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RESEARCH PAPER

Parental perceptions of human papillomavirus vaccination in central China: the moderating role of socioeconomic factors

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ABSTRACT

Background: The huge gap in adolescent human papillomavirus (HPV) uptake between China (< 2%) and developed countries (> 60%) indicates the necessity of comprehensive examination on the modifiable factors for parents' decision-making. The present study investigated parental perceptions of HPV vaccination for children in China from a socio-economic perspective.

Methods: Parents of 9-to-14-year-old adolescents who understood the HPV vaccination (n = 925) completed our questionnaire survey in Fall 2017. Based on the structural equation modeling, we examined the relationship among knowledge, awareness, and intentions of 20 items by 7-point Likert scale, the moderating effects also were tested among 5 socioeconomic variables.

Results: Parents of female students have more positive intention about the HPV vaccination than male students' parents (3.74 vs 2.80, $p < 0.001$). Parents of 12–14-years old students have higher average scores in knowledge ($p = 0.006$) and intention ($p < 0.001$) than that of 9–11-years old students' parents. The average score of mothers on knowledge ($p = 0.018$) and awareness ($p < 0.001$) was lower than that of fathers. The elder parents (≥ 50 years) performed significantly better on knowledge ($p < 0.001$) and awareness ($p < 0.001$) than the other two subgroups. Annual household income is an important factor in determining the knowledge ($p = 0.0017$), awareness ($p < 0.001$), and intention ($p < 0.001$). Knowledge and awareness were considered as the positive determinant of intention, and awareness was partial mediator. Child gender ($P = 0.046$), child age ($P = 0.004$), parent gender ($P = 0.043$) and parental age ($P = 0.021$) were significant moderators.

Conclusion: To improve the acceptability of HPV vaccination among Chinese adolescents, policymakers should develop positive strategies for their parents.

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Human papillomavirus (HPV); willingness; adolescent; vaccination; China

Introduction

Human papillomavirus (HPV) vaccination is highly effective way to prevent sexually transmitted HPV infection and cervical cancer, and adolescents are recommended to vaccinate it, especially girls.[1] HPV vaccination to girls aged 9–14 years was strongly recommended by the World Health Organization (WHO) and be considered as a necessary cost-effective public health policy.[2] The China Food and Drug Administration (CFDA) approved the introduction of the bivalent (Cervarix®) in July 2016, 4-valent (Gardasil®) in June 2017 and 9-valent HPV vaccines (Gardasil®) in April 2018. HPV vaccination is not part of China's national immunization program, and it must be paid for out-of-pocket 5800 RMB ($870). The potential demand for HPV vaccines in China is around 44 million subjects, and the market value of HPV vaccines will exceed $10 billion based on a 30% coverage.[3] While the prospect of HPV vaccination in China is encouraging, the present coverage was < 2% in 2017.[3] Parents are most often responsible for decision-making of adolescent HPV vaccination,[4] therefore, a comprehensive examination of the modifiable factors on parents' is necessary.

Although there are compelling works of literature that analyzed factors affecting parental behavioral intentions by multivariable logistic regression or other statistical tests of relevance,[1,5,6] there is little available evidence regarding multifactor interaction effects and moderating effects that influence parents' decisions about HPV vaccination. Previous studies have been demonstrated that parental hesitantly intentions contribute to the vaccination delay and refusal: 36% of parents in the United States expressed their hesitation about their children's HPV vaccination.[7] Increasing parental knowledge and awareness about HPV is therefore suggested as an effective intervention to promote parents' intentions and improve the vaccine uptake rate among adolescents.[8] In addition, socioeconomic variables that were linked to higher parental acceptability to children vaccination, included female parents, higher household income, and older age of child.[9,10] These psychological and socioeconomic factors were considered in a comprehensive theoretical framework to examine the individual and interactive effects aimed at increasing parents' behavioral intentions.[11,12]

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From the perspective of research data sources, developing countries and HPV emerging markets deserve attention, especially in rapidly changing regions.[13,14] In contrast to the plentiful literature on adolescent vaccination behavior in developed countries, such as the United States,[15] Germany,[16] Greek,[17] and United Kingdom,[18] there are still few comprehensive examinations in the context of developing countries.

To address the lack of research and reduce parents' hesitancy to HPV vaccine uptake, the present study developed a structural equation model of triple constructs (knowledge, awareness, and intention) and collected questionnaire data from Central China. Knowledge and awareness have been independently shown to have a significant relationship with the parental intention of adolescent HPV vaccination. In addition to the above psychological factors, the questionnaire also contains the following demographic items: adolescent age and gender, parental age, gender and education level, annual household income before tax. These variables are filled into a unified theoretical model for cross-analysis to explore the impact on HPV vaccination intentions.

The conceptual framework was modified from TAM (Technology Acceptance Model)[19,20] and knowledge, attitudes, and practice (KAP).[16,21] Three constructs form the core theoretical model: knowledge, consciousness, and intention (see Figure 1). Five socioeconomic factors as disturbance variables influence the relationship between the above constructs, such as changing relationship strength or transforming positive correlation and negative correlation. The following hypotheses were constructed in the present study:

H1. Knowledge is positively related to parental awareness of children HPV vaccination.

H2. Awareness is positively related to parental intention of children HPV vaccination.

H3. Knowledge is positively related to parental intention of children HPV vaccination.

H4. Socioeconomic factors are positively moderating the relationship between knowledge and awareness.

H5. Socioeconomic factors are positively moderating the relationship between awareness and intention.

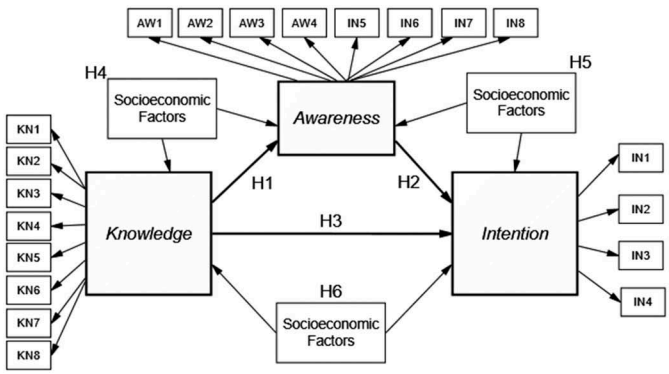

Figure 1. Theoretical model.

H6. Socioeconomic factors are positively moderating the relationship between knowledge and intention.

(1) Knowledge (KN1-KN8) and Awareness (AW1-AW8) are significant predictors of Intention (IN1-IN4).
(2) Awareness (AW) mediates the effects of Knowledge (KN) on Intention (IN).
(3) Socioeconomic factors including five variables as following: Child Gender, Child Age, Parent Gender, Parent Age, Income.
(4) Socioeconomic factors moderates the effects among Knowledge, Awareness and Intention.

Results

Sample descriptive

The demographic analysis results for the parent participants are shown in Table 1. More than 60% of the 925 parent participants in our sample were parents of girls (61.8%), and nearly 60% of the respondents were mothers (59.1%). As to the child age, 9–11 years (46.2%) were less than 12–14 years (53.8%). Over one-third (41.1%) parent participants were aged 30–39 years, and nearly half of them were aged 40–49 years, while only 10.1% parent participants were older than 50 years. About one-fourth (24.2%) reported the household income before tax was lower than $15,000 per year.

In the present study, parents of female students have more positive intention about the HPV vaccination than male students' parents (3.74 vs 2.80, $p < 0.001$). Parents of 12–14-years old students have higher average scores in knowledge ($p = 0.006$) and intention($p < 0.001$) than that of 9–11-years old students' parents. From the gender of the parents, the average score of the mother group on knowledge ($p = 0.018$) and awareness ($p < 0.001$) was lower than that of the father group, whereas the mother group was more positive at the intentions (3.48 vs 3.23, $p < 0.001$). As to the parents' age, the elder parents (≥ 50 years) performed significantly better on knowledge ($p < 0.001$) and awareness ($p < 0.001$) than the other two subgroups. It is worth noting that the subgroup of the elder Parents (≥ 50 years) have the lowest behavioral intent (2.66), and it is significantly ($p < 0.001$) lower than the subgroup of 30–39 years (3.58) and 40–49 years (3.36). Annual household income is an important factor in determining the knowledge ($p = 0.0017$), awareness ($p < 0.001$), and intention ($p < 0.001$) of adolescent parents for HPV vaccination. Parents of low-income families (annual household income before tax <$15,000) have the poorest knowledge (4.19), lowest awareness (3.94) and minimum intentions (2.37) about HPV vaccination. The group of annual household income between $15,000-$29,999 got the highest scores of knowledge and awareness, however, the parents of the highest income families have the strongest intentions.

Reliability and validity

Table 2 summarizes the details of the Items, and the test results of construct reliability and validity, including Standardized

Table 1. Demographic profile of participant(N = 925).

			Average score of Knowledge items[a]			Average score of Awareness items[b]			Average score of Intention items[c]		
Items	*n*	%	Mean	SD	p-value[d]	Mean	SD	p-value[d]	Mean	SD	p-value[d]
Child Gender					0.051			0.980			**< 0.001*** **
Male (1)	353	38.2	4.41	0.93		4.31	1.36		2.80	0.83	
Female (2)	572	61.8	4.28	1.02		4.31	1.19		3.74	0.90	
Child Age					**0.006*** **			0.285			**< 0.001*** **
9–11 years (1)	427	46.2	4.24	0.96		4.26	1.18		3.15	0.80	
12–14 years (2)	498	53.8	4.42	1.00		4.35	1.32		3.57	1.08	
Parent Gender					0.018**			**< 0.001*** **			**< 0.001*** **
Male (1)	378	40.9	4.42	0.96		4.56	1.28		3.23	0.95	
Female (2)	547	59.1	4.27	1.00		4.14	1.21		3.48	1.00	
Parent Age					**< 0.001*** **			**< 0.001*** **			**< 0.001*** **
30–39 years (1)	380	41.1	4.24	0.96		4.31	1.24		3.58	0.96	
40–49 years (2)	452	48.9	4.31	1.01		4.14	1.26		3.36	0.98	
≥ 50 years (3)	93	10.1	4.83	0.84		5.16	0.95		2.66	0.75	
Annual household income before tax					0.017**			**< 0.001*** **			**< 0.001*** **
<$15,000 (1)	224	24.2	4.19	1.04		3.94	1.48		2.37	0.77	
$15,000-$29,999 (2)	374	40.4	4.44	0.93		4.45	1.18		3.58	0.65	
$30,000-$44,999 (3)	238	25.7	4.28	0.97		4.40	1.10		3.76	0.92	
≥$45,000 (4)	89	9.6	4.36	1.08		4.44	1.19		4.06	0.98	

[a]The average scores of Knowledge items among groups (7-point Likert scale), including KN1 to KN8;
[b]The average scores of Awareness items among groups (7-point Likert scale), including AW1 to AW8;
[c]The average scores of Intention items among subgroups (7-point Likert scale), including IN1 to IN4;
[d]Results of the one-way ANOVA, ***p < .001, **p < 0.05.

Table 2. Cronbach's alpha and confirmatory factor analysis.

Constructs	Variables	Corresponding Items	β^a	α^b	AVE[c]
knowledge	KN1	HPV will not be carried for life	0.870	0.952	0.712
	KN2	The incubation period after HPV infection is up to 10 years	0.877		
	KN3	HPV will be infected repeatedly	0.849		
	KN4	There are at least 13 HPVs in the high-risk category, especially HPV-16 and HPV-18	0.860		
	KN5	HPV is one of the leading causes of cervical cancer	0.792		
	KN6	Cervical cancer is a very serious disease	0.862		
	KN7	HPV vaccine is an effective means of preventing cervical cancer	0.815		
	KN8	WHO recommends HPV vaccine to be part of the national immunization program	0.821		
awareness	AW1	My child may be infected with HPV in the future	0.862	0.962	0.76
	AW2	Girls should receive all 3 HPV vaccinations within 6 months	0.848		
	AW3	It is also necessary for boys to uptake HPV vaccination	0.846		
	AW4	HPV vaccination is expensive but valuable	0.895		
	AW5	It is a responsibility of every parent to take their children HPV vaccinations	0.874		
	AW6	I am not worried about the side effects of HPV vaccination	0.881		
	AW7	The doctor advised my child to receive HPV vaccination	0.903		
	AW8	People who are important to me suggested that my child should receive HPV vaccination	0.865		
intention	IN1	I am highly willing to bring my child to uptake HPV vaccination	0.773	0.879	0.645
	IN2	I intent to bring my child to receive HPV vaccination in the next year	0.785		
	IN3	I plan to take my child to complete HPV vaccination in the next year	0.848		
	IN4	I will recommend adolescent HPV immunization services to my friends	0.805		

[a:] Standardized factor loadings (β). All items loading above 0.75 and had good reliability.
[b:] Cronbach's alpha (α) is widely believed to indirectly indicate the degree to which a set of items measures a single unidimensional latent construct.
[c:] average variance extracted (AVE) values, which measure the average variance shared between a construct and its measures, and by calculating the correlations between different constructs.[25]

factor loadings (β), Cronbach's alpha (α) and average variance extracted (AVE) values. All Standardized factor loadings (β) were above the recommended value of Hair (2012),[22] and it verifies the rationality of variables and structures. The values of Cronbach's alpha (α) are exceeded 0.85, which suggests good convergent validity.[22,23] The average variance extracted (AVE) values of each construct are higher than 0.85, indicating that the measurement model has good discriminant validity.[24]

Model fit indices, hypotheses testing, moderating effects and mediating effects

The model fit *indices* are within the recommended values for the theoretical requirements: CHI-QUARE = 439.135, DF = 167, CHI/DF = 2.630 < 3, p-value = 0.000 < 0.05, NFI = 0.974 > 0.9, IFI = 0.984 > 0.9, RFI = 0.970 > 0.9, TLI = 0.981 > 0.9, CFI = 0.984 > 0.9, GFI = 0.952 > 0.9, AGFI = 0.939 > 0.9, RMSEA = 0.042 < 0.05. These model fit indices suggest that the model fits the data well, and the relationships between constructs and variables in the theoretical model have been confirmed by the data.

The Structural equation analysis supports three theoretical assumptions, and the results of hypotheses testing are summarized as follows:

H1: t = 8.825; β = 0.298; p < 0.001. H1 was supported, knowledge was considered as the positive determinant of awareness.

Table 3. Moderating effects testing.

Paths / Moderators	awareness < – knowledge			intention< – awareness			intention< – knowledge		
	p-$132#value [f]	VIJAY$\beta_{(1)}$	VIJAY$\beta_{(2)}$	p-$132#value	VIJAY$\beta_{(1)}$	VIJAY$\beta_{(2)}$	p-$132#value	VIJAY$\beta_{(1)}$	VIJAY$\beta_{(2)}$
Child Gender[a]	0.184	0.25	0.35	**0.046**	0.19	0.37	0.854	0.49	0.45
Child Age[b]	0.065	0.30	0.29	**0.004**	0.46	0.39	**0.019**	0.41	0.30
Parent Gender[c]	0.301	0.27	0.31	**0.043**	0.34	0.47	0.079	0.36	0.39
Parent Age[d]	**0.021**	0.28	0.31	0.562	0.50	0.60	0.266	0.39	0.76
Income[e]	0.587	0.44	0.56	0.390	0.39	0.24	0.290	0.61	0.53

Each moderating variable was tested by two comparison groups as follows:
[a]Child Gender: (1) = "Male", (2) = "Female";
[b]Child Age: (1) = "9–11 years", (2) = "12–14 years";
[c] Parent Gender: (1) = "Male", (2) = "Female";
[d]Parent Age: (1) = "30–39 years", (2) = "≥ 50 years";
[e]Income: (1) = "<$15,000", (2) = "≥$45,000".
[f]p-value is the significance of the two comparison group models, and $p < 0.05$ is an acceptable criterion.

Table 4. Mediating effects testing of Awareness on the path "Intention< – Knowledge".

		Product of Coefficients[c]		Bootstrap[d] Bias-Corrected 95% CI[e]		Bootstrap[d] Percentile 95% CI[f]		
Effects[a]	β[b]	S.E.	Z	lower	upper	lower	upper	Result[g]
Total Effect	0.444	0.029	15.310	0.387	0.502	0.386	0.502	Partial Mediation
Direct Effect	0.330	0.026	12.692	0.280	0.383	0.279	0.381	
Indirect Effect	0.114	0.015	7.600	0.087	0.147	0.086	0.145	

[a]Effects include Total Effect, Direct Effect, and Indirect Effect. The significance test for each Effect includes three criteria: the absolute value of Z should be greater than 1.96; "0" is not included in Bias-Corrected 95% CI and Percentile 95% CI.
[b]β: Regression weight estimate.
[c]S.E.: standard error, Z: The Z-value of Sobel Test, $Z = \beta/S.E.$
[d]4,000 Bootstrapping samples.
[e]95% bias-corrected confidence interval, and not including "0" is significant.
[f]95% percentile confidence interval, and not including "0" is significant.
[g]Total Effect, Direct Effect and Indirect Effect are all significant, then the type is Partial Mediation.

H2: $t = 12.769$; $\beta = 0.426$; $p < 0.001$. H2 was supported, awareness was considered as the positive determinant of intention.
H3: $t = 11.225$; $\beta = 0.367$; $p < 0.001$. H3 was supported, knowledge was considered as the positive determinant of intention.

Table 3 shows the result of moderating effects. On the path of "Awareness < – Knowledge", only "Parent Age" was the significant moderator ($p = 0.021$). There were three moderators significant influence on the path of "Intention< – Awareness", "Child Gender" ($p = 0.046$), "Child Age" ($p = 0.004$) and "Parent Gender" ($p = 0.043$). On the path of "Intention< – Knowledge", only "Child Age" was a significant moderator ($p = 0.019$).

The mediating effect testing result was showed in Table 4. Total Effect ($Z = 15.310$), Direct Effect($Z = 12.692$) and Indirect Effect ($Z = 7.600$) were all significant, and "0" was not included in the Bias-Corrected 95% CI and Percentile 95% CI. The results showed that the awareness was a partial mediator.

Discussion

As effectively way to prevent HPV infection, HPV vaccination should result in higher coverage in adolescents, especially in countries with large populations, such as China. It was after 2016 that the HPV vaccine for adolescents was introduced to China, and the psychological explanation for parents to accept it was very scarce. The socio-economic factors were found have clear correlations with parents' knowledge, awareness, and intention of HPV vaccination in previous literatur.[16,25] Educational interventions for adolescents and parents can further increase parental knowledge about vaccination, sending reminders of vaccination recommendations is an effective way to raise parental awareness about vaccination, and providing tailor-made professional advice from doctors and nurses in the clinic waiting room can decrease parents' refusal and delay to vaccinate their childre.[1,8,20] However, there is literature evidence indicated the cross-impacts among knowledge, awareness, and intentions, and further research is required on the psychological impact mechanisms of parents on adolescent HPV vaccination. In addition, in most of these cases, behavioral studies on HPV vaccination have focused on samples from developed countries, while the results from developing countries are insufficient.

To the best of our knowledge, our study is the first time cross-intervention analysis on multiple psychological factors and socio-economic factors, aiming at examining the key variables determine the behavioral intentions of adolescent parents regarding HPV vaccination. Moreover, the research data were collected from four central cities in China and provided a new and forward-looking analysis of the world's largest market for HPV vaccines. We found that teenagers' parents have clear and enough knowledge and awareness of HPV and vaccines, while most of them have low intentions. The predecessor literature has paid attention to this point and given some explanations. Leung & Law has assessed the parental knowledge about HPV and vaccine among different groups, and the level of education and household income of

respondents was examined as positive impact factor.[16,21] Awareness to adolescent HPV vaccination was somewhat higher among female, better-educated parents, and those aged 35–45 year.[16] Attitudes and practices are considered to be mediated by socioeconomic factors. However, most of these studies are based on univariate association analysis and cannot explain the determinants and mechanisms that influence parental behavioral intentions. The present study found that knowledge is a positive factor affecting awareness, and knowledge and awareness together determine parental behavioral intentions to adolescent HPV vaccination. Furthermore, awareness acts as a partial mediator to strengthen the influence from knowledge to intention. This result better explains why knowledge has a positive impact on intentions but cannot determine it linearly. Under the mediation of awareness, knowledge has a stronger effect on intention. This result has implications for the promotion of HPV vaccination in adolescents in practice, and the strategy is to promote parents' knowledge, awareness and intention simultaneously.

In the current study, girl's parents are more likely to turn awareness into behavioral intentions than the boy's parents if they have the approximate awareness of HPV and HPV vaccination (0.37 vs 0.19, $p = 0.046$). However, adolescent gender does not significantly affect the other paths: knowledge to awareness and knowledge to behavioral intentions. Previous studies have noted that the girls' parents have a higher willingness to have their children vaccinated with HPV. After all, girls are the direct victims of HPV infection.[3,26] In most studies of parents and health care providers, priority is given to girls, not boys.[27,28] But further research is needed to examine the psychological factors that lead to this outcome. The results of this study suggest that the determining factor for the stronger intentions of girls' parents is not knowledge but awareness. One possible reason is that the girls' parents get more awareness about the serious consequences of HPV infection, and thereby promoting their positive willingness.

Comparing with parents of junior middle school students (aged 12–14), parents of primary school students (aged 9–11) have higher possibilities to translate knowledge ($p = 0.004$) and awareness ($p = 0.0019$) into intentions, while the differences in the path of "knowledge–> awareness" between them are not significant. Parents of junior middle school students who participated in the survey were less willing to take their children HPV vaccine than parents of primary school students, which are contrary to our expectations and previous studies. For example, a survey conducted in the United States showed that the mother's intention to vaccinate her daughter under the age of 13 was lower than the intention of vaccinating her 13–18 daughter.[29] The likely reason is that the Chinese parents of the younger students pay more attention to the child's physical health, and strengthening their intention of HPV vaccination. However, the parents of middle school students should concern about the child's rebellious behavior and learning performance.[30,31] In addition, because most vaccinations are implemented before the age of 6, parents of junior middle school students are more likely to ignore vaccination among their adolescents. This also shows that education and reminders for parents of junior middle school students are necessary, and they are encouraged to assign some awareness to the child's physical health and vaccinations.

For adolescent HPV vaccination, mothers are more supportive than fathers. Of a survey of 8832 mothers completed in the United States, 48% of mothers plan to vaccinate their daughters with HPV vaccine if children were 9–12-years, 68% if she were 13–15-years, and 86% if she were 16–18 years old.[32] The current findings agree with previous findings, and mothers expressed a stronger willingness to protect their children from disease through HPV vaccination. Regarding parents' cognitive differences in HPV vaccination, previous studies have also shown that parental acceptance is associated with fewer perceived impairments, susceptibility to HPV, and physician suggestion.[33] Males have higher acceptance (74%-78%) of the HPV vaccine to prevent cervical cancer and genital warts, but the vaccination rate is low (10.7%).[29] Overall, the current findings further suggest that the mothers will be significantly stronger than fathers in the process of turning vaccination awareness into intention, and the mediating effect explains why the mother has a higher intention. These results may be easily targeted as mother-focused adolescent vaccination interventions. For example, health service providers should be effort to provide health education to mothers about vaccination safety and efficacy, and always remind mothers to pay attention to the vaccination schedule.

Regarding Chinese parents' intention of adolescent HPV vaccination, the parental age act as a moderator significantly enhancing the path from knowledge to awareness, and older parents have higher loading. From a demographic perspective, older parents have higher knowledge and awareness about HPV vaccination than younger parents. Under the above dual influence, the intention of HPV vaccination for adolescents is significantly stronger among older parents. Parents who are older-age or with at least one Medical worker in the family, will be significantly more knowledgeable and higher willingness.[34] Healthcare providers were more willing to recommend HPV vaccines to older parents of adolescent.[29] There is no school-based HPV vaccination program in China, and it is only available to young people when they are accompanied by their parents to the hospital's vaccination center. Doctors do not have sufficient time and opportunity to recommend HPV vaccination to parents, so they need to target specific groups of people, such as older parents, mothers, and girls' parents.

HPV vaccination is not included in China's national immunization program, so vaccinators are required to pay about $1,000 at their own expense. For most Chinese families, $1,000 is a considerable expenditure. The cost of vaccination will affect the patient's perceived usefulness and perceived ease of use. For example, most of the people who with higher education and higher incomes likely to approve that "influenza is severer than a bad cold" and "it is likely to develop into pneumonia", and these people are also strongly worried about the outbreak of influenza.[35] From the demographic perspective, parents from the low-income group (annual household income before tax <$15,000) had significantly lower average scores on knowledge, awareness, and intentions about HPV vaccination than the other three groups, which

confirmed the important impacts of family income and vaccination costs on parental psychological perception. Interestingly, new findings come from subgroup comparisons: household income is not a significant moderator in structural equation models, from knowledge to consciousness, from awareness to intentions, or from knowledge to intentions. The possible reason is that parents from the low-income group have insufficient knowledge, low awareness and weak intentions, while high-income parents have the strong perception in all the above three aspects, so income does not strengthen or weaken the relationship among constructs.

Our findings show the practical implications for policymakers, CDCs, and vaccine manufacturers to collaborate with a view to increase HPV vaccination coverage in China. The results highlight the importance of adolescent parents' knowledge and awareness about HPV vaccination, which is psychological factors determining the vaccination intentions. Policymakers should provide parents with abundant knowledge in public places such as schools and communities, especially regarding the serious consequences of HPV infection and the safety of HPV vaccines. The CDC should reminder adolescent parents about the HPV vaccination schedule by integrated ways (such as websites, telephones, and emails) to raise their awareness. Vaccine producers and immunization service providers should focus on key populations and provide effective health education to improve their vaccination intentions. Key populations include parents of girls aged 9–11, mothers of teenagers, and parents in high-income families. It is noteworthy that even parents have a strong vaccination intention for adolescents, while they will not certainly vaccinate their children. Vaccination service providers need to increase accessibility of vaccination services and reduce the total expenditures. In addition, the privacy of vaccinators should be well protected.

The strengths of this study include a large sample of emerging potential markets for HPV immunization, then cross-analysis among psychological factors and socioeconomic factors. These new data and results will provide theoretical support for improving the coverage of HPV vaccination among Chinese adolescents. The limitations of this study include its cross-sectional design, which prevents us from assessing the temporal relationship between HPV vaccination intentions and parental knowledge and awareness. Second, participants were all from urban cities, and the samples from rural areas were not collected because of lacking in validity. In the future, parents in rural areas will improve their HPV awareness and the cross-regional comparative studies should be conducted. In addition, since HPV vaccination was introduced to China only two years ago and vaccinated samples were unavailable. So, this study only analyzed the relationship between knowledge, awareness and intention, the impacts of these factors on actual vaccination behavior were not discussed. For this subject research in mainland China in the future, it is best to include this information in case of enough samples.

Conclusion

China is a huge potential market for 9–14 adolescent human papillomavirus (HPV) vaccination, and their parents' knowledge and awareness of HPV vaccination are important factors determining vaccination intentions. The empirical findings conducted on four cities in central China are partly consistent with previous studies, parents who have more knowledge about HPV will stronger intent to vaccinate their children with HPV, and health educations about HPV and HPV vaccination are necessary for adolescent and their parents. The important new findings are that awareness is a significant mediator that positively reinforces the influence from knowledge to behavioral intentions. In addition, socioeconomic factors are significant moderators, including the child's gender and age, parental gender and age, and family income. To improve the acceptability of HPV vaccination among Chinese adolescents, policymakers should develop positive strategies to parents of teenagers.

Methods

Participants

This cross-sectional study surveyed parents of adolescents (9–14 years) from June 2016 to August 2017 by self-administered questionnaire. Surveys were conducted in eight primary schools and eight junior high schools in four cities of Central China, Changsha, Wuhan, Xiangtan and Yongzhou. The admission age of elementary schools is 6 years old, and pupils in grades four to six are 9–11 years old. The enrollment age of junior middle school is 12 years old, and the junior middle school students are 12–14 years old. The respondents were selected using a random sampling approach based on student ID number. Parents are required to complete a questionnaire and submit it to the investigation team in two days. To facilitate the ongoing participation of parents, the investigators provided a stationery as a reward. The survey team invited 1,200 parents to participate, and 1,108 parents were eligible and completed the survey. We excluded respondents who did not hear about HPV knowledge, and eventually, 925 data consisted analytic sample. All participants signed a written informed consent form prior to entering the study.

Measures

A self-administered questionnaire was initially developed in English by a native translator and then translate it into Chinese. Modified from previous literature, the questionnaire included four parts and 25 items. The textual expression is modified to be more colloquial and some obscure terms are replaced by everyday language, and by this way to eliminate ambiguity. To examine the validity of each construct, a pilot test with 50 respondents was conducted and one item was removed. The questionnaire consists of the following four parts:

Part 1 is socioeconomic information and includes five items: child gender, child age, the gender of the parent who filled out the questionnaire, the age of the parent who filled out the questionnaire, annual household income before tax.

Part 2–4 are items of behavioral intentions and measured by the Likert 7-level scale (1 = strongly disagree; 7 = strongly agree). Eight items are included in part2 to survey the respondents' knowledge about child's HPV vaccination:

"KN1: HPV will not be carried for life"; "KN2: The incubation period after HPV infection is up to 10 years"; "KN3: HPV will be infected repeatedly"; "KN4: There are at least 13 HPVs in the high-risk category, especially HPV-16 and HPV-18"; "KN5: HPV is one of the leading causes of cervical cancer"; "KN6: Cervical cancer is a very serious disease"; "KN7: HPV vaccine is an effective means of preventing cervical cancer" and "KN8: WHO recommends HPV vaccine to be part of the national immunization program".[16,21]

Part3 includes eight items on respondents' awareness about child's HPV vaccination: "AW1: My child may be infected with HPV in the future"; "AW2: Girls should receive all 3 HPV vaccinations within 6 months"; "AW3: It is also necessary for boys to uptake HPV vaccination"; "AW4: HPV vaccination is expensive but valuable"; "AW5: It is a responsibility of every parent to take their children HPV vaccinations"; "AW6: I am not worried about the side effects of HPV vaccination"; "AW7: The doctor advised my child to receive HPV vaccination" and "AW8: People who are important to me suggested that my child should receive HPV vaccination".[25,36]

Part4 includes four items on respondents' intention about child's HPV vaccination: "IN1: I am highly willing to bring my child to uptake HPV vaccination"; "IN2: I intend to bring my child to receive HPV vaccination in the next year"; "IN3: I plan to take my child to complete HPV vaccination in the next year" and "IN4: I will recommend adolescent HPV immunization services to my friends".[17,37]

Statistical analysis

The three-step method recommended by Baron and Kenny (1986) was used to analyze the data. The first step is the demographic analysis, and statistical comparisons were made based on the socioeconomic groups of the participants. Indicators such as quantity accumulation, p-value, ratio, mean, and standard error are commonly used, and SPSS 22.0 for Windows is the analysis software. The second step is to measure the validity of the data, Cronbach's alpha, confirmative factor analysis, and average variance extracted (AVE) values were used to test the reliability of the scales. Cronbach's alpha analyses were conducted for the purpose of determining the consistency of continuous variables and ordered categorical variables, and the threshold value is $\alpha > 0$.[26,38] Confirmatory factor analysis (CFA) was performed on each construct, and the acceptable factor loading should be greater than 0.5.[22,24] Average variance extracted (AVE) was used to examine convergence validity, and the acceptable AVE is greater than 0.5.[22,39] The final step is to test the proposed model and hypotheses. Unlike linear regression or ANOVA, the structural equation model can simultaneously measure the interaction between multiple independent variables and latent variables. Therefore, the overall fit of the structural equations must also be validated, and it was tested by criteria are as follows: CHI/DF< 3, p-value< 0.05, NFI> 0.9, IFI> 0.9, RFI> 0.9, TLI> 0.9, CFI> 0.9, GFI> 0.9, AGFI> 0.9, RMSEA< 0.8.[23,24,40] To test moderating effects and mediating effects, Bootstrapping method was used, and the statistical tests were based on the two-tailed with 95% confidence intervals (CI).[41] In the mediation effect analysis, the data was extracted into two comparison groups based on each moderating variable. Child Gender: "Male" and "Female"; Child Age: "9–11 years" and "12–14 years"; Parent Gender: "Male" and "Female"; Parent Age: "30–39 years" and "≥ 50 years"; Income: "<$15,000" and "≥$45,000". The structural equations of the two sets of data were compared and the results were p-values, and $p < 0.05$ is an acceptable criterion. Guided by the recommendations of Baron and MacKinnon,[42] the mediating effect testing as the following three steps: Sobel test, the two-tailed test by bias-corrected confidence interval and percentile confidence interval based on Bootstrapping samples. Effects include three types: Total Effect, Direct Effect, and Indirect Effect. The significance test for each effect includes three criteria: the absolute value of Sobel-Z should be greater than 1.96; "0" is not included in Bias-Corrected 95% CI and Percentile 95% CI. The Total Effect and Indirect Effect are significant, which is the prerequisite for mediating analysis. If the Direct Effect is also significant, then the mediator is a "Partial Mediation"; otherwise it will be a "Complete Mediation".

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References

1. Krawczyk A, Knäuper B, Gilca V, Dubé E, Perez S, Joyal-Desmarais K, Rosberger Z. Parents' decision-making about the human papillomavirus vaccine for their daughters: I. Quantitative results. Hum Vaccin Immunother. 2015;11(2):322–329. doi:10.1080/21645515.2014.1004030.
2. Lane S, MacDonald NE, Marti M, Dumolard L. Vaccine hesitancy around the globe: analysis of three years of WHO/UNICEF Joint Reporting Form data-2015-2017. Vaccine. 2018;36(26):3861–3867. doi:10.1016/j.vaccine.2018.03.063.
3. Xue L, Hu W, Zhang H, Xie Z, Zhang X, Zhao F, Qiao Y, Gao L, Ma W. Awareness of and willingness to be vaccinated by human papillomavirus vaccine among junior middle school students in Jinan, China. Hum Vaccin Immunother. 2018;14(2):404–411. doi:10.1080/21645515.2017.1393132.
4. Gilkey MB, Calo WA, Marciniak MW, Brewer NT. Parents who refuse or delay HPV vaccine: differences in vaccination behavior, beliefs, and clinical communication preferences. Hum Vaccin Immunother. 2017;13(3):680–686. doi:10.1080/21645515.2016.1247134.
5. Gupta G, Glueck R, Patel PR. HPV vaccines: global perspectives. Hum Vaccin Immunother. 2017;13(6):1–4. doi:10.1080/21645515.2017.1289301.

6. Harrison SM, Wei MY, Lamerato LE, Petrie JG, Toth Martin E. Multimorbidity is associated with uptake of influenza vaccination. Vaccine. 2018;36(25):3635–3640. doi:10.1016/j.vaccine.2018.05.021.
7. Kornides ML, Fontenot HB, McRee A-L, Panozzo CA, Gilkey MB. Associations between parents' satisfaction with provider communication and HPV vaccination behaviors. Vaccine. 2018;36(19):2637–2642. doi:10.1016/j.vaccine.2018.03.060.
8. Lacombe-Duncan A, Newman PA, Baiden P. Human papillomavirus vaccine acceptability and decision-making among adolescent boys and parents: A meta-ethnography of qualitative studies. Vaccine. 2018;36(19):2545–2558. doi:10.1016/j.vaccine.2018.02.079.
9. Zimet GD, Mays RM, Sturm LA, Ravert AA, Perkins SM, Juliar BE. Parental attitudes about sexually transmitted infection vaccination for their adolescent children. Arch Pediatr Adolesc Med. 2005;159(2):132–137. doi:10.1001/archpedi.159.2.132.
10. Smith PJ, Humiston SG, Marcuse EK, Zhao Z, Dorell CG, Howes C, Hibbs B. 2011. Parental delay or refusal of vaccine doses, childhood vaccanation coverage at 24 months of age, and the health belief model. Public Health Rep. 126:135–146. doi:10.1177/00333549111260S215.
11. Gertig DM, Brotherton JM, Budd AC, Drennan K, Chappell G, Saville AM. Impact of a population-based HPV vaccination program on cervical abnormalities: a data linkage study. BMC Med. 2013;11. doi:10.1186/1741-7015-11-227.
12. McCaffery K, Waller J, Nazroo J, Wardle J. Social and psychological impact of HPV testing in cervical screening: a qualitative study. Sex Transm Infect. 2006;82(2):169–174. doi:10.1136/sti.2005.016436.
13. Williams-Brennan L, Gastaldo D, Cole DC, Paszat L. Social determinants of health associated with cervical cancer screening among women living in developing countries: a scoping review. Arch Gynecol Obstet. 2012;286(6):1487–1505. doi:10.1007/s00404-012-2575-0.
14. Poulos C, Yang J-C, Levin C, Van Minh H, Giang KB, Nguyen D. Mothers' preferences and willingness to pay for HPV vaccines in Vinh Long Province, Vietnam. Soc Sci Med. 2011;73(2):226–234. doi:10.1016/j.socscimed.2011.05.029.
15. Lewis RM, Markowitz LE. Human papillomavirus vaccination coverage among females and males, national health and nutrition examination survey, United States, 2007-2016. Vaccine. 2018;36(19):2567–2573. doi:10.1016/j.vaccine.2018.03.083.
16. Stocker P, Dehnert M, Schuster M, Wichmann O, Deleré Y. Human papillomavirus vaccine uptake, knowledge and attitude among 10th grade students in Berlin, Germany, 2010. Hum Vaccin Immunother. 2013;9(1):74–82. doi:10.4161/hv.22192.
17. Hoefer L, Tsikis S, Bethimoutis G, Nicolaidou E, Paparizos V, Antoniou C, Kanelleas A, Chardalias L, Stavropoulos G-E, Schneider J, et al. HPV vaccine acceptability in high-risk Greek men. Hum Vaccin Immunother. 2018;14(1):134–139. doi:10.1080/21645515.2017.1379640.
18. Esposito S, Franco E, Gavazzi G, de Miguel AG, Hardt R, Kassianos G, Bertrand I, Levant M-C, Soubeyrand B, López Trigo JA. The public health value of vaccination for seniors in Europe. Vaccine. 2018;36(19):2523–2528. doi:10.1016/j.vaccine.2018.03.053.
19. Brown KF, Shanley R, Cowley NAL, van Wijgerden J, Toff P, Falconer M, Ramsay M, Hudson MJ, Green J, Vincent CA, et al. Attitudinal and demographic predictors of measles, mumps and rubella (MMR) vaccine acceptance: development and validation of an evidence-based measurement instrument. Vaccine. 2011;29(8):1700–1709. doi:10.1016/j.vaccine.2010.12.030.
20. Esposito S, Tremolati E, Bellasio M, Chiarelli G, Marchisio P, Tiso B, Mosca F, Pardi G, Principi N. Attitudes and knowledge regarding influenza vaccination among hospital health workers caring for women and children. Vaccine. 2007;25(29):5283–5289. doi:10.1016/j.vaccine.2007.05.011.
21. Leung JTC, Law CK. Revisiting knowledge, attitudes and practice (KAP) on human papillomavirus (HPV) vaccination among female university students in Hong Kong. Hum Vaccin Immunother. 2018;14(4):924–930. doi:10.1080/21645515.2017.1415685.
22. Hair JF, Sarstedt M, Ringle CM, Mena JA. An assessment of the use of partial least squares structural equation modeling in marketing research. J Acad Marketing Sci. 2012;40(3):414–433. doi:10.1007/s11747-011-0261-6.
23. Bollen K, Lennox R. CONVENTIONAL WISDOM ON MEASUREMENT - A STRUCTURAL EQUATION PERSPECTIVE. Psychol Bull. 1991;110(2):305–314. doi:10.1037/0033-2909.110.2.305.
24. MacKinnon DP, Lockwood CM, Williams J. Confidence limits for the indirect effect: distribution of the product and resampling methods. Multivariate Behav Res. 2004;39(1):99–128. doi:10.1207/s15327906mbr3901_4.
25. Zou H, Meng X, Jia T, Zhu C, Chen X, Li X, Xu J, Ma W, Zhang X. Awareness and acceptance of human papillomavirus (HPV) vaccination among males attending a major sexual health clinic in Wuxi, China: A cross-sectional study. Hum Vaccin Immunother. 2016;12(6):1551–1559. doi:10.1080/21645515.2015.1099771.
26. Rho MJ, Choi IY, Lee J. Predictive factors of telemedicine service acceptance and behavioral intention of physicians. Int J Med Inform. 2014;83(8):559–571. doi:10.1016/j.ijmedinf.2014.05.005.
27. Cox DS, Cox AD, Sturm L, Zimet G. Behavioral interventions to increase HPV vaccination acceptability among mothers of young girls. Health Psychol. 2010;29(1):29–39. doi:10.1037/a0016942.
28. Bowyer HL, Forster AS, Marlow LAV, Waller J. Predicting human papillomavirus vaccination behaviour among adolescent girls in England: results from a prospective survey. J Family Plann Reproductive Health Care. 2014;40(1):14–22. doi:10.1136/jfprhc-2013-100583.
29. Liddon N, Hood J, Wynn BA, Markowitz LE. Acceptability of human papillomavirus vaccine for males: a review of the literature. J Adolesc Health. 2010;46(2):113–123. doi:10.1016/j.jadohealth.2009.11.199.
30. Hu SY, Hong Y, Zhao F-H, Lewkowitz AK, Chen F, Zhang W-H, Pan Q-J, Zhang X, Fei C, Li H, et al. Prevalence of HPV infection and cervical intraepithelial Neoplasia and attitudes towards HPV vaccination among Chinese women aged 18-25 in Jiangsu Province. Chin J Cancer Res. 2011;23(1):25–32. doi:10.1007/s11670-011-0025-3.
31. Yu, Y., Xu, M., Sun, J., Li, R., Li, M., Wang, J., Zhang, D., Xu, A. Human papillomavirus infection and vaccination: awareness and knowledge of HPV and acceptability of HPV vaccine among mothers of teenage daughters in Weihai, Shandong, China. PLoS ONE. 2016;11(1):e0146741.
32. Williams SE. What are the factors that contribute to parental vaccine-hesitancy and what can we do about it? Hum Vaccin Immunother. 2014;10(9):2584–2596. doi:10.4161/hv.28596.
33. Kahn JA, Ding L, Huang B, Zimet GD, Rosenthal SL, Frazier AL. Mothers' intention for their daughters and themselves to receive the human papillomavirus vaccine: a national study of nurses. Pediatrics. 2009;123(6):1439–1445. doi:10.1542/peds.2008-1536.
34. Di Giuseppe G, Abbate R, Liguori G, Albano L, Angelillo IF. Human papillomavirus and vaccination: knowledge, attitudes, and behavioural intention in adolescents and young women in Italy. Br J Cancer. 2008;99(2):225–229. doi:10.1038/sj.bjc.6604454.
35. Wendlandt R, Cowling BJ, Chen Y, Havers F, Shifflett P, Song Y, Zhang R, Iuliano D, Xu C, Yu H, et al. Knowledge, attitudes and practices related to the influenza virus and vaccine among older adults in Eastern China. Vaccine. 2018;36(19):2673–2682. doi:10.1016/j.vaccine.2018.03.052.
36. Lowry D. An investigation of student moral awareness and associated factors in two cohorts of an undergraduate business degree in a British university: implications for business ethics curriculum design. J Bus Ethics. 2003;48(1):7–19. doi:10.1023/B:BUSI.0000004383.81450.96.
37. Huang JC. Innovative health care delivery system–a questionnaire survey to evaluate the influence of behavioral factors on individuals' acceptance of telecare. Comput Biol Med. 2013;43(4):281–286. doi:10.1016/j.compbiomed.2012.12.011.
38. Teo T. 2015. Comparing pre-service and in-service teachers' acceptance of technology: assessment of measurement invariance

and latent mean differences. Comput Educ. 83:22–31. doi:10.1016/j.compedu.2014.11.015.
39. Sulzle K. Duopolistic competition between independent and collaborative business-to-business marketplaces. Int J Ind Organiz. 2009;27(5):615–624. doi:10.1016/j.ijindorg.2009.02.004.
40. Little TD, Cunningham WA, Shahar G, Widaman KF. To parcel or not to parcel: exploring the question, weighing the merits. Struct Equation Model. 2002;9(2):151–173. doi:10.1207/S15328007SEM0902_1.
41. MacKinnon DP, Lockwood CM, Hoffman JM, West SG, Sheets V. A comparison of methods to test mediation and other intervening variable effects. Psychol Methods. 2002;7(1):83–104.
42. Baron RM, Kenny DA. The moderator mediator variable distinction in social psychological-research - conceptual, strategic, and statistical considerations. J Pers Soc Psychol. 1986;51(6):1173–1182.