Predictors of HPV vaccination uptake: a longitudinal study among parents

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Abstract

To assess among parents longitudinal predictors of human papillomavirus vaccination uptake for their daughters, random samples of parents were identified via municipal services and sent baseline questionnaires in June 2009 and follow-up questionnaires in November 2011 after their uptake decision. Hierarchical logistic regression analysis was used to assess whether demographic characteristics, and affective and social cognitive factors, predicted uptake at follow-up. Response rates of the baseline and follow-up questionnaire were 29.8% (1762/5918) and 74.3% (793/1067), respectively. Uptake was predicted by a later (2011) versus earlier (2010) decision about uptake since HPV vaccination implementation (OR 2.48; 95%CI: 1.11-5.52), anticipated regret about no uptake (OR 1.43; 95%CI: 1.08-1.89), and intention (OR 2.61; 95%CI: 1.47-4.61). There was an interaction between ambivalence and attitude (OR 1.68; 95%CI 1.14-2.47): parents with a positive attitude and a high ambivalence towards vaccination were more likely to have their daughter vaccinated than parents with a positive attitude and a low ambivalence. An informed choice about uptake (5/7 correct items) was made by 44%. In conclusion, uptake was predicted by intention, a later (2011) versus earlier (2010) decision, and by anticipated regret about no uptake. Decisions regarding new vaccines are difficult to make, we recommend a well-balanced implementation process.

Introduction

In Europe 60,000 women are diagnosed with cervical cancer annually (1). Cervical cancer can only develop in the presence of infection with high-risk human papillomavirus (HPV) (2-3). Two vaccines are available which protect against HPV 16 and 18, which together cause about 70% of cervical cancers (4). Preferably, the HPV vaccine is given prior to the initiation of sexual activity because the degree of protection is reduced after HPV infection and the incidence of HPV infection is highest in the first months after sexual debut (5-6).

In November 2008 the Dutch National Immunization Program (NIP), which is free of charge and voluntary, was extended with HPV vaccinations for 12-year-old girls. The effectiveness of the NIP depends on the availability of high-quality vaccines and acceptance by parents (7). Although childhood vaccination is well accepted among parents in the Netherlands, with a 95% vaccination rate (8), uptake rates of the HPV vaccine are much lower (58% in 2010) (9). In the Netherlands, 12-year-old girls are legally entitled to make their own decision about uptake. In practice, however, parents play a considerable role in the decision-making about the uptake of HPV vaccinations (10-11).

The present study aims to elucidate which psychosocial factors of parents predict intended and actual HPV vaccination uptake. Previous studies examining (HPV) vaccination behavior (12-14) have generally relied on psychosocial concepts derived from the Theory of Planned Behavior (TPB) (15) and the Health Belief Model (HBM) (16). Both models are useful in explaining HPV vaccination uptake. The TPB proposes that the most proximal determinant of behavior is intention which, in turn, is guided by three constructs: attitudes towards the behavior (i.e., the evaluation of advantages and disadvantages of a behavior), social norms (perceived approval or support of others), and perceived behavioral control (perceived ease of performing a behavior). In accordance with the TPB, the HBM suggests that behavior is the result of the evaluation of advantages and disadvantages of a behavior. However, the HBM suggests that an important prerequisite of such an evaluation is the perceived severity and personal susceptibility of acquiring an illness.

Although these models are useful in explaining behavior towards vaccination, including HPV vaccination, these models generally neglect more affective components that are likely to influence the decision about and actual uptake of HPV vaccination (17). Such affective factors may explain the vaccination behaviour, beyond the more cognitive predictors (18). In focus group discussions on decisions to vaccinate against HPV among parents of HPV vaccination eligible girls, factors that

played a role were the perceived lack of knowledge about HPV vaccination (risk), the felt ambivalence about the decision to vaccinate (simultaneous positive and negative evaluations of an attitude object) (19-20), (dis)trust in authorities, perceived parental responsibility, and the anticipation of regret of (not) acting (21). These findings underpin observations that the first HPV vaccination campaigns were met by (parental) concerns about the reliability of the vaccine. Therefore, in the present study, we assessed whether HPV vaccination uptake was predicted by anticipated regret (22), (dis)trust in health authorities (23), ambivalence, social norm, intention, knowledge and/or perceived severity and risk of cervical cancer. In addition to studying predictors of HPV vaccination uptake, changes in parental knowledge, attitudes and ambivalence were explored both before and after their decision about uptake.

Methods

Respondents

Questionnaires were sent to parents who had not yet made the decision to have their daughter vaccinated against HPV, but had to decide within 3-15 months when their daughters become 12 years of age. In the Netherlands, all girls receive an invitation to get vaccinated with the bivalent HPV vaccine (free of cost) in the year they turn 12 years of age.

Procedure

Random samples of parents were identified via four municipal health services spread throughout the Netherlands. These municipal services hold the addresses of all girls eligible for HPV vaccination in their region. The Dutch vaccination program offers one opportunity to get vaccinated against HPV, i.e. at age 12. The baseline questionnaire and an information letter were sent by mail to 5918 parents in June 2009 (the information letter was addressed to both parents). Parents could return the completed questionnaire in a self-addressed envelope. The questionnaire was pilot tested to check for face validity and for problems in interpretation (n=10).

In the baseline questionnaire we asked parents if they were willing to complete a follow-up questionnaire after the uptake decision. After the baseline questionnaires were sent, the Mexican flu (H1N1 virus) outbreak in the summer of 2009 led to the implementation of an H1N1 vaccination program. Therefore, the HPV vaccination programs were postponed until March 2010 and March 2011. Those who consented to complete a follow-up questionnaire received this questionnaire in November 2011.

The study was approved by the Medical Ethics Committee, of the Erasmus MC Rotterdam.

Baseline questionnaire

Factors derived from HBM

Perceived risk and severity. One single item assessed parents' perceived risk of their daughter getting cervical cancer if she was vaccinated, and one additional item assessed the perceived severity if their daughter would get cervical cancer. Both risk and severity items (adapted from Weinstein, 2000) were measured on an 11-point Likert scale, with higher scores indicating a higher risk or severity (24).

Factors derived from TPB

Attitudes towards HPV vaccination. Attitude was assessed using 9 items on a 5-point Likert scale phrased as: 'I think having my daughter getting vaccinated against cervical cancer is…', (e.g. bad - good, unimportant - important; unwise – wise, harmful – beneficial, adapted from Marteau et al., 2001 & van den Bergh, 2005) (25-26). The total score was calculated as the mean of the 9 items (Cronbach's alpha = 0.94).

Intention. Parents' intention to have their daughter vaccinated against cervical cancer was assessed with the question: 'I want to have my daughter vaccinated against cervical cancer' [response options: (definitely not, probably not, not sure (yet), probably, definitely)].

Parental subjective norms. Social norms were examined using 8 items on a 5-point Likert scale measuring the perceived beliefs about and desire to comply with family, partner, general practitioner and friends about vaccinating one's daughter against HPV (Cronbach's alpha = 0.82) (adapted from Tiro et al., 2005) (27). Parents' normative belief was assessed using a question about what percentage of other parents the respondents thought would want the vaccination for their 12-year-old daughters (11 options ranging from 0-100%) (adapted from Marlow et al., 2007) (28).

Complementary factors

HPV knowledge. We developed a knowledge scale with items about HPV, HPV vaccination and cervical cancer consisting of 4 true/false/don't know items (e.g. 'The HPV vaccination will decrease the risk of cervical cancer') and 3 multiple choice questions with 3 or 4 response options: [e.g. 'What is the protection rate of the HPV vaccine?' (response options: 55%; 70%; 85%; 100%)]. A total score was calculated by summing the correct responses (score range 0-7).

Decisional evaluation. The subscales satisfaction-uncertainty (e.g. 'I am satisfied with my decision', Cronbach's alpha = 0.80) and informed choice (e.g. 'I made a well-informed choice', Cronbach's alpha = 0.79) from the Decision Evaluation Scales (29) were included to assess how respondents evaluated their decision about having their daughter vaccinated or not. Both scales consisted of 5 items and responses were on a 5-point Likert scale (1=strongly disagree; 5=strongly agree).

Parental responsibility. To asses parental responsibility we used the subscale 'basic needs – health care' of the Perceptions of Parental Role Scales (30), consisting of 7 items (e.g. 'Arrange for child to

see dentist for routine checkup') on a 5-point Likert scale (1=not at all important; 5=very important). Cronbach's alpha = 0.73.

Anticipated regret and worry. To measure anticipated regret and worry we adapted 2 items from Korfage et. al., (2011) (31), measured on a 7-point Likert scale: 'If I don't have my daughter vaccinated against cervical cancer, then I would regret this/then I would worry' (1=definitely not; 7=definitely). The total score was calculated as the mean of the 2 items (Cronbach's alpha = 0.82).

Ambivalence. Ambivalence was measured using 2 items regarding positive and negative thoughts about HPV vaccination (adapted from Kaplan, 1972) (19): 'Considering only the positive things about HPV vaccination, and ignoring the negative things, then what do you think of HPV vaccination?' (response options: not at all positive; slightly positive; quite positive; extremely positive), and vice versa for negative thoughts. Total ambivalence was calculated as half the sum of the positive and negative judgments, minus the absolute difference between the two (32).

Trust. We developed two items to assess trust in the NIP and the HPV vaccine on a 6-point Likert scale (1=none; 6=a lot).

Reasons for vaccinating. Parents' reasons to have or not to have their daughter vaccinated were assessed using 11 predefined items for 'vaccinating', 17 items for 'not vaccinating', and an option to write down additional reasons.

Parental characteristics. We assessed sex, marital status, educational level, job status, ethnicity and religion of the parents. Female respondents were asked about their perceived risk of getting cervical cancer themselves (11-point Likert scale) (adapted from Marlow et al., 2007) (24) and if they had ever had an abnormal pap smear result.

Follow-up questionnaire

In the follow-up questionnaire we again assessed knowledge, attitude towards HPV vaccination, decisional evaluation, social norms (without compliance items, because compliance will logically not change over time), ambivalence, risk perception and severity, and trust. In addition, vaccination uptake was assessed.

An informed choice to participate or not (33-34), i.e. a choice based on relevant knowledge, consistent with the decision-maker's values and behaviourally implemented (25), was calculated using knowledge (at follow-up), attitude (at baseline), and uptake. Since there is no standard cut-off to

measure sufficient decision-relevant knowledge, we presented rates of informed decisions for 3, 4, 5 and 6 correct items (out of 7). As an example, results with the cut-off level of 5 correct items are fully displayed. An informed choice to have one's daughter vaccinated is characterized by sufficient decision-relevant knowledge, a positive attitude towards HPV vaccination (score >3), and having one's daughter vaccinated. An informed choice not to have one's daughter vaccinated is characterized by sufficient decision-relevant knowledge, a negative attitude towards HPV vaccination (score <3), and not having one's daughter vaccinated. An attitude score of 3 was defined as neutral.

Data analyses

The significance of mean and frequency differences between the baseline and follow-up group was assessed with the Mann-Whitney U test and Chi-square statistics. Pearson correlations were calculated to analyze associations between parent characteristics and social cognitive factors . To determine significant predictors of uptake (yes/no) measured at follow-up (T2), multiple hierarchical logistic regression analyses were performed with various factors measured at baseline as independent variables . In model 1 demographic characteristics were entered, because these were considered more distal and non-modifiable predictors. In model 2a parent characteristics were added. Model 2b consisted of demographic characteristics and social cognitive factors. In model 3 we entered demographic characteristics, parent characteristics, social cognitive factors, and an interaction term of attitude x ambivalence. Finally, in model 4 intention was added. Intention was added only in the last model because of its high correlation with other predictors. We aimed to show significant predictors with and without intention in the model. The procedure recommended by Aiken and West (1991) was used to determine whether ambivalence moderated the relationship between attitude and uptake, and the unstandardised regression coefficients were examined for attitude at different levels of ambivalence (i.e. the mean ambivalence score, 1 SD above the mean, and 1 SD below the mean) (35). To compare predictors of uptake and intention, the regression analysis of model 3 was repeated with intention as the dependent variable (ordinal logistic regression analyses).

To assess the impact of the time gap between baseline and follow-up on changes in attitude and ambivalence, two linear regression analyses were performed with change scores between the baseline and follow-up measurement. Variables that showed a significant ($p<0.05$) change over time were included. First, we used attitude as the dependent variable. Independent variables were knowledge, informed choice (subscale of the Decision Evaluation Scales (29)), ambivalence towards HPV vaccination, social norm, and trust in the vaccine. Second, we used ambivalence towards HPV vaccination as the dependent variable. Independent variables were knowledge, informed choice, social norm, and trust in the vaccine.

McNemar's test was used to assess the significance of the difference in correct responses to the knowledge items between baseline and follow-up .

Results

Respondents

The response rate of the baseline questionnaire was 29.8% (1762/5918). A total of 1067 respondents were willing to complete the follow-up questionnaire, of which 793 responded (74.3%) (Figure 1). At baseline, the mean age of those who completed both questionnaires was 43 years. Most respondents were female (baseline: 93.3%; follow-up: 93.7%), had an intermediate (baseline: 47.9%; follow-up: 46.7%) or high educational level (baseline: 40%; follow-up: 45.0%), and were born in the Netherlands (baseline: 91.0%; follow-up: 93.8%). In the follow-up group, 652 (82.2%) daughters had been vaccinated against HPV. The subgroup that completed the follow-up assessment differed significantly from those who did not, on six characteristics (Table 1).

Predictors of HPV vaccination uptake

Pearson's correlations showed that most associations between the predictors were positive (Table 2). Table 3 presents the results of the hierarchical logistic regression analyses to predict HPV vaccination uptake. The first model in which HPV vaccination uptake was regressed on demographic factors showed that uptake at follow-up was significantly predicted by religion, and the year the decision about uptake was made (2011 vs. 2010) (pseudo R2 = 0.06). Specifically, those respondents without a religious affiliation and those who had to decide in 2011 were more likely to have their daughter vaccinated. In model 2a, parent characteristics were added; this model explained an additional 29% variance. HPV vaccination was more likely for parents with a higher educational level, having no religious affiliation, decision about uptake in 2011, and higher trust in the NIP and the vaccine. In model 2b (demographic characteristics and social cognitive factors) significant predictors were: year of decision about uptake (2011 vs. 2010), a positive attitude towards HPV vaccination, social norm, and anticipated regret and worry about no uptake (pseudo R2 = 0.53). In model 3 (including all predictors except intention), vaccination was more likely for parents who had to decide in 2011, ambivalence towards HPV vaccination (under the condition that attitude is equal to 0), and higher anticipated regret and worry about no uptake. The interaction term of attitude x ambivalence was also significant (pseudo R2 = 0.57). In model 4 (including all predictors), significant predictors of uptake were the year the decision about uptake was made (2011 vs. 2010), a higher intention, ambivalence towards HPV

vaccination (under the condition that attitude is equal to 0), and the interaction term of attitude x ambivalence.

The significant interaction term attitude x ambivalence showed that the predictive validity of attitude improved as scores of ambivalence increased from low (b=0.89, p=0.0238) to moderate (b=1.44, p=0.001), and from moderate (b=1.44, p=0.001) to high (b=1.98, p<0.001).

Associations of HPV vaccination intention

Alternatively, we performed an ordinal logistic regression analysis with intention (instead of uptake) as dependent variable (results not shown). This analysis showed that a higher intention was associated with a positive attitude towards HPV vaccination (OR 19.53; 95%CI: 10.32-36.93) (under the condition that ambivalence is equal to 0), ambivalence towards HPV vaccination (OR 2.39; 95%CI: 1.10-5.18) (under the condition that attitude is equal to 0), trust in the vaccine (OR 1.62; 95%CI: 1.16-2.27), anticipated regret and worry about no uptake (OR 1.59; 95%CI: 1.32-1.92), and social norm (OR 1.07; 95%CI: 1.04-1.10). A lower uptake intention was associated with a higher educational level (OR 0.83; 95%CI: 0.70-0.99) and a higher perceived parental responsibility for their daughter's health (OR 0.48; 95%CI: 0.30-0.75). The interaction term of attitude x ambivalence was significant (OR 0.73; 95%CI: 0.59-0.90).

Impact of time

Favorable changes in attitudes towards HPV uptake over time were significantly related to an increase in trust in the vaccine (OR 1.45; 95%CI: 1.36-1.53) and social norm (OR 1.22; 95%CI: 1.15-1.28) over time, and a decrease in ambivalence towards HPV vaccination (OR 0.94; 95%CI: 0.91-0.98). A decrease in ambivalence towards HPV vaccination over time was significantly related to an increase in feeling informed about HPV vaccination (OR 0.79; 95%CI: 0.69-0.91) and an increase in trust in the vaccine (OR 0.88; 95%CI: 0.77-0.99) over time.

Informed decision-making

Overall, knowledge levels about the degree/duration of protection was low at baseline and at follow-up (33-43% correct answers). Percentages of correct responses to 5 knowledge items increased significantly at follow-up (Table 4). When 5 (out of 7) correct items were defined as sufficient decision-

relevant knowledge, then n=338 (43.9%) of the respondents made an informed choice about uptake. When 4 correct items were considered sufficient, then n=437 (65.7%) of the respondents made an informed choice about uptake (Table 5).

Reasons for vaccinating or not

Main reasons as reported by parents at baseline to have their daughter vaccinated include feeling responsible for her health (n=947; 54.9%), a family history of cancer (n=128; 7.4%), anticipating regret in case their daughter gets cervical cancer (n=103; 6.0%), and other (n=547; 31.7%). Main reasons as reported by parents at baseline not to have their daughter vaccinated include that consequences of vaccinating are unpredictable (497; 28.8%), fear of serious side-effects (n=401; 23.2%), and too little information about the vaccine being available (n=125; 7.2%).

Discussion

In this study among parents we assessed longitudinal predictors of HPV vaccination uptake of their daughters. Uptake was predicted by intention, a later (2011) versus earlier (2010) decision about uptake, and anticipated regret and worry in case of abstaining from HPV vaccination. Ambivalence towards HPV vaccination at baseline moderated the attitude (baseline)- uptake (follow-up) relationship, with the attitude-uptake relationship being stronger at higher ambivalence levels.

HPV vaccination was most strongly predicted by intention, which fits the TPB model and was also reported in an earlier study on predictors of HPV vaccination uptake (22). In turn, HPV vaccination intention was positively associated with educational level, perceived parental responsibility for one's daughter's health, trust in the vaccine, the belief that according to significant others their daughter should be vaccinated, and the motivation to comply with that (social norm), and anticipated regret and worry (which also predicted uptake). The relationship found between intention and uptake, and between intention and social norm, is consistent with the TPB model and with another study (22) which also confirms the association we found between anticipated regret/worry and uptake, and anticipated regret/worry and intention. The factors 'perceived susceptibility' and 'severity' of cancer of the HBM were not associated with intention or uptake, which confirms the results of an earlier study (22, 36).

A possible explanation for the positive effect on uptake of having to decide later (2011) versus earlier (2010) might be the amount of time that passed between the baseline questionnaire (2009) when an intensive societal debate involving politics, physicians, media, parents and girls about HPV vaccination was ongoing and the actual decision about uptake of vaccination. In 2011 this debate probably had less impact on the uptake decision than in 2010. Also, after millions of girls worldwide had been vaccinated and no serious side-effects had been reported, parents who had to decide later versus earlier probably felt more reassured about the vaccine's safety.

The present study shows that ambivalence moderated the attitude-uptake relationship. Parents with a positive attitude and a high level of ambivalence towards HPV vaccination were more likely to have their daughter vaccinated than parents with a positive attitude and a low level of ambivalence. This finding might be explained in two ways. First, ambivalence is characterized as being subjectively uncomfortable and people may be motivated to resolve the conflicting evaluations that they hold (37), e.g. by searching for information. Second, earlier studies found that ambivalent

people processed pro-attitudinal messages to a greater extent than counter-attitudinal messages, probably because pro-attitudinal messages are more likely to reduce ambivalence (38-39). Taking these two mechanisms together, it is likely that in our study ambivalent parents with a positive attitude towards HPV vaccination processed 'positive' messages about HPV vaccination to a greater extent than 'negative' messages, and were therefore more likely to have their daughter vaccinated. In other words, parents who had both positive attitudes and were ambivalent towards HPV vaccination, became even more positive because they elaborated only information in favor of HPV vaccination. This may imply that this 'biased' information processing has a negative impact on informed decision-making, although parents will have gained more knowledge during their efforts to resolve their ambivalence.

Assessing decisional factors related to HPV vaccination both before and after the decision-making process about uptake, provided a unique opportunity to determine changes in those factors over time. Since uptake was predicted by intention, and intention was highly correlated with attitude (r=0.84) (at baseline), we think it is relevant to show which factors are important for changes in attitude over time. Our results show that a more positive attitude towards HPV vaccination over time was associated with an increase in trust in the vaccine and in social norm over time, and a decrease in ambivalence towards HPV vaccination over time. This latter factor was related to an increase in feeling informed about HPV vaccination and an increase in trust in the vaccine over time. In summary, over time parents felt better informed, became less ambivalent and had more trust in the vaccine. These results are in accordance with our finding that girls who had to decide with their parents whether or not to be vaccinated in 2011, were more likely to be vaccinated than those who had to decide in 2010.

An important finding is that knowledge about the duration of protection was low at both baseline and follow-up. For instance, about 65% of the parents thought that protection lasts 30 years or even lifelong. Since the duration of protection is still unknown, it is important that parents and girls know that booster vaccinations might be needed in the future. When we applied a cut-off of 4 or 5 correct knowledge items (out of 7), then the rates of informed choice about uptake were not high, 66% and 44%, respectively. However, this finding should be interpreted with caution because the time period between the assessment of knowledge and the last vaccination out of 3 shots was 1 month

(decision in 2011) or 14 months (decision in 2010). In educational material it should be clearly stated what is known and not yet known about HPV vaccination.

Study strengths include: the longitudinal design, as recommended by authors of a cross sectional study (40); the high (absolute) number of respondents of the baseline (n=1725) and follow-up questionnaires (n=793); and the high response rate of the follow-up questionnaire (74%).

Limitations

A limitation was the low response rate of the baseline questionnaire (30%), which might be due to the length of the questionnaire. Our sample may therefore not be representative of the general population, as few parents had a low educational level. Also, demographic characteristics of the follow-up group were slightly different from those of the baseline group, with more parents being better educated and well-off at follow-up. These parents might possibly be more likely than those in the wider population to seek to reduce high ambivalence by searching information, allowing them to respond positively to the vaccine invitation - rather than do nothing.

Conclusion

In conclusion, this study shows that intention, a later versus earlier decision about uptake, and anticipated regret/worry about abstaining from vaccination were predictors of uptake. Anticipated regret was a common predictor of intention and uptake and thus an important factor in the decision-making process about HPV vaccination. In turn, predictors of intention, like social norm and trust in the vaccine, are also important when deciding about HPV vaccination. Over time, parents felt better informed, became less ambivalent and had more trust in the vaccine.

Practice implications

This study shows the usefulness of including affective factors in studies examining HPV vaccination behaviour, since anticipated regret, trust in the vaccine, and ambivalence were found to play a role in the decision-making about uptake. However, it is also important that parents are enabled to base their decision about HPV vaccination of their daughter on decision-relevant knowledge. Since these results suggest that people need sufficient time to decide about the uptake of a new vaccine, we recommend a well-balanced, stepwise process of implementation, i.e. let parents first become aware of the link

between HPV and cervical cancer, then provide them with balanced information about all the knowns and also the unknowns of HPV vaccination, and then finally offer them the opportunity to have their daughter vaccinated. Since two third of parents wrongly thought that protection lasts 30 years or even lifelong, educational material should clearly state that booster vaccinations might be needed in the future.

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Conflict of interest

There is no conflict of interest to declare.

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Table 1: Characteristics of the respondents (parents)**.**

	Total baseline group (n=1725)		Subgroup that completed follow-up assessment (n=793)		
Characteristics	**Mean**	**(SD)**	**Mean**	**(SD)**	**p-value**
Age at baseline (years)	42.8	4.17	43.0	4.05	0.015
range	29-59		32-58		
Children					
Age (years)	13.3	3.42	13.3	3.21	
Age range	0-34		0-34		
Number of girls	1.7	0.78	1.7	0.74	
Number of boys	0.9	0.77	0.9	0.76	
	n	**%**	**n**	**%**	
Marital status					0.372
Married/cohabiting	1477	87.2	693	89.4	
Partner, but living alone	34	2.0	16	2.1	
No partner	165	9.7	66	8.5	
Sex					0.233
Female	1596	93.3	743	93.7	
Educational level					<0.001
Low	200	12.1	64	8.3	
Intermediate	789	47.9	358	46.7	
High	658	40.0	345	45.0	
Job status					0.270
Paid job	1268	78.6	617	81.6	
Housewife or houseman or unpaid job or student	295	18.3	119	15.7	
No job	51	3.2	20	2.6	
Net income per month (euros)					<0.001
< 1,500	161	10.5	45	6.1	
1,500 – 3,000	584	38.2	267	36.4	
3,000 – 4,500	488	32.0	264	36.0	
> 4,500	294	19.3	157	21.4	
Country of birth					<0.001
The Netherlands	1550	91.0	740	93.8	
Turkey; Morocco	37	2.2	6	0.8	
Suriname; Aruba; Netherlands Antilles	16	0.9	4	0.5	
Other	100	5.9	39	4.9	
Country of birth of both parents					0.002
The Netherlands	1459	88.5	703	89.4	

Turkey; Morocco	44	2.7	9	1.1	
Suriname; Aruba; Netherlands Antilles	19	1.2	5	0.6	
Other	126	7.6	69	8.8	
Religion					0.590
None	960	57.0	450	57.9	
Christian	611	36.3	290	37.3	
Muslim	57	3.4	13	1.7	
Other	54	3.2	24	3.1	
Decision about HPV vaccination uptake					
In 2010	-	-	555	71.5	
In 2011	-	-	221	28.5	
If female: abnormal pap smear result					0.103
Yes	185	11.7	98	13.2	
No	1351	85.6	634	85.3	
Never had a pap smear taken	42	2.7	11	1.5	
Daughter vaccinated against DPTP[1] and MMR[2]					0.038
Yes	1654	95.9	778	98.1	
Daughter vaccinated against HPV					
Yes	-	-	652	83.1	

The subgroup that completed the follow-up assessment differed significantly from the baseline group on six characteristics.

[1] DPTP refers to diphtheria, pertussis, tetanus and poliomyelitis.

[2] MMR refers to measles, mumps and rubella.

Table 2. Means, standard deviations (SD) and Pearson's correlation between the predictors at baseline (n=793)

	Mean (SD)	1	2	3	4	5	6	7	8	9	10	11	12
1. Parental responsibility	4.50 (0.46)												
2. Trust in NIP	4.86 (0.67)	0.04											
3. Trust in vaccine	4.31 (0.92)	0.06	0.54*										
4. Perceived susceptibility of mother to cervical cancer	4.97 (1.74)	0.05	0.01	0.02									
5. Intention	3.89 (1.07)	0.03	0.48*	0.73**	0.05								
6. Ambivalence	1.71 (1.07)	-0.07	-0.20**	-0.26**	0.01	-0.29**							
7. Attitude towards HPV vaccination	3.73 (1.44)	0.09**	0.51**	0.77**	0.05	0.84**	-0.33**						
8. Social norm	6.10 (10.31)	0.15**	0.33**	0.51**	0.07	0.61**	-0.18**	0.64**					
9. Normative belief	7.12 (1.57)	0.05	0.19**	0.33**	0.01	0.33**	-0.09*	0.34**	0.37**				
10. Knowledge	4.32 (1.49)	-0.09**	0.10**	0.03	0.03	0.03	-0.07	0.02	0.03	-0.03			
11. Perceived susceptibility of daughter if vaccinated to cervical cancer	3.73 (1.44)	0.06	-0.23**	-0.30**	0.41**	-0.26**	0.03	-0.31**	-0.23**	-0.23**	0.01		
12. Perceived severity of cervical cancer	10.60 (0.93)	0.25**	0.04	0.05	0.03	0.05	0.04	0.06	0.07	0.09*	-0.12**	0.01	
13. Anticipated regret and worry about no uptake	4.92 (1.56)	0.23**	0.38**	0.62**	0.11**	0.69**	-0.19**	0.71**	0.53**	0.36**	-0.06	-0.23**	0.20**

Small effect size: r > 0.10; medium effect size: 0.30 < r < 0.50; large effect size: r > 0.50. * p < 0.05 ** p< 0.01. NIP; Dutch National Immunization Program

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Table 3. Hierarchical logistic regression analyses with uptake (yes/no) as dependent variable: all variables are reported by parents at baseline.

	Univariate	Model 1 (n=708)	Model 2a (n=644)	Model 2b (n=617)
	OR (95% CI)	OR (95% CI)	OR (95% CI)	OR (95% CI)
Demographic characteristics				
Age of parents (years)	1.02 (0.98-1.07)	1.01 (0.96-1.06)	1.03 (0.96-1.09)	1.02 (0.95-1.10)
Educational level	1.15 (1.00-1.34)	1.17 (0.99-1.37)	**1.25 (1.00-1.54)***	1.20 (0.93-1.55)
No religious affiliation	**1.73 (1.19-2.53)****	**1.63 (1.09-2.42)***	**1.73 (1.07-2.81)***	1.12 (0.63-2.00)
Decision about uptake: 2011 (vs. 2010)	**2.08 (1.28-3.36)****	**2.68 (1.57-4.53)*****	**2.69 (1.42-5.10)****	**2.45 (1.20-5.01)***
Parent characteristics				
No abnormal smear experience	1.02 (0.58-1.78)		0.94 (0.45-1.95)	
Parental responsibility	1.23 (0.83-1.84)		1.53 (0.91-2.59)	
Trust in NIP	**3.54 (2.61-4.81)*****		**1.82 (1.21-2.74)****	
Trust in vaccine	**3.64 (2.85-4.64)*****		**3.41 (2.49-4.68)*****	
Perceived susceptibility of mother to cervical cancer	1.04 (0.93-1.16)		1.03 (0.88-1.21)	
Social cognitive factors				
Intention	**4.59 (3.56-5.92)*****			
Ambivalence towards HPV vaccination	**0.82 (0.69-0.92)***			1.07 (0.79-1.45)
Positive attitude towards HPV vaccination	**5.73 (4.26-7.71)*****			**3.43 (2.01-5.84)*****
Social norm	**1.21 (1.16-1.26)*****			**1.07 (1.01-1.13)***
Normative belief	**1.44 (1.28-1.63)*****			0.99 (0.81-1.21)
Knowledge	1.08 (0.95-1.22)			0.95 (0.87-1.04)
Perceived susceptibility of daughter if vaccinated to cervical cancer	**0.65 (0.57-0.74)*****			0.86 (0.70-1.05)
Perceived severity of cervical cancer	**1.22 (1.03-1.46)***			1.08 (0.81-1.42)
Anticipated regret and worry about no uptake	**2.23 (1.93-2.58)*****			**1.43 (1.11-1.84)****
Ambivalence x attitude interaction				
R^2		0.06	0.35	0.53

*p < 0.05 **p < 0.01 and ***p < 0.001
OR, odds ratio. CI, confidence interval.

	Model 3 (n=572) OR (95% CI)	Model 4 (n=569) OR (95% CI)
Demographic characteristics		
Age of parents (years)	1.02 (0.94-1.11)	1.01 (0.93-1.09)
Educational level	1.27 (0.96-1.70)	1.33 (0.99-1.78)
No religious affiliation	1.19 (0.63-2.25)	1.16 (0.60-2.23)
Decision about uptake: 2011 (vs. 2010)	**2.48 (1.11-5.52)***	**2.60 (1.16-5.80)***
Parent characteristics		
No Abnormal smear experience	0.70 (0.26-1.88)	0.68 (0.24-1.95)
Parental responsibility	1.55 (0.76-3.18)	1.86 (0.90-3.83)
Trust in NIP	1.40 (0.86-2.30)	1.33 (0.79-2.24)
Trust in vaccine	1.23 (0.69-1.83)	0.99 (0.59-1.67)
Perceived susceptibility of mother to cervical cancer	0.97 (0.77-1.22)	0.96 (0.76-1.22)
Social cognitive factors		
Intention		**2.61 (1.47-4.61)****
Ambivalence towards HPV vaccination	**0.27 (0.08-0.87)***	**0.22 (0.07-0.71)***
Positive attitude towards HPV vaccination	1.70 (0.69-4.21)	0.89 (0.34-2.36)
Social norm	1.05 (0.99-1.11)	1.03 (0.97-1.09)
Normative belief	1.03 (0.83-1.29)	1.03 (0.81-1.29)
Knowledge	0.93 (0.76-1.13)	0.95 (0.78-1.17)
Perceived susceptibility of daughter if vaccinated to cervical cancer	0.89 (0.69-1.14)	0.88 (0.68-1.14)
Perceived severity of cervical cancer	1.06 (0.78-1.44)	1.08 (0.79-1.48)
Anticipated regret and worry about no uptake	**1.43 (1.08-1.89)***	1.24 (0.92-1.67)
Ambivalence x attitude interaction	**1.68 (1.14-2.47)****	**1.79 (1.22-2.62)****
R^2	0.57	0.59

*$p < 0.05$ **$p < 0.01$ and ***$p < 0.001$

OR, odds ratio. CI, confidence interval. NIP; Dutch National Immunization Program

Table 4: Knowledge items as completed by those who responded to the baseline and follow-up questionnaire (n=793)

	Correct responses				
	Baseline measurement		**Follow-up measurement**		**Significance level for difference between baseline and follow-up**
Item (true/false)	n	%	n	%	*p-value*
HPV causes cervical cancer (true)	496	62.5	479	60.4	0.336
A condom protects 100% against HPV (false)	464	58.5	518	65.3	0.001
The HPV vaccination will decrease the risk of cervical cancer (true)	673	84.9	726	91.6	<0.001
Vaccination in combination with having a smear taken is more protective than only vaccination (true)	521	65.7	598	75.4	<0.001
Item (multiple choice)					
How is HPV transmitted? (through blood; oxygen; sexual contact)	699	88.1	730	92.1	0.006
What is the protection rate of the HPV vaccine (55%; 70%; 85%; 100%)	286	36.1	337	42.5	0.005
What is the protection duration of a complete vaccination against cervical cancer? (at least 6 [8 at follow-up] years; at least 30 years; lifetime)	289	36.4	262	33.0	0.094

Correct answers are shaded

Table 5: Informed decision at follow-up (n=770)

	Daughter vaccinated (n=640)		Daughter not vaccinated (n=130)	
	n	%	n	%
Positive attitude				
≥5 correct items	280	36.4	14	1.8
<5 correct items	246	31.9	16	2.1
Negative attitude				
≥5 correct items	51	6.6	58	7.5
<5 correct items	32	4.2	34	4.4

Knowledge was measured with 7 items at follow-up. Informed decision rate for cut-off at 3 correct items: 76.1% ([504+82]/770); 4 correct items: 65.7% ([437+69]/770); 5 correct items: 43.9% ([280+58]/770); 6 correct items: 18.7% ([117+27]/770). Due to missing items, analyses were based on n=770 respondents instead of n=793. Informed choice (as defined) is shaded.

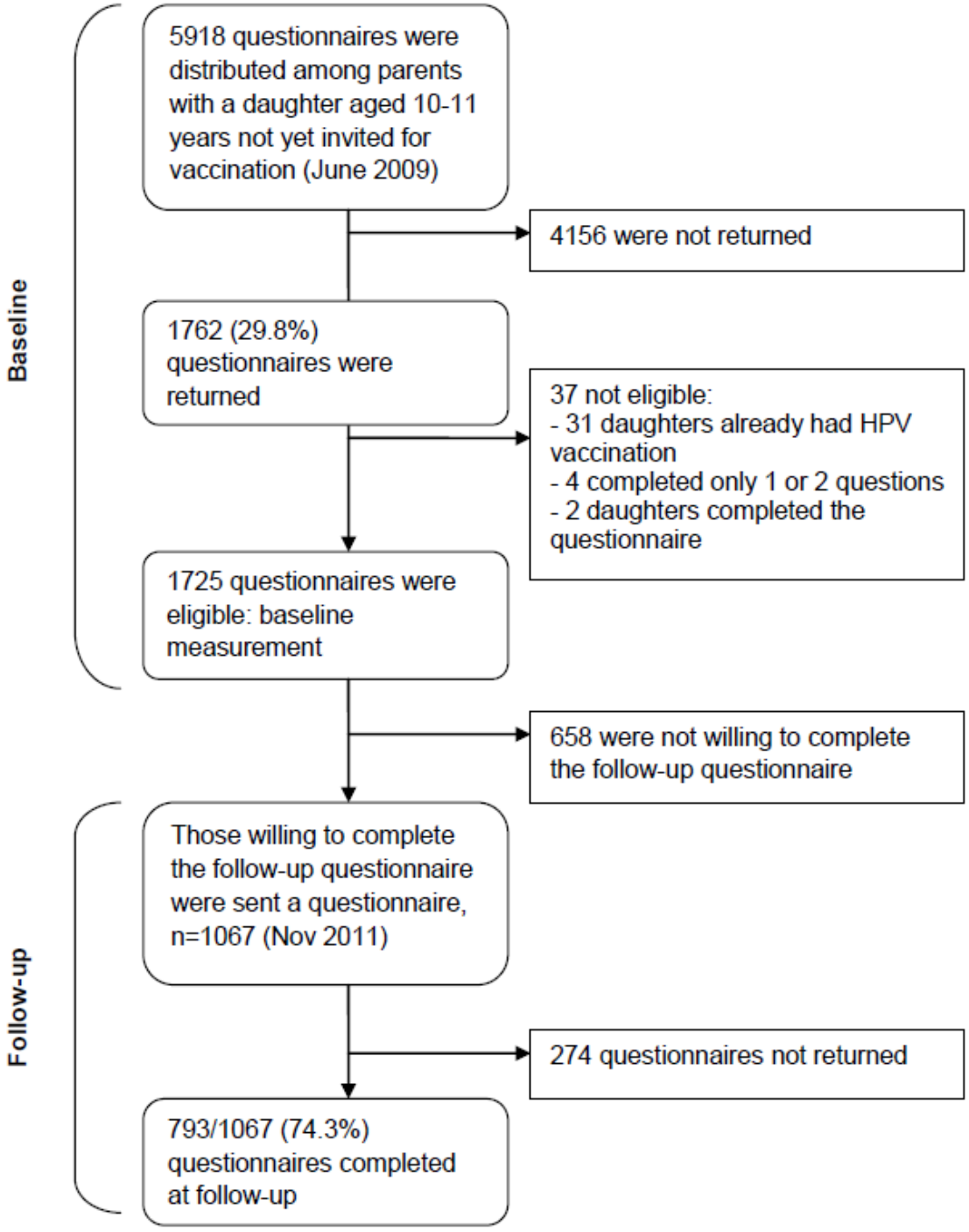

Fig. 1 Flow diagram of numbers of questionnaires at baseline and at follow-up.