The Patient - Patient-Centered Outcomes Research
https://doi.org/10.1007/s40271-024-00687-6

ORIGINAL RESEARCH ARTICLE

# Optimizing Communication on HPV Vaccination to Parents of 11- to 14-Year-Old Adolescents in France: A Discrete Choice Experiment

Sandra Chyderiotis[1] · Jonathan Sicsic[2] · Amandine Gagneux-Brunon[3,4,5] · Jocelyn Raude[6] · Anne-Sophie Barret[7] · Sébastien Bruel[8,9] · Aurélie Gauchet[10] · Anne-Sophie Le Duc Banaszuk[11] · Morgane Michel[12,13] · Bruno Giraudeau[14] · Nathalie Thilly[15,16] · Judith E. Mueller[1,6] · for the PrevHPV Consortium

Accepted: 3 March 2024


## Abstract

**Background** With the aim to optimize communication during HPV vaccination campaigns in France, we elicited parental preferences around HPV vaccination.

**Methods** We conducted a single-profile discrete choice experiment (DCE) among parents of 11- to 14-year-old middle-school pupils, who completed an anonymous, self-administered, internet-based questionnaire during 2020–2021. The DCE comprised five attributes (vaccine-preventable disease, justification of optimal age, information on safety, indirect protection and coverage) of vaccination against an unnamed disease that were presented to respondents in ten choice tasks, or scenarios. We use fixed effect logit models to estimate attribute weights on theoretical vaccine acceptance, and random effect linear regression to estimate attribute coefficients on vaccine eagerness (decision and decision certainty). We estimated marginal effects of attributes on expected vaccine acceptance.

**Results** Vaccination scenarios were accepted by 55.6–89.2% of the 1291 participants. The largest marginal effects on expected vaccine acceptance in the full sample arose from prevention of cancer versus genital warts (+ 11.3 percentage points); from a "severe side effect suspicion that was not scientifically confirmed" versus a statement about "more benefits than risks" (+ 8.9 percentage points), and information on 80% vaccine coverage in neighbouring countries versus on "insufficient coverage" (+ 4.2 percentage points). Explaining the early age of vaccination by sexual debut had a strong negative impact among French monolingual parents with lower education level (vs age-independent, OR 0.48, 95% CI 0.27–0.86), but not other socio-economic groups. After removing low-quality responses (unvaried certainty and short questionnaire completion), among serial non-demanders with children not vaccinated against HPV, only disease elimination impacted vaccine eagerness positively (coefficient 0.54, 0.06–1.02).

**Discussion** Using DCEs to elicit parents' preferences around communication messages, notably on cancer prevention, vaccine coverage and information about vaccine safety, could help to optimize HPV vaccination promotion efforts.

**Key Points for Decision Makers**

We explored how communication to parents regarding the HPV vaccine can be optimized.

Optimized content changed overall hypothetical vaccine acceptance by up to 11%.

Information items to favour are cancer prevention, high vaccine coverage in neighbouring countries, while the formulation "more benefits than risks" had a negative effect on acceptance.

Extended author information available on the last page of the article

## 1 Introduction

Human papillomavirus (HPV) vaccines are highly effective against cervical and other HPV-related cancers, while additionally having a good safety profile and having the capacity for effecting herd immunity [1]. In France, the percentage of adolescent girls aged 15 years vaccinated with at least one dose of a HPV vaccine has stayed below 30% for more than 10 years, to reach 45.8% in 2021 [2]. As in other countries, HPV vaccination suffers from suboptimal accessibility, lack of knowledge among parents and adolescents, and doubts about efficacy and side effects among the public, including among physicians [3]. Recent changes in the French HPV vaccination programme could potentially improve those issues. HPV vaccination has been recommended to boys free of charge since 2021 and a policy with school-based vaccination campaigns started in late 2023.

School systems may be an efficient and equitable channel to inform parents and provide access to vaccination [4], and family physicians are one of the most trusted sources of information on vaccination [5]. However, it remains challenging to provide parents and adolescents with transparent and accurate information that will motivate vaccine intention. In line with behavioural change models, such as the COM-B [6] and social marketing [7], communication during vaccine promotion should meet the target audience's needs in form and content. For example, communication can have unforeseeable negative effects if parents' aversions to specific messages are not taken into account [8, 9]. In addition, communication content may create social inequalities by educational level or cultural reference [10].

Discrete choice experiments (DCEs) are used to explore healthcare users' preferences, including surrounding vaccination [11]. Several discrete choice experiments in Europe, Canada and Asia have elicited parental preferences around HPV vaccination [12], focusing mostly on biomedical facts such as risk of side effects, duration of protection, degree of protection against cancer or genital warts, vaccine costs, and preferred age at vaccination. To our knowledge, none has explored how the formulation of communication messages relating to contextual characteristics of HPV vaccination, such as the rationale for the recommended age at vaccination, information on vaccine safety, or on vaccine uptake rates, could affect parental theoretical decisions to vaccinate their children.

The PrevHPV project is an interventional research project aiming at increasing HPV vaccine coverage in France through a multicomponent intervention delivered through middle schools and general practitioners [13]. Within this project, we conducted single-profile discrete choice experiments (DCE) to elicit adolescents' and parental preferences around HPV vaccination, with the aim to optimize communication during vaccine promotion. Preferences of adolescents were described elsewhere [14], and it was found that emphasis on cancer prevention, information on the scientifically confirmed absence of serious side effects (avoiding the notion of a benefit–risk balance), the possibility of eliminating a disease and information on high vaccine coverage in neighbouring countries increased HPV vaccine theoretical acceptance. In the present paper, we report parental preferences surrounding HPV vaccination communication.

## 2 Material and Methods

### 2.1 Study Design and Data Collection

Parents of 11- to 14-year-old middle-school pupils were invited to complete an anonymous, self-administered, internet-based questionnaire on RedCap®. The survey was accessible from 31 January 2020 throughout 9 April 2021. To obtain a sufficient sample size despite the school closures during the Covid-19 pandemic, two recruitment procedures were used (Electronic Supplementary Material [ESM] A). E-mail invitations to participate were sent to parents by 17 randomly selected middle schools in four mainland France school districts (academies de Nancy, Lyon, Grenoble, Versailles) from 31 January 2020 onwards. E-mailings were interrupted in mid-March by school closures resulting from the Covid-19 epidemic and resumed in early 2021. Details on the choice and selection process of the middle schools have been described elsewhere [14]. In addition, during early 2021, a national School Parent Association (FCPE) sent invitation emails to members of its local branches, with the possibility for chain referral. Due to recruitment procedures, the total number of parents receiving the invitation is not known. We assume that the numbers of parents of the same child both responding to the questionnaire, or the same parent responding twice through both recruitment procedures is negligible.

In addition to the DCE tool, the 15-minute questionnaire collected sociodemographic information, parental attitude towards vaccination in general, school-based vaccination and the child's vaccination status. Parents were asked to answer the questionnaire for the oldest of their 11- to 14-year-old children (girls and boys). We collected information on whether the parents also spoke another language than French with their children, defining "no, only French" as French monolingualism and "yes, also another language" as multilingualism.

### 2.2 Discrete Choice Experiment (DCE) Tool

We designed a DCE tool targeting parents in parallel to the development of a version for adolescents, using a literature review, the feedback of experts and think-aloud pilot testing. We chose attributes to test hypotheses on potentially motivational statements that could be realistically used in HPV vaccine communication in France. A panel of eight experts in epidemiology, social psychology, infectiology, sociology and general practice provided recommendations. We adapted the tool using feedback from a health literacy expert and interviews with nine adults using the think-aloud method [15]. The final DCE tool comprised five main attributes:

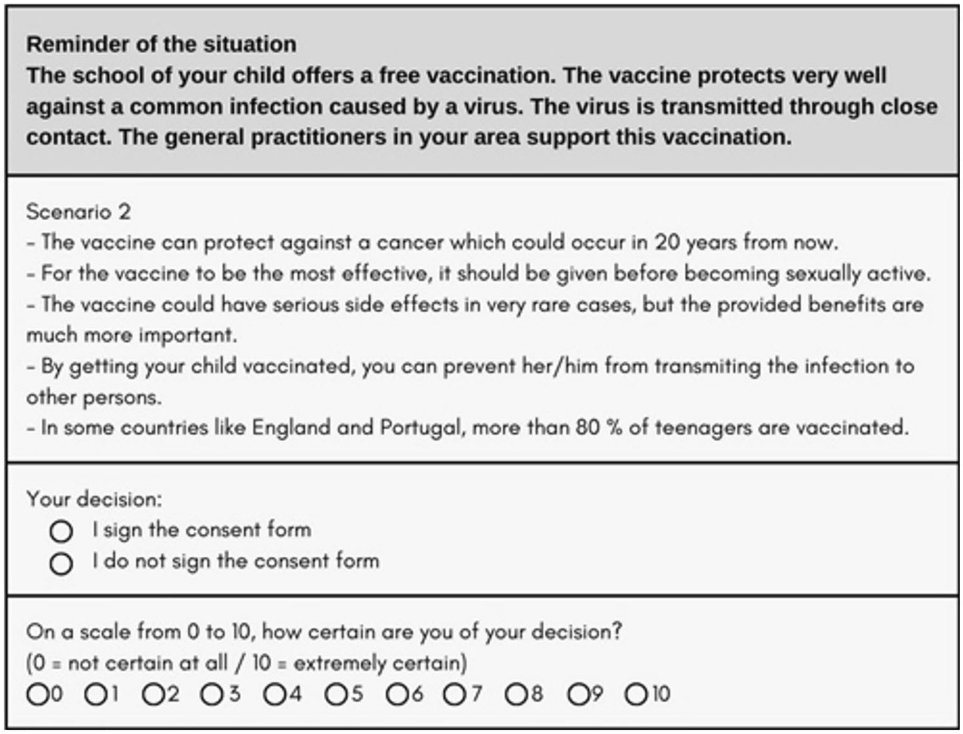
disease prevented by the proposed vaccine, justification of the age recommendation, safety information, indirect protection, and coverage information (Table 1, ESM B). The tool included ten choice tasks with nine scenarios and one repeated scenario with an additional attribute to specifically test whether the presence of internet discussions about the uncertainty around vaccine effectiveness would significantly decrease acceptance [16].

The DCE was designed as a single-profile DCE with a binary choice to mimic real-life vaccination decisions [14] (Fig. 1). The additional attribute 'Uncertain effectiveness', was only present in one repeated choice task per respondent (ESM C). We also collected choice certainty on a 1–10 scale. Parents were asked to imagine the following situation: their child's school informed them of a vaccination campaign organized at school in two weeks' time. The campaign would include an individual consultation with a physician at school, during which their child could be vaccinated for free against an unnamed disease. General practitioners in their area would be supportive of the vaccination. An information sheet would allow parents to accept or refuse vaccination for their child by 'signing' the consent form. We chose not to explicitly name the disease to avoid anchoring biases related to HPV given the French context of this vaccine getting media attention around its safety in the past 10–15 years. Moreover, during the study period, HPV vaccination for boys was being implemented in France and we wanted to capture parental preferences independently of the child's gender to provide results relevant to the new programme. Following recommendations for DCE design, a

**Table 1** Attributes and levels used in a discrete choice experiment for a school-based vaccination campaign, targeting parents

| Attributes | Levels (labels) | Levels (wording) | Hypotheses |
|---|---|---|---|
| Disease | Febrile illness | The vaccine can protect against a disease with high fever and breathlessness | *Reference* |
| | Cancer | The vaccine can protect against a cancer, which could occur in 20 years | $H_1$: OR > 1 |
| | Genital warts | The vaccine can protect against warts on intimate body parts | $H_2$: OR < 1 |
| | Pregnancy complications | The vaccine can protect against a disease which leads to pregnancy complications | $H_3$: OR > 1 |
| Optimal age | Age-independent | The vaccine is effective whatever the age at vaccination | *Reference* |
| | Better immune response | Antibody production is better and the vaccine protects better if given before age 14 | $H_4$: OR > 1 |
| | Before sexual relations | For the vaccine to be the most effective, it has to be given before the onset of sexual activity | $H_5$: OR > 1 |
| Safety | No side effect | The vaccine does not cause severe side effects | *Reference* |
| | No scientific confirmation | The vaccine safety has been monitored for more than 10 years worldwide. No serious side effect has been scientifically confirmed | $H_6$: OR > 1 |
| | Surveillance other countries | In countries where most adolescents are vaccinated, the risk of a severe side effect that could be due to this vaccination has not increased | $H_7$: OR > 1 |
| | More benefits than risks | The vaccine can have serious side effects in very rare cases, but the provided benefits are much greater | $H_8$: OR < 1 |
| Indirect protection | Only your child | The vaccine protects only your child | *Reference* |
| | Protects others | By vaccinating your child, you can avoid her/him transmitting the infection to other persons | $H_9$: OR > 1 |
| | Elimination | By vaccinating most adolescents, the disease can disappear from the population | $H_{10}$: OR > 1 |
| Coverage | Insufficient | The number of vaccinated teenagers is insufficient in France | *Reference* |
| | Already 30% | Already 30% of teens aged 15 are vaccinated in France | $H_{11}$: OR > 1 |
| | 80% in France | 80% of teens aged 15 are vaccinated in France | $H_{12}$: OR > 1 |
| | 80% in other countries | In some countries like England and Portugal, more than 80% of teenagers are vaccinated | $H_{13}$: OR > 1 |
| Uncertain effectiveness | | You can read on the internet that we do not know yet if the vaccine protects against this cancer. This is true but we do know that the vaccine is effective against the infection which leads to it | No a priori assumption |

*OR* Odds ratio


**Reminder of the situation**
**The school of your child offers a free vaccination. The vaccine protects very well against a common infection caused by a virus. The virus is transmitted through close contact. The general practitioners in your area support this vaccination.**

Scenario 2
- The vaccine can protect against a cancer which could occur in 20 years from now.
- For the vaccine to be the most effective, it should be given before becoming sexually active.
- The vaccine could have serious side effects in very rare cases, but the provided benefits are much more important.
- By getting your child vaccinated, you can prevent her/him from transmiting the infection to other persons.
- In some countries like England and Portugal, more than 80 % of teenagers are vaccinated.

Your decision:
○ I sign the consent form
○ I do not sign the consent form

On a scale from 0 to 10, how certain are you of your decision?
(0 = not certain at all / 10 = extremely certain)
○0 ○1 ○2 ○3 ○4 ○5 ○6 ○7 ○8 ○9 ○10

**Fig. 1** Example of the choice task

sufficient sample size was defined as 200 per gender group and per socio-economic strata, yielding a minimum of 1000 respondents [17].

For the experimental design, the five attributes yielded 720 possible combinations of levels in a full factorial design. We used NGENE software to obtain a 36-profile efficient design with pseudo-informative priors for attribute level parameters and a standard error of two for the random intercept parameter (thus allowing for heterogeneity in intrinsic utility of vaccination independent of an attribute's levels). Combination of the level 'Disease–Pregnancy complications' and level 'Indirect protection–Only your child' would have been unrealistic for parents of boys and was thus excluded from the design. We specified a utility function allowing estimation of all main effects. The obtained scenarios were divided into four blocks (versions) of nine scenarios each. In each block of nine scenarios, one scenario with the 'disease' level of 'cancer' was repeated including the Uncertain Effectiveness attribute. This led to a final design of four sets of ten scenarios (40 unique scenarios) randomly assigned in backward or forward order to each respondent.

## 2.3 Statistical Analyses

Parents accepting vaccination in all nine scenarios were classified as 'serial demanders', those refusing as 'serial non-demanders', while those making variable decisions across scenarios were named 'non-uniform respondents' [18]. We compared the characteristics of serial (non-)demanders and non-uniform respondents by using Pearson's chi square tests. We estimated preference weights for theoretical vaccine acceptance (accept vs refuse) with the five attributes as independent variables and using logit models. Results were presented as odds ratios (OR) with confidence intervals of 95%. The main analyses were conducted among non-uniform respondents with fixed effect specification, including stratification by child's gender. Models did not include participant characteristics, as participants were randomized to scenario blocs and saw all scenarios within the bloc, making confounding unlikely. We calculated average marginal effects among non-uniform respondents, and in the full sample (using random effect specification), to predict the average changes in probability of vaccine acceptance for each attribute level.

Using a two-tailed test for equality of proportions, we compared the proportion of parents accepting vaccination in the two scenarios with versus without the additional attribute 'Uncertain effectiveness'.

We tested interactions between attributes and individual participant characteristics. When significant interactions were identified, the attribute effects were represented in stratified models. Following the hypothesis that multilingualism in the family has different effects on literacy depending on educational level (negative impact in the context of low educational level), we used a composite variable to assess combined effects of level of education (≤ vs >

baccalauréat, French high school diploma) and multilingual family context.

To explore the potential impact of the COVID-19 pandemic on parental preferences, we conducted analyses by testing potential interactions with year of participation. Because participants differed between 2020 and 2021 by socio-demographic characteristics (ESM D), we limited this analysis to a homogeneous subgroup that was well represented in both years (French monolingual mothers with higher educational level).

To capture the preferences of serial demanders and non-demanders, we used a vaccine eagerness scale that combined information on decision (accept/refuse) and certainty (0–10 scale) into a linear variable from −10 to +10 [18]. On this scale, a value of −10 represents certain refusal and +10 certain acceptance, while a value of 0 represents maximal uncertainty. We conducted a random effect linear regression using vaccine eagerness as the dependent variable and the attributes as independent variables. To avoid noise from low-quality responses and to focus analyses on individuals potentially opposed to HPV vaccination, we conducted a specific analysis on vaccine eagerness restricting to serial non-demanders with good quality responses, defined as questionnaire completion duration above the 20th percentile, varied certainty, and declaring that their child was not vaccinated against HPV [18].

We defined statistical significance as a two-sided *p*-value < 0.05. All analyses were conducted on Stata 16 (Stata-Corp LP, College Station, TX, USA).

## 3 Results

### 3.1 Participant Characteristics

A total of 2125 connections to the internet questionnaire occurred, with 1291 participants completing at least the DCE part. A large majority of participants participated during 2021 (75.8%) and were mothers (84.5%). Half of the parents responded to the questionnaire with regard to a daughter (51.4%). Compared with demographic indicators for working-age adults in France [19], they more frequently held a high education diploma (74.5% vs around 58% at age 35–54 years) (Table 2), but had a comparable proportion of professionally active individuals (88.5 vs 88% at age 25–49 years) and multilingual context (20.8 vs 18% estimated in 2009 [20]). Compared with national one-dose vaccination coverage estimates for girls aged 15 years born in 2006 (45.8%) [21], more parents (54.4%) declared that their daughter was vaccinated against HPV, which could in part correspond to higher uptake in the later birth cohorts covered by the present study (2006–2010).

A majority of parents declared a favourable attitude towards vaccination in general (90.2%). Overall, 59.3% were favourable towards school-based vaccination for their child and 23.1% were unfavourable (Table 2). The socio-demographic profile of participants differed between the two recruitment periods (2021 vs 2020, during vs before the COVID-19 pandemic) with more fathers (16.8 vs 11.5%), multilingual parents (23.3 vs. 13.0%) and more parents with higher education level (43.4 vs 29.2%) in 2021 (ESM D).

### 3.2 Stated Preferences

Mean theoretical vaccine acceptance was 73.9%, ranging from 55.6 to 89.2% across scenarios (ESM E). Mean theoretical acceptance varied substantially by several participant characteristics, including attitude towards vaccination in general, educational level and professional category, but not by child's gender (Table 2). Forty-six percent of participants ($n = 595$) were serial demanders and 10% ($n = 133$) serial non-demanders. Among parents declaring that their daughter was not vaccinated against HPV ($n = 726$), 40.8% were serial demanders, 12.3% serial non-demanders and 47.0% made non-uniform choices.

All attributes and most levels had a significant impact on theoretical vaccine acceptance of non-uniform respondents (Table 3). Compared with a 'Febrile illness', 'Cancer' (OR 2.68) and 'Pregnancy complications' (OR 1.35) motivated, whereas 'Genital warts' demotivated vaccine acceptance (OR 0.55). Compared with 'Age-independent' vaccination, better immunogenicity before age 14 years motivated acceptance (OR 1.56), while 'Before sexual relations' had no significant impact (OR 1.20 [95% confidence interval 0.94–1.51]). Safety statements referring to a positive benefit–risk balance (OR 0.31) or side effect surveillance in other countries (OR 0.39) strongly reduced acceptance, relative to negation of side effect. By contrast, information that no suspected side effect was scientifically confirmed had no significant effect on acceptance (OR 0.99 [0.80–1.24]). Regarding indirect protection, the level 'Elimination' motivated acceptance compared with the reference level 'Only your child' (OR 1.33), while 'Protects others' did not motivate more than the reference (OR 1.00 [0.81–1.24]). Compared with 'Insufficient' vaccine coverage, 'Already 30%' demotivated (OR 0.73), while '80%' in France (OR 1.65) and in other countries (OR 1.92) increased acceptance.

Acceptance was significantly lower in scenarios with the additional attribute 'Uncertain effectiveness' (mean frequency of acceptance: 52.1% [48.1–56.2] vs 63.3% [59.4–67.2]).

The largest marginal effects resulting from these preference weights were a difference of 11.3 percentage points in expected vaccine acceptance between 'Cancer' and 'Genital

**Table 2** Participant characteristics, mean theoretical vaccine acceptance and distribution of response profiles

| | Full sample ($N = 1291$) | | Non-uniform respondent ($N = 563$, 43.6%) | Serial demanders ($N = 595$, 46.1%) | Serial non-demanders ($N = 133$, 10.3%) |
|---|---|---|---|---|---|
| | *N* (column %) | Mean theoretical vaccine acceptance % | *N* (row %) | *N* (row %) | *N* (row %) |
| Survey year | | | | | |
| 2020 | 313 (24.2) | 72.2 | 143 (45.7) | 137 (43.8) | 33 (10.5) |
| 2021 | 978 (75.8) | 73.7 | 420 (42.9) | 458 (46.8) | 100 (10.2) |
| Recruitment | | | | | |
| Middle schools | 538 (41.7) | 71.2 | 252 (46.8) | 230 (42.8) | 56 (10.4) |
| School parent association | 753 (58.3) | 74.8 | 311 (41.3) | 365 (48.5) | 77 (10.2) |
| Gender of the responding parent | | | *** | | |
| Female | 1091 (84.5) | 72.3 | 499 (45.7) | 478 (43.8) | 114 (10.5) |
| Male | 200 (15.5) | 78.9 | 64 (32.0) | 117 (58.5) | 19 (9.5) |
| Number of children aged 11–14 years ($n = 1278$) | | | | | |
| One | 1007 (78.8) | 72.8 | 450 (44.7) | 453 (45.0) | 104 (10.3) |
| Two or three | 271 (21.2) | 75.4 | 110 (40.6) | 134 (49.5) | 27 (10.0) |
| Sex of oldest child aged 11–14 years | | | | | |
| Female | 664 (51.4) | 73.0 | 287 (43.2) | 304 (45.8) | 73 (11.0) |
| Male | 627 (48.6) | 73.6 | 276 (44.0) | 291 (46.4) | 60 (9.6) |
| Highest level of education of the parent ($N = 1273$) | | | *** | | |
| Baccalauréat or below | 325 (25.6) | 62.9 | 141 (43.4) | 118 (36.3) | 66 (20.3) |
| Above baccalauréat | 948 (74.5) | 78.1 | 410 (43.3) | 474 (50.0) | 64 (6.8) |
| Job category | | | *** | | |
| Business leader, white collar, academic professor | 503 (39.5) | 81.3 | 189 (37.6) | 284 (56.5) | 30 (6.0) |
| Employee | 334 (26.2) | 65.2 | 167 (50.0) | 118 (35.3) | 49 (14.7) |
| Intermediate profession | 324 (25.4) | 75.1 | 156 (48.2) | 147 (45.4) | 21 (6.5) |
| Blue-collar worker | 50 (3.9) | 58.0 | 23 (46.0) | 16 (32.0) | 11 (22.0) |
| Farmer, tradesperson, entrepreneur with fewer than ten employees | 44 (3.5) | 60.0 | 16 (36.4) | 17 (38.6) | 11 (25) |
| No job category | 19 (1.5) | 52.6 | 3 (15.8) | 8 (42.1) | 8 (42.1) |
| Language spoken with children at home | | | ** | | |
| French monolingual | 1007 (79.2) | 74.8 | 451 (44.8) | 468 (46.5) | 88 (8.7) |
| Multilingual | 265 (20.8) | 68.2 | 101 (38.1) | 122 (46.0) | 42 (15.9) |
| Attitude towards school-based vaccination ($N = 1272$) | | | *** | | |
| Favourable | 754 (59.3) | 89.5 | 266 (35.3) | 485 (64.3) | 3 (0.4) |
| Not sure | 224 (17.6) | 67.2 | 140 (62.5) | 66 (29.5) | 18 (8.0) |
| Unfavourable | 294 (23.1) | 39.5 | 146 (49.7) | 39 (13.3) | 109 (37.1) |
| Attitude towards vaccination in general | | | *** | | |
| Very favourable | 612 (47.4) | 88.4 | 212 (34.6) | 388 (63.4) | 12 (2.0) |
| Rather favourable | 553 (42.8) | 65.7 | 295 (53.4) | 193 (34.9) | 65 (11.8) |
| Not sure | 76 (5.9) | 64.4 | 46 (60.5) | 7 (9.2) | 23 (30.3) |
| Rather unfavourable | 41 (3.2) | 39.2 | 7 (17.1) | 3 (7.3) | 31 (75.6) |
| Very unfavourable | 9 (0.7) | 16.3 | 3 (33.3) | 4 (44.4) | 2 (22.2) |
| Daughter vaccinated against HPV ($N = 658$) | | | *** | | |
| Yes | 358 (54.4) | 80.9 | 1305 (40.5) | 1728 (53.6) | 189 (5.9) |
| Does not know | 34 (5.2) | 79.7 | 12 (35.3) | 20 (58.8) | 2 (5.9) |
| No | 266 (40.4) | 63.1 | 128 (48.1) | 90 (33.8) | 48 (18.1) |

Parents of 11- to 14-year-old middle-school pupils in France, 2020–2021 ($N = 1291$). Mean theoretical acceptance: percentage of decisions in favour of vaccination, across all scenarios and participants

**$p < 0.01$; ***$p < 0.001$. $p$ value from Pearson's Chi square tests for difference between serial demanders, serial non-demanders and non-uniform respondents

**Table 3** Main effects of attributes on parental vaccine acceptance among non-uniform respondents ($N = 563$)

| | Total | | Parent of a girl ($N = 287$) | | Parent of a boy ($N = 276$) | | Interaction term |
|---|---|---|---|---|---|---|---|
| | Odds ratio | 95% CI | Odds ratio | 95% CI | Odds ratio | 95% CI | $p$ value |
| Disease | | | | | | | |
| Febrile illness (Reference) | 1 | | 1 | | 1 | | |
| Cancer | 2.68*** | [2.16–3.32] | 3.09*** | [2.29–4.17] | 2.35*** | [1.72–3.22] | 0.217 |
| Genital warts | 0.55*** | [0.45–0.67] | 0.53*** | [0.40–0.71] | 0.55*** | [0.41–0.74] | 0.873 |
| Pregnancy complications | 1.35** | [1.09–1.69] | 1.92*** | [1.40–2.64] | 0.92 | [0.67–1.26] | 0.001 |
| Optimal age | | | | | | | |
| Age-independent (Reference) | 1 | | 1 | | 1 | | |
| Better immune response | 1.56*** | [1.26–1.94] | 1.97*** | [1.45–2.69] | 1.23 | [0.91–1.68] | 0.035 |
| Before sexual relations | 1.20 | [0.94–1.51] | 1.57** | [1.12–2.20] | 0.89 | [0.64–1.25] | 0.021 |
| Safety | | | | | | | |
| No side effect (Reference) | 1 | | 1 | | 1 | | |
| No scientific confirmation | 0.99 | [0.80–1.24] | 1.21 | [0.88–1.65] | 0.77 | [0.56–1.06] | 0.048 |
| Surveillance other countries | 0.39*** | [0.31–0.50] | 0.38*** | [0.27–0.52] | 0.39*** | [0.28–0.54] | 0.897 |
| More benefits than risks | 0.31*** | [0.26–0.38] | 0.30*** | [0.23–0.39] | 0.30*** | [0.23–0.40] | 0.989 |
| Indirect protection | | | | | | | |
| Only your child (Reference) | 1 | | | | | | |
| Protects others | 1.00 | [0.81–1.24] | 0.92 | [0.69–1.23] | 1.14 | [0.83–1.56] | 0.338 |
| Elimination | 1.33** | [1.10–1.62] | 1.14 | [0.87–1.50] | 1.62** | [1.21–2.17] | 0.083 |
| Coverage | | | | | | | |
| Insufficient (Reference) | 1 | | 1 | | 1 | | |
| Already 30% | 0.73** | [0.59–0.90] | 0.92 | [0.69–1.23] | 0.54*** | [0.39–0.74] | 0.014 |
| 80% in France | 1.65*** | [1.29–2.11] | 1.95*** | [1.39–2.74] | 1.32 | [0.91–1.90] | 0.125 |
| 80% in other countries | 1.92*** | [1.53–2.41] | 2.16*** | [1.58–2.96] | 1.59** | [1.13–2.24] | 0.195 |
| Pseudo $R$ squared | 0.133 | | 0.133 | | 0.148 | | |

Parents of 11- to 14-year-old middle-school pupils in France, 2020–2021. Total sample and stratification by child's sex. Effects are estimated from fixed effects logit models. Reading example: hypothetical vaccine scenarios aiming at prevention of cancer were 2.68 times more likely to be accepted by participants who made variable decisions across scenarios than scenarios aiming at prevention of a febrile illness. The pseudo $R$-squared was calculated as $R^2 = 1 - (L_{\text{complete}}/L_{\text{empty}})$, based on a fixed-effects model including year (omitted because of no within-group variance)

*95% CI* 95% confidence interval. *$p < 0.05$; **$p < 0.01$; *** $p < 0.001$

warts' in the full sample (34.2 percentage points among non-uniform respondents), of 8.9 percentage points (25.5 percentage points) between 'No scientific confirmation' and 'More benefits than risks' and of 4.2 percentage points between high coverage in neighbouring countries and 'Insufficient coverage' (13.7 percentage points) (Fig. 2).

Attribute effects were similar for vaccine eagerness when considering the full sample, including serial and non-serial demanders (Table 4). Effects were in general substantially weaker among serial demanders, and not significant in the small sample of serial non-demanders. As an exception, potential for disease elimination showed a trend to a positive impact on vaccine eagerness in serial non-demanders with children not vaccinated against HPV and with good-quality responses ($n = 26$, coefficient 0.54 [0.06–1.02]).

### 3.3 Heterogeneity of Preferences According to Individual Characteristics

Significantly greater attribute effects among parents of girls compared with parents of boys were observed for 'Pregnancy complication' (OR 1.92 vs 0.92), 'Better immune response' (OR 1.97 vs 1.23), 'Before sexual relations' (OR 1.57 vs 0.89) and 'No scientific confirmation' (OR 1.21 vs 0.77) on vaccine acceptance (Table 3). Only parents of boys were significantly dissuaded by the 'Already 30%' level (OR 0.54 vs 0.92 for parents of girls).

Stratification of theoretical vaccine acceptance by parental gender was limited by the small number of participating fathers ($n = 64$ non-uniforms), with no significant interaction between parental gender and attributes (ESM F). The 'Cancer' attribute level showed a trend to higher impact

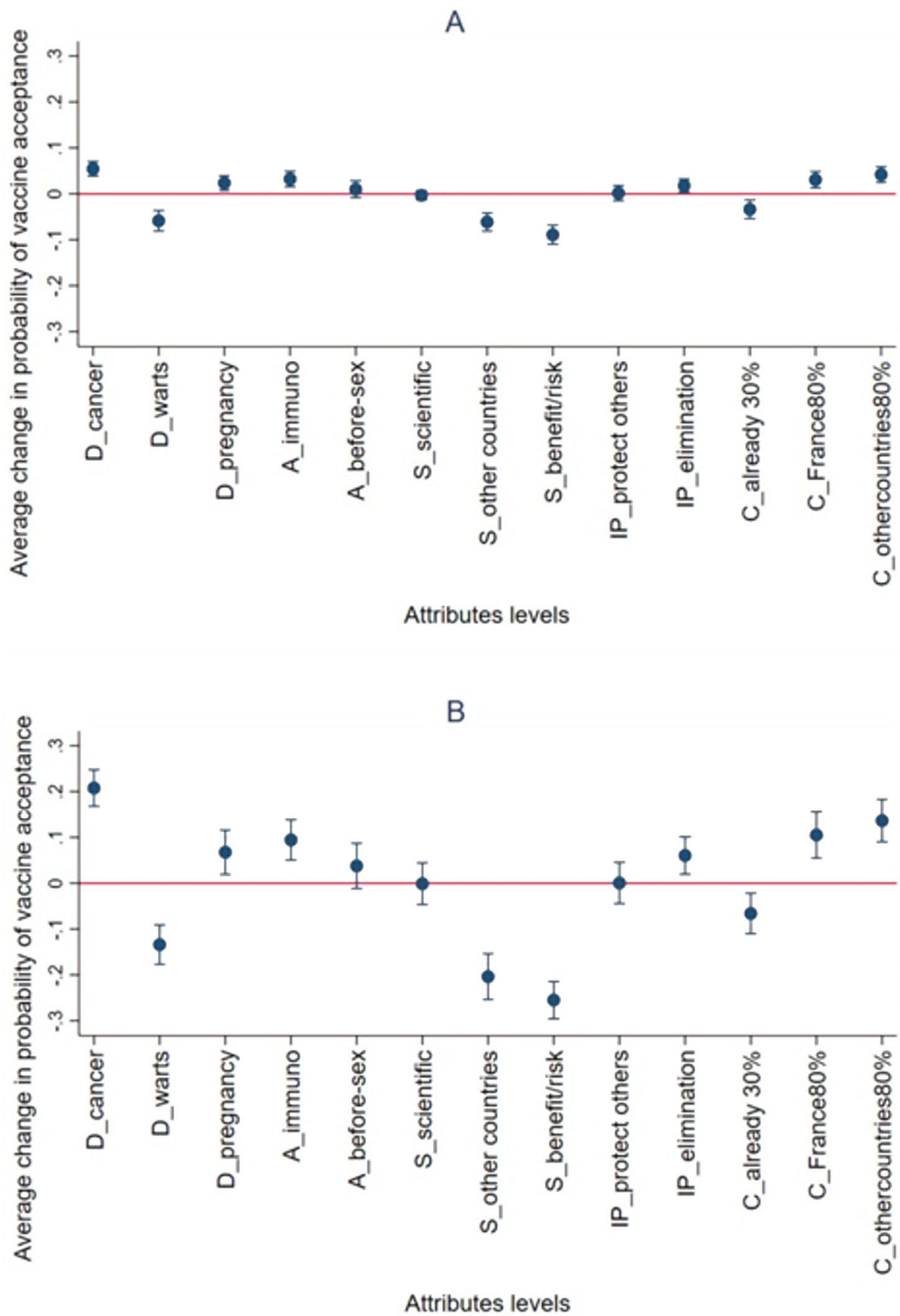



**Fig. 2** Average marginal effects of attribute levels on hypothetical vaccine acceptance. Parents of 11- to 14-year-old middle-school pupils in France, 2020–2021. **A** Full sample ($N = 1291$). **B** Non-uniform respondents only ($N = 563$). Attributes: *D* disease (ref. vaccination against a febrile respiratory disease); *A* age (ref. vaccination possible at any age); *S* safety (ref. no severe side effect known); *IP* indirect protection (ref. only individual protection); *C* coverage (ref. insufficient coverage). Reading example: among all participants, the probability of vaccine acceptance was 5 percentage points higher in scenarios aiming at prevention of cancer than those scenarios in the reference category 'prevention of a febrile illness'. The difference in vaccine acceptance between the 'Cancer' and 'Genital warts' attributes sums up to 11%. Specifically, among participants making variable decisions across scenarios (susceptible to communication content), the probability of vaccine acceptance was 21 percentage points higher in scenarios aiming at prevention of cancer than those aiming at prevention of a febrile illness

among mothers ($p = 0.074$), with a significant interaction in analyses on vaccine eagerness ($p = 0.006$).

'Before sexual relations' had a negative effect, specifically on French monolingual parents with lower educational level (OR 0.48), while this notion was neutral for multilingual parents with lower educational level (OR 1.19) and motivating for parents with high education level, irrespective of multilingualism (OR >1.40) (interaction term $p < 0.001$) (Fig. 3, ESM G). The positive impact of 'Pregnancy complication' appeared only among multilingual parents (OR > 2.70), irrespective of education level.

Among French monolingual mothers with higher education level, we found several significant interactions between survey year and preferences (ESM H). 'Protects others' and 'Elimination' motivated only before the pandemic in 2020, while 'Pregnancy complication' and high coverage levels in France or other countries had motivating effects only in 2021.

**Table 4** Vaccine eagerness towards vaccination of adolescents

| | Full sample ($N = 1291$) | | Serial demanders ($N = 595$) | | Serial non-demanders with good response quality and child not vaccinated against HPV ($N = 26$) | |
|---|---|---|---|---|---|---|
| | β-coefficient | 95% CI | β-coefficient | 95% CI | β-coefficient | 95% CI |
| Disease | | | | | | |
| Febrile illness (Reference) | 0 | | 0 | | 0 | |
| Cancer | 1.31*** | [1.06 to 1.57] | 0.19*** | [0.11 to 0.27] | − 0.20 | [− 0.77 to 0.36] |
| Genital warts | − 1.00*** | [− 1.26 to − 0.73] | − 0.28*** | [− 0.36 to − 0.19] | − 0.13 | [0.69 to 0.43] |
| Pregnancy complications | 0.46** | [0.18 to 0.74] | 0.11* | [0.02 to 0.20] | − 0.26 | [− 0.81 to 0.29] |
| Optimal age | | | | | | |
| Age-independent (Reference) | 0 | | 0 | | 0 | |
| Better immune response | 0.72*** | [0.46 to 0.99] | 0.09* | [0.00 to 0.18)] | 0.38 | [− 0.21 to 0.97] |
| Before sexual relations | 0.29* | [0.01 to 0.58] | 0.01 | [− 0.08 to 0.10] | 0.42 | [− 0.22 to 1.06] |
| Safety | | | | | | |
| No side effect (Reference) | 0 | | 0 | | 0 | |
| No scientific confirmation | − 0.23 | [− 0.50 to 0.03] | − 0.19*** | [− 0.27 to − 0.10] | 0.23 | [− 0.35 to 0.81] |
| Surveillance other countries | − 1.65*** | [− 1.93 to − 1.37] | − 0.61*** | [− 0.70 to − 0.52] | 0.12 | [− 0.46 to 0.69] |
| More benefits than risks | − 1.99*** | [− 2.23 to − 1.76] | − 0.72*** | [− 0.80 to − 0.65] | 0.33 | [− 0.14 to 0.81] |
| Indirect protection | | | | | | |
| Only your child (Reference) | 0 | | 0 | | 0 | |
| Protects others | 0.05 | [− 0.22 to 0.31] | 0.09* | [0.00 to 0.17] | 0.50 | [− 0.04 to 1.03] |
| Elimination | 0.31** | [0.08 to 0.55] | 0.17*** | [0.09 to 0.24] | 0.54* | [0.06 to 1.02]$^{\dagger}$ |
| Coverage | | | | | | |
| Insufficient (Reference) | 0 | | 0 | | 0 | |
| Already 30% | − 0.45*** | [− 0.72 to − 0.18] | − 0.19*** | [− 0.28 to − 0.11] | − 0.12 | [− 0.62 to 0.38] |
| 80% in France | 0.68*** | [0.38 to 0.97] | 0.11* | [0.01 to 0.20] | 0.33 | [− 0.28 to 0.94] |
| 80% in other countries | 0.94*** | [0.66 to 1.22] | 0.16*** | [0.07 to 0.25] | 0.21 | [− 0.30 to 0.73] |

Parents of 11- to 14-year-old middle-school pupils in France, 2020–2021 ($N = 1291$). Vaccine eagerness was estimated from theoretical acceptance and choice certainty. Effects are estimated from fixed effects intercept logit models. Reading example: among all participants and on a scale ranging from − 10 to + 10, uncertainty to refuse/scertainty to accept vaccination in a hypothetical scenario was 1.31 points higher in scenarios aiming at prevention of cancer than those aiming at prevention of a febrile illness

The β-coefficient represents the change in vaccine eagerness on a scale from − 10 to 10. *$p < 0.05$; **$p < 0.01$; ***$p < 0.001$. $^{\dagger}p = 0.027$

'No scientific confirmation' (relative to absence of side effect) demotivated before the pandemic, but not in 2021.

## 4 Discussion

In this single-profile discrete choice experiment, we found that communication to parents of middle-school pupils about HPV vaccination could be optimized to increase theoretical acceptance using DCEs. In particular, we found a strong positive effect from speaking about prevention of cancer instead of genital warts (11% gain in acceptance in the entire sample), and a strong negative effect from the notion of 'more benefits than risks' (9% loss).

Safety attribute levels had the greatest impact on parental vaccine acceptance, with strong negative impacts from two commonly used formulations, in particular that vaccine benefits outweigh the risks related to rare side effects. Similarly, Luyten et al. have described that adults overestimate risks due to a vaccine compared with the benefits of avoiding the same risks thanks to the vaccine [22]. By contrast, as previously described for adolescents, the information that the vaccine safety has been monitored for more than 10 years worldwide and that no serious side effect has been significantly confirmed did not reduce acceptance. This formulation thus appears adequate to reassure parents about vaccine safety, while avoiding inappropriate simplification denying the existence of side effects.

Following the idea that vaccine promotion should not scare to avoid bounce-back [23, 25], healthcare professionals in France sometimes avoid speaking about cancer when offering HPV vaccination. Our study found that presenting a vaccine protecting against a cancer showed clear advantages over other pathologies, in particular genital warts, again

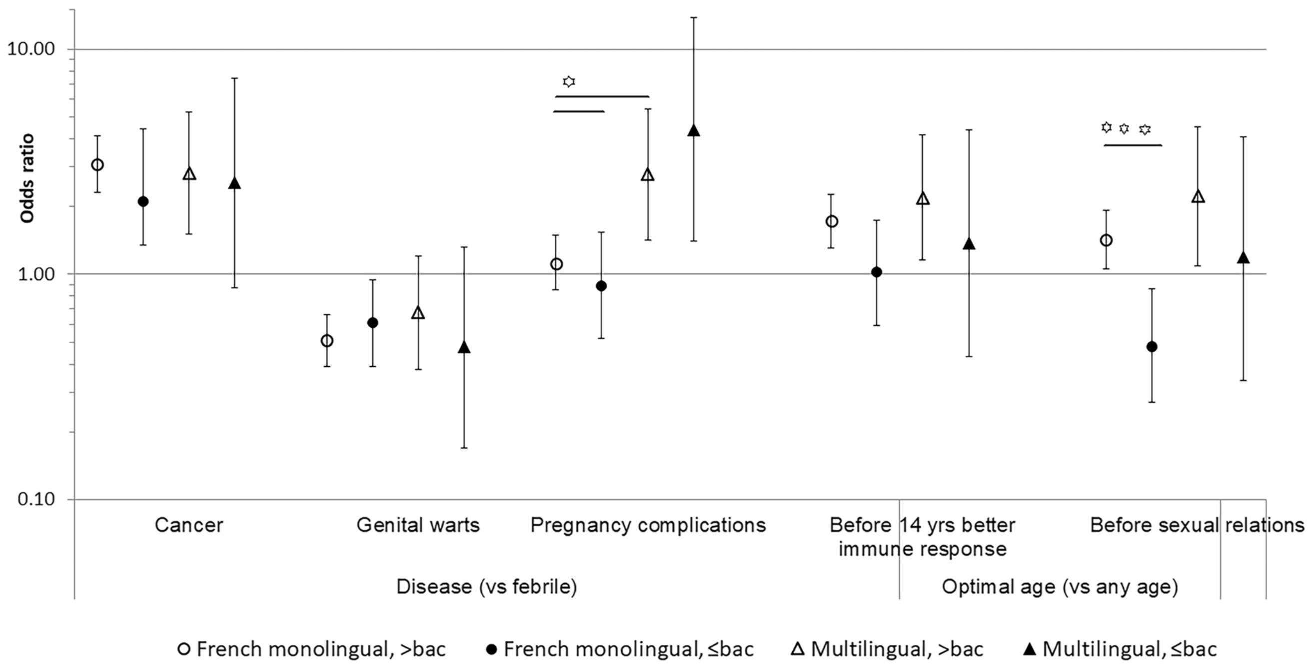



**Fig. 3** Effects of attribute levels 'disease' and 'optimal age' on hypothetical vaccine acceptance, stratified by parental educational level and family multilingualism. Parents of 11- to 14-year-old middle-school pupils in France, 2020–2021 ($N = 563$ non-uniform respondents). *Bac* baccalauréat (French high school diploma). Multilingualism refers to also speaking a different language than French fluently with children at home. Error bars are 95% confidence intervals. *$p < 0.05$, ***$p < 0.001$. Interaction terms: disease–pregnancy complications: (multilingual, > bac) vs (French–monolingual, > bac): $p = 0.015$; (multilingual, ≤ bac) vs (French–monolingual, > bac): $p = 0.023$. Optimal age–before sexual relations: (French–monolingual, ≤ bac) vs (French–monolingual, > bac): $p < 0.001$

in line with the previous adolescent study [14]. Similarly, Gilkey had reported that parents valued cancer prevention as the best reason for communicating on HPV vaccination [23, 24] and mentioning both cancer and warts was found motivating to parents in a DCE in Canada [24, 25].

The prevention of pregnancy complications had a positive effect only among multilingual parents and parents of girls, which may relate to different levels of feeling concerned by pregnancy. We previously had found that adolescent girls were motivated by the possibility of protecting their peers [14]. The potential for disease elimination positively impacted vaccine acceptance and eagerness in all subgroups, including non-demanders, and communication on this collective effect of HPV vaccination may be worthwhile to reinforce. While our data do not allow any strong interpretation of hypothetical effects of the COVID-19 pandemic, they suggest that indirect protection effects may have lost some motivational power between 2020 and 2021. Calling on altruistic motivation for vaccination, be it sympathy- or commitment-driven, requires good knowledge of the target audience, and further investigation is needed before using such arguments more widely.

In our study, the argument of better immune response motivated parental acceptance of adolescent vaccination, as did the reference to sexual debut among parents of girls. In line with our results, Gilkey et al. found that parents ranked the arguments "it works best at this age" and "it should be given before sexual contact" as the 5th and 6th best reasons, respectively, to accept the HPV vaccine for their child [23]. Additional cues to action may be needed to avoid late HPV vaccination with consequent reduced effectiveness, and school-based campaigns can probably have this function.

Parents in our study showed social conformism around HPV vaccination similar to other DCEs testing this hypothesis for various vaccinations among healthcare workers, university students, and adolescents [14, 26, 27]. There is ample evidence that vaccine decisions are made in the individual social context and interventions to positively lever on this phenomenon are needed [28]. While coverage rates in France are currently increasing but remain below target, our results suggest that information about high vaccine coverage in neighbouring countries can motivate vaccine acceptance among French parents. Careful tailoring to the target audience by choosing a relevant reference population appears necessary.

We developed the DCE tool before the publication of high scientific evidence on vaccine effectiveness against cervical cancer, which emerged later in 2020 [29]. The additional attribute referred to this uncertainty, which was a barrier to vaccine recommendation including among medical doctors in France [30]. The dissuasive effect of uncertainty around effectiveness was substantial in our study (acceptance 11%) and in line with previous findings on the impact of controversies on vaccine acceptance [27]. Tools to address this negative effect of uncertainty are direly needed, but initial evidence points towards transparency and up-front information [31].

We found several differences in preferences between subgroups, in particular related to the child's gender, multilingualism and educational level. Such differences are of importance in tailoring vaccine promotion as recommended by the World Health Organisation (WHO) [32]. Teenage pregnancies are more frequent and have more severe consequences in lower-income groups [33], which may explain why specifically French monolingual parents with lower educational achievement reacted negatively to the argument related to sexual debut. This finding supports communication strategies that do not emphasize the link between HPV vaccination and sexual debut or sexual transmission, while further research on this aspect appears needed.

Despite the fact that the vast majority of our study participants had a favourable attitude towards vaccination in general, half of participants varied decisions between acceptance and refusal. Furthermore, even among parents declaring that their child was not vaccinated against HPV, 33% were serial demanders and 48% varied decisions. Furthermore, parents with a rather unfavourable attitude towards vaccination accepted 39% of scenarios. This illustrates the complexity of vaccine decision making and the importance of optimized communication to give parents the information they need to make an informed choice with confidence. Choice-based research methods have the advantage not to classify individuals based on isolated behaviour but to develop strategies that help moving towards recommended decisions.

Our study has several limitations. First, the sample size was small for some specific subgroup analyses, such as comparison of preferences by parental gender or estimation of preferences of parents with an unfavourable opinion on vaccination in general. Second, our sample was not designed to be representative of the parental population in France. As our study invitation indicated vaccination as a research topic, participants may have been more interested (positively or negatively) by vaccination than the general population of parents. Thus, the description of our sample should not be used to estimate prevalence numbers in the French parental population. The characteristics of our study sample further document a substantial underrepresentation of blue collar workers (4 vs 19%, national statistics INSEE (https://www.insee.fr/fr/statistiques/2489546#figure1_radio2), as well as some overrepresentation of parents with HPV-vaccinated daughters (54.4% at age 11–14 years, vs 45.8% at age 15 years in France [2]), and of persons with (very) favourable attitude toward vaccination in general (90.2 vs 82.5% among adults during 2021 in France [34]. Our results on interaction with vaccine attitudes, or in subgroups by decision behaviour (serial non-demanders) or educational attainment and at-home multilingualism are therefore particularly important. They remind us that vaccine promotion to specific population groups should be tailored to their expectations and needs. Third, our study only evaluates hypothetical vaccine acceptance and stated (not revealed) preferences and not actual vaccine uptake. However, preferences estimated from well-conducted DCE have been shown to predict behaviour [35]. We therefore suggest that our findings can be used to guide the development of HPV communication messages. Using a DCE, we cannot directly evaluate the effectiveness of one communication message compared with another. For this, a between-subject design with randomization would be required. We rather observe the sensitivity of respondents to different attributes across various scenarios, which allows adaption of the communication to these preferences. Lastly, in the absence of comparable studies, we cannot assess transferability of the results to other populations. Future studies should explore country- and subgroup-specific preferences around HPV vaccine communication.

## 5 Conclusion

Our study among parents of 11- to 14-year-old middle-school pupils in France suggests that DCEs can be used to optimize the impact of communication about HPV vaccination on vaccine acceptance. Our results suggest that while some content should be used preferentially (referring to cancer prevention, high vaccine coverage rates in neighbouring countries and disease elimination), others should be avoided, such as statements about 'insufficient coverage' and 'more benefits than risks'. We also recommend favouring the better immune response before age 15 years [36] to explain the recommended early age of HPV vaccination, instead of insisting on a decreased effectiveness after sexual debut; while both arguments are exact, the first seems better suited to parents of children aged 11 years. Protection from pregnancy complications (cervical conization as a treatment of precancerous lesions) can also serve as a lever in targeted communities. The results of the present study were used to develop a multicomponent intervention for HPV vaccine promotion in middle schools and by general practitioners, which is being evaluated in the PrevHPV cluster-randomized trial [13].

**Supplementary Information** The online version contains supplementary material available at https://doi.org/10.1007/s40271-024-00687-6.

**Acknowledgements** We thank the middle schools who agreed to collaborate on this study, the Fédération des Conseils de Parents d'Elèves as well as all the parents who participated. We thank the PrevHPV Consortium in which this study was conducted, in particular Stéphanie Bonnay (Université de Lorraine).

## Declarations

**Conflict of interest statement/Funding** The authors declare that they have no competing interests with regard to the content of this article. The PrevHPV study is conducted with the support of Institut de recherche en santé Publique (IReSP) and Institut national de la santé et de la recherche médicale (Inserm), and with financial support from ITMO Cancer AVIESAN (Alliance Nationale pour les Sciences de la Vie et de la Santé/ National Alliance for Life Sciences & Health) within the framework of the Cancer Plan. ITMO Cancer AVIESAN had no role in the collection, analysis, and interpretation of data.

**Ethics** The PrevHPV project was granted approval by Evaluation Committee of Inserm, the Institutional Review Board (IRB00003888, IORG0003254, FWA00005831) on 10 December 2019. All study participants consented to participate after reading the study information. Participants could refuse or stop their participation at any time.

**Data sharing** Research data of this article can be made accessible upon reasonable request to the corresponding author.

**Author contributions** Conceptualization (SC, JS, JEM, JR, ASB); Data curation (SC); Formal analysis (SC, JEM); Funding acquisition (AGB, SB, AG, ASLDB, NT, JEM); Investigation (SC, AGB, AG, ASLDB, NT, JEM); Methodology (SC, JS, MM, BG, JEM); Validation (all authors); Writing – original draft (SC); and Writing – review & editing (all authors).

**Consent to participate** All study participants consented to participate after reading the study information. Participants could refuse or stop their participation at any time.

**Consent for publication** All co-authors approved the final version of the manuscript.

**Code availability** Research data and codes of this article can be made accessible upon reasonable request to the corresponding author.



## References

1. World Health Organization. Human papillomavirus vaccines: WHO position paper. Wkly Epidemiol Rec. 2022;97:645–72.
2. Santé Publique France. Données de couverture vaccinale papillomavirus humains (HPV) par groupe d'âge. 2022. https://www.santepubliquefrance.fr/determinants-de-sante/vaccination/articles/donnees-de-couverture-vaccinale-papillomavirus-humains-hpv-par-groupe-d-age. Accessed 31 Aug 2023.
3. Karafillakis E, Simas C, Jarrett C, Verger P, Peretti-Watel P, Dib F, et al. HPV vaccination in a context of public mistrust and uncertainty: a systematic literature review of determinants of HPV vaccine hesitancy in Europe. Hum Vaccin Immunother. 2019;15:1615–27. https://doi.org/10.1080/21645515.2018.1564436.
4. Wang J, Ploner A, Sparén P, Lepp T, Roth A, Arnheim-Dahlström L, et al. Mode of HPV vaccination delivery and equity in vaccine uptake: a nationwide cohort study. Prev Med. 2019;120:26–33. https://doi.org/10.1016/j.ypmed.2018.12.014.
5. Newman PA, Logie CH, Lacombe-Duncan A, Baiden P, Tepjan S, Rubincam C, et al. Parents' uptake of human papillomavirus vaccines for their children: a systematic review and meta-analysis of observational studies. BMJ Open. 2018;8: e019206. https://doi.org/10.1136/bmjopen-2017-019206.
6. Michie S, van Stralen MM, West R. The behaviour change wheel: a new method for characterising and designing behaviour change interventions. Implement Sci. 2011;6:42. https://doi.org/10.1186/1748-5908-6-42.
7. Nowak GJ, Gellin BG, MacDonald NE, Butler R, Eskola J, Liang X, et al. Addressing vaccine hesitancy: the potential value of commercial and social marketing principles and practices. Vaccine. 2015;33:4204–11. https://doi.org/10.1016/j.vaccine.2015.04.039.
8. Goldstein S, MacDonald NE, Guirguis S, Eskola J, Liang X, Chaudhuri M, et al. Health communication and vaccine hesitancy. Vaccine. 2015;33:4212–4. https://doi.org/10.1016/j.vaccine.2015.04.042.
9. Nyhan B, Reifler J, Richey S, Freed GL. Effective messages in vaccine promotion: a randomized trial. Pediatrics. 2014;133:e835–42. https://doi.org/10.1542/peds.2013-2365.
10. Bekalu MA. Communication inequalities and health disparities. Inf Dev. 2014;30:189–91. https://doi.org/10.1177/0266666914527412.
11. Diks ME, Hiligsmann M, van der Putten IM. Vaccine preferences driving vaccine-decision making of different target groups: a systematic review of choice-based experiments. BMC Infect Dis. 2021. https://doi.org/10.1186/S12879-021-06398-9.
12. Lack A, Hiligsmann M, Bloem P, Tünneßen M, Hutubessy R. Parent, provider and vaccinee preferences for HPV vaccination: a systematic review of discrete choice experiments. Vaccine. 2020;38:7226–38. https://doi.org/10.1016/j.vaccine.2020.08.078.
13. Bocquier A, Michel M, Giraudeau B, Bonnay S, Gagneux-Brunon A, Gauchet A, et al. Impact of a school-based and primary care-based multicomponent intervention on HPV vaccination coverage among French adolescents: a cluster randomised controlled trial protocol (the PrevHPV study). BMJ Open. 2022;12: e057943. https://doi.org/10.1136/bmjopen-2021-057943.
14. Chyderiotis S, Sicsic J, Raude J, Bonmarin I, Jeanleboeuf F, Banaszuk LD, et al. Optimising HPV vaccination communication to adolescents: a discrete choice experiment. Vaccine. 2021;39:3916–25. https://doi.org/10.1016/j.vaccine.2021.05.061.
15. Ryan M, Watson V, Entwistle V. Rationalising the 'irrational': a think aloud study of discrete choice experiment responses. Health Econ. 2009;18:321–36. https://doi.org/10.1002/hec.1369.
16. Mansfield C, Sutphin J, Boeri M. Assessing the impact of excluded attributes on choice in a discrete choice experiment

using a follow-up question. Health Econ. 2020. https://doi.org/10.1002/hec.4124.

17. Bridges JFP, Hauber AB, Marshall D, Lloyd A, Prosser LA, Regier DA, et al. Conjoint analysis applications in health—a checklist: a report of the ISPOR Good Research Practices for Conjoint Analysis Task Force. Value Health. 2011;2011(14):403–13. https://doi.org/10.1016/j.jval.2010.11.013.
18. Chyderiotis S, Sicsic J, Thilly N, Mueller JE. For the PrevHPV consortium. Vaccine eagerness: a new framework to analyse preferences in single profile discrete choice experiments. Application to HPV vaccination decisions among French adolescents. SSM Popul Health. 2022;17:101058. https://doi.org/10.1016/j.ssmph.2022.101058.
19. Institut national de la statistique et des études économiques. Démographie—France, portrait social, édition 2020. 2020. https://www.insee.fr/fr/statistiques/4797574?sommaire=4928952. Accessed 30 Apr 2023.
20. Beauchemin C, Hamel C, Simon P. Trajectoires et Origines. Enquête sur la diversité des populations en France. Premiers résultats. 2020. https://www.insee.fr/fr/information/4172158. Accessed 27 Oct 2023.
21. Hanguehard R, Gautier A, Soullier N, Barret AS, Parent du Chatelet I, Vaux S. Couverture vaccinale contre les infections à papillomavirus humain des filles âgées de 15 à 18 ans et déterminants de vaccination, France, 2021. Bull Epidémiol Hebd. 2022;24–25:446–55.
22. Luyten J, Kessels R, Atkins KE, Jit M, van Hoek AJ. Quantifying the public's view on social value judgments in vaccine decision-making: a discrete choice experiment. Soc Sci Med. 2019;228:181–93. https://doi.org/10.1016/j.socscimed.2019.03.025.
23. Pluviano S, Watt C, Della SS. Misinformation lingers in memory: failure of three pro-vaccination strategies. PLoS ONE. 2017;12:e0181640. https://doi.org/10.1371/journal.pone.0181640.
24. Gilkey MB, Zhou M, McRee AL, Kornides ML, Bridges JFP. Parents' views on the best and worst reasons for guideline-consistent HPV vaccination. Cancer Epidemiol Biomark Prev. 2018;27:762–7. https://doi.org/10.1158/1055-9965.EPI-17-1067.
25. Oteng B, Marra F, Lynd LD, Ogilvie G, Patrick D, Marra CA. Evaluating societal preferences for human papillomavirus vaccine and cervical smear test screening programme. Sex Transm Infect. 2011;87:52–7. https://doi.org/10.1136/sti.2009.041392.
26. Díaz Luévano C, Sicsic J, Pellissier G, Chyderiotis S, Arwidson P, Olivier C, et al. Quantifying healthcare and welfare sector workers' preferences around COVID-19 vaccination: a cross-sectional, single-profile discrete-choice experiment in France. BMJ Open. 2021;11(10):2021. https://doi.org/10.1136/bmjopen-2021-055148.
27. Seanehia J, Treibich C, Holmberg C, Müller-Nordhorn J, Casin V, Raude J, et al. Quantifying population preferences around vaccination against severe but rare diseases: a conjoint analysis among French university students, 2016. Vaccine. 2017;35:2676–84. https://doi.org/10.1016/j.vaccine.2017.03.086.
28. World Health Organization. Understanding the behavioural and social drivers of vaccine uptake WHO position paper—May 2022. Wkly Epidemiol Rec. 2022;97:209–24.
29. Lei J, Ploner A, Elfström KM, Wang J, Roth A, Fang F, et al. HPV vaccination and the risk of invasive cervical cancer. N Engl J Med. 2020;383:1340–8. https://doi.org/10.1056/NEJMoa1917338.
30. Anonymous. Prescrire en Questions: Vaccin papillomavirus à 9 valences : un progrès ignoré ? Revue Prescrire. 2019;39:468-71. https://prescrire.org/Fr/3/31/57333/0/NewsDetails.aspx. Accessed 23 Apr 2023.
31. Büchter RB, Betsch C, Ehrlich M, Fechtelpeter D, Grouven U, Keller S, et al. Communicating uncertainty in written consumer health information to the public: parallel-group, web-based randomized controlled trial. J Med Internet Res. 2020;22: e15899. https://doi.org/10.2196/15899.
32. Butler R, MacDonald NE, Eskola J, Liang X, Chaudhuri M, Dube E, et al. Diagnosing the determinants of vaccine hesitancy in specific subgroups: the guide to Tailoring Immunization Programmes (TIP). Vaccine. 2015;33:4176–9. https://doi.org/10.1016/j.vaccine.2015.04.038.
33. Cook SMC, Cameron ST. Social issues of teenage pregnancy. Obstet Gynaecol Reprod Med. 2015;25:243–8. https://doi.org/10.1016/j.ogrm.2015.06.001.
34. Vaux S, Gautier A, Nassany O, Bonmarin I. Vaccination acceptability in the French general population and related determinants, 2000–2021. Vaccine. 2023;41:6281–90. https://doi.org/10.1016/j.vaccine.2023.08.062.
35. de Bekker-Grob EW, Donkers B, Bliemer MCJ, Veldwijk J, Swait JD. Can healthcare choice be predicted using stated preference data? Soc Sci Med. 2020;246: 112736. https://doi.org/10.1016/j.socscimed.2019.112736.
36. Petersen LK, Restrepo J, Moreira ED, Iversen OE, Pitisuttithum P, Van Damme P, et al. Impact of baseline covariates on the immunogenicity of the 9-valent HPV vaccine—a combined analysis of five phase III clinical trials. Papillomavirus Res. 2017;3:105–15. https://doi.org/10.1016/J.PVR.2017.03.002.

## Authors and Affiliations

**Sandra Chyderiotis[1] · Jonathan Sicsic[2] · Amandine Gagneux-Brunon[3,4,5] · Jocelyn Raude[6] · Anne-Sophie Barret[7] · Sébastien Bruel[8,9] · Aurélie Gauchet[10] · Anne-Sophie Le Duc Banaszuk[11] · Morgane Michel[12,13] · Bruno Giraudeau[14] · Nathalie Thilly[15,16] · Judith E. Mueller[1,6] · for the PrevHPV Consortium**

✉ Judith E. Mueller
Judith.mueller@ehesp.fr

[1] Institut Pasteur, Université Paris Cité, Emerging Disease Epidemiology Unit, 75015 Paris, France

[2] Université Paris Cité, LIRAES, 75006 Paris, France

[3] CHU de Saint-Etienne-Service d'Infectiologie, Saint-Etienne, France

[4] Centre International de Recherche en Infectiologie, Team GIMAP, Université de Lyon, Université Jean Monnet, Université Claude Bernard Lyon 1, Inserm, U1111, CNRS, UMR530, Lyon, France

[5] CIC-Inserm, 1408, CHU de Saint-Etienne, Saint-Etienne, France

[6] Univ. Rennes, EHESP, CNRS, Inserm, Arènes-UMR 6051, RSMS (Recherche sur les Services et Management en Santé)-U1309, 35000 Rennes, France

[7] Santé Publique France, Saint-Maurice, France

[8] Department of General Practice, Jacques Lisfranc Faculty of Medicine, Saint-Etienne-Lyon University, Saint-Etienne, France

[9] Health, Systemic, Process. UR 4129 Research Unit, University Claude Bernard, University of Lyon, Lyon, France

[10] Université Savoie Mont Blanc, Univ. Grenoble Alpes, LIP/PC2S, 73000 Chambéry, France

[11] Centre Régional de Coordination des Dépistages des cancers-Pays de la Loire, 5 Rue des Basses Fouassières, 49000 Angers, France

[12] Université Paris Cité, ECEVE, UMR 1123, Inserm, 75010 Paris, France

[13] Assistance Publique-Hôpitaux de Paris, Hôpital Robert Debré, Unité d'épidémiologie clinique, 75019 Paris, France

[14] Université de Tours, Université de Nantes, INSERM, SPHERE U1246, INSERM CIC 1415, CHRU de Tours, Tours, France

[15] Université de Lorraine, APEMAC, 54500 Nancy, France

[16] Département Méthodologie, Promotion, Investigation, Université de Lorraine, CHRU-Nancy, 54500 Nancy, France