to them via WeChat. They send them to the potential respondents via WeChat groups for their classes. The survey participation was voluntary, and each participant logged in with a unique social media account and IP address, allowing study participants to respond to the survey questionnaire only once. An informed consent was obtained before the participants started to answer the survey. The system would remind respondents of missing responses before

submission, and only fully completed questionnaires can be submitted. The survey took about 15–25 minutes for the participants to complete.

3.1.5.2 Qualitative data collection

A face-to-face interview was conducted From 1st June to 30th June 2023. All participants were informed of the purpose and design of the study. The interviews will last between 30 and 60 minutes (average: 45 minutes). Participants were allocated unique identification numbers to ensure anonymity during data analysis and discussion of results. All data was anonymized and kept securely. Data were collected until saturation was achieved. Saturation, in this case, was defined as a point where no additional data was obtained. This rigorous data collection process was used to assure dependability. Prior to the start of each conversation, the researcher would introduce the interview process, including the arrangements for audio recording.

Three trained research assistants transcribed all interviews verbatim shortly after they were conducted. The accuracy of each transcript was ensured by one of the authors by listening to segments of the audio recording.

3.1.6 Data analysis in phase I

In quantitative data analysis, IBM's SPSS version 19.0 (IBM Corp., Armonk, NY, USA) (285DD4CD2854F4E67605) was used to analyze all data. Descriptive statistics were performed to describe demographic characteristics and variables. Means and standard deviations were used to describe quantitative variables like age, score of knowledge of HPV, and knowledge of HPV vaccine. A number of cases and percentages was applied to describe other categorical variables like education background, father's education background, mother's education background, family yearly household income, sexual intercourse, vaccinated familiars, and willingness to pay for HPV vaccine (WTP), HPV vaccination status, sources of HPV vaccine information, and barriers to receiving the HPV vaccination. The multivariable logistic regression analysis was used to examine the association among all the socio-demographic factors, knowledge of HPV and HPV vaccine, HPV infection prevention awareness, and PMT factors. We develop a series model, such as in model 1, we added three knowledge variables to the model. Then, in model 2, the PMT-related

factors were entered into model 1. Finally, all sociodemographic factors were entered into model 3. The statistically significant level was set as $P < 0.05$.

In qualitative data analysis, content analysis has been used. The data was analyzed using the 7-step method proposed by Colaizzi's (Edward & Welch, 2011). The steps involved (1) repeatedly and carefully reading the collected audio and written transcripts of the interviews; (2) identifying and extracting significant statements; (3) coding recurring ideas; (4) assembling the coded ideas into a codebook; (5) describing each prototype theme in detail and adding expressions from the interviewees; (6) identifying and extracting similar ideas to construct four themes; and (7) categorizing these codes and sublimating them to the main themes for the interviewees for validation.

3.2 In phase II

The development and evaluation the effectiveness of promotion of human papillomavirus vaccination program

3.2.1 Study design

The cluster randomized controlled trial was used to evaluate the effectiveness of promotion of HPV vaccination program among medical students. In this phase, the researcher developed the intervention program by applying the Protective Motivation Theory (PMT).

3.2.2 Study population and samples

Study population

The study population in this phase was the freshman college students in the Wuhan City College and Wuhan College of Foreign Language and Affairs.

Sample size

The sample size estimation was calculated using formula(Sakpal, 2010) as follows:

$$n = \frac{(Z_{\frac{\alpha}{2}} + Z_{\beta})^2 [p_1(1-p_1) + p_2(1-p_2)]}{(p_2 - p_1)^2}$$

Where:

n=Sample size required in each group

p_1=Pre-intervention HPV vaccination rates=11%

p_2=Post-intervention HPV vaccination rates=27%

p_2-p_1=Clinically significant difference=0.16(Sakpal, 2010)

$Z_{\alpha/2}$= The standard value under the normal curve at 95%=1.96

Z_β= depends on the power, for 80%=0.84

α=0.05

β=0.2

When

$$n = \frac{(1.96 + 0.84)^2[0.11(1 - 0.11) + 0.27(1 - 0.27)]}{(0.11 - 0.27)^2}$$

= 90.34~91

Considering there would be a 10% dropout rate in practice, so more subjects should enroll into the study. The adjusted sample size can be calculated by the formula as follows:

N1=n/(1-d)

Where:

N1=The adjusted sample size

n = the sample size required as per formula

d = the dropout rate(10%)

When:

N1=91/ (1-0.1)

= 101.1~102

Therefore, based on the above formula the sample size required per group was 102. Hence the total sample size the researcher should collect was 204.

Inclusion criteria

1. First-year female medical college student aged 17–22 years
2. Not having received any doses in the HPV vaccine series
3. Able to read and understand Chinese Mandarin independently.
4. Able to use a smart phone and have the WeChat app on the phone.
5. Willing to participate

Exclusion criteria

1. Student who refused to answer the questionnaire
2. Student who provided an incomplete response
3. Student who cannot participate in all activities on time.
4. Student who received any dose of the HPV vaccine

Sampling method

The sampling methods in phase II were as follows:

1. In the first stage, the researcher selected two colleges whose student numbers were similar and willing to participate in this study by using cluster random sampling. The experimental group was Wuhan City College, and Wuhan College of Foreign Language and Affairs was the control group.

2. In the second stage, the researcher made the sampling frame for each college, which included a list of all students who met eligible criteria.

3. In the third stage, the students would be selected by using simple random sampling. (Figure 4)

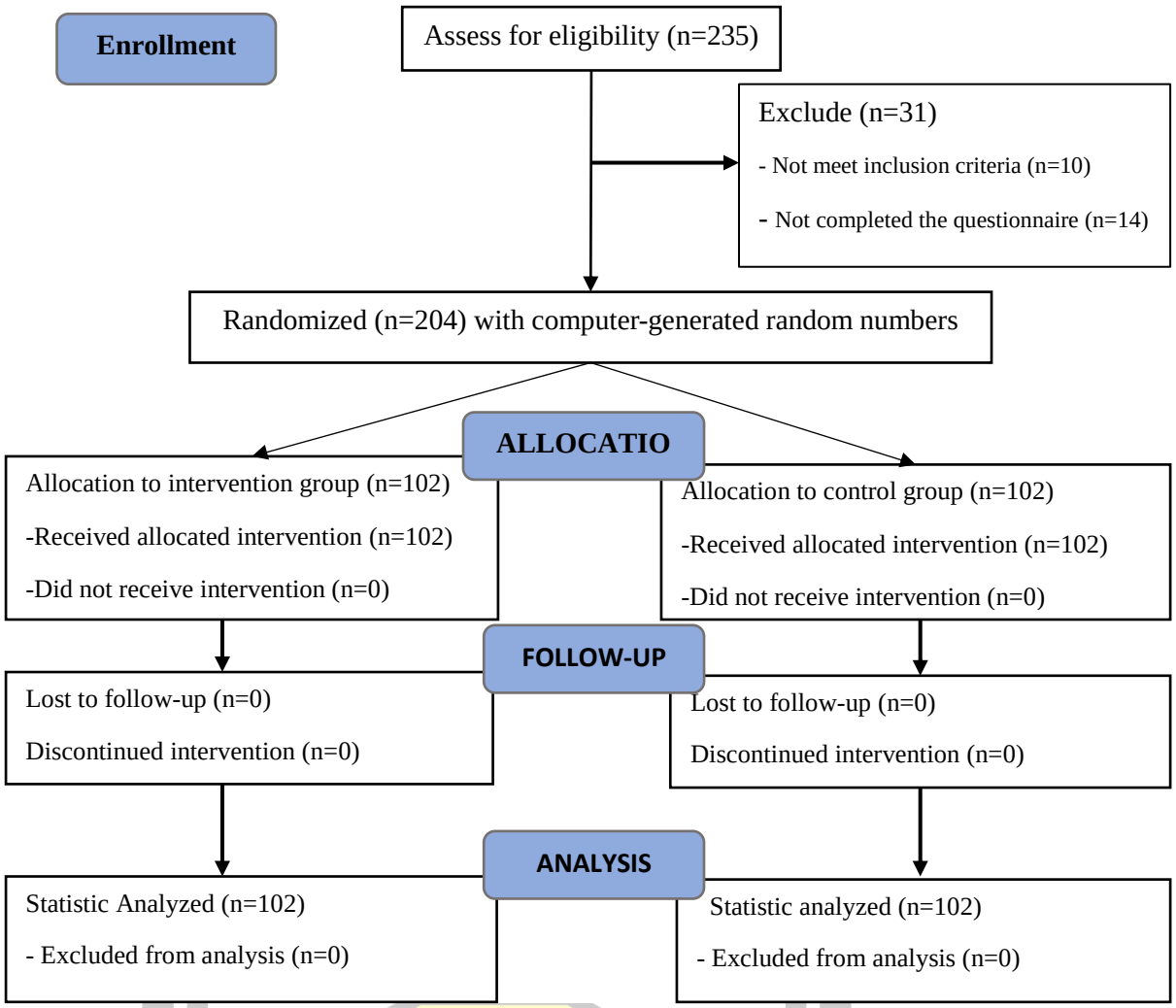


Figure 4 Overview of recruitment and group assignment

3.2.3 Research instruments in phase II

The research instruments in this phase consisted of 2 parts as follows:

Part 1- The self-administered questionnaire, which was used in phase I, consisted of demographic factors such as age, father's education background, mother's education background, family yearly household income, sexual intercourse, vaccinated familiars, willingness to pay for HPV vaccine (WTP), knowledge about HPV, the knowledge of HPV vaccine, intention to initiate HPV vaccination, HPV infection prevention awareness, and the Protection Motivation Theory Scale (PMT scale).

Part 2- HPV vaccine communication competency scale

A 3-item questionnaire was adapted from the Brewer et al. (2021) study. Three items were measured: clarity about informed HPV vaccine knowledge, recommendation willingness, and confidently answering vaccine-related questions. The scale used a 5-point Likert scale ranging from "1 = strongly agree," "2 = agree, "3 = unsure", "4 = disagree," and "5 = strongly disagree." Each item score ranges from 1 to 5, and a higher score indicates more competition to communicate the HPV vaccine. This scale had high internal consistency (Cronbach's alpha was 0.81).

3.2.4 The intervention development (The PMT- based HPV vaccination online education program)

After analyzing the results from phase I and discussion with 3 specialists in women health education, vaccine healthcare, and health promotion, and by refereeing literature review, a PMT-based HPV vaccination online program to promote HPV vaccination was developed. The program was developed under the guidance of Wight et al.'s (2016) six steps in quality intervention development. After the development of the intervention, a pilot study were conducted to check the effects of the intervention. Details were as follows:

3.2.4.1 Drafting of a PMT- based HPV vaccination online education program

According to the result of quantitative study and quantitative study in Phase I, and literature review, factors related to intention to initiate HPV vaccination for female medical college students was discovered. By compounding these information together, according to Wight et al.'s (2016) six steps in quality intervention development, modifiable factors to promotion HPV vaccination intention among female medical college students were could be divided into 2 aspects:1) Knowledge and awareness of HPV and the HPV vaccine ; 2) Perception of PMT constructs toward HPV and HPV vaccines. For these aspects, intervention should focused on it so to solve these problems. About the unmodifiable factors, like the high cost, short of supply, incorporate HPV vaccine into national vaccine program, and implement college health canter based vaccination, we could share the latest news about how to make an appointment easily, where to find the HPV vaccine center, how to save the money, what’s the policy for college students to receive HPV vaccine. Since the

internet is the primary resource of HPV vaccine information, and peer's vaccine experience communication would also promote HPV vaccine intention, the intervention were designed guide by PMT with online platform, plus group discussion to promote the HPV vaccination intention among female college students. According to the previous studies (Bennett et al.2015), one month of intervention and three month of follow-up was designed for the intervention. The steps are shown in Table 6.

Table 7 Steps in quality intervention development

Main steps	Specific details
1.Define and understand the problem and its causes.	Problem: How to improve the intention of HPV vaccination among college medical students; Cause: 1.Lack knowledge and awareness of HPV and the HPV vaccine; 2.Lack perceived susceptibility and perceived severity toward HPV; lack of perceived response efficacy and perceived self-efficacy 3. Willingness to pay the high cost of the HPV vaccine
2.Clarify modifiable factors to improve HPV vaccination.	Modifiable factors: Knowledge and awareness of HPV and the HPV vaccine Perception of PMT constructs toward HPV and HPV vaccines
3.Identify how to bring about change: the change mechanism.	Health Education can narrow down the knowledge gap and change the perception of PMT toward HPV and the HPV vaccine.
4.Identify how to deliver the change mechanism.	Through an online platform, since internet is the primary source of HPV vaccine information for female college students.
5. Test and refine on small scale.	A polit test has been conducted to test the online education program.
6.Collect sufficient evidence of effectiveness of program	The effects of PMT theory-guided and student-centered interactive education on students' knowledge and consideration regarding HPV and HPV vaccines have been seen in the literature.

3.2.4.2 Discussion of a PMT- based HPV vaccination online education program with the experts

After drafting the intervention program, three copies were send to 3 experts by emails. One week after that, the researcher make an appointment to the expert to have a face to face discussion. According to the objectives and PMT model, three experts discussed the themes, objectives, activity details, method of activities, materials, and duration of each activities of the PMT-based HPV vaccination online education program with the researcher.

3.2.4.3 Revising the PMT- based HPV vaccination online education program

According to the comments and suggestions given by the three experts, the researchers revised the PMT- based HPV vaccination online education program. During the revising progress, if there were some questions, the researcher would consult the experts and do the literature review again since the revision version of the PMT-based HPV vaccination online education program was settled.

3.2.4.4 Verifying the PMT- based HPV vaccination online education program

After revising the PMT- based HPV vaccination online education program, the research showed the revision of PMT- based HPV vaccination online education program to the expert by emails. One week later the experts gave agreement for PMT-based HPV vaccination online education program that had the characteristics according to the expert comments. After they showed agreement that the PMT- based HPV vaccination online education program as final intervention method.

3.2.4.5 The characteristics of intervention

Intervention group

The PMT-based HPV vaccination online program consisted of four sessions with a total of 10 activities. One session was delivered per day by the WeChat discussion group, with an intervention education time of 50-60 minutes per day. Thus, participants in the intervention group attended four weeks of a PMT-based HPV vaccination program, followed by three months after the end of the intervention. Each session contains a dimension of PMT. All activities were performed by trained researchers through the WeChat app.

The first session was focused on the perceived susceptibility of HPV and included four activities: 1) developing relationships and introducing the PMT-based HPV vaccine online health education program; 2) introducing the definition, types, and immune response to HPV; 3) introducing the epidemiology of HPV and peak age groups of HPV infection; 4) discussing the risk factors, transmission ways and symptoms of contacting HPV. Participants were encouraged to share their experiences with group members.

The second session focused on the perceived severity of HPV and included two activities: 1) introducing HPV-induced health problems; including cancer and genital warts; and identify the mechanism of how HPV cause cancers 2) discussing the check-up and treatment for HPV, and ways to prevent it.

The third session focused on the perceived response efficacy; it included two activities: 1) introducing the definition, protective efficacy, safety of HPV vaccine and its accurate time to administer it; 2) comparing the difference among the 2, 4, and 9-valent HPV vaccines and discussing the best ways to prevent cervical cancer.

The fourth session focused on perceived self-efficacy; it included two activities: 1) introducing resources for accessing the HPV vaccine, information about place, price, and health insurance of HPV vaccine; 2) motivating self-efficacy to get HPV vaccine and sharing ways to answer questions about HPV vaccination.

3.2.5 The regular health education

Control group

The students who were allocated to the control group did not receive any of the HPV and HPV health program components. Instead, they continued with their regular health education from their college, which was offered by the teacher, and did not focus on the promotion of the HPV vaccine. The characteristics of the regular health education is online article sharing related to the vaccine adult people should receive by WeChat. One article for a week, participant read by themselves.

3.2.6 Study procedure

Before the beginning of the PMT-based HPV vaccination online program intervention, baseline characteristics and outcome measurements were completed by both groups. Then, a PMT-based HPV vaccination online program was delivered to the intervention group for four week of 4 sessions.

Moreover, the follow-up period was 3 months for participants in the intervention group. Then, outcome measurements were conducted in both groups after intervention completion and 3-month follow-up. The data collection procedure was the same for both the intervention and control groups. The trained outcome assessor was blinded to participant allocation.

3.2.7 Data collection in phase II

The primary outcome was the change in HPV vaccination intention from baseline to after the intervention. The secondary outcome was changes in the scores of knowledge of HPV, knowledge of HPV vaccine, HPV infection prevention awareness scores, HPV vaccine communication competency, and PMT scores.

A web-based online survey will be conducted. First, the questionnaires were uploaded to Wenjuanxing (https://www.wjx.cn/), an online questionnaire system, and Wenjuanxing would create a link and QR code for it. Then, before the implementation of the program, the questionnaire link and QR code forwarded to them through WeChat. The survey participation was voluntary, and each participant logs in with a unique social media account and IP address, allowing study participants to respond to the survey questionnaire only once. An informed consent was obtained before the participants start to answer the survey. The system would remind respondents of missing responses before submission, and only fully completed questionnaires can be submitted. The survey took about 15–25 minutes for the participants to complete. After the implementation of the intervention and three months later, the same survey was sent to the participant again.

3.2.6 Data analysis in phase II

Raw data was numerically coded and entered in Excel version 2013 (Microsoft, 2021). It was carefully examined for entry errors and missing values; any questionnaire with missing data would be excluded from analysis. Descriptive statistics were used to analyze the participants' characteristics and outcomes. The frequency and percentage of categorical variables; the mean and standard deviation (SD) of normally distributed continuous variables.

For the comparison of baseline characteristics of participants between intervention and control groups, Chi-square tests were used for categorical variables

and independent sample t-tests were used for normally distributed continuous variables.

We compared the outcome measurement before intervention, after intervention completion, and at follow-up visits for within-group. The repeat analysis of variance (ANOVA) was used for normally distributed continuous variables, and Cochran's Q test was used for categorical variables.

Moreover, to compare the change in outcomes between intervention and control groups at before, after, and follow-up visits, independent sample t-tests were used to evaluate the changes in scores of knowledge of HPV, knowledge of HPV vaccine, HPV infection prevention awareness scores, HPV vaccine communication competency, and PMT scores, and Chi-square tests were used to evaluate the change in HPV vaccine intention. All statistical analyses were carried out using SPSS version 20.0 (IBM Corp., Armonk, NY, USA), and statistical significance was set at $P < 0.05$.

3.3 Ethical Considerations

This study was approved by the Ethics Committee for Research Involving Human Subjects, Mahasarakan University in Thailand (Ethics number: 090-045/2023), on 23 March 2023. The participants were informed of the study objectives and procedures, and their participation was voluntary. They were informed of their rights to decline to participate or withdraw at any time without penalty. In order to maintain ethical principles and the privacy of the participants, all responses were collected and analyzed without identifiers.

CHAPTER 4
RESULTS

This was a mixed-methods study of the effectiveness of the promotion of the HPV vaccination program among female medical students in Hubei Province, China. The study is divided into two phases.

In phases I, the researcher utilized quantitative methods to explore the intention and the factors associated with the intention to initiate HPV vaccination among female medical college students, and qualitative methods were also utilized to explore perceptions toward HPV vaccination based on the PMT model, barriers to receiving the HPV vaccine, and how to promote HPV vaccination. In Phase II, a cluster-randomized controlled trial was used to evaluate the effectiveness of the promotion of the HPV vaccination program among female medical college students in Hubei Province, China. The results of this study were as follows:

4.1 Phase I: Quantitative and qualitative results

4.1.1 Quantitative study

4.1.1 Socio-demographic factors of participants

4.1.2 HPV Vaccination coverage

4.1.3 Sources of HPV vaccine information

4.1.4 Barriers of receiving the HPV vaccine

4.1.5 The knowledge of HPV

4.1.6 The Knowledge of HPV vaccine

4.1.7 HPV infection prevention awareness

4.1.8 Scores of PMT scale

4.1.9 HPV Vaccination intention and its associated factors

4.1.9.1 The distribution of factors by HPV Vaccination intention

4.1.9.2 Factors related to HPV vaccination intention

4.1.10 The hypothesis testing of phase I.

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4.2.2 Perception toward HPV vaccine based on the PMT

4.2.2.1 Perceived susceptibility of HPV

4.2.2.2 Perceived severity of HPV

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4.2.3 Barriers to receiving the HPV vaccine

4.2.4 How to promote HPV vaccination

4.2 Phase II: The development and evaluation the effectiveness of promotion of human papillomavirus vaccination program

4.2.1 The development of the promotion of human papillomavirus vaccination program (the PMT-based HPV vaccination online education program)

4.2.2 The evaluation the effectiveness of promotion of human papillomavirus vaccination program (the PMT-based HPV vaccination online education program)

4.2.2.1 The comparison of baseline characteristics, HPV vaccine intention, the knowledge of HPV and HPV vaccine scores, HPV infection prevention awareness scores, the PMT scores and HPV vaccine communication competency scores between intervention and control groups.

4.2.2.2 The comparison of HPV vaccine intention, the knowledge of HPV and HPV vaccine scores, HPV infection prevention awareness scores, the PMT scores, and HPV vaccine communication competency scores within groups at bassline, after intervention, and follow up.

4.2.2.3 The comparison of HPV vaccine intention, the knowledge of HPV and HPV vaccine scores, HPV infection prevention awareness scores, the PMT scores, and HPV vaccine communication competency scores between groups at bassline, after intervention, and follow up.

4.2.2.4 The hypothesis testing of phase II

4.1 Phase I: Quantitative and qualitative results

4.1.1 Quantitative study

4.1.1.1 Demographics characteristics factors of participants

In this study, a total of 1148 female medical college students initially participated; the mean age was 19.3 (±1.11) years. More than half (69.1%) of the students had a college degree were in sophomore (45.3%). Regarding to the place of birth, 55.0% of them were from village. With parental education background, 61.4% of the fathers and 68.6% of the mothers had an educational background lower than high school level. In terms of family yearly household income, 67.9% of the families had an annual yearly income below 50, 000 RMB per person a year. Over half (54.3%) of the participants had no familiars who had received the HPV vaccine. 83.4% of the female medical college students were willing to pay for the vaccine by themselves. 6.75% of the respondents had sexual intercourse (Table 7).

Table 8 Demographics characteristics characteristics of female students in Hubei

Demographic characteristics	Number(n=1148)	Percentage (%)
Age	19.3±1.1	
	Minimum= 18	Maximum= 23
Place of birth		
Village	631	55.0%
Town	310	27.0%
City	207	18.0%
Year in school		
Freshman	324	28.2
Sophomore	520	45.3
Junior	237	20.6
Senior	67	5.8
Education background		
Bachelor degree	355	30.9%
College degree	793	69.1%
Father’s education background		
Less than high school	705	61.4%
High school and above	443	38.6%
Mather’s education background		
Less than high school	787	68.6%
High school and above	361	31.4%
Family yearly household income(RMB/person)		
Less than 50, 000	780	67.9%
50, 000 and above	368	32.1%
Ever hear of the HPV		
Yes	1032	89.9%
No	116	10.1%

Table 9 Demographics characteristics of female students in Hubei (cont.)

Demographic characteristics	Number(n=1148)	Percentage (%)
Ever hear of the HPV vaccine		
Yes	1084	94.4
No	64	5.6
Vaccinated familiars		
Yes	525	45.7%
No	623	54.3%
WTP for HPV vaccine		
Yes	957	83.4%
No	191	16.6%
Sexual intercourse		
Yes	66	5.7%
No	1082	94.3%
Age of Sexual intercourse		
16	3	5%
17	6	10%
18	18	30%
19	21	35%
20	12	20%
21	6	10%
22	1	2%

Note: continues values are presented as Mean ± Standard deviation; RMB, Chinese Yuan; WTP, Willingness to pay

4.1.1.2 HPV vaccination coverage

Regarding HPV vaccination coverage among female medical college students, it was noteworthy that only a minority of the participants (13.9%) had vaccinated against the HPV vaccine, 2.0% of them vaccinated with 1 dose of HPV vaccine, 4.1% of them vaccinated with 2 doses of HPV vaccines, and 7.8% of them vaccinated with 7.8% of HPV vaccines. While the majority of the participants (86.1%) had not been vaccinated against HPV(Table 8).

Table 10 HPV vaccination coverage of female medical college students in Hubei

HPV vaccination status	Number	Percentage (%)
Unvaccinated	988	86.1%
Vaccinated 1 dose	24	2.0%
Vaccinated 2 doses	47	4.1%
Vaccinated 3 doses	89	7.8%
Total	1148	100.0%

4.1.1.3 Sources of HPV vaccine information

In the context of sources of HPV vaccine information, it was noteworthy that a substantial majority of the participants (89.1%) had conveyed their reliance on the internet as their primary information outlet. Subsequent to the internet, the second and third predominant ways to acquire information were identified as personal connections, encompassing friends (50.4%) and teachers (44.9%) (Figure 5).

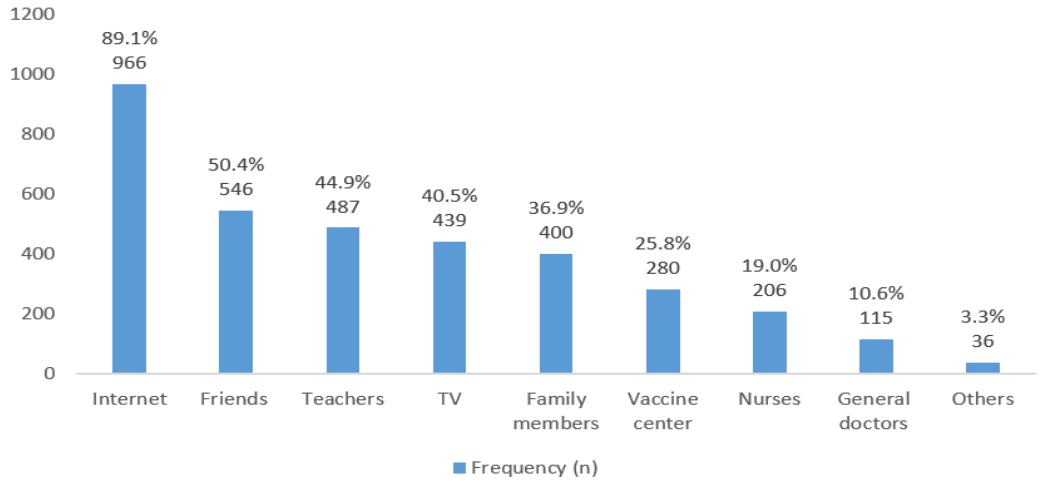

Figure 5 Sources of HPV vaccine information

4.1.1.4 Barriers to receiving the HPV vaccination

Regarding barriers to receiving HPV vaccination, it was important to note that a significant majority of participants in the study (55.7%) identified high cost as the primary barrier. Following cost, the second and third most prevalent barriers to receiving the HPV vaccine were short of vaccine supply (47.3%) and lack information of HPV (37.3%). Other barriers mentioned in the study included a lack of information about the HPV vaccine (32.8%), uncertainty about its effectiveness (29.7%), not knowing where to obtain the HPV vaccine (27.5%), and a lack of recommendation (Figure 6).

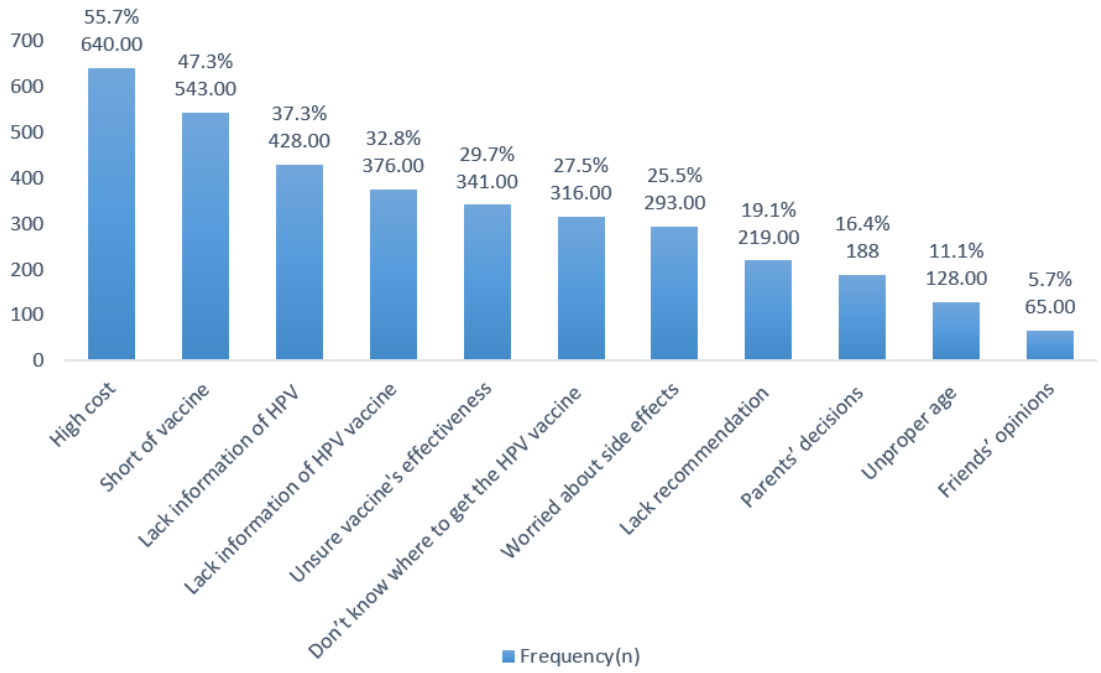

Figure 6 Barriers to receiving HPV vaccination

4.1.1.5 Knowledge about HPV

There were 15-item in the questionnaire of the knowledge about HPV. Participants' average score for their knowledge of HPV-related information was 8.0 (±3.2) points; the average standard score was 53.36 points. The items were arranged descending by the correct rates. Among the questions asked, several had a high rate of correct answers, indicating a good understanding of the topic. These questions were as follows: Q1. HPV is a sexually transmitted infection (78.4%); Q13. A person's chances of getting HPV increase with the number of sexual partners (77.7%); Q3. Early age of sexual debut increase the risk of contracting HPV (74.7%).

On the other hand, a few questions had the lowest correct answer rates among participants. These questions were: Q12. HPV can lay dormant in the body for years without symptoms (11.8%); Q11. A person usually has symptoms when infected with HPV (16.3%); Q9. There is cure for HPV (21.8%) (Table 9).

Table 11 Knowledge about HPV among female medical college students in Hubei

15 Items	Correct answer rates in an descending order	
	n	%
Q1.HPV is a sexually transmitted infection	900	78.40%
Q13. A person's chances of getting HPV increase with the number of sexual partners they have.	892	77.70%
Q3.Early age of sexual debut increase the risk of contracting HPV	858	74.70%
Q8. HPV infection can cause genital warts	834	72.60%
Q10. Having one type of HPV means that you cannot acquire new types	801	69.80%
Q4. Using condoms reduces the risk of HPV transmission	782	80.70%
Q6. HPV infection is widespread	736	64.10%
Q7.HPV only cause cancer in women	615	53.60%
Q8.HPV infection can cause anal cancer	456	39.70%
Q15.Nearly all sexually active men and women will contract HPV at some point.	427	37.20%
Q5. HPV infection can be transmitted from mother to child during pregnancy and delivery	368	32.10%
Q14.HPV can cause oral cancer	360	31.30%
Q2.A person can get HPV from skin to skin contact with a person infected with HPV	250	21.80%
Q9. There is cure for HPV	250	11.80%
Q11. A person usually has symptoms when infected with HPV	187	16.30%
Q12. HPV can lay dormant in the body for years without symptoms	136	11.80%
Minimum=3 Maximum=14 Mean=8.0 S.D.=3.2		

4.1.1.6 The knowledge of HPV vaccine

Moving on to the participants' knowledge of the HPV vaccine, their average score was 6.7 (±2.9), and the average standard score was 63.6 points. The items were arranged descending by the correct rates. Among the questions asked, several items had a high rate of correct answers, indicating a good understanding of the topic. These questions were as follows: Q1. The HPV vaccine protects women from getting HPV infection (88.0%); Q7. The HPV vaccines offer protection against most cervical cancers (80.0%); Q3. The HPV vaccination is only needed if you have multiple sexual partners (78.3%).

However, there were also questions with low correct answer rates among participants. These questions were: Q8. The HPV vaccine protects you from every

type of HPV (41.1%); Q9. The HPV vaccine protects you from every type of HPV (41.1%); Q4. The HPV vaccines offer protection against all sexually transmitted infections (45.6%); Q10. One can cure HPV infection by getting the HPV vaccine (46.6%) (Table 10).

Table 12 Knowledge about HPV vaccine among female medical students in Hubei

11 Items	Correct answer rates in an descending order	
	n	%
Q1.HPV vaccine protect women from getting HPV infection	1010	88.00%
Q7.The HPV vaccines offer protection against most cervical cancers	918	80.00%
Q3.The HPV vaccination is only needed if you have multiple sexual partners	899	78.30%
Q11. The HPV vaccine is also effective in after starting sexual activity	773	67.30%
Q6. The HPV vaccines offer protection against most cervical cancers	688	59.90%
Q8.The HPV vaccines offer protection against genital warts	666	58.00%
Q5.The HPV vaccines are most effective if given to people who've never had sex	554	48.30%
Q2.HPV vaccine protect men from getting HPV infection	550	47.90%
Q10.One can cure HPV infection by getting the HPV vaccine	535	46.60%
Q4.The HPV vaccines offer protection against all sexually transmitted infections	523	45.60%
Q9.The HPV vaccine protects you from every type of HPV	473	41.10%
Minimum=4 Maximum=11 Mean=6.7 S.D.=2.9		

4.1.1.7 HPV infection prevention awareness

About HPV infection prevention awareness, their average score was 11.6 (±1.9), and the average standard score was 72.5 points. Among the questions asked, several items had a high rate of correct answers, indicating a good understanding of the topic, including: HPV is transmitted through Body fluids(97.1%); multiple sexual partners is a HPV infection risk factor(94.3%);HPV infection can be prevented vaccination(93.5%).

Also a low understanding of the topic, including: HPV infection cannot be prevented by washing genitals after intercourse (18.9%); HPV infection cannot be prevented by antibiotics(30.8%); Smoking is a HPV infection risk factor(40.1%)(Table11).

Table 13 HPV infection prevention awareness among female medical students in Hubei

Items	Agree n (%)	Disagree n (%)
What is/are HPV infection risk factor(s)		
Multiple sexual partners	1, 082(94.3)	66(5.7)
Non-use of condom during intercourse	1, 033(90.0)	115(10.0)
Early age of sexual debut	906(78.9)	242(21.1)
Early puberty	517(45.0)	631(55.0)
Smoking	460(40.1)	688(59.9)
Alcohol consume	446(38.9)	702(61.1)
HPV is transmitted through		
Body fluids	1, 115(97.1)	33(2.9)
Skin to skin	457(39.8)	691(60.2)
Cough and sneeze	290(25.3)	858(74.7)
HPV infection can be prevented		
Vaccination	1, 073(93.5)	75(6.5)
Condom use	1, 015(88.4)	133(11.6)
Washing genitals after intercourse	931(81.1)	217(18.9)
Own sexual fidelity	746(65.0)	402(35.0)
Sexual abstinence	758(66.0)	390(34.0)
Antibiotics	354(30.8)	794(69.2)
HPV is not pro preventable	102(8.9)	1, 046(91.1)
Minimum=3 Maximum=16 Mean=11.6 S.D.=1.9		

4.1.1.8 Scores of PMT scale

Examining the scores of the PMT scale, the mean scores for perceived susceptibility, perceived severity, perceived response efficacy, and perceived self-efficacy constructs were 4.9 (±2.2), 12.2 (±5.7), 15.7 (±3.8), and 19.5 (±4.2), respectively (Table 12).

Table 14 The Protection Motivation Theory Scale toward HPV and HPV vaccine

Dimensions	Range of score	Minimum score	Maximum score	Mean ± S.D.
Perceived Susceptibility	3-15	3	15	4.9±2.2
Perceived Severity	4-20	4	20	12.2±5.7
Perceived Response Efficacy	4-20	4	20	15.7±3.8
Perceived self-efficacy	5-25	4	25	19.5±4.2

4.1.1.9 HPV Vaccination intention and its associated factors

4.1.1.9.1 The distribution of factors by HPV Vaccination intention

For participants who did not receive a HPV vaccine, HPV vaccine intentions were asked. Among the 988 female college students who did not take the HPV vaccine, 85.5% of the participants reported a high level of intention to get the HPV vaccine. A majority (70.2%) of the unvaccinated female medical college students had a college degree and were in sophomore (47.1%). Toward to the place of birth, 58.4% of the college students were from village. With regard to parental education, 65.5% of the fathers and 72.2% of the mothers had an educational background lower than high school level. In terms of family yearly household income, 61.5% of the families had an annual yearly household income below 50,000 RMB. Only 5.7% of the respondents engaged in sexual intercourse. Furthermore, over half (51.5%) of the unvaccinated participants had no familiarity with anyone who had received the HPV vaccine. 89.2% and 93.9% of the college students had ever heard of HPV and HPV vaccine. A majority of the unvaccinated participants (82.3%) expressed their willingness to bear the cost of the HPV vaccine.

Turning attention to knowledge factors, the unvaccinated participants exhibited a moderate level of understanding in terms of HPV-related knowledge, as

indicated by a mean score of 7.73 (± 3.01). The unvaccinated participants' knowledge regarding the HPV vaccine and HPV infection prevention awareness scored an average of 6.74 (±2.74) and 11.52 (±1.91), respectively. Examining the PMT scale, the mean scores for perceived susceptibility, perceived severity, perceived response efficacy, and perceived self-efficacy were 4.89 (±2.24), 12.83 (±5.10), 15.79 (±3.54), and 19.38 (±4.09), respectively. (Table13).

Table 15 Distribution of demographic factors, knowledge of HPV and HPV vaccine, HPV infection prevention awareness, and PMT scale by HPV vaccination intention

Variable	HPV vaccination intention		
	Total (n=988)	High intention (n=845)	Low intention (n=143)
	n (%)	n (%)	n (%)
Demographic factors			
Age(years)	19.2±1.1	19.2±1.1	19.1±1.1
Place of birth			
Village	577(58.4)	481(56.9)	96(67.1)
Town	250(25.3)	219(25.9)	31(21.7)
City	161(16.3)	145(17.2)	16(11.2)
Year in school			
Freshman	281(28.4)	229(27.1)	52(36.4)
Sophomore	465(47.1)	401(47.5)	64(44.8)
Junior	190(19.2)	166(19.6)	24(16.8)
Senior	52(5.3)	49(5.8)	3(2.1)
Education background			
Bachelor degree	294(28.8)	579(68.5)	115(80.4)
College degree	694(70.2)	266(31.5)	28(14.5)
Father's educational level			
Less than high school	642(65.0)	537(63.6)	105(73.4)
High school and above	469(35.0)	308(36.4)	38(26.6)
Mather's educational level			
Less than high school	713(72.2)	601(71.1)	112(78.3)
High school and above	275(27.8)	244(28.9)	31(21.7)
Family yearly household income (RMB/person)			
Less than 50, 000	608(61.5)	479(56.7)	129(90.2)
50, 000 and above	380(38.5)	366(43.3)	14(9.8)

Table 16 Distribution of sociodemographic factors, knowledge of HPV and HPV vaccine, HPV infection prevention awareness, and PMT scale by HPV vaccination intention(cont.)

Variable	HPV vaccination intention		
	Total (n=988)	High intention (n=845)	Low intention (n=143)
	n (%)	n (%)	n (%)
Ever hear of the HPV			
Yes	881(89.2)	772(91.4)	109(76.2)
No	107(10.8)	73(8.6)	34(23.8)
Ever hear of HPV vaccine			
Yes	928(93.9)	807(93.5)	121(84.6)
No	60(6.1)	38(4.5)	22(15.4)
Sexual intercourse			
Yes	56(5.7)	51(6.0)	5(3.5)
No	932(94.3)	794(94.0)	138(96.5)
Vaccinated familiars			
Yes	479(48.5)	438(51.8)	41(28.7)
No	509(51.5)	407(48.2)	102(71.3)
WTP for HPV vaccine			
Yes	813(82.3)	738(87.3)	75(52.4)
No	175(17.7)	107(12.7)	68(47.6)
Knowledge and information receiving			
Knowledge of HPV	7.7±3.0	8.1±2.7	5.4±3.7
Knowledge of HPV vaccine	6.7±2.9	7.1±2.4	4.6±3.3
HPV infection prevention awareness	11.5±1.9	11.6±1.8	10.3±2.0
The PMT scale			
Perceived susceptibility	4.9±2.2	5.0±2.3	4.6±1.9
Perceived severity			
Perceived response efficacy	15.8±3.5	16.2±3.2	13.0±4.1
Perceived self-efficacy	19.4±4.1	19.9±3.9	16.4±3.7

Note: Values are presented as n (%) or mean ± Standard deviation; RMB= Chinese Yuan; WTP= Willingness to pay

4.1.1.9.2 Factors related to HPV vaccination intention

In binary logistic regression analyses, model 1 revealed that factors related to knowledge and information receiving, PMT-related factor except the perceived susceptibility were positively associated with a higher intention to receive the HPV vaccine (P<0.05). For Socio-demographic factors, the place of birth, father's

education background, yearly household incomes, vaccinated family member and willingness to pay were factors effected intention to receive HPV vaccine (P<0.05).

In multiple logistic regression analysis, model 2 extended upon model 1 by incorporating additional factors from the PMT factors. Notably, the presence of knowledge regarding HPV and awareness of HPV infection prevention remained significantly associated with a higher intention to receive the HPV vaccine. Moreover, three out of the four PMT factors showed a positive association with HPV vaccine intention, with the exception of perceived susceptibility. Further expanding upon model 2, model 3 introduced socio-demographic factors. Within model 3, two knowledge and information receiving factors and three PMT factors continued to exhibit a significant association with a higher intention to receive the HPV vaccine. After accounting for the influence of other predictors, it was determined that only the willingness to pay for the vaccine factor, among the socio-demographic factors, was related to a high level of HPV vaccination intention (Table 14).

Table 17 Odds ratios and 95% confidence intervals from logistic regression for HPV vaccination intention

Variables	Bivariate		Model 1		Model 2		Model 3	
	Unadjusted OR (95%CI)	*P* value	Adjusted OR (95%CI)	*P* value	Adjusted OR (95%CI)	*P* value	Adjusted OR (95%CI)	*P* value
Knowledge and information receiving								
Knowledge of HPV	1.33(1.26-1.42)	<0.001	1.27(1.14-1.41)	<0.001	1.18(1.08-1.28)	<0.001	1.18(1.08-1.29)	<0.001
Knowledge of HPV vaccine	1.37(1.29-1.46)	<0.001	1.18(1.08-1.29)	<0.001	1.07(0.97-1.18)	0.156	1.04(0.94-1.04)	0.421
HPV infection prevention awareness	1.44(1.30-1.59)	<0.001	1.19(1.07-1.26)	<0.001	1.25(1.11-1.40)	<0.001	1.22(1.09-1.37)	<0.001
The PMT scale								
Perceived susceptibility	1.08(0.99-1.18)	0.069	-	-	1.03(0.93-1.14)	0.574	1.01(0.91-1.13)	0.798
Perceived severity	1.13(1.09-1.18)	<0.001	-	-	1.06(1.01-1.10)	0.022	1.06(1.01-1.11)	0.018
Perceived response efficacy	1.26(1.20-1.32)	<0.001	-	-	1.09(1.02-1.17)	0.016	1.10(1.03-1.17)	0.004
Perceived self-efficacy	1.23(1.17-1.29)	<0.001	-	-	1.12(1.05-1.19)	<0.001	1.09(1.00-1.16)	0.040
Socio-demographic factors								
Age(year)	1.15 (0.97 -1.35)	0.094	-	-	-	-	0.86(0.68-1.07)	0.175
Education background (ref.: bachelor degree)	0.53(0.34~0.82)	0.004	-	-	-	-	0.78(0.43-1.40)	0.409
Father's educational background: high school and above (ref.: less than high school)	0.63(0.42-0.95)	0.023	-	-	-	-	0.70(0.40-1.23)	0.212
Mother's educational background: high school and above (ref.: less than high school)	1.46(0.96-2.24)	0.077	-	-	-	-	1.02(0.56-1.86)	0.946
Family yearly household income (RMB/person) (ref.: less than50 000)	0.14(0.08 -0.25)	0.006	-	-	-	-	0.16(0.08-0.30)	0.162
Sexual intercourse(ref.: no)	0.56(0.22-1.44)	0.231	-	-	-	-	1.46(0.48-4.45)	0.507
Vaccinated family members(ref.: no)	0.37(0.25-0.55)	<0.001	-	-	-	-	0.73(0.46-1.15)	0.172
WTP for HPV vaccine(ref.: no)	0.16(0.10-0.23)	<0.001	-	-	-	-	0.02(0.17-0.44)	<0.001

OR=odds ratio; CI=confidence interval; ref=reference group; RMB= Chinese Yuan; WTP= Willingness to pay

4.1.1.10 The hypothesis testing of phase I

We hypothesized that social demographic factors, knowledge of HPV and HPV vaccine, HPV infection prevention awareness, and PMT scale factors are associated with the intention to initiate HPV vaccination among female medical college students. Our results supported this hypothesis, which showed that social demographic factors (willingness to pay for HPV vaccine), knowledge of HPV and HPV vaccine, and PMT scale factors (including perceived severity, perceived response efficacy, and perceived self-efficacy) were related to the intention to initiate HPV vaccine among female medical college students in Hubei province.

4.1.2 Qualitative study results

4.1.2.1 Demographic information about the participants

In the qualitative study, 24 participants were sampled for the qualitative study, including 10 medical college students, 8 healthcare providers from the college clinics, and 6 teachers of college to have an in-depth interviewee (age range: 18–63 years old). Among medical college students, four had received at least one dose of the HPV vaccine. For the participant ID number, S represented a student, H represented a healthcare provider, and T represented a teacher of college (Table 15).

Table 18 Characteristic of participants in qualitative study

Participant ID	Gender	Age (years)	Education Background	Academic years or working year	Vaccination status
S1	female	23	Bachelor degree	Fourth year	Vaccinated
S2	female	18	College degree	First year	/
S3	female	22	Bachelor degree	Third year	Vaccinated
S4	female	20	College degree	Second year	/
S5	female	20	Bachelor	Second year	/
S6	female	23	College degree	Third year	/
S7	female	19	College degree	First year	/
S8	female	23	Bachelor degree	Third year	Vaccinated
S9	female	20	College degree	Second year	Vaccinated
S10	female	23	Bachelor degree	Fourth year	/
H1	Male	31	Bachelor degree	10 years	/
H2	Female	48	College degree	28 years	/
H3	Male	56	College degree	32 years	/

Participant ID	Gender	Age (years)	Education Background	Academic years or working year	Vaccination status
H4	Female	61	College degree	41 years	/
H5	female	63	College degree	43 years	/
H6	Female	31	Bachelor degree	5 years	/
H7	Female	63	College degree	48 years	/
H8	female	37	Bachelor degree	13 years	/
T1	female	63	Bachelor degree	35 years	/
T2	female	31	Master degree	6 years	/
T3	Female	63	Master degree	41 years	/
T4	Female	63	Bachelor degree	42 years	/
T5	Female	41	Bachelor degree	17 years	/
T6	Female	62	Bachelor degree	40 years	/

4.1.2.2 Themes categorized from the interview

Three themes were generated from content analysis after interview, which were perception toward HPV vaccine based on PMT model, barriers to receiving HPV vaccine, and how to promote HPV vaccination. Themes and sub-themes were showed in table 16.

Table 19 Themes from the qualitative study

Themes	Sub-themes
Perception toward HPV vaccine based on PMT	Perceived susceptibility Perceived severity Perceived response efficacy
Barriers to receiving HPV vaccine	1) High cost of HPV vaccine 2) Short of supply 3) Limited knowledge for HPV vaccine
How to promote HPV vaccination	1) Health education 2) Parents' attitude 3) Peer's vaccine experience communication 4) Implement college health center based vaccination 5) Incorporate HPV vaccines into the national vaccine program

4.1.2.2.1 Perception toward HPV vaccine based on PMT model

4.1.2.2.1.1 Perceived susceptibility

The students who were well-informed about HPV and thinking about future sexual encounters such as marriage, exhibit a high level of knowledge tend to be more aware of the potential risks and thus believe that they were more susceptible to HPV infection. The perceived susceptibility of HPV-related disease refers to the understanding on the part of the woman of her low chance of developing genital HPV, cervical cancer and genital warts if they did not obtain HPV vaccination. Increasing understanding of susceptibility toward HPV, would influence individuals to take the necessary steps to keep themselves safe from a particular health concern.

There are so many ways we can get the HPV, even swimming in the same pool will have a chance to get infected.S1

I think it's not necessary. I will not having sex in the future, it could be contagious.S3

However, there were still college students who were not aware of the risk associated with HPV and do not consider themselves vulnerable to HPV infection due to their current lack of sexual activity. Lower level of intention to initiate HPV vaccination was related to lower level of perceived susceptibility of HPV infection. Consequently, they might not see the necessity of taking the HPV vaccine until they become sexually active in the future.

"I don't think I'm going to get it, so I am very careful about my health. "S2

Most healthcare providers and teachers thought that it's very susceptible to get HPV infection for college students. However, two healthcare providers (male) displayed a lack of awareness on these topics.

College students, young women, and especially women with a lack of knowledge are vulnerable to HPV infection.H6

The chances of HPV infection have increased this year among college students.T1

4.1.2.2.1.2 Perceived severity

Participants including students, healthcare providers and teachers in a college possessed a deep understanding of the detrimental consequences associated with HPV, such as the development of cervical cancer or other related health issues that

may even lead to death, tend to perceive a higher severity of the infection. Students who felt that HPV was a likely problem had greater intentions to be vaccinated

"Cervical cancer caused by HPV is, after all, a cancer, and although it can be treated by surgical way , but it is still an invasive thing to the body, so we must protect ourself against it."S6

HPV virus is a high-risk virus and vary contagious, it may be transmitted to sexual partners. It will affect the female's fertility, induce malignant cancers and urinary difficulties.H5

Once infected, it has both psychological and physical effects on the woman and can even lead to the disintegration of the family and, in the worst case, death. T3

4.1.2.2.2.3 Perceived response

One prominent perceived response effect of HPV vaccination reported by participants was the protection it provides against cervical cancer. This benefit was of utmost importance and consistently highlighted during the discussions. Participants expressed a sense of safety knowing that they were taking proactive steps to reduce their risk of developing a potentially life-threatening condition. The perception of response refers to the recognition by the woman of her ability to protect her health status specifically against genital warts, cervical cancer and HPV infection if she obtained HPV vaccination.

"The vaccine prevents us from getting the cervical cancer. At some point we can be sexually active but if we never had that vaccine, HPV can be easily transmitted into us. So as for that when you get the (HPV) vaccine it will prevent cervical cancer (hmm), it will act as a shield. "S9

HPV Vaccines can produce antibodies. Preventing HPV infection and reducing cervical cancer. H5

4.1.2.2.2 Barriers to receiving HPV vaccine

Several barriers were identified by both vaccinated and unvaccinated students, and among healthcare provider and college teachers. These were coded as subthemes, namely: high cost of the vaccine, short of supply, concern about the safety of vaccine.

4.1.2.2.2.1 High cost of HPV vaccine

The high cost of HPV vaccination refers to the woman's estimation of the cost which prevents her from obtaining HPV vaccination. The high cost of HPV vaccine

was mentioned as a significant barrier, deterring some students from seeking vaccination. The high price with the cost of per-dose regimen ranging from USD 80 to USD 180 and the insufficient supply of the imported HPV vaccine has made it poorly accessible to college female students and prevented its widespread use in China.

"The price of the vaccine is far more than I thought."S8

7 of the healthcare provider mentioned that the high cost of the HPV vaccine was a major barrier, deterring college students from getting HPV vaccination.

"The prince of 3 doses the HPV vaccine is too high, most of the students cannot afford it."H6

Teachers also mentioned that the high cost of the HPV vaccine was a major barrier, deterring college students from getting HPV vaccination.

"The prince is the too high, someone who want to get the vaccine but has no money will choose to not vaccine."T3

4.1.2.2.2.2 Short of supply

Currently, the desire for HPV vaccination is strong among the health-conscious group of university students. To date, China has approved five types of HPV vaccines against cervical cancer, making it the country with the most types of HPV vaccines. But the participants in our study preferred the 9-valent Gardasil vaccine, the limited supply of the vaccine in the country hinders the possibility of obtaining the vaccination.

"It's very difficult to get an appointment now, the clinic where can provided vaccine is very limited. "S1

"It's very hard to get an appointment now, it's very inconvenient."T4

4.1.2.2.2.3 Limited the knowledge for HPV vaccine

Knowledge for HPV vaccine refers to the understanding of the college students of HPV infections and the related behavioral risk factors, and the effectiveness of HPV vaccine. Participants also talk about that the knowledge regarding HPV and HPV vaccination would affect the HPV vaccination. knowledge of HPV and cervical cancer is significantly associated with intention and indirectly through the mediation of attitudes. Lack of knowledge of HPV and HPV vaccine was commonly mentioned as reasons that hinder participants from obtaining the HPV vaccine.

“Lack of related knowledge, before I go to university, no one has share this kind of information to me. ”S7

“Students nowadays are more concerned about their health and would be more willing to receive the HPV vaccine if they knew more about it.”T2

4.1.2.2.3 How to promote HPV vaccination

4.1.2.2.3.1 Health education

Participants emphasized the need to enhance knowledge and awareness of HPV vaccination by making information more accessible within communities through social mobilization campaigns. They also recommended including HPV information within the school curriculum and actively involving politicians in promoting vaccination. Health education can address the knowledge gap of the HPV vaccine and HPV, students can understand the HPV infection, cervical cancer and related behavioral risk factors, causes, prevention and treatment for women after educated with related health information.

“In the related class, the teacher can share the recently knowledge to us, maybe will help us know more.”S10

“*Health education on campuses, especially the prevalence and incidence of HPV infection, can promote HPV vaccination.”H8*

4.1.2.2.3.2 Parents’ attitude

The attitudes and opinions of parents were identified as key factors influencing the decision to vaccinate. While college students are at an appropriate age for vaccination and show improving health literacy, parental opinions still hold considerable weight. In some cases, the final decision regarding vaccination comes from the parents. The decision to vaccinate is the responsibility of parents who, by giving their consent, give their daughter the chance to avoid a disease that is dangerous to their health and even their life.

"I think it is a combination (of opinions), to discuss with them first, and after discussion, they decide whether to vaccinate or not and how many doses to vaccinate.” P10

"It is the fact that for major things, I will discussed with parents to make a decision, they know about this (vaccine) and are more supportive."P9

4.1.2.2.3.3 Peer's vaccine experience communication

Peer-to-peer communication includes a standard dialogue discussion, it occurs when two or more people are together and able to speak in person, over the phone, virtually or otherwise. This may include people communicating unregulated shared and private opinions as well as information based on fact and feeling. Peers' vaccine experiences communication was cited as a more trustworthy source of information about HPV and its vaccination, compensating for the uncertainty associated with online information. Participants emphasized the influence of peers' vaccine experiences communication on their own inclination to receive the HPV vaccine. Active peer-to-peer communication both discouraged unhealthy habits and promoted the individual's self-efficacy to practice healthy behaviors.

"I asked my classmate, who had already got 9-valent HPV vaccine, and she told me about the vaccine related knowledge, then I begin to looking for these things online."S6

"Friends around me recommend it because they have had it and they recommend it, they say where it is available for the vaccine, and then I will go and check for it, that is, first go to the people who have had it, and then ask them to tell me where it is."S3

4.1.2.2.3.4 Implement college health center based vaccination

Healthcare providers in the study mentioned that if vaccination was available on university campuses, and the university arranges the HPV vaccination program will prompt HPV vaccination. To provide a place for vaccination close by will be more convenient for college student. Introducing the HPV vaccine in a college health center-based setting, the HPV vaccination progress will be easy to access and be equity of opportunity for female college students to uptake.

"The University has vaccination points, just like the Covid-19 vaccine, which can be booked on campus at fixed times of the week will promote the HPV vaccination among college students ."H7

4.1.2.2.3.5 Incorporate HPV vaccines into the national vaccine program

Additionally, some participants believed that incorporating the HPV vaccine into the national vaccine program would significantly increase awareness and facilitate widespread adoption**.** National vaccine program will make the price of the vaccine be

acceptable for college students, and be constraint for college students to get, then the HPV vaccination coverage rate would be improve.

"If the HPV vaccines can be scheduled into the national vaccines plan, more people could be aware of them." S9

"To schedule HPV vaccines into the national vaccines plan, so it will become compulsory which would make parents and college students to consider seriously." T6

4.2 Phase II: The development and evaluation the effectiveness of promotion of human papillomavirus vaccination program

4.2.1 The development of the promotion of human papillomavirus vaccination program (the PMT-based HPV vaccination online education program)

4.2.1.1 The intervention development process

After analyzing the results from phase I and discussion with 3 specialists in women health education, vaccine healthcare, and health promotion, and by refereeing literature review, we developed a PMT-based HPV vaccination online program to promote HPV vaccination. The program was developed under the guidance of Wight et al.'s (2016) six steps in quality intervention development. Details were as follows:

4.2.1.1.1 Drafting of a PMT- based HPV vaccination online education program

According to the result of quantitative study in Phase I, we found that knowledge of HPV, knowledge of HPV vaccine, HPV infection prevention awareness were associated with female medical college students' intention to initiate HPV vaccination, and about the PMT constructs, perceived severity toward HPV, perceived response efficacy, perceived self-efficacy were predict factors of intention to initiate HPV vaccination for female medical college students; among social-demographic factors, willingness to pay for HPV vaccine was significant factor to intention to initiate HPV vaccination among female medical college students. The results from qualitative study found that health education, parent's attitude, peer's vaccine experience communication, implement college health center based vaccination and incorporate HPV vaccines into national vaccine program can help to promote HPV

vaccination among female medical college students. The primary three barriers to receiving HPV vaccine were high cost, insufficient supple and lack of information. By compounding these information together, according to Wight et al.'s (2016) six steps in quality intervention development, we found that modifiable factors to promotion HPV vaccination intention among female medical college students were:1) Knowledge and awareness of HPV and the HPV vaccine ; 2) Perception of PMT constructs toward HPV and HPV vaccines, so that to conquer the barrier of limited knowledge of HPV and HPV vaccine among female medical college students. About the unmodifiable factors, like the high cost, short of supply, incorporate HPV vaccine into national vaccine program, and implement college health canter based vaccination, we also share the latest news about how to make an appointment easily, where to find the HPV vaccine center, how to save the money, what's the policy for college students to receive HPV vaccine. Since the internet is the primary resource of HPV vaccine information, and peer's vaccine experience communication would also promote HPV vaccine intention, our intervention were designed guide by PMT with online platform, plus group discussion to promote the HPV vaccination intention among female college students. According to the previous studies (Bennett et al.2015), one month of intervention and three month of follow-up was designed for the intervention. The steps are shown in Table 17.

Table 20 Steps of drafting a intervention program

Main steps	Intervention development
1. Define and understand the problem and its causes.	In phase I, our study found that 86.3% of participants had a high intention to initiate the HPV vaccine. However, 86.1% of the medical college students did not get any dose of the HPV vaccine, which was quite lower than the average vaccination level (21% in 2022) (WHO, 2023) However, The factors related to the intention to initiate the HPV vaccine were: 1. The knowledge and awareness toward HPV and HPV vaccine, our study found that medical college students were with low corrected answers with the knowledge like most people with HPV have visible signs or symptoms of infection; HPV is curable; a person can get HPV from skin to skin contact with an infected person; HPV vaccines offer protection against all sexually transmitted infections; one can cure HPV infection by getting the HPV vaccine. 2.The perceived susceptibility, perceived severity, and perceived response efficacy toward the HPV vaccine 3. The high cost and the short supply of the HPV vaccine 4. Parents' education background 5. The vaccinated relatives 6. Lack of specific information about the HPV vaccine.

Table 17. Steps of drafting the intervention program (cont.)

Main steps	Intervention development
2. Clarify modifiable factors to improve HPV vaccination.	1. Knowledge and awareness toward HPV and the HPV vaccine. 2. The perceived susceptibility. 3. The perceived severity. 4. The perceived response efficacy. 5.The specific information about HPV vaccination.
3. Identify how to bring about change: the change mechanism.	1. Improve the knowledge of HPV and HPV vaccines which with low corrected answers. 2. Promote perceived susceptibility and perceived severity toward HPV infection. 3. Identify the efficacy of having an HPV vaccination.
4. Identify how to deliver the change mechanism.	1. Discuss with experts from health education, vaccine healthcare providers, and health promotion to identify a suitable population and a suitable method to do the health program. 2. Explain the program to raise critical thinking about HPV and the HPV vaccine. 3. Introduce the knowledge of HPV, the prevalence of HPV among young adults, and the susceptibility of HPV. 4. Introduce ways of transmitting HPV and the severity of HPV. 5. Introduce the HPV vaccine and the effects of different kinds of vaccines. 6. Introduce the response efficacy toward the HPV vaccine.
5. Test and refine on small scale.	1. Recruit volunteers in each group. 2. Pilot a manual within groups with observation research. 3. Revise problematic sessions and test again. 4. Conduct group discussions with group members to explore views on intervention. 5. Finalize the draft of the manual.
6. Collect sufficient evidence of effectiveness of program	1.Implement interventions with different academic year college students. 2.Group discussions and a semi-structured interview with the participants. 3. Re-check the intervention with the experts.

4.2.1.1.2 Discussion of a PMT- based HPV vaccination online education program with the experts

After drafting the intervention program, three copies were send to 3 experts by emails. One week after that, the researcher make an appointment to the expert to have a face to face discussion. According to the objectives and PMT model, three experts discussed the themes, objectives, activity details, method of activities, materials, and

duration of each activities of the PMT-based HPV vaccination online education program with the researcher.

4.2.1.1.3 Revising the PMT- based HPV vaccination online education program

Three experts gave advices to the PMT- based HPV vaccination online education program.

The first expert's comments about the program including: 1) susceptibility should list in the intervention; 2) since the WeChat article sharing did not have a feedback, group discussion can be a way to help students to involve into the study; 3) the severity of the HPV-related health problems should give more details to the college students; 4) assimilation of the contents would help students to think more about the contents;

The second expert's comments about the program including: 1) what's the difference between the different HPV vaccines should gave more details to the college students to let them have more choice; 2) is there a student who succussed receiving the HPV vaccine? The true story of a peer's experience can motivate college students to receive HPV vaccine; 3) brainstorming question about the benefits of the HPV vaccine can also help students searching related information to help them know more; 4) the time of only four day for the intervention, will the effects lasting? Maybe one week for one session will help students to understand the topic better.

The third expert's comments about the program including: 1) the susceptibility and severity of the HPV infection should gave more details; 2) how to prevent the HPV infection should be more specify; 4) common questions like if someone had sex whether she can receive the vaccine should be put into the intervention; 5) more photos should be given in your article to attract students interesting.

According to the comments of the experts; more details about the susceptibility and severity of the HPV infection were including into intervention, like the transmission way, the prevalence of HPV in college age years; the type of the HPV and it's health problems related to it; the prevention method of HPV infection, and it's effectiveness; according to the searching results from the Internet, common question hold by college students was include into the intervention. More related photos were put into articles; two videos were include into the intervention, group discussion and

brainstorming question were set as the usual method besides articling sharing to help students better understand the topics.

4.2.1.1.4 Verifying the PMT- based HPV vaccination online education program

After revising the PMT- based HPV vaccination online education program, the research showed the revision of PMT- based HPV vaccination online education program to the expert by emails. One week later the experts gave agreement for PMT-based HPV vaccination online education program that had the characteristics according to the expert comments. They showed agreement that the second version of PMT- based HPV vaccination online education program as final intervention method.

4.2.1.2 The final intervention characteristics

The final intervention was divided into four sessions, including the perceived susceptibility session, perceived severity session, the perceived response efficacy session, and the perceived self-efficacy session, according to the PMT. The final PMT-based HPV vaccination online education program consisted of 10 activities. The topics, objectives, the details of the activities, PMT dimension and the activity timing of the PMT-based HPV vaccination online program are shown in Table 18.

In the intervention group, the female medical college students received the PMT-based HPV vaccination online education program by WeChat.

The PMT-based HPV vaccination online education program consisted of four sessions with a total of 10 activities. One session was delivered per day by the WeChat discussion group, with an intervention education time of 50–60 minutes per day. The first step of the intervention was preparation: the research team, including public health specialists and college teachers, would first search the website of WHO, China's Centers for Disease Control and Prevention, review literature to find information related to the four sessions, and edit an online article on the Gynecology and Obstetrics Nursing WeChat subscription platform according to the theme of each activity. In this article, it outlined the activity topics of each session and gave the questions of the topics. After that, each session would be guided by three steps, including reading, assimilation, and discussion. The trained researcher would share the article with the intervention group through a WeChat discussion group. The

students were assigned to 10 groups. After reading the article, participants were asked to assimilate the contents and find the answer to each question on their own. Then, they shared the answers to each question in the WeChat discussion group. Finally, the trained researcher would give a final summary of this session according to the student responses.

The process and time allocated for each session were as follows: the trained researcher introduced the theme of the session and shared the article (5 min) (the first session would plus building relationships (10 mins); the participants read the sharing article (10 min); the participants assimilated the contents and according to the questions in the article to find answers on their own (15 min); the group members discussed the answers to group members through a WeChat discussion group (15 min); the trained researcher summarized the session (5 min) (groups: 8 groups of 10 students and 2 groups of 11 students); questions were always welcome.

In the control group, the female medical college students received one article related to the HBV vaccine, influenza vaccine, Bacillus Calmette-Guerin vaccine, and rabies vaccines by WeChat with one group of 102 participants. The details of the intervention between the intervention group and the control group are shown in Table 19.

Table 21 The characteristics of PMT based HPV vaccination online education program

Session	Topics of activities	PMT dimension	Objectives	Contents	Method of Activity	Materials	Duration
1	Building relationships	Perceived susceptibility	To develop a trust relationship between the researcher and participants, introduce the program and regulations.	**Building relationships:** The research team introduced the process and purpose of the program, and the regulations of the program were highlighted. **Preparing:** The research team searched the website of WHO, China's Centers for Disease Control and Prevention, reviewed literature to find information related to the susceptibility of HPV, and wrote an article on the Gynecology and Obstetrics Nursing WeChat subscription platform. **Reading:** After receiving the article from WeChat, the participants read the article item by item. Assimilation: According to the questions given in the article, participants assimilated the susceptibility of HPV. **Discussion:** The group members discussed questions like the methods of HPV transmission and the risk factors of HPV in the WeChat discussion group. A representative of each group would share the answers to each question with the whole	Words Introduction; WeChat Article sharing; Group discussion; Question and answers	Phone with WeChat software; WeChat discussion group	60 Minutes
	Introducing HPV definition, types and immune response to HPV		To let participants know the definition of HPV and differentiate between the high-risk and low-risk types of HPV, they must understand the immune response to HPV.			Computer; Phone with WeChat software; WeChat discussion group	
	Introducing the epidemiology of HPV and peak age groups of HPV infection		To introduce the prevalence of HPV and the peak age groups of HPV infection			Computer; Phone with WeChat software; WeChat discussion group	
	Discussing the risk factors, transmission ways, and symptoms of contacting HPV		To offer information to recognize the risk factors, transmission method, and symptoms of contacting HPV			Computer; Phone with WeChat software; WeChat discussion	

Session	Topics of activities	PMT dimension	Objectives	Contents	Method of Activity	Materials	Duration
				group. Students of different answers were welcomed. The trained researcher summarized the session.		group	
2	Introducing HPV-induced health problems, including cancers and genital warts, and identifying the mechanism by which HPV causes cancer	Perceived severity	To inform participants about the relationship between HPV and health problems and identify the mechanism by which HPV causes cancer	**Preparing:** The research team searched for information related to the severity of HPV and wrote an article emphasizing the severity of HPV on the Gynecology and Obstetrics Nursing WeChat subscription platform. One video related to cervical cancer was also included in this article. **Reading:** After receiving the article from WeChat, the participants read the article item by item. Assimilation: Participants assimilated the severity of HPV and found answers to questions like strategies to reduce the incidence of HPV, ways to treat HPV, and cervical cancer. **Discussion:** The group members discussed the answers through the WeChat discussion group, and students of different answers were welcomed. The trained researcher summarized the session.	WeChat Article sharing; Show educational video; Group discussion; Question and answers	Computer; Phone with WeChat software; WeChat discussion group	50 Minutes
	Discussing the check-up and treatment for HPV and ways to prevent it		To inform participants about the severity of cervical cancer, ways to prevent it, and treatments for cervical cancer and HPV			Computer; Phone with WeChat software; WeChat discussion group	
3	Introducing the definition, protective	Perceived response efficacy	To offer participants information about the benefits and protective	**Preparing:** The research team searched for information related to the HPV vaccine and wrote an article	WeChat Article sharing;	Computer; Phone with WeChat	50 Minutes

Session	Topics of activities	PMT dimension	Objectives	Contents	Method of Activity	Materials	Duration
	efficacy, and safety of the HPV vaccine and the accurate time to administer it.		efficacy of the HPV vaccine and to understand the importance of an accurate time to administer the HPV vaccine	with an emphasis on the efficacy of the HPV vaccine and the benefits of waiting to receive the HPV vaccine on the Gynecology and Obstetrics Nursing WeChat subscription platform. A video related to the HPV vaccine was also in the article. **Reading:** After receiving the article from WeChat, the participants read the article. **Assimilation:** Participants assimilated the efficacy of the HPV vaccine and found answers to questions like the benefits and side effects of different HPV vaccines; **Discussion:** The group members discussed the answers in the WeChat discussion group; students of different answers were welcomed. The trained researcher summarized the session.	educational video; Group discussion; Show Brainstorming question and answer	software WeChat discussion group	
	Comparing the differences between HPV vaccines and discussing the best ways to prevent cervical cancer.		To inform participants of information to differentiate the effects of 2, 4, and 9-valent HPV vaccines and the choice for college-age students			Computer; Phone with WeChat software; WeChat discussion group	
4	Introducing resources for accessing the HPV vaccine	Perceived self-efficacy	To equip participants with the details of how to get the HPV vaccine, the place, the price, the appointment method, etc.	**Preparing:** The research team searched the information related to HPV vaccine self-efficacy in Wuhan and wrote the information about where, how much, and how to make an appointment for HPV vaccines at the Gynecology and Obstetrics Nursing WeChat subscription platform.	WeChat Article sharing; Sharing Websites for making appoint of HPV vaccine;	Phone with WeChat software; WeChat discussion group	50 Minutes
	Motivating self-efficacy to get the HPV		To motivate participants to receive the HPV vaccine by			Phone with WeChat software;	

Session	Topics of activities	PMT dimension	Objectives	Contents	Method of Activity	Materials	Duration
	vaccine and sharing ways to answer questions about HPV vaccination.		discussing self-efficacy and self-acceptance toward the HPV vaccine and sharing ways to answer questions about HPV vaccination.	**Reading:** After receiving the article from WeChat, the participants read the article. **Assimilation:** Participants assimilated self-experiences about the HPV vaccine and the benefits of HPV vaccination. **Discussion:** The group members would talk about their experiences with the HPV vaccine, vaccination problems, and ways to deal with them. And how to boost HPV vaccination among college students as a healthcare provider. The trained researcher provided an overview and summary of all sessions.	Group discussion; Brainstorming question and answer	WeChat discussion group	

Table 22 The comparison between PMT based HPV vaccination online education program and regular vaccine education program

Session	PMT based promotion HPV vaccination education program	Regular vaccine education program in control group
1	**Theme:** Perceived susceptibility of HPV **Objective:** 1.To develop a trust relationship between the researcher and participants, introduce the program and regulations. 2.To let participants know the definition of HPV and differentiate between the high-risk and low-risk types of HPV, they must understand the immune response to HPV. 3.To introduce the prevalence of HPV and the peak age groups of HPV infection 4.To offer information to recognize the risk factors, transmission method, and symptoms of contacting HPV	**Theme:** The vaccine guideline for adult **Objective:** 1. To describe the vaccines college students can have 2. To explain the reason to get vaccine 3. To compare the difference of vaccines
2	**Theme:** Perceived severity of HPV **Objective:** 1.To inform participants about the relationship between HPV and health problems and identify the mechanism by which HPV causes cancer 2.To inform participants about the severity of cervical cancer, ways to prevent it, and treatments for cervical cancer and HPV	**Theme:** How to get the HBV vaccine, the knowledge you should know **Objective:** 1. To interpret the definition of hepatitis B vaccine 2. To understand the prevalence of hepatitis B 3. To describe the results of Hepatitis B tests 4. To administer hepatitis B vaccine 5. To recognize the side effect of the vaccine
3	**Theme:** Perceived response efficacy of HPV vaccine **Objective:** 1.To offer participants information about the benefits and protective efficacy of the HPV vaccine and to understand the importance of an accurate time to administer the HPV vaccine 2.To inform participants of information to differentiate the effects of 2, 4, and 9-valent HPV vaccines and the choice for college-age students	**Theme:** How to get the influenza vaccine, Answers are here **Objective:** 1. To interpret the definition of influenza vaccine 2. To understand the prevalence of influenza vaccine 3.To describe the results of influenza test 4. To administer influenza vaccine 5. To recognize the side effect of the vaccine

4	**Theme:** Perceived self-efficacy of HPV vaccine **Objective:** 1. To equip participants with the details of how to get the HPV vaccine, the place, the price, the appointment method, etc. 2.To motivate participants to receive the HPV vaccine by discussing self-efficacy and self-acceptance toward the HPV vaccine and sharing ways to answer questions about HPV vaccination.	**Theme:** Why to get Bacillus Calmette Guerin vaccine **Objective:** 1. To interpret the definition of Bacillus Calmette Guerin vaccine 2. To understand the prevalence of tuberculosis 3.To describe the methods of tuberculin test 4. To recognize the results of tuberculin test 5. To administer tuberculin test 6. To recognize the side effect of Bacillus Calmette Guerin vaccine

4.2.2 The evaluation the effectiveness of promotion of human papillomavirus vaccination program (the PMT-based HPV vaccination online education program)

4.2.2.1 The comparison of baseline characteristics, HPV vaccine intention, the knowledge of HPV and HPV vaccine scores, HPV infection prevention awareness scores, the PMT scores and HPV vaccine communication competency scores between intervention and control groups.

A total of 204 first-year female medical college students were initially recruited from two colleges at baseline and participated until the end of the three-month follow-up. At baseline assessment, participants had an average age of 18.8±0.7 years. For 53.4% of the participants, their father's education background was less than high school, and for 66.7% of the participants, their mother's education background was less than high school. More than half (57.4%) of the participants reported that their family's' yearly household income was less than 50,000 CNY.

Moreover, the majority of the participants (65.2%) had vaccinated familiars around them, and 86.3% expressed WTP for the HPV vaccine. 51.5% of the participants showed a high level of HPV vaccine intention. The average score of knowledge about HPV and the HPV vaccine was 4.5±2.1 and 4.1±1.9, respectively. The HPV infection prevention awareness scores were 9.8 ± 1.6. The average scores of the PMT, including perceived susceptibility, perceived severity, perceived response efficacy, and perceived self-efficacy, were 4.7±2.1, 9.8±4.5, 14.4±2.9, and 17.8±3.6, respectively. And for HPV vaccine communication competency, the average score was 8.6 ± 1.9. The baseline characteristics showed no statistically significant differences between the intervention and control groups. (P>0.05) (Table 20).

Table 23 Baseline characteristics of participants (n=204)

Characteristics	Total (n=204)	Control (n=102)	Intervention (n=102)	*P*-value
	n (%)	n (%)	n (%)	
Father's education background				0.777*
Less than high school	109(53.4)	54(54.0)	51(51.0)	
High school and above	95(46.6)	46(46.0)	49(49.0)	
Mather's education background				0.456*
Less than high school	136(66.7)	69(69.0)	63(63.0)	
High school and above	68(33.3)	31(31.0)	37(37.0)	
Family yearly household income (RMB/yearly/person)				0.154*
Less than 50 000	117(57.4)	62(62.0)	51(51.0)	
50000 and above	87(42.6)	38(38.0)	49(49.0)	
Vaccinated familiars				0.833*
Yes	133(65.2)	67(65.7)	66(64.7)	
No	71(34.8)	35(34.3)	36(35.3)	
WTP for HPV vaccine				0.416*
Yes	176(86.3)	90(88.2)	86(84.3)	
No	28(13.7)	12(11.8)	16(15.7)	
Sexual intercourse				0.122*
Yes	11(5.4)	8(7.8)	3(2.9)	
No	193(94.6)	94(92.2)	99(97.1)	
HPV vaccine intention				0.322*
High level	105(51.5)	49(48.0)	56(54.9)	
Low level	99(48.5)	53(52.0)	46(45.1)	
	Mean ± S.D.	Mean ± S.D.	Mean ± S.D.	*P-value*
Age (years)	18.8±0.7	18.8±0.6	18.8±0.7	0.442‡
Knowledge and information receiving				
Knowledge of HPV vaccine scores	4.5±2.1	4.5±2.1	4.4±1.7	0.691‡
Knowledge of HPV scores	4.1±1.9	4.1±2.1	4.2±1.7	0.853‡
HPV infection prevention awareness scores	9.8±1.6	9.7±1.7	10.0±1.9	0.349‡
The PMT scores				
Perceived susceptibility	4.7±2.1	4.8±2.2	4.5±1.7	0.237‡
Perceived severity	9.8±4.5	10.0±5.0	9.6±3.3	0.508‡
Perceived response efficacy	14.4±2.9	14.3±2.3	14.7±2.3	0.153‡
Perceived self-efficacy	17.8±3.6	17.7±2.9	18.0±3.5	0.560‡
HPV vaccine communication competency scores	8.6±1.9	8.7±1.9	8.6±1.9	0.332‡

Note: RMB , Chinese Yuan; S.D., Standard deviation; *P-value for Chi-square test, ‡ P-value for independent sample t-test. Statistically significant level as $P < 0.05$

4.2.2.2 The comparison of HPV vaccine intention, the knowledge of HPV and HPV vaccine scores, HPV infection prevention awareness scores, the PMT scores, and HPV vaccine communication competency scores within groups at bassline, after intervention, and follow up

The comparison of HPV vaccine intention within the intervention group from baseline (before intervention), after intervention completion, and three months follow-up by using Cochran's Q test indicated that there was a significant difference ($P<0.05$) in HPV vaccine intention. It was also found that the proportion of students with a high level of HPV vaccine intention increased after the intervention and follow-up period. In addition, a repeated analysis of variance (ANOVA) was performed to determine the difference in the mean scores of knowledge of HPV and HPV vaccine, HPV infection prevention awareness, and HPV vaccine communication competency. The results showed that there was a significant difference ($P<0.05$), also these scores were increased significantly from before intervention to follow-up. In terms of the PMT scores, it showed that the mean scores of perceived susceptibility, perceived severity, perceived response efficacy, and perceived self-efficacy increased significantly from before intervention to follow-up ($P<0.05$) (Table 21).

However, in the control group, it was found that no significant changes ($P>0.05$) were observed in HPV vaccine intention, the mean scores in the knowledge of HPV and HPV vaccine scores, HPV infection prevention awareness scores, the PMT scores, and HPV vaccine communication competency scores (Table 21).

Table 24 Comparison of the outcome measurements within groups at baseline, after intervention, and follow-up

Outcomes	Intervention			*P* value	Control			*P* value
	Before intervention (n=102)	After intervention (n=102)	Follow-up (n=102)		Before intervention (n=102)	After intervention (n=102)	Follow-up (n=102)	
	n (%)	n (%)	n (%)		n (%)	n (%)	n (%)	
HPV vaccine intention								
High level	49(48.0)	84(82.4)	84(82.1)	<0.001¶	56(54.9)	51(50.0)	48(47.0)	0.525¶
Low level	53(52.0)	18(17.6)	18(17.9)		46(45.1)	51(50.0)	54(53.0)	
	M±SD	M±SD	M±SD		M±SD	M±SD	M±SD	
Knowledge and information receiving								
Knowledge of HPV scores	4.5±2.1	9.8±2.2	9.8±2.1	<0.001Δ	4.4±1.7	5.0±2.1	5.0±2.2	0.081Δ
Knowledge of HPV vaccine scores	4.1±2.1	8.4±1.9	8.8±1.5	<0.001Δ	4.2±1.7	4.4±2.0	4.7±2.2	0.137Δ
HPV infection prevention awareness scores	9.7±1.7	13.2±1.3	13.5±2.4	<0.001Δ	10.0±1.9	10.1±1.8	9.9±1.8	0.676Δ
The PMT scores								
Perceived susceptibility	4.8±2.2	5.1±2.1	5.2±2.4	0.008Δ	4.5±1.7	4.4±1.6	4.5±1.6	0.947Δ
Perceived severity	10.0±5.0	15.2±3.5	16.2±4.6	<0.001Δ	9.6±3.3	9.6±3.0	9.7±3.3	0.961Δ
Perceived response efficacy	14.3±2.3	17.1±2.5	17.9±2.1	<0.001Δ	14.7±2.3	14.8±2.8	14.6±2.9	0.819Δ
Perceived self-efficacy	17.7±2.9	20.5±3.6	20.6±3.5	<0.001Δ	18.0±3.5	18.1±2.8	18.5±3.7	0.503Δ
HPV vaccine communication competency scores	8.7±1.9	12.0±2.0	12.5±2.3	<0.001Δ	8.6±1.9	8.9±1.3	8.9±1.8	0.175Δ

Note: Values are presented as number (%) and M±SD (Mean ±Standard deviation); ¶ *P*-value for Cochran's Q test; Δ *P*-value for repeated measure ANOVA
Statistically significant level as $P < 0.05$

4.2.2.3 The comparison of HPV vaccine intention, the knowledge of HPV and HPV vaccine scores, the PMT scores, HPV infection prevention awareness scores, and HPV vaccine communication competency scores between groups at bassline, after intervention, and follow up.

Before intervention, the comparison of HPV vaccine intention between intervention and control groups was done using the chi square test, and the results showed that there was no significant difference ($P > 0.05$). Besides, the independent sample t-test was used to compare the means scores of knowledge of HPV and HPV vaccine, HPV infection prevention awareness, the PMT scores, and HPV vaccine communication competency between the intervention and control groups before intervention, and the results showed no significant difference ($P > 0.05$) (Table 22).

After intervention completion, the results indicated a significant difference in HPV vaccine intention ($P<0.05$). Additionally, we found that the proportion of students with a high level of HPV vaccine intention increased in the intervention group when compared with the control group. Moreover, the difference in mean scores between the two groups was statistically significant ($P<0.001$) in the knowledge of HPV and HPV vaccine, HPV infection prevention awareness, the PMT scores, and HPV vaccine communication competency. Additionally, the mean scores of knowledge of HPV and HPV vaccine, HPV infection prevention awareness, PMT scores, and HPV vaccine communication competency in the intervention group were significantly higher than the scores of the control group ($P<0.05$) (Table 22).

At three-month follow-up, the results indicated a significant difference in HPV vaccine intention between the intervention and control groups ($P<0.05$). When comparing the mean scores of knowledge of HPV and HPV vaccine scores, HPV infection prevention awareness scores, PMT scores, and HPV vaccine communication competency scores between the intervention and control groups at three-month follow-up, the results also showed significant differences between the intervention and control groups ($P<0.05$). Furthermore, we also found that the proportion of students with a high level of HPV vaccine intention increased in the intervention group when compared with the control group. Also, the mean scores of knowledge of HPV and HPV vaccine, HPV infection prevention awareness, PMT scores, and HPV

vaccine communication competency were increased in the intervention group when compared with the control group (Table 22).

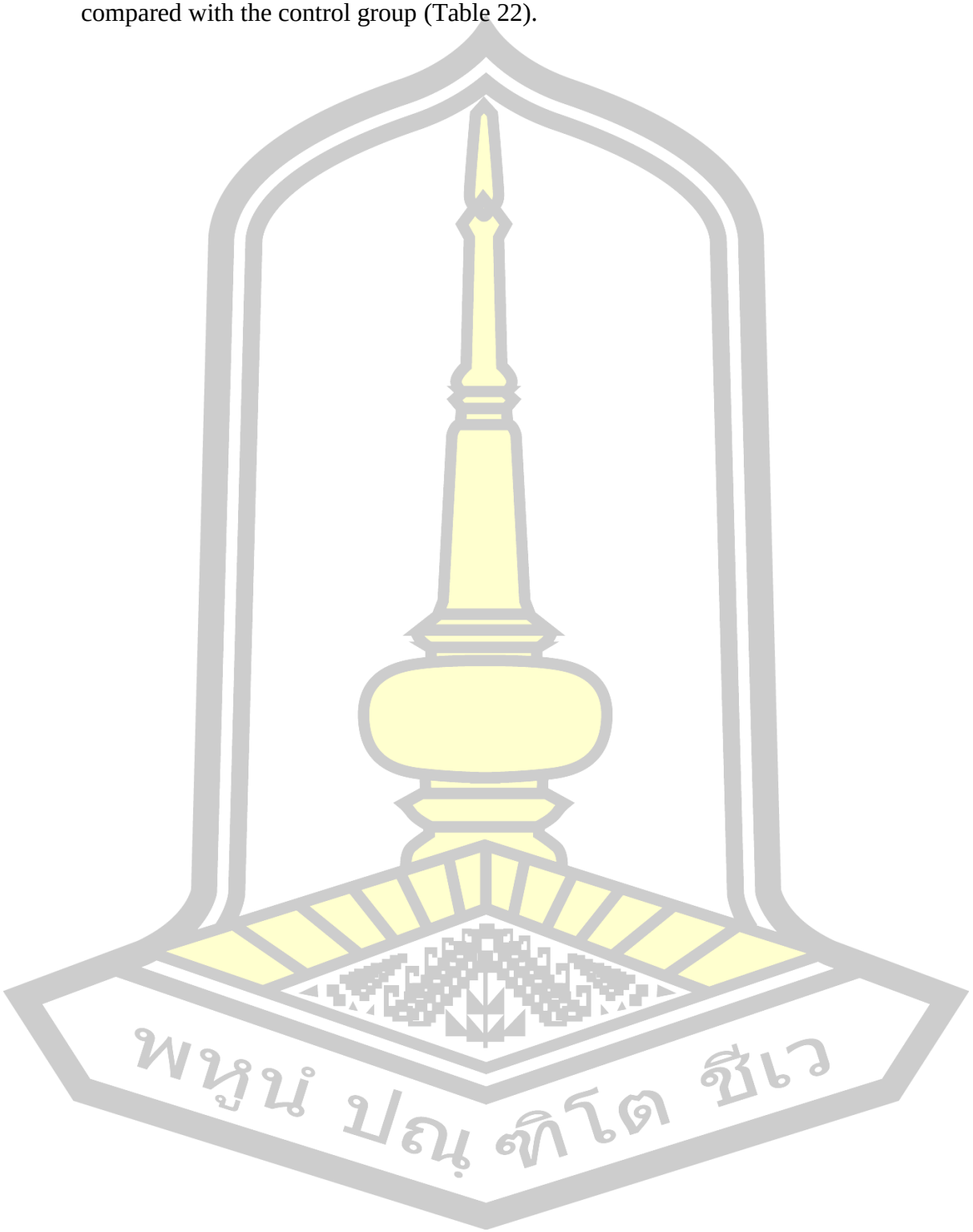

Table 25 Comparison of the outcome measurements between intervention and control groups at baseline, after intervention, and follow-up

Outcomes	Before intervention		*P* value	After intervention		*P* value	Follow-up		*P* value
	Intervention (=102)	Control (n=102)		Intervention (n=102)	Control (n=102)		Intervention (n=102)	Control (n=102)	
	n (%)	n (%)		n (%)	n (%)		n (%)	n (%)	
HPV vaccine intention									
High level	49(48.0)	56(54.9)	0.322*	84(82.4)	51(50.0)	0.001*	84(82.1)	48(47.0)	0.001*
Low level	53(52.0)	46(45.1)		18(17.6)	51(50.0)		18(17.9)	54(53.0)	
	M±SD	M±SD		M±SD	M±SD		M±SD	M±SD	
Knowledge and information receiving									
Knowledge of HPV scores	4.5±2.1	4.4±1.7	0.691‡	9.8±2.2	5.0±2.1	0.001‡	9.8±2.1	5.0±2.2	0.001‡
Knowledge of HPV vaccine scores	4.1±2.1	4.2±1.7	0.853‡	8.4±1.9	4.4±2.0	0.001‡	8.8±1.5	4.7±2.2	0.001‡
HPV infection prevention awareness scores	9.7±1.7	10.0±1.9	0.349‡	13.2±1.3	10.1±1.8	0.001	13.5±2.4	9.9±1.8	0.001‡
The PMT scores									
Perceived susceptibility	4.8±2.2	4.5±1.7	0.237‡	5.1±2.1	4.4±1.6	0.008‡	5.2±2.4	4.5±1.6	0.008‡
Perceived severity	10.0±5.0	9.6±3.3	0.508‡	15.2±3.5	9.6±3.0	0.001‡	16.2±4.6	9.7±3.3	0.001‡
Perceived response efficacy	14.3±2.3	14.7±2.3	0.153‡	17.1±2.5	14.8±2.8	0.001‡	17.9±2.1	14.6±2.9	0.001‡
Perceived self-efficacy	17.7±2.9	18.0±3.5	0.560‡	20.5±3.6	18.1±2.8	0.001‡	20.6±3.5	18.5±3.7	0.001‡
HPV vaccine communication competency scores	8.7±1.9	8.6±1.9	0.332‡	12.0±2.0	8.9±1.3	0.001‡	12.5±2.3	8.9±1.8	0.001‡

Note: Values are presented as number (%) and M±SD (Mean ±Standard deviation); * *P*-value for Chi-square test; ‡ *P*-value for independent sample t-test. Statistically significant level as $P < 0.05$.

4.2.2.4 The hypothesis testing of phase II

We hypothesized that the PMT-based HPV vaccination online education program could increase HPV vaccine intention among first-year medical college students. Our results supported this hypothesis, which revealed that after intervention completion and at three-month follow-up, the students with a high level of HPV vaccine intention in the intervention group were significantly higher than the control group ($P<0.05$).

Moreover, we also hypothesized that the PMT-based HPV vaccination online education program could increase the knowledge of HPV and HPV vaccine scores, HPV infection prevention awareness scores, PMT scores, and HPV vaccine communication competency scores in the intervention group. Our results supported this hypothesis, which revealed that after intervention, the knowledge of HPV and HPV vaccine scores, HPV infection prevention awareness scores, PMT scores, and HPV vaccine communication competency scores of the intervention group were significantly higher than the scores of the control group ($P<0.05$).

In conclusion, our findings revealed that the PMT-based HPV vaccination online education program is effective in increasing HPV vaccine intention and improving the knowledge of HPV and HPV vaccine scores, HPV infection prevention awareness scores, PMT scores, and HPV vaccine communication competency scores among female medical students.

CHAPTER 5
CONCLUSION, DISCUSSION, AND RECOMMENDATION

This chapter presents aspects of the conclusions, discussion of the findings, and recommendations for practice and further research as follows:

5.1 Conclusions the results

5.1.1 Conclusions the results of Phase I

The results of the quantitative study were as follows: (1) 85.5% of female medical college students posed a high intention for HPV vaccination in Hubei province. (2) the HPV vaccination coverage among female medical college students in Hubei province was 13.9%; (3) the first three sources of HPV vaccine information among female medical college students in Hubei were the internet (89.1%), friends (50.4%), and teacher (44.9%) among female medical college students; (4) HPV infection prevention awareness among female medical college students in Hubei province was at a moderate level, with an average score of 11.6 (±1.9) and an average standard score of 72.5 points; (5) Factors associated with the intention to initiate HPV vaccination among female medical college students, including social demographic factors (willingness to pay for HPV vaccine), knowledge and information received about HPV and HPV vaccine, and three PMT scale factors (including perceived severity, perceived response efficacy, and perceived self-efficacy).

The results of the qualitative study were as follows: (1) perception toward HPV vaccine based on PMT, this study found that participants who posed a understanding of the HPV thought college students were susceptible to HPV infection, perceived a high severity of HPV infection and thought HPV vaccine can protect female college students from cervical cancer;(2) the barriers to receiving HPV vaccine, the qualitative study found that high cost of the vaccine, short of supply, and limited knowledge for HPV vaccine were the barriers to receiving HPV vaccine among female college medical students, the results were same with the results of the quantitative study; (3) for how to promote HPV vaccination, the qualitative study indicated that from individual aspects, measure like health education to improve

knowledge of HPV and HPV vaccine, parents' attitude, peer's vaccine experience communication could improve HPV vaccination among female medical college students, and from political aspects, measures like implementing college health center based vaccination and incorporating HPV vaccine into the national vaccine program can improve HPV vaccination among female medical college students

5.1.2 Characteristics of the intervention (The PMT-based HPV vaccination online health program)

The interventions were developed based on Roger's Protective Motivation Theory (PMT) (Rogers, 1975) and Wight et al.'s (2016) six steps in quality intervention development. The purpose of these interventions was to improve female medical college students' HPV vaccine intention and knowledge of HPV and HPV vaccine scores, HPV infection prevention awareness scores, PMT scores, and HPV vaccine communication competency scores. The PMT-based HPV vaccination online health program consisted of four sessions with a total of 10 activities. One session was delivered per day by WeChat, with an intervention education time of 50–60 minutes per day. The process of each session was as follows: The trained researcher introduced the theme of the session and shared the article (5 min) (the first session would plus building relationships (10 min)); the participants read the sharing article (10 min); the participants assimilated the contents and, according to the questions in the article, found answers on their own (15 min); the group members discussed the answers to group members through a WeChat discussion group (10 min); the representatives of groups shared their answers in a WeChat discussion group (5 min); and the trained researcher summarized the session (5 min).

The intervention is developed as follows: (1) Define and understand the problem and its causes. In phase I, our study found that 86.3% of participants had a high intention to initiate the HPV vaccine. However, 86.1% of the medical college students did not get any dose of the HPV vaccine, which was quite lower than the average vaccination level (21% in 2022) (WHO, 2023). The factors related to the intention to initiate the HPV vaccine were: knowledge and awareness toward HPV and the HPV vaccine; the PMT factor; high cost and short supply; parents' educational background; vaccinated relatives; and a lack of specific information about the HPV vaccine. (2)

Clarify modifiable factors to improve HPV vaccination: knowledge and awareness toward HPV and HPV vaccine and PMT factor were the modifiable factors. (3) Identify how to bring about change: knowledge about the threats and benefits of HPV and HPV vaccines was introduced according to the PMT model to adopt protective behavior. (4) Identify how to deliver the change mechanism; a discussion with experts from health education, vaccine healthcare providers, and health promotion would be conducted to identify a suitable population and a suitable method to do the health program. (5) Test and refine on a small scale: a pilot test was conducted to test the effect and content of the intervention program; (6) Collect sufficient evidence of the effectiveness of the program: group discussions and a semi-structured interview with the participants; and re-check the intervention with the experts to settle down the intervention.

5.1.3 Conclusions the results of Phase II

The findings of the second phase of the randomized controlled trial:

(1) The comparison of baseline characteristics, HPV vaccine intention, the knowledge of HPV and HPV vaccine scores, HPV infection prevention awareness scores, the PMT scores and HPV vaccine communication competency scores between intervention and control groups.

The findings showed that there was no statistically significant difference ($P > 0.05$) in terms of HPV vaccine intention, knowledge of HPV and HPV vaccine scores, HPV infection prevention awareness scores, PMT scores, HPV vaccine communication competency scores, and baseline characteristics (e.g., family yearly household income, vaccinated familiars, WTP for HPV vaccine) between intervention and control groups.

(2) The comparison of HPV vaccine intention, the knowledge of HPV and HPV vaccine scores, HPV infection prevention awareness scores, the PMT scores, and HPV vaccine communication competency scores within groups at bassline, after intervention, and follow up

The results revealed that in the intervention group, HPV vaccine intention, the knowledge of HPV and HPV vaccine scores, HPV infection prevention awareness

scores, the PMT scores, and HPV vaccine communication competency scores were significantly higher than those before intervention (P<0.05). Conversely, in the control group, it was not found.

(3) The comparison of HPV vaccine intention, the knowledge of HPV and HPV vaccine scores, the PMT scores, HPV infection prevention awareness scores, and HPV vaccine communication competency scores between groups at bassline, after intervention, and follow up

The results showed that after intervention completion, HPV vaccine intention, knowledge of HPV and HPV vaccine scores, HPV infection prevention awareness scores, PMT scores, and HPV vaccine communication competency scores in the intervention group increased significantly compared to the control group (P<0.05).

At three-month follow-up, the results showed HPV vaccine intention, knowledge of HPV and HPV vaccine scores, HPV infection prevention awareness scores, the PMT scores, and HPV vaccine communication competency scores in the intervention groups still showed a significant increase compared to the control group (P<0.05).

Therefore, the PMT-based HPV vaccine online health program was effective in improving HPV vaccine intention, knowledge of HPV and HPV vaccine scores, HPV infection prevention awareness scores, the PMT scores, and HPV vaccine communication competency scores among female medical college students.

5.2 Discussion

5.2.1 Discussion of the findings of Phase I of the study

5.2.1.1 Intention to initiate HPV vaccination

In this study, the intention to initiate HPV vaccination among female medical students was 85.5% in Hubei province. A similar result was also found in Dai et al.'s (2022) study and Xu et al.'s (2021) study, where up to 89.7% and 75.5% of college students showed an intention to be vaccinated, respectively. However, another systematic review reported that only 55.2% and 30.4% of female college students were intent on initiating the HPV vaccine among medical students in Mailand, China (Bai et al., 2022). A lower intention rate was found among non-medical background

students; the HPV vaccination intention was only 32.0% (Si et al., 2022). The intention rate in this study was also higher than in countries like India (65.2%) (Shetty et al., 2019).

The increased intention rate to initiate HPV vaccination might be because medical college students' have a higher desirability to seek protective health behaviors related to the severity of the disease. As the Advisory Committee on Immunization Practices (ACIP) recommends catch-up HPV vaccinations for young adults to 26 years old who were not vaccinated during adolescence (Markowitz et al., 2014), it's of high importance to make use of the high intention to get the college students vaccinated to meet the goal of eliminating cervical cancer as a public problem in China.

5.2.1.2 HPV vaccination status

In this study, the uptake rate of the HPV vaccine among medical female college students was 13.9% in Hubei province. Compared to the studies conducted in China in 2019 (9.5%) (You et al., 2020) and 2020 (2.6%) (Si et al., 2021), HPV vaccine coverage is increasing. It was reported that 20 million out of 382 million females aged 9 to 45 had received HPV vaccination by 2021 (Xie et al., 2023). However, it is still lower than countries like the United States (75%) (Pingali, 2021), Ethiopia (61.2%) (Hailu et al., 2023), and Melaka Malasia (77.9%) (Al-Naggar et al., 2012). As of 2023, 134 (69%) of the 194 WHO member states have introduced HPV vaccination into the national immunization program. It was estimated that the global coverage of the first dose of HPV vaccination in females will be 21% in 2022 (WHO, 2023).

This may be because, in comparison to other countries, China has not yet included the HPV vaccine in the national immunization program, so the HPV vaccination rates have remained rather low. WHO recommends that Healthy People target 90% coverage for age-eligible girls (Natipagon-Shah et al., 2021). Evidence showed that if 50% of eligible females were HPV vaccinated, HPV type 16 and 18 infections would decrease by almost 70% in countries (Drolet et al., 2019). Our study found that the majority of the participants (94.3%) in this study had never had sexual intercourse, and all of them were less than 26 years old, so catch-up vaccination can

provide unvaccinated college students with substantial benefits. A meta-analysis including 7 RCT trails also pointed out that HVP catch-up vaccination could be a valuable primary prevention against HPV infection for college students (Couto et al., 2014). Some cities in China, like Guangzhou and Chengdu, have implemented a local HPV vaccination program with different reimbursement methods to improve HPV vaccination coverage among teenage girls, but for college-aged girls, there is still no reimbursement. So, this age group still needed to be paid attention to improve their vaccination intentions and rates.

5.2.1.3 Sources of HPV vaccine information

In our study, 89.1%, 50.4%, and 44.9% of participants stated that their information source for HPV and HPV vaccine was the internet, friends, and teachers, respectively. The same results were also found in a previous study: the internet was the main source of information about HPV and HPV vaccination (Xu et al., 2021). This suggests that online health information-seeking behavior may have a potential positive correlation with college students' intentions to get the HPV vaccine. One compelling reason for the prevalence of internet usage as an information source is the accessibility and vast amount of information available online. Internet-based online health information sources are also more convenient compared to traditional media. Making online health interventions more reliable, attractive, and accessible to young adults would lead to more usage of the internet as a cost-effective strategy that can contribute to more knowledge, perceived susceptibility, perceived severity, self-response, and self-efficacy.

Furthermore, the influence of peers and friends is a recognized factor in shaping individuals' health-related beliefs and behaviors. One data-driven computational model also shows that peer influence is one of the key determinant factors for vaccine perception (Ghosh et al., 2024). This may be because people often turn to their social circles for information and advice, creating a network where discussions about health topics, including HPV, can thrive. The endorsement or sharing of information among friends contributes to the widespread dissemination of knowledge within a community.

Teachers, as trusted figures in an educational setting, also play a crucial role in disseminating information about health issues. College-based education, as identified in the study by Xu et al. (2021), underscores the importance of educational institutions as key sources of information about HPV and the HPV vaccine. Students may naturally turn to their teachers for guidance, given the educational context and the credibility associated with academic sources.

5.2.1.4 HPV infection prevention awareness

This study found HPV infection prevention awareness among female medical college students in Hubei province was at a moderate level. Specifically, most of the participants knew that non-use of condoms during intercourse (90.0%) and multiple sexual partners (94.3%) would increase the chance of infecting HPV. However, only 39.8% of the participants knew that the HPV would be transmitted from skin to skin, and only 40.1% of the participants thought smoking would increase the chance of getting HPV. This result indicated that college students' knowledge about HPV prevention behaviors was not enough. Lack of knowledge of HPV infection prevention awareness would lead to a situation where the person would perceive a low risk of infection. This result indicated that college students' knowledge about HPV prevention behaviors was not enough. Lack of knowledge of HPV infection prevention awareness would lead to a situation where the person would perceive a low risk of infection. This was consistent with Chanprasertpinyo & Rerkswattavorn (2020) and Kasymova et al., (2019) studies, which highlight that college students who have a median level of knowledge about HPV infection turn out to have a low-risk awareness toward HPV infection. A study showed that college students in China had a high-risk HPV infection rate peaking less than 25 years old and an infection rate of 24.3%. A previous study conducted in the United States with college students found a large part of female college students who believe themselves to be "not at risk" for HPV infection but actually test HPV positive, with a 35% HPV prevalence rate (Ramirez et al., 1997). Hence, awareness of HPV infection prevention behaviors should be increased among college students to increase the intention of HPV vaccination.

5.2.1.5 Factor associated with intention to initiate HPV vaccine

This present study revealed that knowledge plays an important role in vaccine intention among female medical college students. The students who had higher scores of knowledge of HPV and HPV infection prevention awareness were more likely to express an intention to get vaccinated. This aligns with previous research of Natipagon Shah et al. (2021) and Oz et al. (2018)who reported that intention to obtain HPV vaccine was significantly associated with knowledge of HPV and HPV vaccine. One possible explanation is that comprehensive knowledge empowers individuals with a clear grasp of the potential health risks posed by HPV infection and the preventive efficacy of the vaccine (Dai et al., 2022). Informed individuals are more likely to perceive a personal susceptibility to the associated health hazards, thus instilling a sense of urgency to proactively safeguard their well-being through vaccination (Tran et al., 2018).

Our study also found that HPV vaccination intention was influenced by PMT-related factors, particularly perceived severity, perceived response efficacy, and perceived self-efficacy. Thus, participants who perceived HPV infection as severe, believed in the effectiveness of the vaccine, and felt confident in their ability to receive and benefit from the vaccine were more inclined to express an intention to receive it. Consistent with previous studies of Huang et al. (2021) and Dai et al. (2022) who postulated that individuals' perceptions of threat and efficacy play a central role in motivating health-related behaviors. However, our study showed that perceived susceptibility to HPV infection and HPV-associated diseases was not a predictor of HPV vaccine intention. A previous study also showed that people with a medical background who believed that they were at low risk of HPV infection had a lower intention to get vaccinated (Aga et al., 2022). Furthermore, we also found that the willingness to pay for HPV vaccines was related to vaccine intention. This consistent with the studies conducted in Vietnan (Tran et al., 2018) and Philippines (Llave et al., 2022), the willingness to pay was a major factor in the intention to receive the HPV vaccine. However, in China, the HPV vaccine is not currently a part of China’s national immunization program or medical insurance. This has resulted in many individuals refusing or delaying getting vaccinated due to the cost of the

vaccine. Also, the socioeconomic factor has always been a major obstacle to the HPV vaccination behavior (X. Lu et al., 2022; Pingali, 2021), since the high price for three doses of HPV vaccine is still a financial burden. Besides, previous studies revealed that the medical students' average willingness to pay for the HPV vaccines was lower than the market price (X. Lu et al., 2022), the majority of doctors and nurses also found the HPV vaccine to be too expensive (Cheung et al., 2019). Thus, strategies aimed at increasing the willingness to receive HPV vaccination among young women with lower incomes should be adopted by the government to increase the rates and intention of HPV vaccination. For example, prior research suggested that the "semi-mandatory HPV vaccination strategy," which subsidizes HPV vaccination targeted at low-income settings for high-risk individuals or demands targeted approaches to enhance the willingness to be vaccinated against HPV in high-risk geographic areas, might lead to a higher willingness to receive HPV vaccination (Zhang et al., 2013).

5.2.1.6 Barriers to receiving the HPV vaccine

5.2.1.6.1 High cost of HPV vaccine

In the qualitative study, students pointed out that the high cost of the vaccine was a significant barrier to the HPV vaccine. The same result can also be seen in a quantitative study, which showed that 55.7% of the female medical college students pointed out that high cost was the primary barrier to the HPV vaccine. The finding of the study, along with evidence from a meta-analysis, was that the cost of the vaccine was the most common barrier to HPV vaccine acceptance (Wang et al., 2022). That may be because in China now, the cost of three doses of imported HPV vaccines ranges from $344 to $551 (2493–3993 CNY), which is higher than the monthly average income in Hubei province. Previous studies conducted in Vietnam (Tran et al., 2018) and Thailand (Chanprasertpinyo & Rerkswattavorn, 2020) also indicated the high cost as a major barrier to HPV vaccination. In Hong Kong, one study showed that if the vaccine was at a market price, the acceptability of the HPV vaccine would drop from 51.6%–63.0% to 14.9%–27.4% (Wang et al., 2018). Without universal healthcare coverage, the financial costs of the HPV vaccine appear to prevent uptake of the vaccine by most disadvantaged families (Batista Ferrer et al., 2015). A high level of uptake (43%) has been reported in countries where the HPV vaccine is free-

of-charge under a government-mandated immunization schedule. The gap between the acceptable price and the real cost-effective price highlights the need for strategies to reduce the HPV vaccine cost, particularly in rural areas and less resourced provinces. Worldwide, HPV vaccines for Gavi-supported countries are priced at USD 4.6 (bivalent HPV vaccines produced by GSK) and USD 4.5 (tetravalent HPV vaccines produced by Merck) per dose. And 14 middle-income countries (MICs) supplied through UNICEF are also purchasing HPV vaccines at a low price of USD 10.25–14.14 and USD 14.34–26.75 per dose, respectively (Zhao et al., 2023). In contrast, HPV vaccine pricing in China is significantly higher for both the general public (≥ USD 43 per dose) and government procurement (≥ USD 35 per dose). Notably, the nonavalent HPV vaccine in China costs as high as USD 187 per dose, beyond the reach of most eligible women and the government funded program. In 2017, WHO recommended that all countries include HPV vaccines within their national immunization programs. These results highlight that an affordable alternative like financial support to make the vaccine more affordable for college-aged students in Hubei Province is still needed. Hence, it is recommended that the government provide appropriate subsidies to reduce the burden of vaccination costs for high-risk college student groups. Future studies associated with the optimum price of the vaccine, combined with price negotiation with manufacturers are encouraged.

5.2.1.6.2 Short of supply

Our study found that college students ranked the shortage of HPV vaccines as the second barrier to getting a vaccination. For now, HPV vaccine supply in China could hardly meet the current demand, which causes the limited availability of HPV vaccine. According to the data derived from the National Bureau of Statistics of China, approximately 80 million doses of HPV vaccines would be needed to cover 90% of the entire cohort of girls aged 9–14 (Zhao et al., 2023). However, data showed that there were only about 30 million bivalent vaccine doses, 14 million quadrivalent vaccine doses, and 15 million nonvalent vaccine doses available on the market in China in 2022 (Zhao et al., 2023). All the above vaccine doses were inadequate to fulfill the national vaccination program for people aged 15–45, even in one year. So

for college students' catch-up vaccination, there is a need to consider supply and accessibility issues.

5.2.1.6.3 Limited knowledge for HPV vaccine

In this study, both the qualitative and quantitative results showed that a lack of HPV and HPV vaccine-related knowledge was considered one of the barriers to improving HPV vaccine uptake. These findings were consistent with previous studies conducted in Hong Kong (A. Liu et al., 2018) and Malaysia (Lin et al., 2019). Higher HPV-related knowledge levels were the important factors predicting vaccine uptake and intention to recommend vaccination. In a study conducted among Turkish college students, 37.5% of the medical students cited a lack of adequate knowledge as the foremost reason for not getting vaccinated (Koç, 2015). In India, 48.3% of nursing students expressed insufficient knowledge as their primary deterrent (Ganju et al., 2017). One meta-analysis also pointed out those female college students should receive standard and unbiased HPV vaccination advice, including adequate knowledge about the risks of cervical cancer and HPV infection-related diseases, as well as unbiased information about HPV vaccine coverage (Bai et al., 2022). This study also found information about where to get the vaccine, how to make a reservation, and the vaccine's effectiveness, which has been a consideration for female college students too. Even in urban areas of Wuhan, only a few community health service centers provide HPV vaccination services. This poor availability of the HPV vaccine could explain the fact that a large proportion of college students in this study did not know where to get vaccinated. These findings are consistent with results conducted in the USA showing that limited knowledge about vaccination locations was a barrier to HPV vaccination (Tung et al., 2023). Prior studies conducted in a range of countries and settings found HPV-related specific information to be useful in increasing HPV vaccine uptake. Hence, it is imperative for medical college students to receive comprehensive knowledge and information about HPV and its vaccine, even within health-related programs, as students often have inaccurate or insufficient knowledge regarding the subject.

5.2.1.7 How to promote HPV vaccination

5.2.1.7.1 Health education

Our study found that all of the participants, including healthcare providers, teachers, and college students, mentioned that health education to strengthen college students' knowledge and awareness would be a facilitator to promote HPV vaccination. The findings of this study, along with evidence from other studies (Bethke et al., 2022), highlight the health-educational benefits of vaccination interventions that enhance vaccination intention and rates among college students. Different kinds of health education methods can be found today to provide health education. Traditional education methods like lectures, PowerPoint presentations containing visual and scientific information, discussions, and question-and-answer sessions that developed as student-centered can enhance college student knowledge levels and increase 20% of HPV vaccination intention after education with a significant difference (Açıkgöz & Göl, 2023). Video-assisted HPV education Webster et al. (2023) found that web-based videos with HPV vaccine-related educational content were enjoyable to use and understandable and could improve 90% of participants' understanding of the importance of HPV vaccination. This probability exists because education interventions can contribute to raising awareness among college students regarding their susceptibility to HPV-related diseases, consequently leading to higher HPV vaccination rates. Therefore, it is recommended to implement educational programs focused on the susceptibility and severity of HPV and the efficiency of the HPV vaccine.

5.2.1.7.2 Parents's attitude

The qualitative study found that the attitudes and opinions of parents were identified as key factors influencing the decision to vaccinate among female college students. While university students are at an appropriate age for vaccination and show improvement in health literacy, parental opinions still hold considerable weight. In some cases, the final decision regarding vaccination still comes from the parents. Evidence showed that parents' attitudes towards vaccination strategies could influence the vaccination status of college students (Xie et al., 2023). Parents who had a strong belief that the HPV vaccine was safe in terms of adverse effects were 10

times more likely to decide to vaccinate their daughters against HPV (Park et al., 2023). Parents' perceived knowledge of HPV also had a significant impact on HPV vaccination intention. A recent study conducted by Dickinson et al. (2023)also pointed out that more than half of the parents had knowledge of HPV and the HPV vaccine, with 79.2% of them considering having their child vaccinated. However, parents with general 'anti-vaccination' beliefs were unlikely to make positive HPV vaccine decisions; insufficient or misleading information could also reduce trust and prevent young women from receiving the HPV vaccine (Ferrer et al., 2014). Hence, ways to improve parents' knowledge and awareness should be adopted to improve the acceptance of the HPV vaccine and then to improve the vaccination intentions of college students.

5.2.1.7.3 Peer's vaccine experience communication

The results in qualitative study, the results found that peers' vaccine experiences and communication were cited as a more trustworthy source of information about HPV and its vaccination, compensating for the uncertainty associated with online information. This may be because interpersonal communication could help college students know the experience, benefits, and feelings of getting the HPV vaccine. Participants emphasized the influence of peers' vaccine experiences on their own inclination to receive the HPV vaccine. A previous study conducted in the United States found that college students who had fewer friends vaccinated would have a high risk of being infected with HPV (Wilson et al., 2018). However, this finding was inconsistent with the results reported by Yin et al. (2023), who found that social support had little effect on HPV vaccination. The dissimilarity between the findings of this study and those of Yin et al. (2023) may be attributed to the dissimilarity of the study's implementation and methodology.

5.2.1.7.4 Implement college health center based vaccination

Participants mentioned that if vaccination is available on university campuses and the university arranges the HPV vaccination program, it will prompt HPV vaccination. The ease of access to vaccination in the college to overcome geographic barriers and the direct offer of vaccination may increase the likelihood of action for

college students. The same results were found in other studies, which also highlighted the distance and time as obstacles to HPV vaccination among university students (Huang et al., 2022). In the USA, college students could get the HPV vaccine at the college student health center or youth-friendly clinics, where the HPV vaccine coverage rate reached 55.8% (Natipagon-Shah et al., 2021). Another study conducted in Germany also revealed that students at host-school sites compared to satellite sites were more likely to have received any dose of the HPV vaccine (Bethke et al., 2022). This may be because college-located vaccination is more feasible (Daley et al., 2014)), and delivering vaccines during college is a promising approach to improving vaccination coverage (Humiston et al., 2014).

5.2.1.7.5 Incorporate the HPV vaccines into the national vaccine program

The qualitative study found that incorporating HPV vaccines into the national vaccine program may promote HPV vaccination. In the present China's market where HPV vaccines are purchased privately, most HPV vaccines are given to the adult women rather than the young girls aged 9–14 years old (vaccination coverage < 1% in 2020). Introducing HPV vaccination into the NIP is essential to reach 90% (Zhao et al., 2023). The result was consistent with (Chen et al.,2021), which also highlighted the need for a fully government-funded, population-based HPV vaccination program in China to offset the financial burden. Concerns about costs, including for vaccine procurement and programmatic costs for vaccine delivery, are one of the reasons that most LMICs have not yet introduced the HPV vaccine into their national vaccination programs (Mvundura et al., 2023). A pilot project among adolescent female students in one of the cities in China on promoting free HPV vaccination showed a high HPV vaccination rate and intention (Dai et al., 2022). This may be because, by making the HPV vaccine a part of routine immunization schedules, individuals, particularly those in high-risk groups like college students, are more likely to receive the vaccine as part of standard preventive healthcare practices. Before the availability of rolling out the HPV vaccination program in China, local governments with adequate resources are encouraged to pilot the vaccination program firstly, to help increase the HPV vaccination rate and to facilitate its full nationwide rollout. several pilot cities with adequate resources have first initiated local government funded HPV vaccination

programs targeted at young adolescents, providing a promising start for free HPV vaccination in China. Several flexible funding approaches have been set up for HPV vaccination, including (1) free charge for a certain type of HPV vaccine, or (2) fixed financial compensation whichever types of HPV vaccines, or (3) free charge for one certain type of HPV vaccine combined with fixed financial compensation for other types of HPV vaccines.

5.2.2 Discussion of the interventions

The PMT-based HPV vaccination online health education program consists of four dimensions, including perceived susceptibility, perceived severity, perceived response efficacy, and perceived self-response. The program was developed through six steps in quality intervention development that focus on the threats of HPV and the benefits of the HPV vaccine to female college students. According to PMT model, a person is motivated to protect himself by assessing the threat of potentially harmful behavior and coping with the behavior to decrease the risk severity, so our intervention program focused on the prevalence, the peak infection age groups, risk factor, and transmission way of HPV in the first session, the HPV-related health problems and their severity, and their treatment to those health problems of HPV in the second session; in the third session, the intervention program offer information about the benefits and protective efficacy of HPV vaccine, and understand the importance of accurate time to administer HPV vaccine to activate college students' response effect; in the fourth session, the intervention program shared details of how to get HPV vaccine, the place, the price, the appointment method and the communication methods toward HPV vaccine as a healthcare provider to activate college students' self-efficacy. The education session pattern was consistent with Elgzar et al. (2023), which consisted of four sessions concerning the perceived susceptibility and severity of COVID-19, the perceived response effect, and self-efficacy toward the COVID-19 vaccine, with one theme in each session. However, in Dehdari et al.'s (2014) PMT-based education intervention program, which also consists of 4 sessions, in its first session, both perceived susceptibility and perceived severity of cervical cancer were introduced to participants; following the second session, they introduced the perceived response effect and self-efficacy toward the

Pap test, too. The perceived self-response was discussed both in the third and fourth sessions. This may be because beliefs in high personal self-efficacy toward HPV vaccination strongly decreased the perceived barriers to performing it.

In this study, we implemented the intervention program on WeChat. It breaks the time and space limitations of traditional classrooms, improves autonomous learning, and strengthens cooperation with peers focused on health information acquisition (Zhang et al., 2017). WeChat-based behavioral interventions have shown feasibility and acceptability to deliver low-cost interventions to public health acquisition in China. Guo et al. (2018) used WeChat as the intervention platform for people living with HIV, and results showed that participants preferred WeChat as the platform for receiving information and interactive communication for ease of access. Sun et al. (2022) conducted a WeChat-based cognitive behavioral therapy intervention to improve cancer-related symptoms in gynecological cancer survivors and supported the effectiveness of the WeChat platform to provide interventions.

Since the WeChat system could not track whether the participants had actually opened or read the information sent by the research team, a group discussion was conducted by the research team. In terms of group discussion, it is one of the most common methods used in medical research. Li et al. (2015) indicated that following the group education intervention, significant increases were detected in awareness regarding HPV and cervical cancer. Also, using the group discussion method to carry out research can be a good solution to the problem. The reason may be similar to the peer effect, that is, the interaction between peers is very influential. This conclusion can also be confirmed by the famous American psychologist Bandura's social learning theory (Tadayon Nabavi & Bijandi, 2023), which states that peer imitation and role modeling have a kind of behavior. Therefore, the PMT-based HPV vaccination online education program implemented by using WeChat and group discussion as a research methodology is feasible and accessible. Different education strategies can be seen in previous studies to implement HPV-based education. Elgzar et al. (2023) implemented lectures, video shows, and group discussions in the PMT-based COVID-19 vaccine education intervention. Besides these three methods, Dehdari et al. (2014) also adopted question and answer sessions in the PMT-based Pap smear education

intervention. These intervention methods were widely used in education interventions, but it was not easy for participants to join and use them continuously.

5.2.3 Discussion of the findings of Phase II of the study

The findings of this study showed that a PMT-based HPV vaccination online health education program was effective in improving HPV vaccine intention, knowledge of HPV and HPV vaccine scores, HPV infection prevention awareness scores, PMT scores, and HPV vaccine communication competency scores among female medical college students.

After the completion of the PMT-based HPV vaccination online education program, there was a significant increase in HPV vaccine intention in the intervention group. The same increase can also be seen in the three-month follow-up. This finding of this study, along with evidence from previous studies (McRee et al., 2018; Si et al., 2021), shows that the participants' motivation towards HPV vaccination exhibited a noticeable increase after engaging in an online educational program. The same results were also found in Elgzar et al.'s (2023) study and Chen's study (2020), which reported that PMT education programs were effective in improving intention to take mitigation behaviors. Specifically, we found that the percentage of college students receiving the vaccine (any dose) on the day of the six-month follow-up increased by 32.6%. The findings of this randomized control trial were consistent with a previous systematic review that reviewed 79 articles and reported that HPV vaccine completion rates increased, ranging from 6.8% to 93.0% (Escoffery et al., 2023). Poscia et al. (2019) also found the HPV vaccination rate increased by 11% for the female students in the intervention group after an education in Italy.

One possible explanation is that the components of our PMT-based HPV vaccination online program emphasize helping college students reshape their perceptions toward susceptibility and severity toward HPV to increase their motivation to seek protective behavior. According to the PMT model, perceived susceptibility is an important factor that can motivate people to seek preventive measures (Rogers, 1975). After attending the program, college students increased their knowledge about HPV and understood the susceptibility of contracting HPV,

which maximized their protection-motivation to increase the intention of HPV vaccination and HPV vaccination behavior. Also, the more severe an individual feels about the risk of the disease, the more protection and motivation they maximize. The current study indicated that the scores of threat appraisal, which were perceived severity and perceived susceptibility, increased significantly after the intervention. An increased perception of susceptibility and severity about the HPV motivates college students to adopt the recommended protection behavior. Also, the PMT model showed that high response efficacy and self-efficacy motivate intentions and behaviors. After the PMT-based HPV vaccination online program, college students' response efficacy and self-efficacy both increased. That means college students believed the recommended response of getting the HPV vaccine was a highly effective preventive measure to prevent HPV. Then the HPV vaccination intention and behavior were strongly motivated among the college students. Thus, providing PMT-based online HPV health information may be a useful strategy to improve the currently low rates of HPV vaccination in China.

Also, the current study findings indicated a significant improvement in knowledge in the intervention group after the program implementation compared to the control group after the PMT-based HPV vaccination online education program. This was in line with a meta-analysis in which 33 studies highlighted the result that educational interventions were effective in increasing knowledge levels of HPV and HPV vaccines (Fu et al., 2014). One possible explanation is that PMT-based HPV education intervention programs focus on the knowledge of the susceptibility and severity of HPV (Elgzar et al., 2023). After the education intervention, a substantial improvement in the overall score of HPV information was seen among the medical college students (Açıkgöz & Göl, 2023). Perceived knowledge significantly and positively influenced protection motivation via its positive influence on threat appraisal and coping appraisal. The increased knowledge of the benefits of HPV vaccination would be able to transform into a willingness to accept the vaccination. Insufficient knowledge about HPV and the HPV vaccine can place medical college students at risk of HPV-related diseases and result in deficiencies in the preventive health services they can offer to the population they will serve. Aga et al. (2022)

mentioned that future health professional education for medical college students should increase their knowledge of HPV and HPV vaccines to boost their awareness of these topics. Increasing medical college students' understanding of HPV and the HPV vaccine holds significance not only for safeguarding their own health but also for disseminating the knowledge they acquire to the individuals in the population they will serve in the future, thereby contributing to the prevention of HPV-related cancers and diseases.

Furthermore, this study also found that the PMT-based promotion HPV vaccine program significantly increased female medical college students' HPV vaccine communication competency. This may be because educational intervention would improve students' knowledge of the HPV vaccine and their readiness to seek counseling (Berenson et el., 2015). Research has shown that students who report receiving a strong, high-quality recommendation from their healthcare provider have an eightfold greater likelihood of initiating and completing HPV vaccination than those who do not (Darville-Sanders et al., 2022). It showed that healthcare providers' knowledge was related to recommendations. But evidence showed that healthcare providers only posed a moderate level of knowledge about HPV and HPV vaccines and were not familiar with HPV vaccination guidelines (Berenson et al., 2015; Shetty et al., 2019). One possible explanation is that the PMT-based HPV promotion online education program among female medical college students greatly increased their knowledge and communication competency toward the HPV vaccine. Improved knowledge toward HPV and HPV vaccine may improve their recommendation communication competency to help the women make the decision of HPV vaccination in their future working lives.

5.3 Strengths and limitations of the study

5.3.1 The strengths and limitations of phase I

In phase I of this study has some limitations. First, the cross-sectional design restricted our ability to establish causal relationships between the predictors and HPV vaccine intention. Further longitudinal research would be beneficial in elucidating the temporal dynamics of these factors. Second, the study relied on self-reported data, which may introduce response biases. Future research could employ objective

measures or utilize mixed-method approaches to enhance data validity. Additionally, the study was conducted among a specific population of female medical college students, which limits the generalizability of the findings to other populations. Despite these limitations, our study has a compensatory strength that allows for large sample sizes and controls for a wide range of covariates. Our results provided a better understanding of the complex factors that contribute to HPV vaccine intention and can enable us to identify the barriers to HPV vaccination among female medical students. Additionally, these can be beneficial to designing intervention programs to improve vaccination rates and educational and training programs among female medical students in health schools and colleges for their future actions as health service providers in vaccination programs.

5.3.2 The strengths and limitations of phase II

Phase II of this study has some limitations. First, bias may have occurred because the sample was limited to first-year female medical college students from two colleges in Wuhan, Hubei Province, with no female medical college students from other academic years or cities participating. Thus, generalizability to female medical students in other academic years and settings might be limited but may reflect the situation of HPV vaccine intention in a college-based context. Therefore, further studies may include female medical students from colleges or universities in different academic years and cities in Hubei Province. Second, our study was conducted among a specific population of medical college students, who may have different experiences of HPV vaccine intention from other adolescents who were non-medical students; thus, caution must be used when generalizing the results to other groups. Third, the study was conducted through an online survey with self-reported information that can be implicated in social desirability bias. To minimize self-report bias, validated and standardized instruments were used. Lastly, in phase II, the intervention group was a small group and the follow-up was short; the results might have been different with a longer follow-up. Despite these limitations, our study had compensatory strength, which was one of the first to develop the themes and content of activities to increase HPV vaccine intention among female medical students in Hubei Province based on the PMT model and validate the effectiveness of the PMT-based HPV vaccination

online education program in increasing HPV vaccine intention among medical students.

5.4 Recommendations

5.4.1 Recommendations for results

(1) In phase I of the study, our research indicated that factors associated with the intention to initiate the HPV vaccine among female medical college students include social demographic factors (willingness to pay for the HPV vaccine), knowledge and information received about HPV and HPV vaccine, and PMT scale factors (including perceived severity, perceived response efficacy, and perceived self-efficacy). Additionally, these results support the idea that improving PMT scale score and knowledge and information received about HPV and HPV vaccine should be considered a part of the development of a promotion of HPV vaccination programs.

(2) In phase II of the study, our research showed that the PMT-based HPV vaccination online health program can effectively improve female medical college students' HPV vaccine intention, knowledge of HPV and HPV vaccine scores, HPV infection prevention awareness scores, PMT scores, and HPV vaccine communication competency scores. Therefore, this study suggests that a PMT-based HPV vaccination online health program should be cited in HPV vaccine health education to change the mindset of the public and help promote HPV vaccine intention and vaccination nationally.

5.4.2 Suggestions for future research

(1) Non-medical college students may have a different HPV vaccine intention and knowledge about HPV and HPV vaccine than medical students, so further studies may expand the study sample to non-medical college students to investigate and improve their HPV vaccine intention and knowledge about HPV and HPV vaccine, which may increase HPV vaccination coverage.

(2) The PMT has been widely used as an educational framework for predicting and adopting protective behaviors in response to health problems. Thus, healthcare providers may apply the PMT to designing interventions to address other health-

related problems, such as predicating and promoting Pap smear screening and breast cancer screening among women.

(3) It is worth mentioning that there is still a gap between HPV vaccine intention and actual vaccination behavior. Hence, the facilitating factors that motivate the transformation of HPV vaccine intention into actual vaccination behavior need to be further explored in future research.

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Appendix

Appendix I——Ethical approval certificate

MAHASARAKHAM UNIVERSITY ETHICS COMMITTEE FOR RESEARCH INVOLVING HUMAN SUBJECTS

Certificate of Approval

Approval number: 090-045/2023

Title : The effectiveness of promotion of human papillomavirus vaccination program among female medical students in Hubei province, China .

Principal Investigator : Miss. Huan Yang and Asst.Prof.Suneerat Yaugyuen

Responsible Department : Faculty of Public Health

Research site : Hubei province, China.

Review Method : Expedited Review

Date of Manufacture : 23 March 2023 **expire :** 22 March 2024

This research application has been reviewed and approved by the Ethics Committee for Research Involving Human Subjects, Mahasarakham University, Thailand. Approval is dependent on local ethical approval having been received. Any subsequent changes to the consent form must be re-submitted to the Committee.

Ratree S.

(Asst. Prof. Ratree Sawangjit)

Chairman

Approval is granted subject to the following conditions: (see back of this Certificate)

ECMSU01-05.03 Update 2021

Research Subject Information Sheet for Questionnaire

(For Participants aged 18 years and older)

Dear, All Participants

My name is Ms. Huan Yang, the doctoral degree student of Doctor of Public Health program, Faculty of Public Health, Mahasarakham University. I am conducting the research entitle: " The effectiveness of promotion of human papillomavirus vaccination program among female medical students in Hubei province, China". The research objective consist of 5 items such as 1) To determine the factors associated with intention to initiate HPV vaccination, 2) To assess the HPV vaccination coverage and HPV infection prevention behavior among college students, 3) To explore the facilitators and barriers to access HPV vaccine, intention to get HPV vaccine, and how to promote HPV vaccination, 4) To develop the promotion of HPV vaccination program, and 5) To evaluate the effectiveness of the promotion of HPV vaccination program. The benefits you will receive from this research such as 1) the health education programs can provide some reference for selecting appropriate health education strategies to improve the public's willingness to be vaccinated and 2) provide a realistic basis for the formulation of policies in the subsequent immunization planning work. However, the participants may not get the benefit directly from participating in this research project but the information obtained will be useful for the Center for Disease Control in China, the educational institutes or other health facilities for guidance to improve intention to initiate HPV vaccination among adolescent.

Your participation in this study is voluntary. It is up to you to decide whether or not to take part in this study. If you decided to participate in this research, I would like you to answer the questionnaire of the factors associated with intention to initiate HPV vaccination among female medical students. This self-administered questionnaire comprise of 6 parts with 66 items, the duration of response approximately 25-30 minutes. When you are finished answer all of item, please send it back to the researcher team. Please take time to answer the questionnaire carefully or ask the researcher if there is anything that is not clear or if you have any question.

If you feel uncomfortable or undesired with some questions, you have the right to refuse to answer questions. Also, you have the right to withdraw from this program at any time without prior notice. In additional, the refusal or withdrawal from this project will involve no affect your learning, now or in the future.

The data will be kept and not publicly disclosed on an individual person. All data will be identified only by a code, with personal details kept in a locked file or secure computer with access only by the immediate research team. The results will only present in terms of overall and these data will be destroyed at the end of the study. In this research, you do not receive compensation and will not be charged anything.

If you have any questions about the research, or if you would like more information, please contact Ms. Huan Yang, Faculty of Public Health, Mahasarakham University. Tel. (mobile phone): (+86) 15926351396. E-mail 821185045@qq.com.

If you are not treated as described or want to know your rights while participating in this research. You can contact the Review Ethics Broads of Mahasarakham University, Division of research facilitation and dissemination, Mahasarakham University. Tel. 043-754416 (internal number 1755)

Best Regards,

.....

( )

Researcher

ECMSU01-06.03

Informed Consent Form

(For Participants aged 18 years and older)

Name-Surname (Mr./Mrs./Ms.).....Age.....(years)

Address: House No. .....Village No.....Sub-district.....

District.....Province.....

I read the research subject information sheet and obtain the description of this study by Ms. Huan Yang about the voluntary of "The effectiveness of promotion of human papillomavirus vaccination program among female medical students in Hubei province, China". These information including the rational and purpose of the study and list all procedures that I have to act and be treated, list the benefits that I will receive from the research and risks that may occur from participating in the research, also the guidelines for prevention and correction in case of danger by reading/listening to the description of the message from research subject information sheet for questionnaire. Moreover, I have also received an explanation and response from the research project leader already.

As well as an assurance from the researcher that my data will be kept confidential, will not be anonymous, and the results will presented in an overview or summary to academic benefit

"The participation in this study, I participate voluntarily" and I am free to withdraw at any time, without giving a reason and without cost, and no affect to my learning, now or in the future.

I have read and I understand the provided information from research subject information sheet and informed consent form. I voluntarily agree to take part in this study and give my signature already.

Sign..... Participant

(.....)

Date.....

Sign..... Witness (in case of reading the explanation to the volunteers)

(.....)

Date.....

Sign..... Investigator/ person taking the consent

(.....)

Date.....

Appendix II—— Cover letter

COVER LETTER

Dear participants,

My name is Yang Huan. I am a Doctor student of Faculty of Public Health at Mahasarakham University. I am currently conducting a study on promoting HPV vaccination among female university students in Hubei, China. The purpose of this project is to (a) increase knowledge regarding HPV and the HPV vaccine and (b) promote HPV vaccination uptake among college female students aged 18 to 26.

A pre- and post-surveys to evaluate your knowledge, attitudes, and beliefs before and after will be asked to evaluate the project. The population of interest for this study are female students aged 18-26, however all sexes and age groups may complete the module.

The survey is anonymous and contains no personal identifying items. All survey responses will be kept confidential, only for research purpose. You will be asked to write your email address to fulfill a follow-up survey. There are no known or expected risks from participating in this study. Your participation is voluntary. If you do not wish to participate, you may decline or withdraw from participation at any time without penalty. The questionnaires and completion of the module should take less than 20 minutes to complete. Completion of the survey will constitute your consent to participate in the survey.

Thank you for your participation in my dissertation project. I believe that this information will be helpful in improving our HPV vaccination rates and thus reducing the burden of HPV-related cancers within our community.

If you have any questions or comments, please feel free to contact me at 821185045@qq.com.

Thanks again.

Appendix III—— Demographics

Demographics

1.Gender

A. Male

B. Female

2.What's your age_____

3.Where do you live now _____ (city names of Hubei province)

4. Place of Birth

A. Village

B. Town

C. City

5.Year in school

A. Freshman

B. Sophomore

C. Junior

D. Senior

6.Study Major

A. Medicine

B. Non-Medicine

7. Father's education background

A. Primary School and below

B. Junior high school

C. High School/technical secondary school

D. University and above

8. Mather's education background

A. Primary School and below

B. Junior high school

C. High School/technical secondary school

D. University and above

9. What's your family yearly household income (RMB/year/person) _____

10. What is your monthly allowance disposable fund from family per month(RMB)

_____

11. Did you ever hear of the HPV?

A. Yes B. No

12.Did you ever hear of the HPV vaccine?

A. Yes B. No

13. If you have heard the HPV vaccine, where did you receive the information?

A.Family member

B. Internet

C. Teacher

E. Healthcare provider of a vaccine center

F. General practitioner

G. Friends

H.TV

I.Nurse

J. Other_____(Please write)

14. How many dose of HPV vaccine do you receive?

A. 0 B.1 C.2 D.3

15. Were there any vaccinated family members or friends

A. No, no one B. Yes, someone vaccinated

16. What do you think might be barriers to get the HPV vaccine?(Multiple choice)

A. High Cost

B. Concerns about side effects

C. Uncertain about effectiveness

D. Lack of self-perceived risks for HPV infection

E. Never received recommendation from health care provider

F. Parents' decisions

G. Friends' opinions

H. Don't know where to get the HPV vaccine

I. Sexually inactive

G. Not eligible because of age

K. Inconvenient time

L. short of supply

M. Other _____(Please write)

17. Did you ever have sexual intercourse?

A. Yes B. NO

18. Age of had first sex encounter _____.

19.Number of sexual partner _____.

19. Do you think that the vaccine should be offered free of charge

A. Yes B. NO

Appendix IV—— Knowledge about HPV

Knowledge about HPV

1. HPV is a sexually transmitted infection

A. True• B. False C.I don't know

2. A person can get HPV from skin to skin contact with a person infected with HPV

A. True• B. False C.I don't know

3. Early sexual debut increases the risk of contracting HPV

A. True• B. False C.I don't know

4. Using condoms reduces the risk of HPV transmission

A. True• B. False C.I don't know

5. HPV infection can be transmitted from mother to child during pregnancy and during delivery

A. True• B. False C.I don't know

6.HPV infection is widespread

A. True• B. False C.I don't know

7.HPV causes cancer only in women

A. True B. False• C.I don't know

8.HPV infection can cause genital warts.

A. True • B. False C.I don't know

9.There is cure for HPV

A. True B. False• C.I don't know

10.Having one type of HPV means that you cannot acquire new types

A. True B. False• C.I don't know

11.A person usually has symptoms when infected with HPV.

A. True B. False• C.I don't know

12.HPV can lay dormant in the body for years without symptoms.

A. True • B. False C.I don't know

13.A person's chances of getting HPV increase with the number of sexual partners they have.

A. True • B. False C.I don't know

14.Most people with HPV have visible signs or symptoms of the infection

A. True B. False • C.I don't know

15.Nearly all sexually active men and women will contract HPV at some point.

A. True • B. False C.I don't know

Appendix V —— The Knowledge of HPV vaccine

The Knowledge of HPV vaccine

1.HPV vaccine protect women from getting HPV infection

A. True• B. False C. I don't know

2.HPV vaccine protect men from getting HPV infection

A. True• B. False C. I don't know

3.The HPV vaccination is only needed if you have multiple sexual partners?

A. True B. False • C. I don't know

4.The HPV vaccines offer protection against all sexually transmitted infections

A. True B. False • C. I don't know

5.The HPV vaccines are most effective if given to people who've never had sex

A. True• B. False C. I don't know

6.Someone who has had the HPV vaccine cannot develop cervical cancer

A. True B. False • C. I don't know

7.The HPV vaccines offer protection against most cervical cancers

A. True• B. False C. I don't know

8.The HPV vaccines offer protection against genital warts

A. True• B. False C. I don't know

9.The HPV vaccine protects you from every type of HPV

A. True B. False • C. I don't know

10.One can cure HPV by getting the HPV vaccine

A. True B. False • C. I don't know

11. The HPV vaccine is also effective in after starting sexual activity

A. True* B. False C. I don't know

Appendix VI —— Intention to initiate HPV vaccination

Intention to initiate HPV vaccination.

1. Pleases rate your intention to get HPV vaccination in the future from 1 (totally unwilling to) to 10 (extremely willing to).

1	10
Totally unwilling	Extremely willing

Appendix VII—— HPV infection prevention awareness

1.What is/are HPV infection risk factor(s)(Choose the answer you think is right)

A. Non-use of condom during intercourse(true)

B. Multiple sexual partners(true)

C. Early age of sexual debut(true)

D. Smoking(true)

E. Alcohol consume

F. Ealy puberty

2. HPV is transmitted through(Choose the answer you think is right)

A. Body fluids(true)

B. Skin to skin(true)

C. Cough and sneeze

3. How an HPV infection can be prevented? (Choose the answer you think is right)

A. condom use(true)

B. Vaccination(true)

C. Washing genitals after intercourse

D. Own sexual fidelity

E. Antibiotics

F. Sexual abstinence(true)

G. HPV is not pro preventable

Appendix VIII—— The Protection Motivation Theory scale

The Protection Motivation Theory Scale (PMT scale)

Factors	Item
Perceived Susceptibility 3 items	1.The risk of getting HPV by not practicing safer sex
	2.The risk of contracting HPV in your lifetime
	3.The risk of infecting HPV in your lifetime
Perceived Severity 4 items	1.The level of impact on daily life after infection with HPV.
	2.The possibility of long-term health effects after HPV infection
	3.The possibility of getting cervical cancer after infection with HPV
	4.The possibility of getting genital warts after infection with HPV
Perceived Response Efficacy 4 items	1. Being vaccinated against HPV can reduce the risk of HPV-related cancer.
	2.Being vaccinated against HPV would can reduce the risk of genital warts.
	3. Being vaccinated against HPV would be extremely effective in protecting me against HPV.
	4. Being vaccinated against HPV would improve the quality of your life.
Perceived self-efficacy 5 items	1.I can decide if I need HPV vaccination
	2.I can get HPV vaccination whenever I want
	3. I will get HPV vaccine even if it was not covered by health insurance
	4.I will get HPV vaccine even if my family and friends don't think it's necessary
	5.I am sure I can complete the whole procedure of HPV vaccination once I get the first dose.

The Protection Motivation Theory Scale (PMT scale)

1.The risk of getting HPV by not practicing safer sex

1= No chance at all

2= A little chance

3=Normal chance

4= High chance

5=Very high chance

2.The risk of contracting HPV in your lifetime

1= No chance at all

2= A little chance

3=Normal chance

4= High chance

5=Very high chance

3.The risk of infecting HPV in your lifetime

1= No chance at all

2= A little chance

3=Normal chance

4= High chance

5=Very high chance

4. The level of impact on daily life after infection with HPV.

1=Not at all

2=A little impact

3=Normal impact

4=High impact

5=Extremely high

5.The possibility of long-term health effects after HPV infection

1=Not at all

2=A little impact

3= Unsure

4=High impact

5=Extremely high

6.The possibility of getting cervical cancer after infection with HPV

1=Not at all

2=A little impact

3= Unsure

4=High impact

5=Extremely high

7.The possibility of getting genital warts after infection with HPV

1=Not at all

2=A little impact

3= Unsure

4=High impact

5=Extremely high

8.Being vaccinated against HPV can reduce the risk of HPV-related cancer.

1=Strongly disagree

2=Disagree

3= Unsure

4=Agree

5=Strongly agree

9.Being vaccinated against HPV would can reduce the risk of genital warts.

1=Strongly disagree

2=Disagree

3= Unsure

4=Agree

5=Strongly agree

10. Being vaccinated against HPV would be extremely effective in protecting me against HPV.

1=Strongly disagree

2=Disagree

3= Unsure

4=Agree

5=Strongly agree

11. Being vaccinated against HPV would improve the quality of your life.

1=Strongly disagree

2=Disagree

3= Unsure

4=Agree

5=Strongly agree

12.I can decide if I need HPV vaccination

1=Strongly disagree

2=Disagree

3= Unsure

4=Agree

5=Strongly agree

13.I can get HPV vaccination whenever I want

1=Strongly disagree

2=Disagree

3= Unsure

4=Agree

5=Strongly agree

14. I will get HPV vaccine even if it was not covered by health insurance

1=Strongly disagree

2=Disagree

3= Unsure

4=Agree

5=Strongly agree

15. I will get HPV vaccine even if my family and friends don't think it's necessary

1=Strongly disagree

2=Disagree

3= Unsure

4=Agree

5=Strongly agree

16.I am sure I can complete the whole procedure of HPV vaccination once I get the first dose.

1=Strongly disagree

2=Disagree

3= Unsure

4=Agree

5=Strongly agree

Appendix IX—— HPV vaccine communication competency scale

1.I have strong knowledge about HPV vaccine.

A. Strongly agree

B. Agree

C. Unsure

D. Disagree

E. Strongly disagree

2.I will routinely recommend HPV vaccine in my future work.

A. Strongly agree

B. Agree

C. Unsure

D. Disagree

E. Strongly disagree

3. I will confident addressing concerns about HPV vaccine.

A. Strongly agree

B. Agree

C. Unsure

D. Disagree

E. Strongly disagree

BIOGRAPHY

NAME	Ms.Huan Yang
DATE OF BIRTH	28/02/1990
PLACE OF BIRTH	Sichuan Province-China
ADDRESS	Unit 602, Building 3, Block 2, Poly City, Hongshan District, Wuhan City, Hubei Province, China
POSITION	Teacher
PLACE OF WORK	Huangjiadawan Special No.1, East Lake Scenic District, Wuhan City, Hubei Province, China
EDUCATION	2013 Bachelor of Science in Nursing, Chengdu University of Chinese Medicine at Chengdu City 2015 Master of Science in Nursing, Wuhan University at Wuhan City 2024 Doctor of Public Health, Mahasarakham University, at Mahasarakham city, Thailand
Research grants & awards	1. Research on the construction and practice of a Civic and Political Resource Bank for nursing courses in the post-epidemic era National Vocational Education Teaching Reform Research Project in 2020 2. Research on the introduction of Chinese traditional culture into nursing vocational education adapted to the care of the elderly population in Hubei Province School-level Teaching and Research Project 3. Research on Psychological Crisis Intervention System for Community Residents in the Context of Prevention and Control of Public Health Emergencies School-level Teaching and Research Project 4. Research on the training model of medical institutions in medical schools for order-based health talents Hubei Health Talents Scientific Research Special Project Ranking 3rd 5. Research Grants Supporting Faculty of Public Health, Mahasarakham University, 2024
Research output	1. Huan Yang, Qiong Wu. Research progress of micro-course teaching model in nursing education[J]. Nursing Research, 2017, 31(16):1927-1930.(In Chinese) 2. Huan Yan, Jun Zhang, Xianghong Fan. Research progress of CBL pedagogy in undergraduate nursing teaching[J]. Nursing Research, 2016, 30(4):402-405. (In

Chinese)
3. Huan Yan, Guanghong Zhao, Qiang Lin, Chenxiang Xiao. Qualitative study on "dual-teacher" clinical practice of full-time nursing teachers in non-nursing professions[J]. Guangxi Medicine,2021,43(09):1171-1173.3. (In Chinese)
4. Huan Yan, Xianghong Fan, Qiong Wu. Analysis of the current situation and trends of first aid training research in China based on CiteSpace[J]. Occupational Health and Emergency Rescue,2021,39(05):514-518. (In Chinese)
5. Huan Yang. Professional Identity of Nursing Students in the Post-COVID 19 Epidemic in Wuhan: a Cross-Sectional Study[J]. Applied & Educational Psychology,2022,3(2).
6.Yang Huan. Research progress on public psychological trauma management in the context of public health emergencies [J]. Psychological Monthly, 2022, 17(14): 231-233. (In Chinese)