

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

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13 **Running Title:** WTP for HPV in Hong Kong

14

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21

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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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2 **their daughters: a discrete choice experiment in Hong Kong**

3

4 **Abstract**

5

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

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

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

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

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

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**Manuscript Text**

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**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

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

68

## 69 **Methods**

70

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

76

### 77 ***Target population***

78

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

83

### 84 ***Study Design***

85

#### 86 ***Attributes and levels identification***

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

97 participants a range of the best and worst levels in our experimental design. All levels of each  
98 shortlisted attribute were selected based on the overseas DCE studies (16-18). Therefore, the  
99 identification of the four attributes and their relevant levels were justified and supported by  
100 literature review, and expert and respondent input from pilot data. The ‘Protection against  
101 cervical cancer’ levels were expressed in percentages (50% / 70% / 80% / 100%) and presented  
102 in terms of an absolute risk reduction that was mainly used for the description of risk  
103 information in the DCE survey(21). The ‘Protection duration’ levels were expressed in years (2 /  
104 5 / 10 / lifetime = 100 years). The ‘Side effects’ levels concern the potential side-effects  
105 following administration of the HPV vaccination and were expressed in frequency (2:100 /  
106 6:100 / 10:100 / 14:100). The ‘Out-of-pocket cost’ levels were expressed in HK dollars (\$0 /  
107 \$1,000 / \$2,000 / \$3,000).

108

### 109 *Discrete choice experimental design*

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

115

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

121

122 To ensure sufficient statistical efficiency by simultaneously considering respondent fatigue and  
123 cognitive feasibility, each respondent was asked to treat nine choice sets with the first choice set  
124 used for checking the respondents' rationality and the following eight choice sets for the  
125 statistical analyses.(22, 23). All respondents received the same nine choice sets (see **Table 2**). In  
126 the first choice set, the second vaccine was better than the first vaccine with regard to protection,  
127 protection duration and side effects and the second vaccine cost less than the first one (see **Table**  
128 **2**). Respondents who preferred the first to the second vaccine were considered as irrational and  
129 excluded from the analyses. All eight choice sets were established from achieving four desirable  
130 properties(24) of orthogonality (i.e. the independence between attributes), a balanced level (i.e.

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

133

#### 134 *Data collection*

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

146

#### 147 *Sample Size Calculation*

148

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

154

#### 155 *Statistical Analysis*

156

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

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

172

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

174

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

177

178 **Equation 2:**

179 
$$\text{Total WTP} = \text{Marginal WTP}_{\text{protection}} + \text{Marginal WTP}_{\text{protection duration}} + \text{Marginal WTP}_{\text{side effects}}$$

180

181 The maximum WTP for development of the vaccine using ideal technology was calculated by  
 182 incorporating 100% protection, lifetime protection duration (i.e. 100 years), and 0% side effects  
 183 (i.e. Marginal WTP for 0% side effects = 0) into **Equation 2**. Furthermore, the total WTP for  
 184 vaccines currently available is calculated by substituting the difference between the attribute  
 185 levels of having the currently available vaccination (i.e. 70% protection against cervical cancer,  
 186 10-year protection duration and 10% of side effects, which were generally obtained from related  
 187 clinical literature (26-29)) and not having the vaccination at all (0% protection against cervical  
 188 cancer, 0-year protection duration and 0% of side effects). The corresponding marginal WTPs  
 189 were computed using **equation 1** and adding them up by using **equation 2**.

190

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



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

203

## 204 **Results**

205

### 206 *Socio-demographic profiles and HPV perceptions*

207

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

221

### 222 *Preferences and WTP for HPV vaccines of all respondents*

223

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

227

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

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

239

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

252

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

254

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

261

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

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

271

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

279

## 280 **Discussion**

281

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

296

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

305

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

323

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

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

335

### 336 **Limitations**

337

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

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

369

### 370 **Conclusion**

371

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

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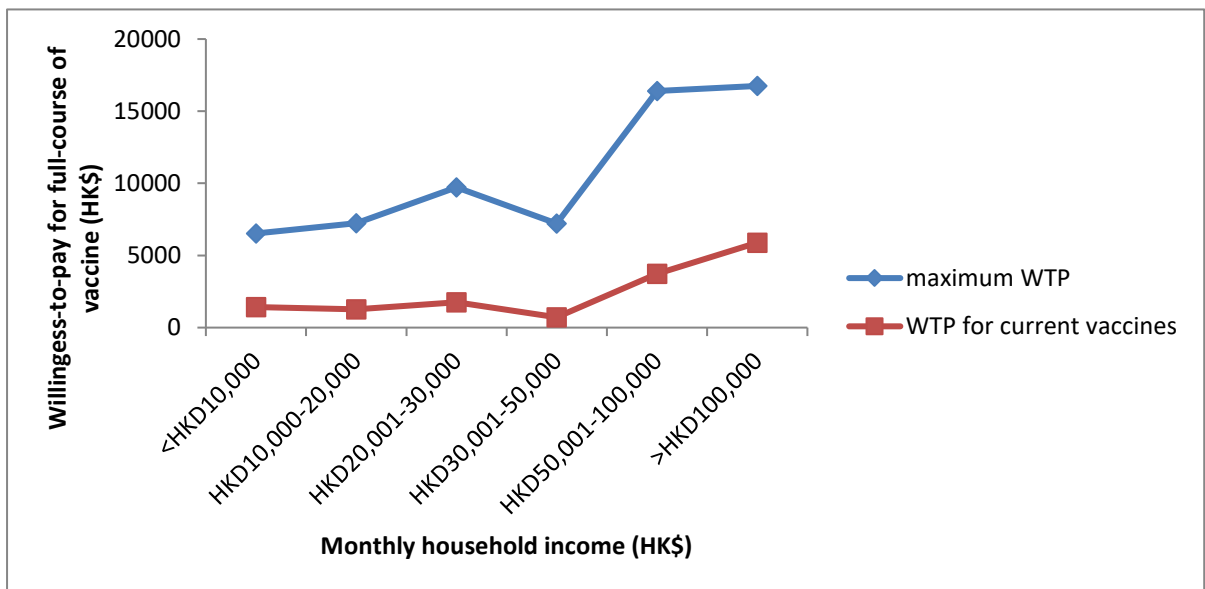
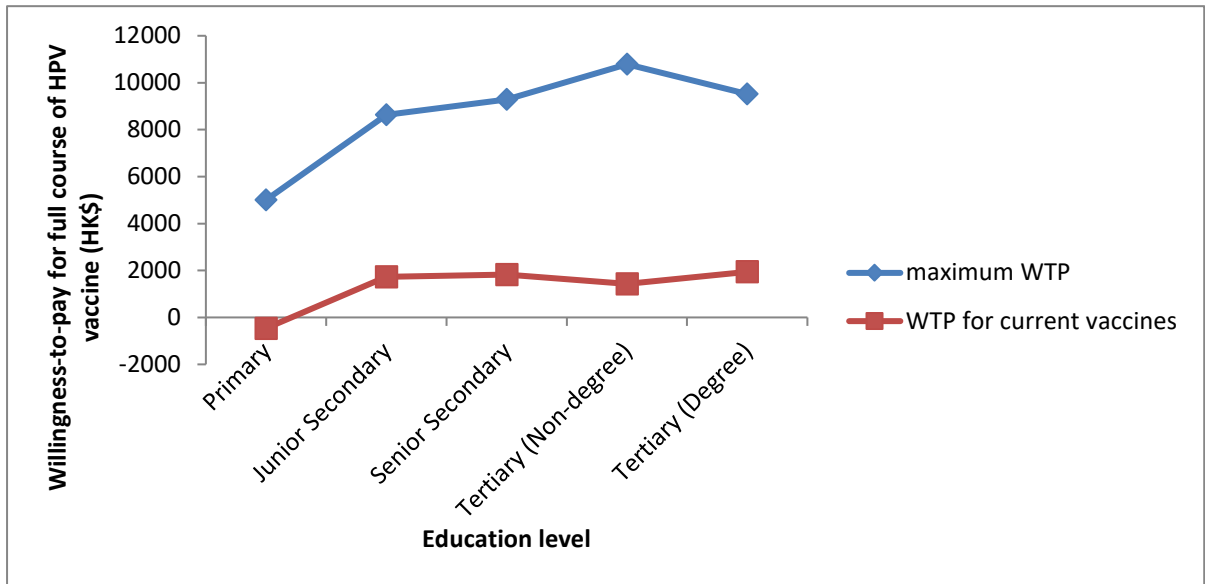


467 **Figure Legend**

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

470

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)
<i>Socio-demographic, n (%)</i>			
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%)
<i>Personal history and attitudes toward HPV, cervical cancer and related tests, n (%)</i>			
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	SE	P-value	95% CI	
	Weights				
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<sup>2</sup> = 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