Exploration and Evaluation of Factors Influencing HPV Vaccination Intention Among Young Chinese Women

Authors: Song Mengyao, Zhu Tingshao, Zhu Tingshao

Date: 2024-02-29T13:40:22Z

Abstract

HPV vaccination can effectively prevent not only the development of cervical cancer and its precancerous lesions, but also diseases in other anatomical sites caused by HPV infection. However, the vaccination status in China is not optimistic, with many young individuals exhibiting hesitation toward HPV vaccination. Grounded in the Theory of Planned Behavior model, this study aims to investigate the factors influencing HPV vaccination intention, develop a psychometrically sound questionnaire for assessing the importance of factors influencing HPV vaccination intention, and examine the differential importance of various influencing factors. In Experiment 1, semi-structured interviews were employed to explore individual-level factors influencing HPV vaccination intention, yielding 25 influencing factors including vaccine safety, vaccine efficacy, vaccination convenience, professionalism, conformity, and data. In Experiment 2, through exploratory factor analysis, confirmatory factor analysis, and reliability and validity testing, a 17-item, 4-dimensional questionnaire for assessing the importance of factors influencing HPV vaccination intention was constructed. Confirmatory factor analysis supported the 4-factor model (^{2}/df<3, RMR=0.059, RMSEA=0.054, GFI=0.928, TLI=0.914, IFI=0.929), demonstrating excellent model fit. The questionnaire exhibited a Cronbach' s coefficient of 0.853 and a 4-week test-retest reliability of 0.804, indicating satisfactory reliability and validity. Additionally, significant differences existed in individuals' assessments of the importance of different influencing factors, and individuals with varying family histories of cancer and educational levels also showed significant differences in their evaluation of factor importance. This study provides valuable insights for vaccination promotion strategies and offers a scientific basis and reference for developing targeted interventions.

Full Text

Investigation and Evaluation of Influencing Factors of HPV Vaccination Intention in Young Chinese Women

Song Mengyao[12], Zhu Tingshao[12]*

[1]Institute of Psychology, Chinese Academy of Sciences, Beijing
[2]Department of Psychology, University of Chinese Academy of Sciences, Beijing

Abstract

HPV vaccination can not only effectively prevent the development of cervical cancer and its precancerous lesions but also prevent diseases in other body parts caused by HPV infection. However, the vaccination situation in China is not optimistic, and many young people are hesitant to get the HPV vaccine. Based on the Theory of Planned Behavior, this study aims to explore the factors influencing HPV vaccination intention, develop a questionnaire with good reliability and validity to evaluate the importance of these influencing factors, and investigate the degree of importance of different factors.

In Experiment 1, we explored influencing factors of individual HPV vaccination intention through semi-structured interviews and obtained 25 influencing factors including vaccine safety, vaccine effectiveness, vaccination convenience, professionalism, conformity, and data. In Experiment 2, through exploratory factor analysis, confirmatory factor analysis, and reliability and validity testing, we constructed a 17-item, 4-dimensional questionnaire to evaluate the importance of factors influencing HPV vaccination intention. Confirmatory factor analysis supported the 4-factor model (^{2}/df < 3, RMR = 0.059, RMSEA = 0.054, GFI = 0.928, TLI = 0.914, IFI = 0.929), showing good model fit. The questionnaire' s Cronbach' s coefficient was 0.853, and the retest reliability at a 4-week interval was 0.804, indicating good reliability and validity. Additionally, there were significant differences in the evaluation of importance among different influencing factors, and individuals with different family cancer histories and education levels also showed significant differences when evaluating factor importance. This study will provide valuable insights for vaccination promotion strategies and provide scientific basis and reference for developing targeted approaches.

Keywords: HPV vaccine, vaccination intention, influencing factors, thematic analysis, factor importance

---

Cervical cancer ranks second among cancers in women worldwide and is a common malignant tumor threatening women' s health. The majority of cervical cancer cases are closely associated with persistent infection by high-risk human papillomavirus (HR-HPV) (Gou Rui & Lin Bei, 2019). Approximately 70%-80%

of women will be infected with HPV at least once in their lifetime. HPV infection is asymptomatic, but when women experience persistent infection with high-risk HPV, it can lead to cervical intraepithelial neoplasia and even progress to cervical cancer. Moreover, with China' s socioeconomic development and accelerated industrialization and urbanization, residents' living environments and lifestyles have changed rapidly, leading to a continuous increase in cervical cancer incidence at a rate of 2%-3% annually and a trend toward younger onset (Johnson et al., 2019; Wang Qiong, 2023). Fortunately, cervical cancer is currently the only cancer with a clear etiology that can be prevented and cured through early intervention. Numerous studies have demonstrated that HPV vaccines can block persistent infection by high-risk HPV. HPV vaccination not only effectively prevents cervical cancer and its precancerous lesions but also provides protection against diseases in other body parts caused by HPV infection (Chen Yamei, 2020; Sun Xiu et al., 2021).

Despite extensive clinical trials confirming that HPV vaccines can effectively prevent persistent HPV infection, and their safety being recognized and recommended by multiple authoritative organizations such as the World Health Organization and the International Federation of Gynecology and Obstetrics, adolescent girls in China have not received effective coverage of HPV vaccines in actual practice. The current HPV vaccination rate in China remains lower than that in developed countries (Sun Xiu et al., 2021). Vaccine hesitancy is a significant reason for the low HPV vaccination rate (WHO, 2019). Vaccine hesitancy refers to the delay in acceptance or refusal of vaccination despite the availability of vaccination services (MacDonald & Hesitancy, 2015). It has been listed by the World Health Organization as one of the top ten threats to global health (WHO, 2019) and is considered one of the most destructive factors affecting people' s willingness to receive vaccines against infectious diseases (Geoghegan et al., 2020).

The SAGE Working Group advocates that to reduce vaccine hesitancy among different populations at the national or regional level, it is essential first to gain an in-depth understanding of the current degree, context, and determinants of vaccine hesitancy in that region. This information can then be used to customize and adjust appropriate intervention strategies (Butler et al., 2015; Nowak et al., 2015). Therefore, exploring and identifying the influencing factors of HPV vaccination intention is a high-priority task. Researchers have found that many sociodemographic characteristics are associated with vaccination intention, such as age (Kreps et al., 2020; Luyten et al., 2019), gender (Latkin et al., 2021; Sallam, 2021), education level (Sun Jingyi et al., 2018), and religious background (Kalok et al., 2020) (Dube et al., 2013). In addition to demographic characteristics, individuals' vaccination intention is also largely related to their level of trust in vaccines (Gefenaite et al., 2012; Karafillakis et al., 2019) and certain individual beliefs and perspectives (Kim & Nan, 2019) (Mupandawana & Cross, 2016; Wong et al., 2020).

Vaccination can be regarded as a health behavior, a perspective acknowledged in

many related studies (Biswas et al., 2021; Cai et al., 2022; Ferwana & Varshney, 2021). In this study, we require a theory related to health behavior to identify the factors influencing vaccination.

The Theory of Planned Behavior (TPB) is a social psychology theory proposed by psychologist Icek Ajzen in 1985 to explain and predict individuals' behavioral intentions and decision-making. The theory posits that a person' s behavioral intention is the primary determinant of their actual behavior. Behavioral intention is influenced by three components: (1) Attitude: an individual' s positive or negative evaluation of a specific behavior; (2) Subjective norms: an individual' s perception of social pressure and expectations from others, including others' opinions and expectations as well as the individual' s concern about others' views; and (3) Perceived behavioral control: an individual' s confidence in their ability to perform a specific behavior and their perception of obstacles. If a person believes they possess sufficient capabilities and resources and that environmental factors will not pose significant barriers to the behavior, they are more likely to take corresponding action (Ajzen & Fishbein, 1975). Canadian researchers applied TPB to conduct an in-depth investigation of parental vaccine hesitancy behavior. The study found that 14.8% of parents chose to delay or refuse vaccination for their children. When further exploring factors related to parents' intention to vaccinate their children, the researchers discovered that positive attitudes, higher perceived social support, and greater perceived behavioral control were significantly associated with enhanced parental intention to vaccinate their children (Dube et al., 2018). In the present study, we will utilize this framework to explore HPV vaccination intention among Chinese women.

Leveraging factors that influence vaccination intention represents the optimal approach for addressing vaccine hesitancy and improving vaccine acceptance (Fadhel, 2021). Therefore, identifying which factors can more effectively enhance individuals' vaccination intention is crucial. We need to understand what factors are important to individuals, which will facilitate more targeted and directional vaccine promotion efforts. Due to resource constraints, we cannot comprehensively test every influencing factor; we still need to explore which factors exert greater influence and guidance on HPV vaccination intention. To our knowledge, there is currently no validated measurement tool available for this purpose. Consequently, this study will develop a factor importance assessment questionnaire for HPV vaccines to comprehensively investigate the importance of factors related to HPV vaccination.

This study aims to explore the factors influencing HPV vaccination intention, develop a reliable and valid questionnaire for assessing the importance of factors influencing HPV vaccination intention, and investigate the importance levels of different vaccination intention influencing factors. The study will conduct two experiments. In Experiment 1, based on TPB theory, we will use semi-structured interviews to explore factors related to HPV vaccination intention and employ thematic analysis to analyze the interview content. In Experiment 2, we will develop a reliable and valid questionnaire for assessing the impor-

tance of factors influencing HPV vaccination intention through exploratory and confirmatory factor analysis, while also examining individuals' assessments of the importance of different vaccination intention influencing factors and the differences in factor importance evaluation based on family cancer history and education level.

2.1 Materials and Methods

In this experiment, we employed TPB theory as our theoretical foundation and utilized semi-structured interviews to explore factors influencing HPV vaccination intention. The interviews focused on investigating people' s concerns about HPV vaccines and the information factors that participants considered influential in their vaccination decision-making process. Following the interviews, we used thematic analysis to code and summarize the interview content, identifying information factors that impact HPV vaccination intention. Based on previous literature (Momplaisir et al., 2021; Siu et al., 2022), three psychology experts (two psychology faculty members and one psychology student) collaboratively developed the interview outline for this study (see supplementary materials). After in-depth discussion and analysis, the three experts reached consensus on the interview outline content. The interview outline comprised two sections: first, potential concerns people might have about vaccines, and second, information factors that people considered influential when discussing vaccination.

Currently, HPV vaccines in China are only available for female populations, and HPV vaccines are non-immunization program vaccines that require self-payment. Therefore, this study' s interview participants were limited to women aged 18 and above with a certain degree of financial autonomy. We posted recruitment information on social media, and interested individuals could register by completing a questionnaire in the recruitment announcement. Participants were screened according to specific criteria: (1) women aged 18 or older; (2) individuals who had concerns about HPV vaccination and had not yet been vaccinated; (3) non-medical majors and non-cervical cancer patients; and (4) individuals who had not participated in similar research within the past year. Ultimately, we selected 30 eligible participants for the interviews.

All interviewers in this study were psychology students with expertise in conducting interviews. Prior to the interviews, the principal investigator provided systematic training to the interviewers to ensure they were familiar with the interview procedures and considerations. After collecting and verifying basic information, the interviewers conducted semi-structured interviews following the outline while also probing deeper based on the specific circumstances of each interview. All interviews in this study were conducted via Tencent Meeting platform. Before each interview began, interviewers obtained informed consent from each participant and, with their permission, recorded the entire interview for further analysis. The interviews lasted approximately 30-60 minutes. Interviews concluded when data saturation was reached, meaning no new ideas emerged in subsequent interviews. Following the interviews, the recordings were

transcribed verbatim to create interview transcripts.

Thematic analysis is a traditional qualitative analysis method widely used in health sciences. In this study, we followed the thematic analysis steps recommended by Braun and Clarke (Braun & Clarke, 2006): familiarizing ourselves with the data, generating initial codes, searching for themes, reviewing themes, defining and naming themes, and writing the report. To enhance the rigor of the analysis, the initial coding and subsequent theme generation were completed through discussion between two researchers.

2.2 Results

In this study, we conducted 30 interviews. Table 1 presents the demographic information of our interview participants. The participants had a mean age of 23.73 years (SD = 2.18). The interviewees were relatively highly educated, and their geographical distribution was quite diverse.

Table 1 Demographic Information of Interview Participants

Characteristic	Value
Age (Mean ± SD)	23.73 ± 2.18
Education Level n(%)	College/Associate degree: 9 (30%)Bachelor' s degree: 21 (70%)
Region n(%)	Region 1: 14 (47%)Region 2: 7 (23%)Region 3: 9 (30%)

After completing all interviews, we followed the thematic analysis steps to analyze the interview transcripts, generating 25 initial codes and establishing operational definitions for each code based on the interview content (see supplementary materials). Based on TPB theory, we identified five key themes: vaccine effectiveness and safety, perceived benefits, reference groups, reference information, and behavioral barriers. Specific results are presented in Table 2.

Table 2 Thematic Analysis Results

Theme	Sub-factors
Vaccine Effectiveness and Safety	Vaccine safety, vaccine effectiveness, vaccination restrictions and contraindications, adverse reactions, risk perception
Perceived Benefits	Physical benefits, social benefits

Theme	Sub-factors
Reference Groups	Professionalism, trustworthiness, official stance, unofficial stance, high-standard groups, peer groups, conformity, in-group pressure, sense of responsibility
Reference Information	Scientific principles, dual-role persuasion, providing choice space, data, explainability, vicarious experience
Behavioral Barriers	Stigmatized cognition, scarcity, vaccination convenience

The first theme was vaccine effectiveness and safety, which was mentioned most frequently by interviewees. This theme encompassed vaccine safety, vaccine effectiveness, and vaccine adverse reactions. Most interviewees expressed concerns about whether HPV vaccines would pose threats to personal safety. As one participant stated, "I might be a bit uncertain about the safety of that vaccine," and another noted, "I would be quite worried about its safety, afraid that getting the shot might cause harm to my body." Some interviewees also expressed concerns about whether HPV vaccines could effectively prevent HPV infection. One participant mentioned, "I previously saw on Xiaohongshu that someone still got AIDS after getting vaccinated, which sometimes makes me a bit hesitant," while another said, "What I pay most attention to is first and foremost its actual effectiveness." Additionally, interviewees reported concerns about the side effects of HPV vaccination. One participant explained, "For me, if I feel the side effects are acceptable, such as short-term pain or fatigue and discomfort, I can accept them," while another expressed, "I would be afraid of those adverse effects, such as urticaria and allergic reactions."

The second theme was perceived benefits, which refers to the benefits individuals perceive after receiving HPV vaccination. This theme was mentioned less frequently by interviewees, with only a few individuals referencing it. Considering the sufficiency of coding, we retained this theme. One interviewee mentioned, "If getting the HPV vaccine could increase my hair volume, I would be more willing to get vaccinated," while another stated, "Getting the HPV vaccine could make me feel more at ease when visiting public places."

Subjective norms include others' opinions and expectations as well as individuals' concern about others' views, encompassing two themes: reference groups and reference information.

The third theme was reference groups, which refers to the influence of specific individuals or groups on a person' s behavior. These reference objects include specific communities, the majority of society, or individuals with similar life backgrounds. As one participant expressed, "I believe doctors are professional; they definitely understand more clearly than ordinary people. Since they have chosen to get vaccinated, what reason do I have not to?" Another stated, "If

everyone is willing to get it, if more people tend to get the HPV vaccine, and the vaccination rate has reached a high level, it would make me want to get vaccinated." A third participant noted, "If people around me have all been vaccinated, then I feel I would definitely be more inclined to get vaccinated. But if people around me produce some relatively negative news, I think it might cause me to have concerns, and perhaps these concerns would be greater than those from seeing related negative news in the media recently." Another interviewee explained, "I don' t just listen to what the doctor says; I also want to see what the real experience is like for people like me who have already been vaccinated."

The fourth theme was reference information, which emphasizes that vaccine-related information should be expressed in accurate and easily understandable language in a scientifically objective manner. As one participant stated, "If the promotional information can have very clear and detailed data about safety analysis, I would be more willing to get vaccinated." This highlights the importance of information transparency and accuracy in enhancing public willingness to vaccinate. Xu et al. analyzed the effects of message framing and evidence type on HPV vaccination intention, finding that statistical information could promote audience information-seeking behavior regarding vaccination (Xu et al., 2021). Moreover, information supported by substantial data can better stimulate women' s relevant information needs, and information needs can prompt people to adopt recommendations in the information (Kim & Nan, 2019).

Perceived behavioral control refers to an individual' s confidence in their ability to perform a specific behavior and their perception of obstacles. If a person believes they possess sufficient capabilities and resources and that environmental factors will not pose significant barriers to the behavior, they are more likely to take corresponding action. This dimension encompasses the theme of behavioral barriers.

The fifth theme was behavioral barriers, which emphasizes some of the obstacles individuals might encounter when getting HPV vaccinated. For example, vaccination convenience refers to the time and financial costs individuals need to consider during the vaccination process. Interviewees pointed out, "The vaccine is very difficult to schedule; it takes a long time to get an appointment. I think this also hinders my desire to get vaccinated. If it were easy to schedule, I might be more interested." Another participant stated, "If the HPV vaccine could be administered across different cities, like having a unified national vaccine database where I could get the first shot at home and then get the second and third shots in Beijing, then I think I would choose to get vaccinated." Additionally, due to the relatively recent introduction of HPV vaccines to China, some individuals still hold misconceptions about HPV vaccines. One interviewee noted, "I see that some men have misunderstandings about women infected with HPV or about the HPV vaccine itself, thinking that someone got infected because of promiscuous behavior." Another explained, "In those small places, when discussing this issue, people always think that if you didn' t get this vaccine and got cervical cancer, it' s because you were not self-disciplined, you

didn' t love yourself, so you got this disease. Everyone has a misunderstanding about the vaccine, thinking it doesn' t seem that necessary, or even that getting vaccinated is something shameful."

3.1 Experimental Process and Results

This study primarily consisted of the following phases: developing the initial version of the HPV Vaccination Intention Influencing Factors Importance Assessment Questionnaire (hereinafter referred to as the initial questionnaire), questionnaire administration, and data analysis.

Based on the 25 initial codes obtained in Experiment 1, we developed the initial questionnaire. Specifically, we created one corresponding item for each code derived from the interviews, resulting in a total of 25 items.

To ensure the professionalism of the psychological questionnaire measurement, we invited five psychology experts, including two faculty members and three graduate students, to form a review panel to evaluate each item' s grammar, readability, and accuracy for potential modification or deletion. Subsequently, two researchers collected all suggestions, discussed revisions, and ultimately reached consensus on the final wording of each item, establishing the final version of the 25 items (see supplementary materials). The questionnaire employed a 7-point Likert scale, where 1 indicated strong disagreement, 4 indicated uncertainty, and 7 indicated strong agreement. Participants were required to respond to all questions using this 1-to-7 agreement scale.

After the initial questionnaire was developed, we posted participant recruitment information on social media. The recruitment criteria were consistent with Experiment 1, and interested participants voluntarily took part in the study.

We used SPSS 26.0 for data processing and analysis. Item analysis was conducted through homogeneity testing and discrimination testing. The Kaiser-Meyer-Olkin (KMO) test was used to assess sampling adequacy, and Bartlett' s test of sphericity was used to examine the adequacy of inter-item correlations (Hill, 2011). We then conducted exploratory factor analysis, using principal component analysis to extract factors and orthogonal rotation with varimax to complete factor rotation. Subsequently, we calculated Cronbach' s coefficient to test the reliability of the initial questionnaire.

To ensure the quality of collected data, we eliminated invalid questionnaires and excluded those with excessively long or short completion times. Ultimately, we obtained 500 valid responses. The basic characteristics of the participants are presented in Table 3.

Table 3 Basic Characteristics of Participants in the Initial Questionnaire Survey

Characteristic	Value
Sample size	n = 500

Characteristic	Value
Age (Mean ± SD)	24.70 ± 4.99
Education level n(%)	High school and below: 36 (7.2%)Undergraduate/College: 408 (81.6%)Master' s degree and above: 56 (11.2%)
Family history of cancer n(%)	Yes: 160 (32%)No: 340 (68%)

Homogeneity test results showed that the correlation coefficients between each item score and the total score ranged from 0.424 to 0.606, all reaching significance at the 0.01 level, indicating strong inter-item correlations. Discrimination analysis results revealed significant differences between high and low scoring groups on all 25 items of the initial questionnaire, demonstrating good item discrimination. The KMO value was 0.916, and Bartlett' s test of sphericity was significant (^{2} = 3707.762; p < 0.001), indicating that factor analysis was appropriate for our sample data. After multiple rounds of exploratory factor analysis, eight items were deleted, leaving 17 items. We then examined the scree plot to ensure the appropriateness of the factor solution.

The final version of the HPV Vaccination Intention Influencing Factors Importance Assessment Questionnaire contained 17 items comprising four factors, explaining 53.466% of the total variance. Factor 1 included six items with the theme of "reference information." Factor 2 consisted of five items with the theme of "reference groups." Factor 3 comprised three items related to the theme of "vaccine safety," while Factor 4 included three items related to the theme of "behavioral barriers."

Table 4 presents the factor loadings from the exploratory factor analysis.

To test the stability of the remaining 17 items in the initial questionnaire, we conducted a preliminary analysis of the internal consistency reliability. Results showed that the Cronbach' s coefficient for the remaining 17 items was 0.858, indicating good stability.

Correlations among questionnaire dimensions ranged from 0.289 to 0.551, representing moderate correlations, while correlations between dimensions and the total score ranged from 0.579 to 0.857, representing relatively high correlations. The correlations between each dimension and the total questionnaire were significantly higher than those between dimensions. Additionally, all inter-dimensional correlations and correlations between dimensions and the total questionnaire reached statistical significance. This indicates that the dimensions are both independent of each other and unified with the content measured by the total questionnaire, demonstrating good construct validity. Specific results are

presented in Table 5.

Table 5 Correlation Values Between Each Dimension Score and Total Score

[Correlation matrix showing moderate correlations among dimensions (0.289-0.551) and higher correlations with total score (0.579-0.857), all significant at $p < 0.01$]

3.2 Formal Questionnaire

Based on the analysis results of the initial questionnaire, the remaining 17 items were mixed and arranged to form the formal version of the HPV Vaccination Intention Influencing Factors Importance Assessment Questionnaire. The questionnaire was similarly distributed online, with recruitment criteria consistent with previous phases. The collected questionnaires from the first formal administration were organized, numbered, and invalid questionnaires were eliminated according to the same exclusion criteria used previously. After eliminating invalid responses, we obtained 279 valid formal questionnaires. The basic characteristics of the participants are presented in Table 6.

Table 6 Basic Characteristics of Participants in the Formal Questionnaire Survey

Characteristic	Value
Sample size	n = 279
Age (Mean ± SD)	24.78 ± 5.01
Education level n(%)	High school and below: 31 (11.1%)Undergraduate/College: 211 (75.6%)Master' s degree and above: 37 (13.3%)
Family history of cancer n(%)	Yes: 160 (32%)No: 340 (68%)

We used SPSS 26.0 and AMOS 26.0 for data processing and analysis. Confirmatory factor analysis was employed to evaluate the quality of the questionnaire' s structural model. We utilized established indices to assess model fit. Specifically, a ^{2}/df value less than 3, and GFI, CFI, IFI, and TLI values reaching 0.9, with RMR and RMSEA less than 0.08, indicate reasonable model fit (Xu Wei).

We conducted statistical analysis on the importance levels of the 17 influencing factors. To explore differences in HPV vaccination intention influencing factor importance assessment among individuals with different demographic characteristics, we referenced previous research practices and calculated the average score of item responses for each factor (Saho, 2018; Sullivan & Artino, 2013). Considering sample adequacy, we used the valid data collected from both Experiment

1 and Experiment 2 for analysis. Subsequently, we used t-tests to examine differences in factor importance assessment based on family cancer history, and ANOVA to explore differences in factor importance assessment among different education levels.

3.3 Data Results

The confirmatory factor analysis results are presented in Table 7. The confirmatory factor analysis revealed that all indices for the HPV Vaccination Intention Influencing Factors Importance Assessment Questionnaire were satisfactory. Specifically, ^{2}/df < 3, RMR and RMSEA < 0.08, and GFI, TLI, and IFI values were all above 0.9 and close to 1, indicating that the four-dimensional model structure was appropriate.

Table 7 Model Validation Fit Indices

[Fit indices showing ^{2}/df < 3, RMR and RMSEA < 0.08, GFI, TLI, IFI > 0.9]

To further establish the questionnaire' s stability, we recruited 150 participants for a retest reliability study with a 4-week interval. After eliminating participants who did not respond seriously, 120 valid questionnaires remained. The retest correlation coefficient was 0.804, indicating good test-retest reliability and further demonstrating the high stability of our questionnaire.

We statistically analyzed the importance assessment levels of the 17 influencing factors and presented the results in Figure 1. Based on the 7-point scale we used to measure factor importance, higher scores represent greater importance of the factor to the individual. As shown in the figure, all 17 factors had some influence on individuals, but the importance levels differed across factors. Factors related to the vaccine itself, such as safety, vaccination restrictions and contraindications, and adverse reactions, were the most important.

Independent samples t-tests on the four dimensions of HPV vaccination intention influencing factors between participants with and without a family history of cancer revealed that individuals with a family history of cancer rated Factor 3 as more important than those without such history ($t = 3.297$, $p = 0.001$). Specific results are presented in Table 8.

Figure 1 Mean Importance Assessment of Influencing Factors

Independent samples t-tests on the four dimensions of HPV vaccination intention influencing factors between participants with and without a family history of cancer revealed that individuals with a family history of cancer rated Factor 3 as more important than those without such history ($t = 3.297$, $p = 0.001$). Specific results are presented in Table 8.

Table 8 Differences in Factor Importance Assessment by Family History of Cancer

Factor	Yes (n=251) Mean (SD)	No (n=528) Mean (SD)	t	p
Factor 1	36.57 (3.83)	27.68 (4.43)	-	-
Factor 2	19.34 (1.79)	17.01 (2.79)	-	-
Factor 3	36.26 (3.90)	28.19 (4.28)	3.297	0.001**
Factor 4	18.86 (2.19)	17.09 (2.73)	-	-

Note: **p < 0.01.

Individuals with different education levels showed differences in their assessment of factor importance. Significant differences across education levels were found for Factor 1 (F = 3.539, p = 0.030), Factor 2 (F = 6.802, p = 0.001), and Factor 3 (F = 3.705, p = 0.025). Specific results are presented in Table 9.

Table 9 ANOVA Results of Factor Importance Assessment by Education Level

Factor	High school and below (n=67) Mean (SD)	Undergraduate/College (n=619) Mean (SD)	Master' s and above (n=93) Mean (SD)	F	p
Factor 1	36.2 (3.55)	36.52 (3.87)	35.38 (4.04)	3.539	0.030*
Factor 2	28.0 (4.39)	28.25 (4.22)	26.49 (4.77)	6.802	0.001**
Factor 3	18.9 (2.80)	19.10 (1.95)	18.47 (2.26)	3.705	0.025*
Factor 4	17.0 (2.37)	17.16 (2.76)	16.42 (2.85)	2.974	

Note: *p < 0.05; **p < 0.01.

This study first employed semi-structured interviews and thematic analysis to conduct an in-depth exploration of factors influencing HPV vaccination intention and identified 25 influencing factors. Based on these findings, we constructed and validated an importance assessment questionnaire for HPV vaccination intention influencing factors. Factor analysis results revealed that factors influencing people' s vaccination decisions can be primarily categorized into four main categories. Furthermore, the importance levels of different influencing factors varied, with significant differences in factor importance assessment observed between individuals with and without a family history of cancer and among individuals with different education levels.

In our study, through factor analysis we found that considerations influencing people' s vaccination decisions can be mainly summarized into four major categories. This finding is similar to the results of our TPB-based thematic analysis, fully demonstrating that TPB can serve as a theoretical framework for

interpreting influencing factors of HPV vaccination intention among Chinese populations.

The theme of vaccine safety encompasses three factors: vaccine safety, vaccination restrictions and contraindications, and adverse reactions. This factor emphasizes how individuals view the importance of safety when deciding whether to receive HPV vaccination.

In our interviews, most interviewees also expressed concerns about whether HPV vaccines would pose threats to personal health. For example, one participant stated, "I would be quite worried about its safety, afraid that getting the shot might cause harm to my body." Vaccine safety has also been identified as a key influencing factor of vaccination intention in many previous studies (Karafillakis et al., 2019; Zhang et al., 2016). This has been confirmed in prior research.

Zhang et al., in a meta-analysis of 58 studies across 18 provinces in China, found that 68% of parents primarily focused on vaccine safety and effectiveness when considering vaccination for their daughters (Zhang et al., 2016). Additionally, data from Karafillakis et al. showed that in Europe, 43% of HPV vaccine-hesitant individuals expressed concerns about vaccine safety, while 55% of hesitant individuals held distrustful attitudes toward the healthcare system (Karafillakis et al., 2019). Giambi et al. conducted a cross-sectional study among parents of children, revealing that potential vaccine safety issues were the dominant factor leading them to refuse or discontinue vaccination (Giambi et al., 2018). These research findings further confirm the validity of our results, demonstrating that concerns about vaccine safety constitute one of the important factors influencing HPV vaccination intention.

The theme of reference groups encompasses five factors: official stance, unofficial stance, high-standard groups, peer groups, and conformity. This factor emphasizes the value and trust people place on recognized individuals or groups. When considering vaccination, individuals value and seek opinions from these people or groups, such as specific communities, the majority of society, or individuals with similar life backgrounds. As one participant stated, "I believe doctors are professional; they definitely understand more clearly than ordinary people. Since they have chosen to get vaccinated, what reason do I have not to?" This is consistent with the findings of Ratanasiripong et al., who discovered that attitudes toward vaccines and support and encouragement from parents, classmates, or friends could effectively predict female college students' vaccination decisions (Ratanasiripong et al., 2018). Similarly, Kim and Nan, in a cross-sectional study of South Korean female college students, also found that personal experiences of family members and friends, along with their recommendations and support, influenced individuals' vaccination decisions. Furthermore, the opinions of the majority have a significant influence on individual decision-making (Godinot et al., 2021). This perspective was further confirmed in our study.

The theme of reference information encompasses six influencing factors: scientific principles, dual-role persuasion, providing choice space, data, explainability,

and vicarious experience. This theme primarily emphasizes that vaccine-related information should be expressed in accurate and easily understandable language in a scientifically objective manner. As one participant stated, "If the promotional information can have very clear and detailed data about safety analysis, I would be more willing to get vaccinated." This highlights the importance of information transparency and accuracy in enhancing public willingness to vaccinate. Xu et al. analyzed the effects of message framing and evidence type on HPV vaccination intention, finding that statistical information could promote audience information-seeking behavior regarding vaccination (Xu et al., 2021). Moreover, information supported by substantial data can better stimulate women' s relevant information needs, and information needs can prompt people to adopt recommendations in the information (Kim & Nan, 2019).

The theme of behavioral barriers emphasizes some of the obstacles individuals might encounter when getting HPV vaccinated, encompassing three elements: stigmatized cognition, scarcity, and vaccination convenience. Since HPV vaccines are non-immunization program vaccines in China that require self-payment, our analysis found that vaccination convenience—namely, the time and cost of vaccination—is an important factor influencing individual vaccination intention. Kim et al. conducted a cross-sectional study of South Korean female college students and found that when female students felt confident they could handle potential problems during vaccination, they were more willing to actively get vaccinated (Kim & Nan, 2019).

In the process of promoting HPV vaccination, the factor of stigmatized cognition should be fully considered. Stigmatized cognition refers to misconceptions held by people in one' s surroundings about HPV vaccines and the act of getting vaccinated. Since HPV vaccines primarily target sexually transmitted diseases, their administration may be influenced by specific cultural backgrounds, levels of sex education, and perceptions of sexual behavior. For example, in some Asian countries, including South Korea and Asian Muslim countries, parents have shown hesitancy about HPV vaccination and expressed concerns about the potential impact of vaccination on adolescents. Their primary worry was that it might inadvertently encourage adolescents to engage in sexual activity prematurely (Mupandawana & Cross, 2016; Wong et al., 2020). These research findings suggest that in promoting HPV vaccination, it is necessary to provide scientific sex education to the public, correctly guide public perceptions of sexuality, and eliminate misconceptions about HPV vaccines to improve vaccination rates.

In this study, we found that the importance levels of different influencing factors varied, with factors related to the vaccine itself—such as safety, vaccination restrictions and contraindications, and adverse reactions—being the most important. This finding aligns with our interview results, as these factors were mentioned most frequently during interviews, demonstrating individuals' high level of concern about them. This further illustrates the validity of our research findings. We found that individuals with a family history of cancer placed

greater importance on vaccine safety, while showing no differences in importance assessment for reference groups, reference information, or behavioral barriers. Education level also influenced individuals' assessment of the importance of HPV vaccination intention influencing factors. We found that individuals with undergraduate or college education placed greater importance on reference information, reference groups, and vaccine safety. Meanwhile, we found no significant differences in the assessment of behavioral barriers between individuals with or without a family history of cancer or across different education levels. This finding may indicate that regardless of education level or family cancer history, behavioral barriers represent a common concern.

This study employed semi-structured interviews to conduct an in-depth investigation of people' s concerns about HPV vaccines and the information factors that participants considered influential in their vaccination decision-making process. The research provides us with a deeper and more nuanced understanding of the factors influencing HPV vaccination intention among Chinese women. Furthermore, the HPV Vaccination Intention Influencing Factors Importance Assessment Questionnaire developed in our study is the first validated measurement tool specifically designed to assess how individuals weigh factors related to HPV vaccination intention. This questionnaire can provide evidence-based guidance for public health agencies, enabling relevant departments to select more effective influencing factors when promoting and publicizing vaccines. For example, since people scored high on "vaccine safety," public health workers can emphasize the safety of HPV vaccines in subsequent vaccination campaigns. The findings of this study can provide scientific basis and reference for delivering targeted persuasive messages, thereby strengthening the persuasive effect of information and enabling more effective allocation and utilization of social resources.

This study has several limitations. First, the research was conducted in China, and the findings regarding factors influencing HPV vaccination intention and the questionnaire we developed may not be applicable to other cultural contexts. Caution is needed when applying these research results in different cultural environments. Second, our questionnaire was specifically designed for HPV vaccines and may not be suitable for other vaccine types. However, our research methodology and framework can provide references for future studies on other vaccines. Additionally, the study sample primarily consisted of young people and individuals with higher education levels, which may limit the generalizability of our findings. In future research, we could consider adopting broader and more random sampling methods to obtain more comprehensive and representative results.

This study first employed semi-structured interviews and thematic analysis to conduct an in-depth exploration of factors influencing HPV vaccination intention and identified 25 influencing factors. Based on these factors, we developed and validated a highly reliable and valid questionnaire for assessing the importance of HPV vaccination intention influencing factors. We utilized the de-

veloped questionnaire to examine factor importance and the differences in how demographic characteristics influence factor importance assessment. We further used this questionnaire to evaluate the importance of each influencing factor and explored the differential impact of demographic characteristics on these importance assessments. The research findings revealed significant differences in the importance levels of various influencing factors. Additionally, both family history of cancer and different education levels showed significant differences in how individuals assessed the importance of influencing factors. The findings of this study not only provide valuable insights for optimizing HPV vaccine promotion strategies but also reveal the possibility of developing personalized and targeted vaccination strategies.

References

Ajzen, I., & Fishbein, M. (1975). Bayesian analysis of attribution processes. *Psychological Bulletin*, 82(2). https://doi.org/10.1037/h0076477

Biswas, N., Mustapha, T., Khubchandani, J., & Price, J. H. (2021). The nature and extent of COVID-19 vaccination hesitancy in healthcare workers. *Journal of Community Health*, 46(6). https://doi.org/10.1007/s10900-021-00984-3

Braun, V., & Clarke, V. (2006). Using thematic analysis in psychology. *Qualitative Research in Psychology*, 3(2), 77-101.

Butler, R., MacDonald, N. E., & Hesitancy, S. W. G. V. (2015). Diagnosing the determinants of vaccine hesitancy in specific subgroups: The Guide to Tailoring Immunization Programmes (TIP). *Vaccine*, 33(34), 4176-4179. https://doi.org/10.1016/j.vaccine.2015.04.038

Cai, Z., Hu, W., Zheng, S., Wen, X., & Wu, K. (2022). Cognition and behavior of COVID-19 vaccination based on the health belief model: A cross-sectional study. *Vaccines*, 10(4). https://doi.org/10.3390/vaccines10040544

Chen Yamei. (2020). Investigation on the awareness of HPV vaccine knowledge, vaccination intention, and factors influencing vaccination [Master' s thesis, Nanchang University].

Dube, E., Gagnon, D., Ouakki, M., Bettinger, J. A., Witteman, H. O., MacDonald, S., Fisher, W., Saini, V., Greyson, D., & Canadian Immunization Res, N. (2018). Measuring vaccine acceptance among Canadian parents: A survey of the Canadian Immunization Research Network. *Vaccine*, 36(4), 545-552. https://doi.org/10.1016/j.vaccine.2017.12.005

Dube, E., Laberge, C., Guay, M., Bramadat, P., Roy, R., & Bettinger, J. (2013). Vaccine hesitancy: An overview. *Human Vaccines & Immunotherapeutics*, 9(8), 1763-1773. https://doi.org/10.4161/hv.24657

Fadhel, F. H. (2021). Vaccine hesitancy and acceptance: An examination of predictive factors in COVID-19 vaccination in Saudi Arabia. *Health Promotion International*, 13. https://doi.org/10.1093/heapro/daab209

Ferwana, I., & Varshney, L. R. (2021). Social capital dimensions are differentially associated with COVID-19 vaccinations, masks, and physical distancing. *PLOS ONE*, 16(12), e0260818. https://doi.org/10.1371/journal.pone.0260818

Gefenaite, G., Smit, M., Nijman, H. W., Tami, A., Drijfhout, I. H., Pascal, A., Postma, M. J., Wolters, B. A., van Delden, J. J. M., Wilschut, J. C., & Hak, E. (2012). Comparatively low attendance during Human Papillomavirus catch-up vaccination among teenage girls in the Netherlands: Insights from a behavioral survey among parents. *BMC Public Health*, 12, 498. https://doi.org/10.1186/1471-2458-12-498

Geoghegan, S., O' Callaghan, K. P., & Offit, P. A. (2020). Vaccine safety: Myths and misinformation. *Frontiers in Microbiology*, 11, 372. https://doi.org/10.3389/fmicb.2020.00372

Giambi, C., Fabiani, M., D' Ancona, F., Ferrara, L., Fiacchini, D., Gallo, T., Martinelli, D., Pascucci, M. G., Prato, R., Filia, A., Bella, A., Del Manso, M., Rizzo, C., & Rota, M. C. (2018). Parental vaccine hesitancy in Italy—Results from a national survey. *Vaccine*, 36(6). https://doi.org/10.1016/j.vaccine.2017.12.074

Godinot, L. D., Sicsic, J., Lachatre, M., Bouvet, E., & Mueller, J. E. (2021). Quantifying preferences around vaccination against frequent, mild disease with risk for vulnerable persons: A discrete choice experiment among French hospital health care workers. *Vaccine*.

Gou Rui, & Lin Bei. (2019). Systematic review of the safety of prophylactic HPV vaccine. *Chinese Journal of Practical Gynecology and Obstetrics*, 35(07), 827-832. https://doi.org/10.19538/j.fk2019070125

Hill, B. D. (2011). The sequential Kaiser-Meyer-Olkin procedure as an alternative for determining the number of factors in common-factor analysis: A Monte Carlo simulation. Oklahoma State University.

Johnson, C. A., James, D., Marzan, A., & Armaos, M. (2019). Cervical cancer: An overview of pathophysiology and management. *Seminars in Oncology Nursing*, 35(2). https://doi.org/10.1016/j.soncn.2019.02.003

Kalok, A., Loh, S. Y. E., Chew, K. T., Aziz, N. H. A., Shah, S. A., Ahmad, S., Ismail, N. A. M., & Mahdy, Z. A. (2020). Vaccine hesitancy towards childhood immunisation amongst urban pregnant mothers in Malaysia. *Vaccine*, 38(9), 2183-2189. https://doi.org/10.1016/j.vaccine.2020.01.043

Karafillakis, E., Simas, C., Jarrett, C., Verger, P., Peretti-Watel, P., Dib, F., De Angelis, S., Takacs, J., Ali, K. A., Celentano, L. P., & Larson, H. (2019). HPV vaccination in a context of public mistrust and uncertainty: A systematic literature review of determinants of HPV vaccine hesitancy in Europe. *Human Vaccines & Immunotherapeutics*, 15(7-8). https://doi.org/10.1080/21645515.2018.1564436

Kim, J., & Nan, X. (2019). Temporal framing effects differ for narrative versus non-narrative messages: The case of promoting HPV vaccination. *Communication Research*, 46(3). https://doi.org/10.1177/0093650215626980

Kreps, S., Prasad, S., & Brownstein, J. S. (2020). Factors associated with US adults' likelihood of accepting COVID-19 vaccination (vol 3, e2025594, 2020). *JAMA Network Open*, 3(11), e2030649. https://doi.org/10.1001/jamanetworkopen.2020.30649

Latkin, C., Dayton, L. A., Yi, G., Konstantopoulos, A., Park, J., Maulsby, C., & Kong, X. (2021). COVID-19 vaccine intentions in the United States: A social-ecological framework. *Vaccine*, 39(16), 2237-2243. https://doi.org/10.1016/j.vaccine.2021.02.058

Luyten, J., Bruyneel, L., & van Hoek, A. J. (2019). Assessing vaccine hesitancy in the UK population using a generalized vaccine hesitancy survey instrument. *Vaccine*, 37(18). https://doi.org/10.1016/j.vaccine.2019.03.041

MacDonald, N. E., & Hesitancy, S. W. G. V. (2015). Vaccine hesitancy: Definition, scope and determinants. *Vaccine*, 33(34), 4161-4164. https://doi.org/10.1016/j.vaccine.2015.04.036

Momplaisir, F., Haynes, N., Nkwihoreze, H., Nelson, M., Werner, R. M., & Jemmott, J. (2021). Understanding drivers of Coronavirus Disease 2019 vaccine hesitancy among Blacks. *Clinical Infectious Diseases*, 73(10), 1784-1789. https://doi.org/10.1093/cid/ciab102

Mupandawana, E. T., & Cross, R. (2016). Attitudes towards human papillomavirus vaccination among African parents in a city in the north of England: A qualitative study. *Reproductive Health*, 13, 97. https://doi.org/10.1186/s12978-016-0209-x

Nowak, G. J., Gellin, B. G., MacDonald, N. E., Butler, R., & Hesitancy, S. W. G. V. (2015). Addressing vaccine hesitancy: The potential value of commercial and social marketing principles and practices. *Vaccine*, 33(34), 4204-4211. https://doi.org/10.1016/j.vaccine.2015.04.039

Ratanasiripong, N. T., Sirinat, S. U., Duangrat, K., Suda, H., & Paul, R. (2018). Human papillomavirus (HPV) vaccination and factors related to intention to obtain the vaccine among young college women in Thailand. *Journal of Health Research*, 32(2), 142-151.

Sallam, M. (2021). COVID-19 vaccine hesitancy worldwide: A concise systematic review of vaccine acceptance rates. *Vaccines*, 9(2), 160. https://doi.org/10.3390/vaccines9020160

Siu, J. Y.-m., Cao, Y., & Shum, D. H. K. (2022). Perceptions of and hesitancy toward COVID-19 vaccination in older Chinese adults in Hong Kong: A qualitative study. *BMC Geriatrics*, 22(1). https://doi.org/10.1186/s12877-022-03000-y

Sun Jingyi, Li Yitian, Chu Yanhui, Xiao Zheng, Liu Xiaoxiao, Kong Qingzheng,

& Qiao Fuyu. (2018). Survey on EV71 vaccine awareness and vaccination intention among parents of children in Xicheng District, Beijing. *Chinese Journal of Health Education*, 34(9), 820-823.

Sun Xiu, Zhang Liuren, & Fu Chuanxi. (2021). Research progress on interventions for HPV vaccine hesitancy. *Progress in Microbiology and Immunology*, 49(06). https://doi.org/10.13309/j.cnki.pmi.2021.06.015

Wang Qiong. (2023). Multiple departments jointly issued the "Accelerating Cervical Cancer Elimination Action Plan (2023-2030)" : Promoting the construction of a cervical cancer prevention and treatment system and accelerating the process of cervical cancer elimination. *Journal of Women and Children' s Health*, 2(6), 6-6.

WHO. (2019). Ten threats to public health in 2019. https://www.who.int/news-room/spotlight/ten-threats-to-global-health-in-

Wong, L. P., Wong, P.-F., Hashim Megat, M. A. A. M., Han, L., Lin, Y., Hu, Z., Zhao, Q., & Zimet, G. D. (2020). Multidimensional social and cultural norms influencing HPV vaccine hesitancy in Asia. *Human Vaccines & Immunotherapeutics*, 16(7). https://doi.org/10.1080/21645515.2020.1756670

Xu, X., Yang, M., Zhao, Y. C., & Zhu, Q. (2021). Effects of message framing and evidence type on health information behavior: The case of promoting HPV vaccination. *Aslib Journal of Information Management*, 73(1), 63-79. https://doi.org/10.1108/ajim-02-2020-0055

Xu Wei. Development and preliminary application of a questionnaire on learning engagement among junior high school students [Zhejiang Normal University].

Zhang, Y., Wang, Y., Liu, L., Fan, Y., Liu, Z., Wang, Y., & Nie, S. (2016). Awareness and knowledge about human papillomavirus vaccination and its acceptance in China: A meta-analysis of 58 observational studies. *BMC Public Health*, 16, 216. https://doi.org/10.1186/s12889-016-2873-8

Note: Figure translations are in progress. See original paper for figures.