Effect of Internet Use for Searching Information on Vaccination on the Uptake of Human Papillomavirus Vaccine in France: A Path-Analysis Approach

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Title page

Effect of Internet use for searching information on vaccination on the uptake of human papillomavirus vaccine in France: a path-analysis approach

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Abstract

Internet is a popular source of information regarding vaccination. This study aimed to determine whether there is a negative association between Internet use among French vaccine-hesitant mothers and HPV vaccine uptake by their daughters, and to gain insight into the pathways that would link Internet use to the lack of HPV vaccine uptake. We conducted a pooled cross-sectional analysis across the 2015, 2016, 2017 and 2018 Vaccinoscopie® Survey. Multivariate logistic regression and path models were used in the analysis. The study sample included a total of 2038 respondent mothers. Of those, 89 (4.4%) declared having never been in the situation of searching for information regarding a vaccination they had hesitated about, leaving 1949 mothers for the present analysis. Approximately 24% (466/1949) of the mothers declared using the Internet as a source of vaccine information. In multivariate logistic regression adjusted for physician recommendation of HPV vaccination, attitudes towards vaccines in general, perception of HPV vaccine usefulness, maternal level of education, region of residence, and the survey year, the use of Internet by the mothers was significantly associated with a lower HPV vaccination among their daughters (adjusted odds ratio (aOR), 0.66; 95% confidence interval (CI), 0.47-0.91). Path analysis further confirmed the negative effect of Internet use (β =-0.10, standard error (SE)=0.02, P<0.0001), highlighting how the Internet plays a detrimental role in HPV vaccine uptake through a lower perceived level of HPV vaccine usefulness, a lower perceived level of information on childhood vaccination, and unfavorable attitudes towards vaccination in general.

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INTRODUCTION

Since its introduction in the French immunization program in 2007, the initiation rate of HPV vaccination in girls aged 15 years only reached 29.4% at its highest point, in 2018 (1). The same year, the coverage rate for a two-dose regimen among 16-year-olds girls was estimated at 23.7% (2). This figure represents less than half of the target set for a two-dose regimen (3). The HPV vaccine appears among those viewed less favorably in 2016 in France (4), against the general background of a noticeable rise in vaccine hesitancy (5), which may be viewed as pretty astonishing in Pasteur's country.

Internet has become a popular source of information regarding health-related topics, and HPV vaccine makes no exception. Indeed, this vaccination is a popular topic among "googling" searches for vaccine-preventable infectious diseases (6). The Eurobarometer Survey on the European citizens' digital health literacy conducted in 2014 showed that around one out of two respondents in France have used the Internet to search for health-related information within the last year, 40% of whom indicated looking on behalf of their children. The French National Health Barometer Survey conducted the same year showed that as many as 69 % of the French population used the Internet to search for health-related topics (7).

Whilst the Internet represents a remarkable tool for health information dissemination, it also provides a medium where misinformation (misinformed advice) and disinformation (deliberate falsehoods) (8) are easily introduced, accessed and spread. This has become more problematic as we live in an era of "post-truth" (defined by Oxford dictionary as "circumstances in which objective facts are less influential in shaping public opinion than appeals to emotion and personal belief"(9)). in The use of social media (such as Facebook) and messaging platforms (such as WhatsApp) allows instant global dissemination of false information (10). This comes with its own share of challenges in the health information field. For example, one study analyzing the reach of online disinformation in Europ(9)e showed that the most popular false

news website in France, a website claiming to "vulgarize information on health and wellness", had received approximately as many interactions on social media (shares, comments, reactions) as five prominent and reliable French news websites combined (11). The spread of misinformation on the benefits and risks of vaccines has certainly been fueling vaccine hesitancy (12)(13)(14)(15), although it remains to be seen to what extent this translates into the decision to vaccinate. The World Health Organization has listed the “uncontrolled dissemination of misinformation” - including in the field of vaccination - among its urgent health challenges for the next decade (16).

HPV vaccination in France provides an interesting case study of challenges facing vaccination in an era of online mis/disinformation, as the introduction of the HPV vaccine in the French vaccine immunization program has coincided more or less with the rise of social media utilization. Furthermore, HPV vaccination in France is delivered opportunistically through healthcare providers, with no dedicated school-based vaccination program. Therefore, parents who have not heard about the HPV vaccine from their healthcare providers may have questions to be answered about this vaccination.

In this context, we aimed to determine whether there was a negative association between Internet use among French vaccine-hesitant mothers and HPV vaccine uptake by their daughters, and to gain insight into the pathways that would link Internet use to a lack of HPV vaccine uptake. Such an understanding is required to fully appreciate the impact of the Internet on the uptake of HPV vaccination in France, and provide relevant data for policymakers and practitioners to take necessary action.

METHODS

Data source

This study was carried out using the data acquired from the 2015, 2016, 2017 and 2018 Vaccinoscopie® Survey modules targeting mothers of girls aged 14 and 15 years. The methodology of this survey commissioned by GlaxoSmithKline (GSK) and conducted by IDM Families, an independent market research and polling company, has been published in detail

elsewhere (17)(18). Briefly, Vaccinoscopie® is a pluriannual web-based survey among French representative quota samples of mothers, with respect to the socio-professional category (SPC) of the reference person in the household, the number of children, and the geographic region of residence, per child's years of age. It has been designed to monitor the dynamics of childhood vaccine coverage, and perception and attitudes towards vaccination in France. A new sample of study participants is interrogated from one year to another.

Study variables

The dependent variable was HPV vaccine initiation (i.e., the receipt of at least one dose of HPV vaccine) in the 14-15 year-old daughter. The exposure of interest was "Internet use by the mother" (yes/no), given the mother's answers to the question "When you hesitate about a vaccine, what source(s) of information do you turn to to decide whether or not to have your child vaccinated?". This question had a multiple-choice response format. For the purpose of this analysis, we derived a dummy variable for each source of information.

Guided by reviews of the literature on the factors associated with HPV vaccine uptake (19) (20)(21), we took into account the following relevant factors in the association between the exposure of interest and the dependent variable: 1) mother's demographics and socioeconomic stratus: age, level of education, household income and geographical region of residence; 2) maternal attitudes towards vaccination in general (response to the single answer question "How do you feel about vaccines?": in favour of vaccinating against all serious diseases if there are vaccines/ in favour of minimizing the number of vaccinations/ opposed to all vaccines/ no opinion), and perception of HPV vaccine usefulness (response to the single answer question "For each of these diseases (cervical cancer), supposing there was a vaccine, would vaccinating your child seem: indispensable/ useful/ not very useful/ useless/ do not know"); 3) physician recommendation of HPV vaccination (response to the single answer question "Has your doctor advised you to have your child vaccinated against HPV": yes/ no/ do not remember); 4) perceived level of information regarding childhood vaccination (response to the single answer question: "Do you think you are well informed about child vaccinations?": not at all well-informed/ rather not well-informed/ rather well-informed/ fully informed and); and 5)

daughter's usual medical follow-up setting (response to the single answer question : "Your child is followed by : a general practice/ a pediatrician practice/ a free preventive clinic for mother and infants").

Statistical analysis

We conducted a pooled cross-sectional analysis across the four aforementioned years of the Vaccinoscopie® Survey. We combined these data sets in order to achieve a large enough sample size to perform multivariate analysis. The data sets included data weighted according to the French general population census of the French National Institute for Statistics and Economic Studies. Although the data were generated each year from a quota sample and not from a random probability one, we decided to conduct inferential statistical analysis commonly used to make inferences about the larger population from which the sample was drawn. Since it is difficult to guarantee that the study sample is representative for characteristics other than those for which quotas units have been set, inferential statistical measures (95% confidence intervals (95%CI) and P-values) are meant only for indicative purposes in the present study.

Logistic regression analysis

We conducted a descriptive analysis of study variables followed by a bivariate analysis, where HPV vaccine initiation was regressed on the covariates, which were were assessed for multicollinearity beforehand. We then estimated a multivariate logistic regression model using a backward selection process, with a threshold of P=0.20 for a variable to stay in the model. The full model included the year of the Vaccinoscopie® Survey, in addition to the aforementioned exposure variable and covariates. For ease of interpretation, we used the grouping of response modalities required by the path analysis described below. The goodness-of-fit of the final model was tested using the information matrix test.

Crude and adjusted odds ratios were calculated with their 95%CI.

Path analysis

We formulated a general hypothetical model for how Internet use, attitudes towards childhood vaccination, perceived usefulness of HPV vaccine, and the other above mentioned factors might be interrelated to HPV vaccine uptake. The hypothesized interrelationships between the

variables are depicted in a conceptual model in **Figure 1.** To test our proposed hypothetical model, we applied path analysis, a form of statistical modeling consisting of a set of linear equations that simultaneously assess the relationships between the measured variables. We conducted these analyses using the PROC CALIS procedure in SAS with the weighted least squares (WLS) estimation method, which handles categorical variables (22). Nominal variables with more than two categories of response modalities (geographic area of residence, perceived usefulness of HPV vaccine, attitudes towards childhood vaccination, and perceived level of information) were dichotomized by grouping responses modalities, as the PROC CALIS procedure handles continuous, binary and ordinal variables, but not nominal variables.

We first tested the hypothesized conceptual model, which included all possible associations between variables **(Figure 1).** Afterward, we reviewed the path coefficients to see if any of the paths in the initial model should be deleted, and we dropped non-significant associations from the original hypothetical model. The resulting model, called the "final model", was then re-estimated **(Figure 2).** We used standardized regression coefficients (β) to assess the strength of association between the variables (effect). Total, direct, and indirect effects of each variable on HPV vaccine uptake were estimated (a direct effect represents a path coefficient, an indirect effect represents the product of sequential path coefficients, and a total effect represents the sum of direct and indirect effects).

We used Cohen's recommendations to interpret the relative size effect of the standardized coefficients (a β value varying around 0.1 is considered as low, a value varying around 0.3 as moderate, and a value greater than 0.5 as large) (23). To evaluate the goodness-of-fit between the final model and the data, we used the comparative fit index (CFI), the standardized root mean square residual (SRMR), and the root-mean-square error of approximation (RMSEA) including 90%-confidence interval (90%CI). Values for CFI >0.94 suggest a good fit between data and path models, whereas SRMR and RMSEA values less than 0.090 suggest acceptable fit, and values less than 0.055 suggest good model fit (24).

All statistical analyses were performed using SAS (version 9.4, SAS Institute Inc., Cary North Carolina), and p-values below 0.05 were considered statistically significant.

Ethics statement

The Vaccinoscopie® Survey is a healthcare market research undertaken by professional market researchers (IDM families) on behalf of a pharmaceutical company (GSK). It has been conducted in accordance with the legal and ethical guidelines issued jointly by the European Society for Opinion and Market Research (ESOMAR) and the International Chamber of Commerce (ICC), as well as the French law on computer data and freedom. It does not require ethical committee review. It warrants the total confidentiality of collected data, which, in any case, cannot be used to any other end than the ones defined for the survey. Furthermore, each participant may stop answering the questionnaire at any time and refuse that some pieces of data to be processed. Study participants consented to IDM terms of use and privacy policy, which indicated that their data would be used anonymously. The Vaccinoscopy® data file was approved by the French National Committee for Data Protection (n°1551077, dated 08/12/2011).

RESULTS

Study sample

The global Vaccinoscopie® Survey data set (2015 to 2018) included in total 2038 different respondent mothers. Of those, 89 (4.4%) declared having never been in the situation of searching for information regarding a vaccination they had hesitated about, leaving 1949 records for the present study. The mean (+/- SD) age of the survey respondents was 43.5 (±4.9) years. Approximately half of the participants had a level at high school diploma (baccalaureate) or two-year post high school diploma (49.6%) and had a monthly household income of over 2700 Euros (48.0%). The full characteristics of the study participants, together with their responses to the survey questionnaire, can be found in **Table 1.**

HPV vaccine coverage

The mean uptake of the first dose of HPV vaccine over the study period was 27.7% (23.7% in 2015, 23.5% in 2016, 30.3% in 2017 and 33.1% in 2018). The full 2-dose regimen was completed in 18.7% of their daughters (14.4% in 2015, 16.1% in 2016, 21.3% in 2017 and 22.6% in 2018).

Internet and other sources of vaccine information

Approximately 24% of the mothers declared using the Internet as a source of vaccine information. This medium was the third most frequently cited source of information reported by the mothers, after the family physician (91.8%) and the relatives/family/friends (26.1%), and before the pharmacist (14.9%) **(Table 1)**.

Logistic regression analysis

The uptake of the first dose of HPV vaccine was lower among daughters of the mothers who indicated using the Internet as a source of vaccine information compared to daughters of those who indicated not using it: 18% compared to 31%, respectively (P<0.0001). In multivariate analysis adjusted for physician recommendation of HPV vaccination, attitudes towards vaccines in general, perception of HPV vaccine usefulness, maternal level of education, geographical region of residence, and the year of the survey, the use of the Internet as a source of vaccine information was significantly associated with a lower HPV vaccination (aOR=0.66; 95% CI, 0.47-0.91) (**Table 2**).

Path analysis

The results of the path analysis modeling are depicted in **Figure 2.** The estimated « final model » shows a good overall fit: CFI=0.97, SRMR=0.03 and RMSEA=0.02, 90%CI (0.02-0.03). Overall, 26 % of the variance in HPV vaccine uptake was explained by the model. **Table 3** shows the direct, indirect, and total effects of Internet use and other sources of information on HPV vaccine uptake (effects of other variables are reported in the **Supplementary Table**). The total effect of Internet use on HPV vaccine uptake was proved to be significant and negative. It is considered as low (β=-0.10, Standard Error (SE)=0.02, P<0.0001), and represents in absolute value 27% of the highest total effect on HPV vaccine uptake, which is observed with the physician recommendation of HPV vaccination (β=0.37, SE=0.01, P<0.0001) (**Table 3 and Supplementary Table).**

A total of 4 paths were significant to explain the relationship between Internet use and HPV vaccine uptake:

1) Internet use -> perceived level of information regarding childhood vaccination-> attitudes towards vaccines in general -> perception of HPV vaccination usefulness -> HPV vaccination;
2) Internet use -> perceived level of information regarding childhood vaccination -> attitudes towards vaccines in general -> HPV vaccination;
3) Internet use -> attitudes towards vaccines in general -> perception of HPV vaccination usefulness -> HPV vaccination;
4) Internet use -> attitudes towards vaccines in general -> HPV vaccination (**Figure 2**).

Internet use was also found to mediate the negative effect of the « family and friends » source of information on HPV vaccine uptake (β=-0.10, SE=0.02, P<0.0001), as Internet use was positively associated with this source of information (β=0.10, SE=0.02, P<0.0001). In reverse, Internet use was negatively associated with the «family physician» source of information (β=-0.28, SE=0.03, P<0.0001), which was found to have a total positive effect on HPV vaccine uptake (β=0.08, SE=0.01, P<0.0001).

DISCUSSION

The spread of false information online and its influence on vaccination have been frequently addressed in the literature. However, the quantification of the effect of Internet use as a resource for answering questions on vaccination on actual vaccine uptake is much less documented. We found that maternal search for vaccine information in the Internet was associated with a lower HPV vaccination initiation by their daughters. This result is congruent with the findings of the 2016 French National Health Barometer, in which parents of children aged 1 to 15 who relied uniquely on the Internet for information on vaccination were less likely to vaccinate their children against diphtheria, tetanus, and pertussis (25). Path analysis further confirmed the negative effect of Internet use on HPV vaccine uptake (β=-0.10, SE=0.02, P<0.0001). The analysis further revealed how Internet mediated its effect through a lower perceived level of information on childhood vaccination (which could be explained by the confusion resulting from contradicting pieces of information found on the Internet),

unfavorable attitudes towards vaccination in general, and a lower perceived level of HPV vaccine usefulness. This effect runs contrary to the positive effect of obtaining information from a family physician (β=0.08, SE=0.01, P<0.0001), through more favorable attitudes towards vaccines and higher perception of HPV vaccine usefulness.

The Internet affords unprecedented opportunities for finding answers to health questions, but also poses some challenges for its users. Parents should take complete responsibility to base their vaccination decision on accurate information, wisely and consciously choosing their sources of information whenever questions arise as to the benefit, efficacy or safety of any given vaccine. Until each and every parent is equipped with the necessary knowledge and skills to interrogate the Internet safely, healthcare providers remain the most suitable and accurate sources of information on the topic of vaccination, and parents should be encouraged to seek information primarily from them. Interventions should be designed to empower parents to better recognize mis/disinformation, and consult only reputable sources of information if they wish to go online. In any case, the need to question the veracity of the information retrieved online should be emphasized, as it is sometimes not easy to distinguish between trustworthy and questionable websites.

Strengths and limitations

To the best of our knowledge, this is the first study investigating the association between Internet use as a source of information by vaccine-hesitant mothers and the uptake of HPV vaccine by their daughters. A key strength of this study is the use of path analysis to examine specific pathways by which Internet use among vaccine-hesitant mothers is associated with a lack of HPV uptake by their daughters, beyond the traditional logistic regression approach which only allows quantification of the association between two variables, all others things being equal.

The following limitations should be considered when interpreting the results of this study. First, the exposure measure was related to the behavior of seeking online information for vaccines in general, rather than HPV vaccine specifically. Nevertheless, only HPV vaccination is recommended in the target's age group of the daughters in the surveyed sample, hence most

probably the source of questioning among their mothers. Second, the quota sampling approach employed for the recruitment of the mothers in the Vaccinoscopie® Survey allows a study sample that is representative of the general population with respect to specific criteria (SPC, geographic region of residence and number of children), but does not ensure that it is representative of the general population with regard to other criteria. Therefore, caution is warranted when generalizing the results of the responding sample to the broader French population. In particular, confidence intervals and P-values have to be very carefully interpreted: they would apply if the data were obtained from a random probability sample. Furthermore, there is a possibility of selection bias through self-selection of participants, and also because the Internet population might not be fully representative of the general population (excluding the most disadvantaged groups and/or the non-French-speaking immigrants). Third, some factors possibly intervening in the process unfolding between Internet use and HPV vaccine uptake were not questioned in Vaccinoscopie® Survey and could not be introduced in our model. In a Delphi survey based on the World Health Organisation Strategy Advisory Group of Experts framework of vaccine hesitancy, we have shown that the factors possibly determining HPV vaccine uptake in France are numerous (26). These include, for example, vaccine knowledge, perception of the safety of the vaccine, and trust issues towards the health system. This may explain the direct effect observed of Internet use on HPV vaccine uptake, which probably indicates a residual effect not captured by the model variables, rather than a genuine direct effect. Fourth, this analysis was based on cross-sectional data. Therefore, causal inferences cannot be drawn, and reverse links between some variables cannot be completely ruled out. For example, the association between Internet use and perceived level of information on childhood vaccination may be due to reciprocal effects. Despite these limitations, this study seems to confirm the detrimental impact of Internet use as a source of vaccine information in vaccine-hesitant mothers. Additional studies are needed using prospective study designs among a random sample of parents.

CONCLUSION

In conclusion, this study found a weak but significant association between vaccine-hesitant mothers' use of the Internet as a source of vaccine information and a lack of HPV vaccine uptake by their daughters, through a lower perceived level of HPV vaccine usefulness, a lower perceived level of information on childhood vaccination, and unfavorable attitudes towards vaccination in general. While further studies are needed to confirm this link, there is no doubt on the need to raise awareness about the importance of seeking information from a healthcare provider, and consulting only reputable sources of information on the Internet.

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Tables

Table 1. Distribution of study variables among 1949 vaccine-hesitant mothers (Vaccinoscopie® Survey 2015 to 2018).

Table 2. Results of bivariate and multivariate logistic regression analysis exploring the factors associated with HPV vaccination (weighted data).

Table 3. Total, direct, and indirect effects of the Internet and other sources of information on HPV vaccine uptake (weighted data).

Supplementary table. Total, direct, and indirect effects of variables other than sources of information on HPV vaccine uptake (weighted data).

Figures

Figure 1. Conceptual model with the hypothesized interrelationships between the variables.

Figure 2. Final model of associations with standardized path coefficients.

Author's contributions

FD and PC had designed the study. FD had performed the data analysis, the redaction of the manuscript, and the revision process of this paper based on Vaccinsoscopie Survey data acquired by OL. PC, OL, PM and LL have participated in the revision process and the redaction of the manuscript. GSK and IDM had no role in the study design nor in the data analysis. All authors have approved the final manuscript which was reviewed by GSK before submission.

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Conflict of interest

FD declares that MSD vaccines have covered registration fees, transport and accommodation costs for attendance to a conference in 2018 and received a research grant. PM was an investigator on projects that received funding from GSK and MSD for the evaluation of HPV vaccines in Africa. OL declares punctual interventions and support during conferences with Pfizer, MSD, Sanofi Pasteur, Janssen and GSK. PC declares no conflict of interest.

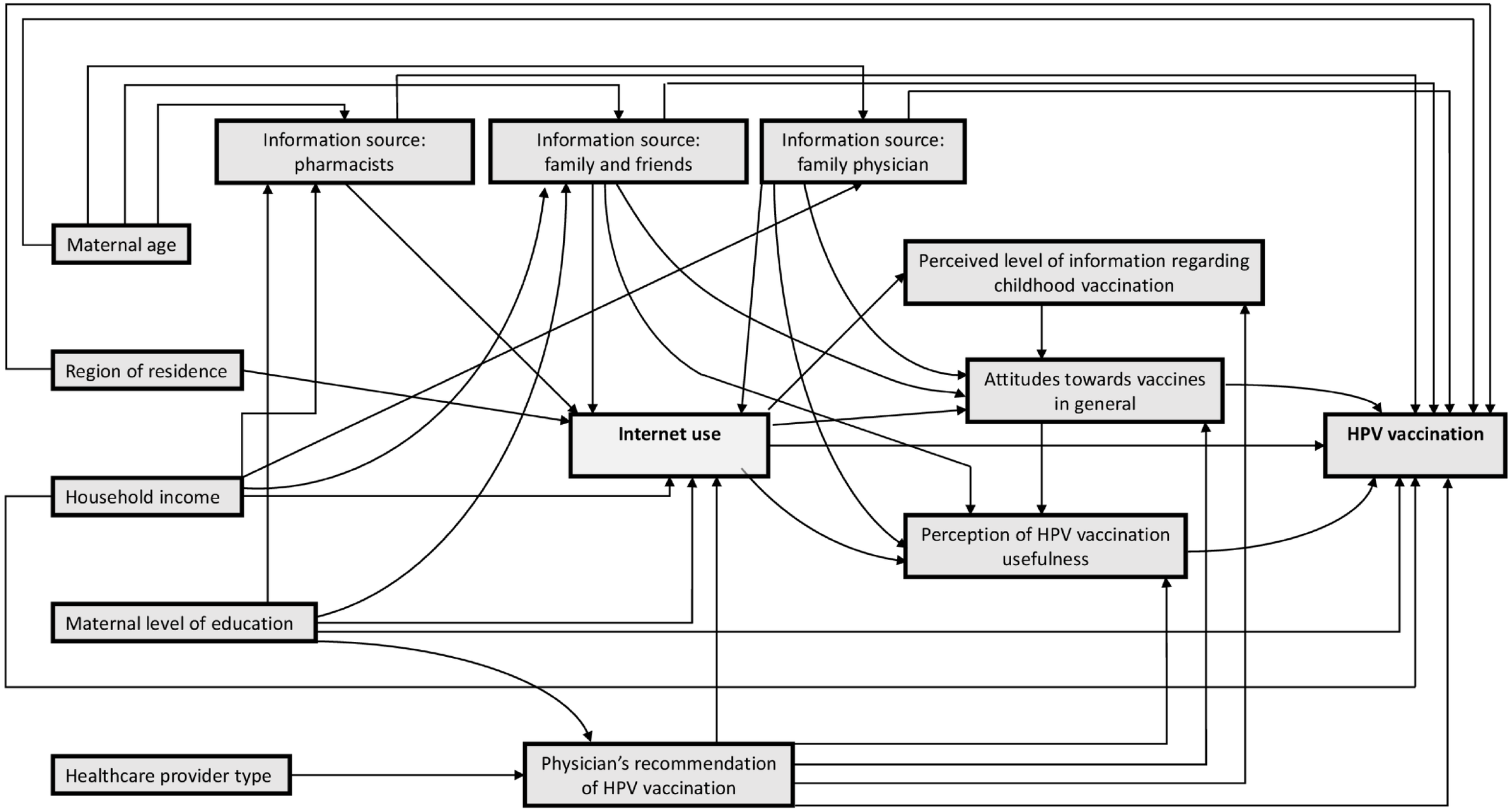

Figure 1: Conceptual model with the hypothesized interrelationships between the variables.

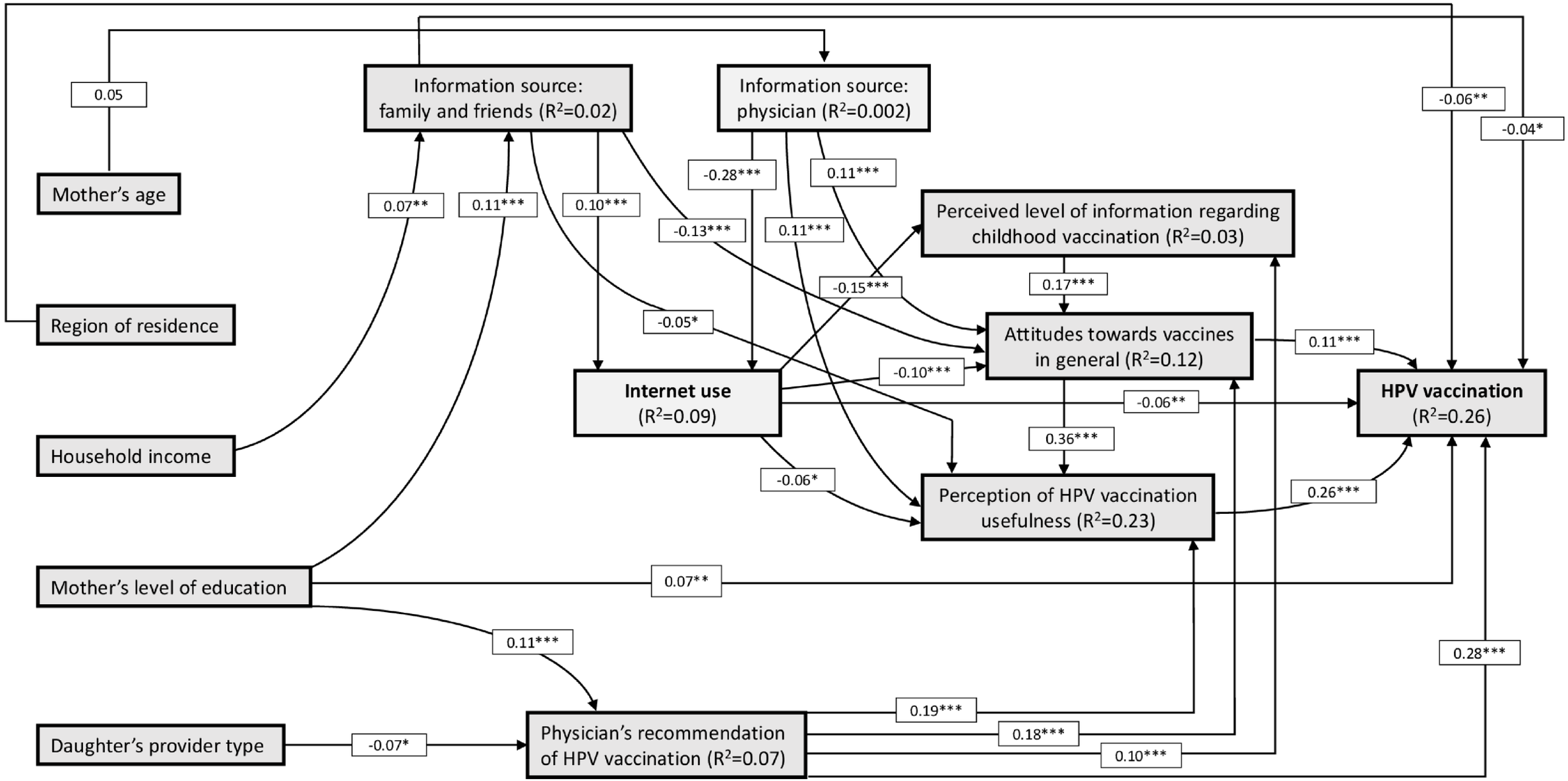

Figure 2. Final model of associations with standardised path coefficients.

Note: standardized path coefficients are presented on the arrows; R^2= squared multiple correlation (explained variance). *p<0.05, **p<.01, *** p<.0001

Table1. Distribution of study variables among 1949 vaccine hesitant mothers (Vaccinoscopie® Survey 2015 to 2018).

	Unweighted data		**Weighted data**	
	Total		**Total**	
	(N=1949)		(N=1835)	
	n or mean	(% or SD)	n or mean	(% or SD)
Demographics				
Maternal age (years) [a]	43.3	(4.9)	43.5	(4.9)
Monthly household income (Euros) [b]				
<1700	323	(16.9%)	311	(17.3%)
[1700-2700]	660	(34.5%)	625	(34.7%)
>2700	930	(48.6%)	865	(48.0%)
Educational attainment				
Below high school diploma	395	(20.3%)	379	(20.7%)
High school diploma – two-year post high school diploma	961	(49.3%)	911	(49.6%)
Beyond two-year post high school diploma	593	(30.4%)	545	(29.7%)
Geographic region of residence				
Greater Paris area	319	(16.4%)	295	(16.1%)
Ile de France	330	(16.9%)	362	(19.7%)
Center-East	275	(14.1%)	238	(13.0%)
East	169	(8.7%)	156.6	(8.5%)
North	141	(7.2%)	126	(6.9%)
West	304	(15.6%)	247	(13.5%)
South-West	206	(10.6%)	182	(9.9%)
Mediterranean	205	(10.5%)	229	(12.5%)
Attitudes towards vaccines in general				
In favor of vaccinating against all serious diseases if there are vaccines	1315	(67.5%)	1234	(67.2%)
In favor of minimizing the number of vaccinations	608	(31.2%)	574	(31.3%)
Opposed to all vaccines	9	(0.5%)	9	(0.5%)
No opinion	17	(0.9%)	18	(0.9%)
Perception of HPV vaccination usefulness				
Indispensable	697	(35.8%)	651	(35.5%)
Useful	622	(31.9%)	589	(32.1%)
Not very useful	244	(12.5%)	230	(12.5%)
Useless	140	(7.2%)	135	(7.4%)
Does not know	246	(12.6%)	229	(12.5%)
Physician' recommendation of HPV vaccination				
Yes	1282	(65.8%)	1199	(65.3%)
No	566	(29.0%)	537	(29.3%)
Does not remember	101	(5.2%)	98	(5.3%)
Perceived level of information regarding childhood vaccination				
Not at all well-informed	32	(1.6%)	30	(1.7%)
Rather not well- informed	280	(14.4%)	267	(14.6%)
Rather well-informed	1347	(69.1%)	1266	(69%)
Fully informed	290	(14.9%)	271	(14.8%)
Information sources				
Internet	466	(23.9)	439	(23.9)
Family physician	1789	(91.8)	1686	(91.8)
Pharmacist	283	(14.5%)	273	(14.9%)
Relatives/family/friends	508	(26.1%)	479	(26.1%)
Other	71	(3.6%)	66	(3.6%)
Daughter's healthcare provider type				
Free preventive clinic for mothers and infants	7	(0.4%)	8	(0.4%)
General practice	1790	(91.8%)	1687	(91.9%)
Pediatrician practice	152	(7.8%)	140	(7.6%)
HPV vaccination status				

At least one dose	552	(28.3%)	509	(27.7%)
Not vaccinated	1397	(71.7%)	1327	(72.3%)

Abbreviations: HPV, human papillomavirus

[a] 4 missing values

[b] 36 missing values

	Vaccinated daughters (N=508)		Unvaccinated daughters (N=1327)		Crude OR	95% CI	Adjusted OR *	95% CI
	n or mean	(% or SD)	n	(% or SD)				
Vaccinoscopie® Survey year								
2018	159	(33.1)	321	(66.9)	Ref.			
2017	136	(30.3)	314	(69.7)	0.88	0.67-1.16	1.00	0.71-1.41
2016	107	(23.5)	350	(76.5)	0.62	0.46-0.83	0.64	0.45-0.91
2015	106	(23.7)	342	(76.3)	0.63	0.47-0.84	0.66	0.46-0.94
Demographics								
Maternal age (years) [a]	43.6	(4.6)	43.5	(5.0)	1.00	0.98-1.02	-	-
Household income (Euros per month) [b]								
<1700	74	(23.7)	238	(76.3)	Ref.			
[1700-2700]	177	(28.3)	448	(71.7)	1.27	0.93-1.74	-	-
>2700	250	(28.9)	615	(71.1)	1.31	0.97-1.77	-	-
Educational attainment								
Below high school diploma	78	(20.5)	301	(79.5)	Ref.			
High school diploma – two-year post high school diploma	251	(27.6)	660	(72.4)	1.47	1.10-1.96	1.40	0.99-1.98
Beyond two-year post high school diploma	179	(32.9)	366	(67.1)	1.90	1.40-2.58	1.81	1.24-2.64
Geographic region of residence								
Regions other than Ile de France	424	28.8	1049	71.2	Ref.			
Ile de France	84	23.3	278	76.7	0.75	0.57-0.98	0.76	0.55-1.04
Attitudes towards vaccines in general								
In favor of minimizing the number of vaccinations or opposed to all vaccines or no opinion	55	(9.2)	546	(90.8)	Ref.			
In favor of vaccinating against all serious diseases if there are vaccines	453	(36.7)	781	(63.3)	5.70	4.23-7.69	2.34	1.64-3.33
Perception of HPV vaccination usefulness								
No very useful or useless or no opinion	12	(2.1)	582	(97.9)	Ref.			
Useful or indispensable	496	(40.0)	745	(60.0)	31.62	17.76-56.29	19.65	10.36-37.24
Physician's recommendation of HPV vaccination								
No or does not remember	27	(4.3)	609	(95.7)	Ref.			
Yes	481	(40.1)	718	(59.9)	15.04	10.06-22.46	10.40	6.85-15.80
Perceived level of information regarding childhood vaccination								
Rather not well or not at all well-informed	51	(17.2)	247	(82.8)	Ref.			

Rather well or fully informed	457	(29.8)	1080	(70.2)	2.04	1.48-2.81	-	-
Information sources								
Family physician								
No	15	(10.4)	134	(89.6)	Ref.			
Yes	493	(29.3)	1193	(70.7)	3.55	2.08-6.07	-	-
Pharmacist								
No	429	(27.5)	1133	(72.5)	Ref.			
Yes	79	(29.1)	194	(70.9)	1.09	0.82 -1.44	-	-
Relatives/family/friends								
No	407	(30.0)	949	(70.0)	Ref.			
Yes	101	(21.2)	378	(78.8)	0.63	0.49-0.80	0.75	0.55-1.01
Internet								
No	429	(30.8)	967	(69.2)	Ref.			
Yes	79	(18.0)	360	(82.0)	0.49	0.38-0.65	0.66	0.47-0.91
Healthcare provider type								
Pediatrician practice or free preventive clinic for mothers and infants	50	(34.2)	98	(65.8)	Ref.			
General practice	458	(27.1)	1229	(72.9)	0.72	0.50-1.02	-	-

Abbreviations: CI, confidence interval; HPV, human papillomavirus; OR, odds ratio; Ref., reference category for odds ratio, SD, standard deviation.

[a] 4 missing values.

[b] 36 missing values.

* Adjusted odds ratio determined by backward multivariate logistic regression of HPV vaccination.

Table 3. Total, direct, and indirect effects of Internet and other sources of information on HPV vaccine uptake (weighted data).

	Total effect		**Direct effect**		**Indirect effect**	
	Standardized β estimate (standard error)	**P value**	**Standardized β estimate (standard error)**	**P value**	**Standardized β estimate (standard error)**	**P value**
Information source						
Internet	-0.10 (0.02)	<0.0001	-0.06 (0.02)	0.002	-0.04 (0.008)	<0.0001
Family physician	0.08 (0.01)	<0.0001	0	-	0.08 (0.01)	<0.0001
Relatives/family/Friends	-0.09 (0.02)	<0.0001	-0.04 (0.02)	0.033	-0.05(0.007)	<0.0001

Supplementary table. Total, direct, and indirect effects of variables other than sources of information on HPV vaccine uptake (weighted data).

	Total effect		**Direct effect**		**Indirect effect**	
	Standardized β estimate (standard error)	**P value**	**Standardized β estimate (standard error)**	**P value**	**Standardized β estimate (standard error)**	**P value**
Perceived level of information of childhood vaccination	0.03 (0.01)	<0.0001	0	-	0.03(0.01)	<0.0001
Attitudes towards vaccines in general	0.20 (0.02)	<0.0001	0.11 (0.02)	<0.0001	0.09 (0.01)	<0.0001
Perception of HPV vaccine usefulness	0.26 (0.01)	<0.0001	0.26 (0.01)	<0.0001	0	-
Physician recommendation of HPV vaccination	0.37 (0.01)	<0.0001	0.28 (0.01)	<0.0001	0.09 (0.008)	<0.0001
Healthcare provider type	-0.02 (0.01)	0.001	0	-	-0.02 (0.01)	0.001
Geographic region of residence	-0.06 (0.02)	0.002	-0.06 (0.02)	0.002	0	-
Household income	-0.006 (0.002)	0.013	0	-	-0.006 (0.002)	0.013
Maternal age	0.004 (0.002)	0.054	0	-	0.004 (0.002)	0.054
Maternal level of education	0.10 (0.02)	<0.0001	0.07(0.02)	0.001	0.03 (0.01)	0.001