Mother's preferences and willingness to pay for human papillomavirus vaccination for their daughters: a discrete choice experiment in Hong Kong

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Key Points

(i) What is already known about the topic?

- Mother's preferences and willingness-to-pay (WTP) for human papillomavirus (HPV) vaccines are specific to culture and socio-economic status.
- HPV vaccines have not been integrated into Hong Kong government's immunisation schedule whilst the uptake rates amongst adolescent girls was 2.4% in 2008 and 9.1% in 2012.

(ii) What does the paper add to existing knowledge?

- This study provides new data on how HPV vaccine features are viewed and valued by mothers, by measuring how much benefit that mothers are perceived for ideal and current vaccine technologies.

- Side-effects, protection against cervical cancer, protection duration, and out-of-pocket cost determined the decision to receive or not receive the vaccine.

- The demand for HPV vaccines is high as indicated by maximum WTP but WTP for current vaccines is relatively lower than current market price, except for those who had a monthly household income of >HK$100,000 (US$12,821).

(iii) What insights does the paper provide for informing health care-related decision making?

- These findings would contribute to policy makings for the improvement of HPV vaccine uptake and inform the immunization service in Hong Kong.

- Subsidy or co-payment from government should be considered for the unmet demand of HPV vaccination.

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Abstract

Objective: To determine the preference of mothers in Hong Kong and their willingness-to-pay (WTP) for human papillomavirus (HPV) vaccination for their daughters.

Method: A discrete choice experiment survey with a two-alternative study design was developed. Data was collected from pediatric specialist outpatient clinics from 482 mothers with daughters aged 8-17 years old. Preferences of the four attributes of HPV vaccines (protection against cervical cancer, protection duration, side-effects, and out-of-pocket costs) were evaluated. The marginal and overall WTP were estimated using multinomial logistic regression. A subgroup analysis was conducted to explore the impact of socio-economic factors on mothers' WTP.

Results: Side-effects, protection against cervical cancer, protection duration, and out-of-pocket cost determined the decision to receive or not receive the vaccine. All attributes had a statistically significant effect on the preference of and the WTP for the vaccine. Maximum WTP for ideal vaccines (i.e. 100% protection, lifetime protection duration and 0% side effects) was HK$8,976 (US$1,129). The estimated WTP for vaccines currently available was HK$1,620 (US$208), lower than current market price. Among those who had a monthly household income of >HK$100,000 (US$12,821), the WTP for vaccines currently offered were higher than the market price.

Conclusions: This study provides new data on how features of the HPV vaccine are viewed and valued by mothers by determining their perception of ideal or improved and current vaccine technologies. These findings could contribute to future policies on the improvement of HPV vaccine and be useful for the immunization service in Hong Kong.

Keywords: vaccination; HPV; willingness-to-pay; discrete choice experiment;

Manuscript Text

Introduction

Cervical cancer was the eighth most common cancer among females in Hong Kong in 2014, accounting for about 3.3% of all new cancer cases in females(1). In the most recent cancer registry conducted in Hong Kong, there were 472 cases of cervical cancer diagnosed in 2014 with an age-standardised incidence rate of 8.1 per 100,000 in the population. In the past two decades, burden of the disease is relatively higher compared to other developed countries(2), although both the incidence and mortality rates of cervical cancer show a decreasing trend(1).

To further reduce the burden of cervical cancer, a cervical cancer screening program was organised and launched in 2004(3) and two preventive vaccines were introduced and became available for females in the community since 2006(4). The two commercially-available vaccines offer about 70% protection against various strains of the human papillomavirus (HPV)(5), which causes cervical carcinoma(6). However, HPV vaccines have yet to be integrated into the government's immunisation schedule in Hong Kong(7). Instead, people voluntarily can seek the vaccine in private clinics with the administration rate for adolescent girls being as low as 2.4% in 2008 and 9.1% in 2012 due to lack of HPV vaccination program currently organised(4, 8). However, including the HPV vaccination for girls aged from 12 years old and upwards is considered a cost-effective option compared to only offering cervical cancer screening (9, 10).

The success of the HPV vaccination program largely depends on the attitude of local stakeholders towards the risks and benefits of the vaccination (11-13). For the purpose of policy decision-making and improving health services, it is important to understand the various factors that may affect consumer's demand and their decision towards administering the vaccine. Factors associated with decision-making not only include the results of economic evaluation but also other considerations such as consumer's demand and preference. With regards to the HPV vaccination, mothers, who are highly involved in the decision to vaccinate or not vaccinate their daughters aged under 18 years old (14, 15), were therefore regarded as the critical consumer of the HPV vaccination. This study adopted a discrete choice experiment (DCE) to determine consumer preference of the HPV vaccine attributes and their willingness-to-pay (WTP) for the vaccine in Hong Kong. Similar studies have been conducted in other countries (16-20), however given that consumer preference may be subject to cultural differences, the applicability of research from overseas to the local community may be limited. The aim of this study is to

investigate the mothers' choices and decision-making when contemplating the attributes of the HPV vaccination, to determine local mothers' preferences and their WTPs towards the HPV vaccination. It is anticipated that this study will provide useful information on immunization services in Hong Kong to help create local HPV vaccination policies in a more effective and economically-sustainable way.

Methods

A cross-sectional survey was conducted in two local public hospitals where a stratified sampling approach was adopted to recruit mothers as subjects who match the inclusion criteria in paediatric specialist outpatient clinics in the Princess Margaret Hospital (PMH), Kowloon, and Queen Mary Hospital (QMH), Hong Kong Island. Mother with at least one daughter aged 8-17 years who has not received any HPV vaccination fulfilled the inclusion criteria of the study.

Target population

Given that the decision to vaccinate girls aged 8-17 would largely be determined by their mothers(14, 15), mothers in the paediatric clinics are regarded as the consumers in this study, as was the case in similar studies conducted overseas(16, 19). As such, fathers or any other carers of the girls were not considered in this survey.

Study Design

Attributes and levels identification

The relevant attributes and levels for DCE have been identified through literature review with reference to attributes used in the HPV vaccine DCE studies conducted in the US, Canada, the Netherlands and Vietnam (16-19) and interviews with relevant local experts, consisting of two paediatricians and two non-paediatric medical practitioners, who are involved in policy-making and are clinical experts in the fields of vaccinations and infectious diseases. A pilot of these attributes was conducted in October 2012 when our research team interviewed eight paediatricians and eight mothers who matched the inclusion criteria to identify the most important attributes to be included in the DCE survey. As a result, this pilot data shortlisted four most important attributes: 'Protection against cervical cancer', 'Protection duration', 'Side effects' and 'out-of-pocket cost'. Each attribute was assigned by four levels to give the

participants a range of the best and worst levels in our experimental design. All levels of each shortlisted attribute were selected based on the overseas DCE studies (16-18). Therefore, the identification of the four attributes and their relevant levels were justified and supported by literature review, and expert and respondent input from pilot data. The 'Protection against cervical cancer' levels were expressed in percentages (50% / 70% / 80% / 100%) and presented in terms of an absolute risk reduction that was mainly used for the description of risk information in the DCE survey(21). The 'Protection duration' levels were expressed in years (2 / 5 / 10 / lifetime = 100 years). The 'Side effects' levels concern the potential side-effects following administration of the HPV vaccination and were expressed in frequency (2:100 / 6:100 / 10:100 / 14:100). The 'Out-of-pocket cost' levels were expressed in HK dollars ($0 / $1,000 / $2,000 / $3,000).

Discrete choice experimental design

To avoid impractically-large sample sizes, the complete set of combinations of all attribute levels corresponding to a full factorial design (4*4*4*4=256 hypothetical vaccine profiles) was not used in this experiment. Rather, an orthogonal design (ORTHOPLAN procedure, IBM SPSS Statistics for Windows, Version 22.0) was used to produce 16 hypothetical vaccine profiles (see ***Table 1)*** allowing the main effects to be estimated.

In our experimental design we used choice sets which contained three options: two vaccine profiles and one "opt-out" option (i.e. no vaccination) (see ***Table 1 and 2***). The "opt-out" option is a realistic alternative for mothers who choose to vaccinate their daughters or not. Hence, when including the "opt-out" option, respondents were not forced to choose one of the vaccine profiles.

To ensure sufficient statistical efficiency by simultaneously considering respondent fatigue and cognitive feasibility, each respondent was asked to treat nine choice sets with the first choice set used for checking the respondents' rationality and the following eight choice sets for the statistical analyses.(22, 23). All respondents received the same nine choice sets (see ***Table 2***). In the first choice set, the second vaccine was better than the first vaccine with regard to protection, protection duration and side effects and the second vaccine cost less than the first one (see ***Table 2***). Respondents who preferred the first to the second vaccine were considered as irrational and excluded from the analyses. All eight choice sets were established from achieving four desirable properties(24) of orthogonality (i.e. the independence between attributes), a balanced level (i.e.

the same frequencies among levels of attributes) and a minimum overlap of levels for each attribute in each choice set.

Data collection

The survey included questions on socio-demographics, and aspects of health and vaccine experiences as identified from the literature. Trained research assistants screened the eligibility of participants identified in the paediatric specialist outpatient clinics in PMH and QMH between June 2014 and May 2015. The purpose of the study was explained to all participants and written consent was obtained. Each participant was presented with a choice to be surveyed in Traditional Chinese or English using an online platform (SurveyMonkey Inc, Palo Alto, California, USA, more information is available at www.surveymonkey.com). The survey was conducted using a portable electronic device on either a laptop or tablet. The research assistant accompanied each participant from commencement to completion of the survey with assistance on any queries they may have. Participants who refused to give consent were excluded from the study.

Sample Size Calculation

The experimental design consisted of eight choice set questions, each one examined by the respondents, and the largest number of levels for any of the attributes was four. According to Orme's rule of thumb formula(25), at least 125 participants (500 x 4 ÷ 8 ÷ 2) are required for a two-alternative experimental design (the alternatives of two vaccines profiles and "no vaccination" did not have varying attributes).

Statistical Analysis

The DCE choices were analysed by a multinomial logistic regression model, which regressed the response to the choice question (i.e. vaccine 1, vaccine 2, or no vaccination) of the vaccine attributes and levels (see ***Table 1***). For 'no vaccination' which is defined as the opt-out option, the levels of all attributes were all set to zero. It is assumed that there is a linearity in the levels of each attribute and there is no interaction between the attributes. By adopting the linear assumption, the marginal WTP would increase by the preference weight value with each percentage change of protection and side effects or each year change for protection duration. Therefore, the WTP could be determined by taking the ratio of the preference weight of the

attribute to the preference weight of out-of-pocket cost. The marginal WTP, which represents the monetary value that the participant is willing to pay for per unit for the attribute, is calculated by multiplying the preference weight of the attribute with changes in levels per unit (i.e. % for protection against cervical cancer and side effects or year for protection duration) as shown in ***Equation 1***. It can be derived from a specific case of the multinomial logistic regression model by solving the equation for this case for marginal WTP which is that the level for the attribute in question is set equal to one and the levels of all other attributes equal to zero.

Equation 1: $$\text{Marginal WTP} = -\frac{\text{Preference Weight}_{\text{attribute}} \times \Delta\text{Level}_{\text{attribute}}}{\text{Preference Weight}_{\text{out-of-pocket cost}}}$$

To calculate the total WTP for a specific vaccine profile, the marginal WTP for each attribute could be added together as follows:

Equation 2:

$$\text{Total WTP} = \text{Marginal WTP}_{\text{protection}} + \text{Marginal WTP}_{\text{protection duration}} + \text{Marginal WTP}_{\text{side effects}}$$

The maximum WTP for development of the vaccine using ideal technology was calculated by incorporating 100% protection, lifetime protection duration (i.e. 100 years), and 0% side effects (i.e. Marginal WTP for 0% side effects = 0) into ***Equation 2***. Furthermore, the total WTP for vaccines currently available is calculated by substituting the difference between the attribute levels of having the currently available vaccination (i.e. 70% protection against cervical cancer, 10-year protection duration and 10% of side effects, which were generally obtained from related clinical literature (26-29)) and not having the vaccination at all (0% protection against cervical cancer, 0-year protection duration and 0% of side effects). The corresponding marginal WTPs were computed using ***equation 1*** and adding them up by using ***equation 2***.

Nagelkerke's Pseudo R-square was reported to inform the goodness-of-fit of our regression models (30). The Nagelkerke's Pseudo R-square provides a measure of relative mode fit, ranging from 0 to 1 with higher values indicating better model fit. Regression model was considered as a good fit if Pseudo R-square ranged from 0.2 to 0.4(30). Regression coefficients estimates for each attribute with their corresponding 95% confidence intervals and the WTP were reported. Sub-group analyses were conducted for different groups of education levels (Primary 1 to 6 for those aged between 6-11 years old, junior secondary year 1 to 3 for those aged between 12-14

years old, senior secondary year 4 to 6 for those aged between 15-17 years old, tertiary leading to non-degrees and tertiary leading to degrees) and monthly household income (<HK$10,000; HK10,000-20,000; HK$20,001-30,000; HK$30,001-50,000; HK$50,001-100,000; and >HK$10,000). All statistical analyses were conducted using the Statistical Analysis System (SAS) version 9.3.

Results

Socio-demographic profiles and HPV perceptions

A total of 482 mothers (equalling a response rate of 79.1%) were interviewed with 181 and 301 complete responses from PMH and QMH respectively. The percentage of mothers who declined to participate the study was 20.9% with the main reasons for refusal given as not enough time or not interested in the study. ***Table 3*** shows the respondents' characteristics and experiences in relation to HPV or the HPV vaccine. The respondents had a mean age of 42.9 years, more than a half were born in Hong Kong and the majority were educated to secondary level or higher. Less than a half of the respondents had monthly household income more than HK$30,000. In general, respondents were familiar with the vaccine. More than three-quarters of the mothers had previously heard about the HPV vaccines and were concerned about their daughters' risk of HPV infection and cervical cancer. However, more than a half of the mothers believed the vaccines are somewhat / very unsafe and some of them refused their daughter to be administered. More than 95% declared that either sex education or abstinence should be taught at school.

Preferences and WTP for HPV vaccines of all respondents

In the rationality test, 11% of mothers chose no vaccination whereas 88.4% of mothers made a more reasonable choice of higher protection effectiveness, longer protection duration and lower out-of-pocket costs and probability of side effects.

With all the attributes treated as continuous variables in the regression, larger preference weights indicate a more-preferred vaccine attribute. For a specific attribute, a positive coefficient indicates that the corresponding attribute increases positivity and a higher level of this attribute is preferred. This also implies that a higher level of this attribute is associated

with a higher WTP as well as the increased likelihood to purchase. Conversely, a negative coefficient indicates that the attribute generates negativity and so lower levels are preferred. ***Table 4*** shows the mothers' preferences estimated from the statistical model. All the attributes have significant impact on WTP ($p<0.001$). Side-effects, protection against cervical cancer, protection duration, and out-of-pocket cost determined the decision to receive or not receive the vaccine. Our multinomial logistic regression had a pseudo R-square of 0.19612, indicating marginally acceptable model fit.

The marginal WTP for each attribute and the overall WTP for the vaccine are reported in ***Table 5***. For each attribute, zero was used as the reference group (i.e. no vaccination: 0% protection against cervical cancer, 0-year protection duration and 0% of side effects) for the corresponding marginal estimation of WTP. Vaccine effectiveness, defined as the cervical cancer protection rate, is highly valued with largest WTP margin of HK$5,431. Mothers are similarly willing to pay for lifetime protection (HK$3,545) and 0% side-effect (treated as HK$0). The maximum WTP for ideal vaccines developed (i.e. 100% protection, lifetime protection duration = 100 years and 0% side effects) is HK$8,976. It essentially reflects mothers' perceived benefits and the great demand of eliminating their daughter's risk of cervical cancer. On the other hand, the WTP calculated for vaccines currently available on the market is HK$1,620, which is relatively lower than the current market price (HK$4,500 for full-course consisting of 3 injections).

Preferences and WTP for HPV vaccines among different socio-economic groups

To further explore the impact of socio-economic factors on mothers' preferences and the WTP HPV vaccines, we conducted subgroup analyses on different levels of household income and education using the same statistical model. All the attributes showed a similar significant ($p<0.05$) impact on the WTP across all income and education groups, except the out-of-pocket cost attribute for primary education level. Preference weights and ranking of attributes were consistent with the overall analysis.

Mothers' WTP for current HPV vaccines among different education levels and income groups are accordingly illustrated in ***Figure 1***. In general, the maximum WTP and WTP for current

vaccines are positively correlated with education level. However, the maximum WTP for the full vaccine course peaked at non-degree tertiary level to the amount of HK$10,786 while the WTP for vaccines currently offered peaked at degree tertiary level to the amount of HK$1,942. It was also noted at a primary education level, the value of the WTP for current vaccines was negative (-HK$462) due to the greater negative impact of the marginal WTP of side effects than the positive impact of that of protection against cervical cancer and protection duration (see ***Appendix 2***).

Interestingly, in the stratified analysis for different income groups, both the maximum WTP and WTP for vaccines currently offered were higher for those with a household income level greater than HK$50,000 (see ***Figure 1***). The income group with a monthly household income of HK$30,001-50,000 is willing to pay the least for both the ideal or currently-offered vaccine for the prevention of cervical cancer. Mothers with a monthly household income of >HK$100,000 are the only one subgroup of the population who are willing to pay (HK$5,885) more than the current market price ($4,500) for vaccines currently offered.

Discussion

Cervical cancer is one of the common causes of cancer death and yet preventable cancers(1). The disease burden in Hong Kong is relatively higher than that in other developed countries (1). Currently, there is no universal organized vaccination program in Hong Kong while the HPV vaccination among teenage girls is largely opportunistic and the reported administration rate is continuously low (4, 8). Understanding the factors that determine the administration of the HPV vaccine is crucial for designing a more-effective vaccine-promotion program and for re-evaluating current immunisation policies. It is particularly important in the light of the recently-available and newly-developed 9-valent vaccine(31). As far as we are aware, this is the first local study using a quantitative approach and systemic analysis to reveal consumers' preferences and the WTP in relation to HPV vaccines in Hong Kong. Our study suggests that the effectiveness of cervical cancer protection, the protection duration, side effects and out-of-pocket costs are all significant factors in the determination of whether to administer the HPV vaccine. However, preferences and WTP for HPV vaccine are culture-specific and subject to socio-economic status as indicated by education level and household income.

In line with the previous studies(16-19), findings from this DCE survey demonstrate that 'protection effectiveness' and 'protection duration' were significant attributes when making the decision of whether to administer the HPV vaccination. This may be attributed to the differences in culture, ethnicity and education levels in medical decision-making(32). For example, our sample group from Hong Kong appears to be more conservative on sexual health issues (such as believing abstinence should be taught in schools, a rate of 96.7% vs. 21.6%) and less educated (tertiary level education or above, a rate of 27.5% vs. 39.7%) when compared with mothers in the US(16).

According to our survey, 80% of mothers have previously heard of the HPV vaccines, and the demand and conceived health benefits/risks from HPV vaccines are high as indicated by the maximum WTP. In the main and sub-group analyses, mothers' maximum WTP was consistently beyond the market price for the currently-available vaccine, regardless of their education and income levels. The value of the HPV vaccination might reflect the fear of cervical cancer, in part contributed by health education and marketing for HPV vaccinations and cervical cancer prevention from diverse sectors in the recent years(33). On the other hand, the overall WTP for vaccines currently offered is still lower than the market price (HK$4,500) except for those with monthly household income of >HK$100,000 (HK$5,885). Subsidised or part-payment from the government should be considered for to help meet the demand for the HPV vaccination, similar to that of the Childhood Influenza Vaccination Subsidy Scheme(34) which encourages parents of children aged between 6 months and 6 years to let their children receive influenza vaccinations in private clinics. Nevertheless, the WTP for current vaccines (HK$1,620) is likely to be underestimated due to its 70% effectiveness against cervical cancer, 10-year protection duration and 10% of all side effects based on literature. With the launch of the 9-valent HPV vaccine and a longer follow-up period being offered, the WTP for vaccines is expected to increase, and subsequently, the effectiveness and protection duration will also increase.

As expected, social disparity in Hong Kong is evident and the WTP of mothers varies depending on their monthly household incomes ($P<0.001$). However, it may be inappropriate to generalise the overall WTP to all consumers across Hong Kong when determining vaccination policy. As stratified by different income sub-groups (Figure 1), mothers with monthly household income of >HK$50,000 had a greater maximum WTP and WTP for vaccines currently being offered than mothers with an income of HK$50,000 or less. Mothers belonging to the monthly income group of HK$20,001-30,000 were willing to pay the least for either the vaccines currently offered or

those created by using ideal vaccines to prevent cervical cancer. However, mean WTP values of the sub-groups and the comparisons of WTP values between sub-groups should be interpreted with caution because there were no statistical inference tests for the mean differences in WTP values between sub-groups.

Limitations

Several limitations are worth mentioning. Firstly, although this is a stated-preference survey, it may also be argued that true preferences are not revealed as the decisions made are only hypothetical. However, we tried to maximize the validity of preferences by providing alternative options within the nine choice sets. Secondly, all choice sets considered a limited number of attributes based on the literature review and pilot study. Other attributes, especially for the protection against genital warts, may also reflect other preferences. Nevertheless, we included eight candidate attributes based on the best relevant literature available and selected the most important four attributes from the preferences of medical practitioners and mother at the pilot stage of the study. Our approach also reflects local stakeholders' preferences and was efficient and practical for the DCE design and questionnaire (35). Thirdly, this study examined preferences among mothers who were seeking medical care for their children in paediatric specialist outpatient clinics in two public hospitals. This survey does not include preferences of the WTP for HPV vaccines among mothers who choose not to seek medical care for their children at that time or from among mothers take their children to private healthcare institutions. Thus, a selection and response bias from the convenience sampling method cannot be avoided and the general applicability of the findings of this study to Hong Kong as a whole must be cautiously interpreted. Fourthly, in the multinomial logistic regression, we treated all variables as continuous with a linear specification and no interaction between attributes. Respondents' demographic characteristics and past experience of HPV/HPV vaccines were not adjusted in the model. Instead, we performed a stratified analysis based on income and the level of education that casts a light on the impact of social-economic factors of respondents' preferences and their willingness to allow their daughters to receive the vaccine. Despite that, our multinomial logistic regression had a pseudo R-square of 0.19612, marginally attaining the lower bound of model good fit and thus supporting the linear continuous specification. Finally, despite the majority of factors related to the respondents' socioeconomic status and knowledge of cervical cancer being collected (including household income, educational level, employment status, and past experience with cervical cancer/screening/vaccines), information on mothers' insurance status

was not collected in this survey. From previous systematic review(36) and local surveys(37, 38), health insurance status was one of the most important socioeconomic factors that would impact their vaccination intention and decision. Further studies could collect information on the status of insurance which may be an important factor affecting the WTP of respondents.

Conclusion

Side-effects, protection against cervical cancer, protection duration, and out-of-pocket cost were significant attributes making the decision of whether mother with daughters of 8-17 years ago choice to vaccinate or not. This study provided data on how features of the HPV vaccine are viewed and valued by mothers by determining their perception of ideal or improved and current vaccine technologies. These findings could contribute to future policies on the improvement of HPV vaccine and be useful for the immunization service in Hong Kong.

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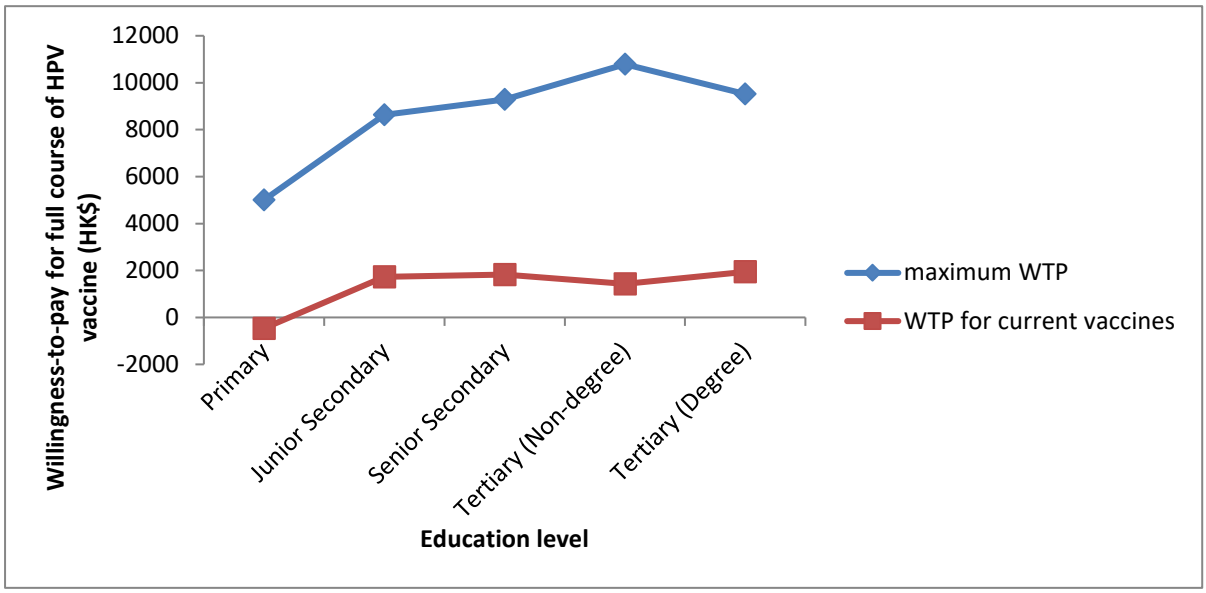
Figure Legend

Figure 1. Willingness-to-pay for HPV vaccines by mothers' education level (upper) and by monthly household income (lower).

Figure 1. Willingness-to-pay for HPV vaccines by mothers' education level (upper) and by monthly household income (lower)



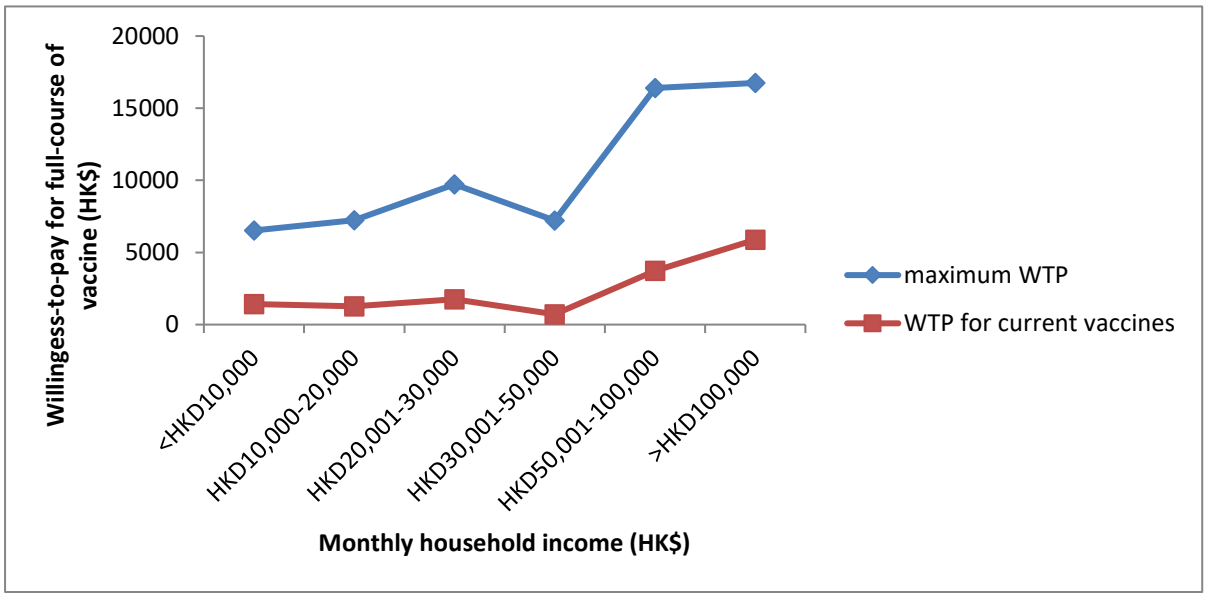


Table 1. Vaccine profiles

Profile	Protection against cervical cancer	Protection duration	Side effects	Out-of-pocket cost (HK$)
Vaccine 1	80%	2 years	6 :100	3000
Vaccine 2	50%	Lifetime	10 :100	2000
Vaccine 3	50%	5 years	14 :100	3000
Vaccine 4	100%	2 years	10 :100	1000
Vaccine 5	80%	5 years	10 :100	0
Vaccine 6	100%	Lifetime	2 :100	3000
Vaccine 7	50%	2 years	2 :100	0
Vaccine 8	80%	Lifetime	14 :100	1000
Vaccine 9	70%	10 years	10 :100	3000
Vaccine 10	100%	5 years	6 :100	2000
Vaccine 11	70%	Lifetime	6 :100	0
Vaccine 12	80%	10 years	2 :100	2000
Vaccine 13	70%	5 years	2 :100	1000
Vaccine 14	100%	10 years	14 :100	0
Vaccine 15	50%	10 years	6 :100	1000
Vaccine 16	70%	2 years	14 :100	2000

Table 2. Choice sets

Choice set	Vaccine profile (choose one only in each choice set)		
Rationality test	Protection against cervical cancer = 50% Protection duration = 2 years Side effects = 10 : 100 Out-of-pocket cost (HK$) = 3000	Protection against cervical cancer = 80% Protection duration =Lifetime Side effects = 6 : 100 Out-of-pocket cost (HK$) = 0	No vaccination
Choice set 1 of 8	Vaccine 1	Vaccine 2	No vaccination
Choice set 2 of 8	Vaccine 3	Vaccine 4	No vaccination
Choice set 3 of 8	Vaccine 5	Vaccine 6	No vaccination
Choice set 4 of 8	Vaccine 7	Vaccine 8	No vaccination
Choice set 5 of 8	Vaccine 9	Vaccine 10	No vaccination
Choice set 6 of 8	Vaccine 11	Vaccine 12	No vaccination
Choice set 7 of 8	Vaccine 13	Vaccine 14	No vaccination
Choice set 8 of 8	Vaccine 15	Vaccine 16	No vaccination

Table 3. Characteristics of respondents

Characteristics	Total (N=482)	PMH (N=181)	QMH (N=301)
Socio-demographic, n (%)			
Mothers' age (Mean, standard deviation)	42.9 (5.5)	41.4 (5.6)	43.8 (5.2)
Place of Birth			
Hong Kong	282 (58.5%)	95 (52.5%)	187 (62.1%)
Mainland China	174 (36.1%)	72 (39.8%)	102 (33.9%)
Others	26 (5.4%)	14 (7.7%)	12 (4.0%)
Education			
Primary or below	27 (5.6%)	15 (8.3%)	12 (4.0%)
Secondary	322 (66.9%)	136 (75.1%)	186 (61.8%)
Tertiary or above	133 (27.5%)	30 (16.6%)	103 (34.3%)
Monthly Household Income			
<HK$10,000	33 (6.85%)	21 (12.5%)	12 (4.0%)
HK$10,000-20,000	130 (27.0%)	66 (36.5%)	64 (21.3%)
HK$20,001-30,000	84 (17.4%)	28 (15.5%)	56 (18.6%)
HK$30,001-50,000	103 (21.4%)	29 (16.2%)	74 (24.6%)
HK$50,001-100,000	89 (18.5%)	22 (12.2%)	67 (26.3%)
>HK$100,000	27 (5.6%)	4 (2.2%)	23 (7.6%)
No income-retired	6 (1.24%)	4 (2.2%)	2 (0.7%)
No income-unemployed	10 (2.8%)	7 (3.9%)	3 (1.0%)
Number of Children (Mean, standard deviation)	1.84 (0.759)	1.94 (0.883)	1.78 (0.669)
1	161 (33.4%)	58 (32.0%)	103 (34.2%)
2	253 (52.5%)	87 (48.1%)	166 (55.2%)
>3	68 (14.1%)	36 (19.9%)	32 (10.6%)
Personal history and attitudes toward HPV, cervical cancer and related tests, n (%)			
Has previously heard of HPV vaccines before completing this survey	385 (79.9%)	151 (83.4%)	234 (77.7%)
Familiar with HPV	107 (22.2%)	42 (23.2%)	65 (21.6%)
Familiar with cervical cancer	312 (64.7%)	113 (62.4%)	199 (66.1%)
Knows a child/teenager who has had HPV vaccination	94 (19.5%)	28 (15.5%)	66 (21.9%)
Personal history of HPV vaccination	23 (4.8%)	7 (3.9%)	16 (5.3%)
Personal history of HPV infection	12 (2.5%)	5 (2.8%)	7 (2.3%)
Personal history of cervical cancer	5 (1.0%)	2 (1.1%)	3 (1.0%)
Personal history of other cancer	15 (3.1%)	4 (2.2%)	11 (3.7%)
Personal history of abnormal Pap smear test result	26 (5.4%)	9 (5.0%)	17 (5.7%)
Daughter has had Pap smear test	8 (1.7%)	1 (0.6%)	7 (2.3%)
Has concerns about daughter's risk of HPV	363 (75.3%)	135 (74.6%)	228 (75.8%)
Has concerns about daughter's risk of cervical cancer	370 (76.8%)	142 (78.5%)	228 (75.8%)
Believes daughter not at risk of HPV because not sexually active	466 (96.7%)	175 (96.7%)	291 (96.7%)
Refused vaccine for daughter	32 (6.6%)	7 (3.9%)	25 (8.3%)
Believes vaccines are somewhat / very unsafe	267 (55.4%)	98 (54.0%)	169 (56.2%)
Believes either sex education or abstinence should be taught at school	466 (96.7%)	174 (96.1%)	292 (97.0%)

Note: HPV = human papillomavirus; PMH = Princess Margaret Hospital; QMH = Queen Mary Hospital

Table 4. Coefficients estimates for attribute main effects using multinomial logistic regression

Attribute	Preference Weights	SE	P-value	95% CI	
Protection against cervical cancer (%)	0.01633	0.0007514	<0.0001	(0.01486	0.0178)
Protection duration (year)	0.01066	0.0005	<0.0001	(0.00968	0.01164)
Side effects (%)	-0.07626	0.00487	<0.0001	(-0.0858	-0.0667)
Out-of-pocket cost (HK$)	-0.0003007	0.0000207	<0.0001	(-0.0003	-0.0003)

SE = standard error; CI = confidence level

Notes:

Nagelkerke Pseudo R^2 = 0.19612

Table 5 Willingness-to-pay for the attributes of HPV vaccination

Attributes	Alternatives	Marginal WTP (HK$)
Protection against cervical cancer	from 0% to 100%	5430.66
	from 0% to 80%	4344.53
	from 0% to 70%	3801.46
	from 0% to 50%	2715.33
Protection duration	from 0 years to lifetime	3545.06
	from 0 to 10 years	354.51
	from 0 to 5 years	177.25
	from 0 to 2 years	70.90
Side effects	from 0 to 14 in 100	-3550.52
	from 0 to 10 in 100	-2536.08
	from 0 to 6 in 100	-1521.65
	from 0 to 2 in 100	-507.22
Maximum WTP*		8975.72
WTP for current available vaccine**		1619.89

WTP = Willingness-to-pay

Notes:

* Maximum WTP for ideal vaccines developed is calculated by incorporating 100% protection, lifetime protection duration (100 years) and 0% side effects (Marginal WTP for 0% side effects is treated as 0)

** WTP for current vaccine calculated by incorporating 70% protection against cervical cancer, 10-year protection duration and 10% side effects

Appendices

Appendix 1 List of Identified Attributes from Literature Review and Expert Interviews

Attributes	Levels	Reference
Protection against cervical cancer	50% / 70% / 90%	de Bekker-Groba et al. 2010
	50% / 70% / 90%	Poulos et al. 2011
	50% / 70% / 80% / 100%	Brown et al. 2010
	90% / 95% / 98% / 100%	Oteng et al. 2010
Protection against genital warts	No protection / 90%	Brown et al. 2010
	No protection / 90% / 95% / 98%	Oteng et al. 2010
Need for vaccine booster	Never / Every 5 years / Every 10 years	Oteng et al. 2010
Target group to vaccinate	Girls only / Girls and boys	Oteng et al. 2010
Protection duration	6 years / 25 years	de Bekker-Groba et al. 2010
	2 years / 10 years / lifetime	Poulos et al. 2011
	2 years / 5 years / 10 years / lifetime	Brown et al. 2010
Side effects - Serious - Mild side effects	2:100 / 6:100 / 10:100 / 14:100	Oteng et al 2010
	1:750,000 / 1:150000 / 1:30000	de Bekker-Groba et al. 2010
	1:50 / 1:30 / 1:10	de Bekker-Groba et al. 2010
Start age at vaccination	9 / 12 / 14 years old	de Bekker-Groba et al. 2010
Out-of-pocket cost	0 / 100 / 300 / 700 ($USD)	Brown et al. 2010
	6 / 29 / 118 / 353 ($USD)	Poulos et al. 2011
	0=insurance / 200 / 400 / 600 ($CAD)	Oteng et al 2010

Appendix 2 Coefficients estimates for attribute main effects by mothers' education levels

Education level	Attribute	Coefficient	SE	P-value
Primary	Protection against cervical cancer (%)	0.0073	0.00325	0.0244
	Protection duration (year)	0.01271	0.00219	<0.0001
	Side effects (%)	-0.08228	0.02215	0.0002
	Out-of-pocket cost (HK$)	-0.0003998	0.0000933	0.0819
Junior Secondary	Protection against cervical cancer (%)	0.01668	0.00176	<0.0001
	Protection duration (year)	0.01012	0.00116	<0.0001
	Side effects (%)	-0.0733	0.01132	<0.0001
	Out-of-pocket cost (HK$)	-0.0003104	0.0000482	<0.0001
Senior Secondary	Protection against cervical cancer (%)	0.01567	0.00107	<0.0001
	Protection duration (year)	0.01071	0.0007149	<0.0001
	Side effects (%)	-0.06862	0.0069	<0.0001
	Out-of-pocket cost (HK$)	-0.000284	0.0000293	<0.0001
Tertiary (Non-degree)	Protection against cervical cancer (%)	0.0162	0.00249	<0.0001
	Protection duration (year)	0.00931	0.00168	<0.0001
	Side effects (%)	-0.08897	0.0165	<0.0001
	Out-of-pocket cost (HK$)	-0.0002365	0.0000689	0.0006
Tertiary (Degree)	Protection against cervical cancer (%)	0.02117	0.00183	<0.0001
	Protection duration (year)	0.01141	0.00118	<0.0001
	Side effects (%)	-0.09315	0.01158	<0.0001
	Out-of-pocket cost (HK$)	-0.0003422	0.0000505	<0.0001

Appendix 3 Coefficients estimates for attribute main effects by monthly household income

Income level	Attribute	Coefficient	SE	P-value
<HK$10,000	Protection against cervical cancer (%)	0.01663	0.00288	<0.0001
	Protection duration (year)	0.0084	0.00189	<0.0001
	Side effects (%)	-0.07047	0.0186	0.0002
	Out-of-pocket cost (HK$)	-0.0003836	0.0000787	<0.0001
HK$10,000-20,000	Protection against cervical cancer (%)	0.01443	0.00145	<0.0001
	Protection duration (year)	0.01089	0.0009646	<0.0001
	Side effects (%)	-0.06716	0.00939	<0.0001
	Out-of-pocket cost (HK$)	-0.00035	0.00004	<0.0001
HK$20,001-30,000	Protection against cervical cancer (%)	0.01609	0.0018	<0.0001
	Protection duration (year)	0.0113	0.0012	<0.0001
	Side effects (%)	-0.07417	0.01164	<0.0001
	Out-of-pocket cost (HK$)	-0.0002817	0.0000496	<0.0001
HK$30,001-50,000	Protection against cervical cancer (%)	0.01448	0.00164	<0.0001
	Protection duration (year)	0.01137	0.0011	<0.0001
	Side effects (%)	-0.08713	0.01087	<0.0001
	Out-of-pocket cost (HK$)	-0.0003579	0.0000464	<0.0001
HK$50,001-100,000	Protection against cervical cancer (%)	0.0211	0.00177	<0.0001
	Protection duration (year)	0.00967	0.00117	<0.0001
	Side effects (%)	-0.08749	0.01129	<0.0001
	Out-of-pocket cost (HK$)	-0.0001876	0.0000479	<0.0001
>HK$100,000	Protection against cervical cancer (%)	0.03178	0.00385	<0.0001
	Protection duration (year)	0.01083	0.00224	<0.0001
	Side effects (%)	-0.08357	0.02154	0.0001
	Out-of-pocket cost (HK$)	-0.0002544	0.0000958	0.008