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## Shared HPV vaccine readiness within families: a psychometric analysis of parent-adolescent dyads in France

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## Authors contribution

JEM and DOD conceived the original study concept and the analysis plan. SC, JR and AG revised the analysis plan. DOD performed the statistics and wrote the first draught. All authors contributed to data collection and interpretation and revised and approved the final version of the manuscript.

## Data Availability Statement

The data that support the findings of this study are not publicly available. They are however available upon restrictions from the authors upon reasonable request and with permission of the French National Institute for Health and Medical Research (Inserm). The reuse of data is subject to compliance with the GDPR and French regulations.

## Competing Interest Statement

None to declare.

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## Abstract

**Background.** In France, uptake of the recommended HPV vaccination remains low. The vaccine cannot be administered without parental consent, but studies have shown that adolescents can make informed decisions about their health. We aimed at understanding the weight of adolescents' vaccination intention in parents' vaccination decision, using data from parent-adolescent dyads collected at baseline of a randomised trial of vaccine promotion interventions.

**Methods.** 649 parent-adolescent dyads from 61 middle schools in France independently completed an online questionnaire on their knowledge and attitudes toward HPV vaccination, structured around the seven psychological domains of vaccine readiness (VR). We used multivariate and path analyses to understand the family decision-making process.

**Results.** HPV vaccination was reported by 50.1% of adolescents and 45.5% of parents. Individual antecedents of VR were poorly correlated within dyads ( $r$ : 0.14 to 0.36). Vaccine intentionality among parents of girls depended both on their own VR ( $\beta = .53, p < .001$ ) and on their daughters' vaccine intention ( $\beta = .25, p < .001$ ). But among parents of boys, vaccine intention depended only on their own VR ( $\beta = .72, p < .001$ ). Adolescents' VR depended more strongly on the social environment's attitude among boys than among girls ( $\beta = .54$  vs.  $.34, p < .01$ ).

**Conclusions.** The defined model showed shared decision processes between parents and adolescent girls, but not boys, which can be understood in the context of a recent expansion of HPV vaccination to boys. Beyond this, it suggests that promotion targeting adolescents and their social environment can have a positive influence on parental intentions.

*Keywords:* HPV vaccination, Parent-adolescent dyads, vaccination decision-making process, Vaccine readiness

*Public abstract:* Achieving a high level of vaccination against HPV could reduce or even eliminate certain cancers, including cervical cancer. Ideally, adolescents should be vaccinated at middle school, but their parents are the only ones who can decide whether to accept a vaccination, even

though adolescents can make health decisions. In a school-based intervention, our aim was to explore the involvement of adolescents in their parent's vaccination decision.

## Shared HPV Vaccine Readiness Within Families: A Psychometric Analysis of Parent-Adolescent Dyads in France

Anogenital infection by oncogenic human papillomavirus (HPV) is transmitted through intimate contact, usually during the first years of sexual life (World Health Organisation, 2020b). These viruses are responsible for several cancers of the anogenital and head and neck sphere, and in particular cervical cancer (Bansal et al., 2016; Lei et al., 2020). HPV vaccines are highly effective in preventing infection (Drolet et al., 2019), and thus cervical cancer (Lei et al., 2020). For optimal immunogenicity and effectiveness, vaccination is recommended between the age of 9 and 14 years (World Health Organisation, 2020a).

In France, two doses of HPV vaccine are recommended for boys and girls aged 11–14 years, with a catch-up reimbursed until age 19 years (Haute Autorité de Santé, 2019). Vaccination costs are reimbursed at a rate of 65% by French Social security system and 35% by mutual insurance companies, which benefit more than 95% of the French population (Haut Conseil pour l’Avenir de l’Assurance Maladie, 2022). Despite these recommendations and the absence of costs or financial burden for the majority of the population, French vaccination coverage remains one of the lowest in Europe (Nguyen-Huu et al., 2020). Only 37.4% of 16-year-old girls are fully vaccinated, and 45.8% of 15-year-old girls had received at least one dose in 2021 (Santé Publique France, 2022b). Previously reported parental reasons for under-vaccination are diverse and include: lack of information about the HPV vaccination, concerns about the vaccine safety, low perception of vaccine efficacy, mistrust in health authorities and the sexual aspect of HPV vaccination (Karafillakis et al., 2019). In addition to these reasons, a previous study pointed out the lack of general physician recommendation due to unfavourable perceptions of its risk-benefit balance (Collange et al., 2016), and low accessibility in the French health system. Indeed, HPV vaccination is accessible only through physicians and requires getting the vaccine at the pharmacy. In addition, there was no French national programme of school-based vaccination against HPV. However, local school-based vaccination initiatives may exist in municipalities or

territories. Currently, there are plans for nationwide vaccine access directly in pharmacies and vaccine campaigns in middle schools.

Furthermore, in France, vaccination of those under 18 years of age (legal age of majority) requires parental consent, which may limit adolescents' participation in decision making (Lefevre et al., 2019). A qualitative study exploring the role of maturity in adolescent decision-making about HPV vaccination (Karafillakis et al., 2021) highlights the passivity of French adolescents, despite their willingness to be informed and involved in the decision-making process. By contrast, psychological studies have shown that adolescents are competent to make informed medical decisions (Grootens-Wiegers et al., 2017), and there has been debate about the right of older adolescents, typically aged 16 years and older, to access vaccination without parental consent, similar to contraception (Lefevre et al., 2019). Indeed, as with adults, increased awareness and confidence in immunisation among adolescents have a positive impact on vaccine acceptance (Cadeddu et al., 2021). In addition, adopting health behaviour is not a binary process. Following the transtheoretical model of behaviour change (Prochaska & DiClemente, 1984) adapted to vaccination, several stages lead from ignorance of both the vaccine and vaccine-preventable diseases to the action of vaccination. Adolescents' stated involvement in the decision-making process may also depend on whether they concord with their parents' opinions.

In the context of school-based vaccination initiatives – shown to be effective in increasing HPV vaccination coverage (Grandahl et al., 2016; Rickert et al., 2015; Underwood et al., 2019; Wegwarth et al., 2014) – a key question is whether efforts should concentrate solely on communicating with parents as decision-makers, or whether adolescents under the age of 16 should also be targeted. Parent-adolescent dyadic studies can help with such questions, but remain rare and tend to be qualitative with small sample sizes. Nevertheless, findings from such studies include (i) a lack of communication between parents and adolescents about HPV vaccination (Chang et al., 2018), but with no impact on actual vaccination; (ii) the finding of generally low knowledge about HPV among both parents and adolescents, but with little impact on the decision to vaccinate (Fishman et al., 2014); and (iii)



misconceptions that the vaccine protects against other sexually transmitted infections (Alexander et al., 2012). Among adolescent boys in particular, the decision to vaccinate was clearly associated with a desire for protection (Alexander et al., 2012).

Consequently, in the present study, we aimed at exploring quantitatively and in a larger sample the extent to which adolescents in France contribute to HPV vaccine decision-making and influence their parents' intention. The study was structured around three research questions with according methodological approaches:

Question 1: To which extent do adolescents and their parents share awareness, knowledge, and opinion surrounding HPV vaccination, and intentionality? Adolescents can make informed health decisions (Grootens-Wiegers et al., 2017), but may be excluded from the HPV vaccine decision-making process by parents or health professionals (Karafillakis et al., 2021). We evaluated the concordance in different aspects around HPV vaccination, including awareness, knowledge and intentionality between parents and adolescents, as well as their attitude about vaccination in general and in their social environment.

Question 2: To which extent do the levels of HPV vaccine readiness and its seven antecedents (Moirangthem et al., 2022; Oudin Doglioni et al., 2023) correlate between parents and adolescents? Some studies have found a lack of communication between parents and adolescents about HPV vaccination (Chang et al., 2018) which may lead to large differences in attitudes around this vaccination. We evaluated the correlation between adolescent and parental levels of vaccine readiness for HPV vaccination and of its seven antecedents. In addition to this question, we examine the influence of concordant (high vs. low)/non-concordant levels of vaccine readiness within dyads on parental vaccine intention.

Question 3: Does the cross-sectional data on parent-adolescent dyads in France support a hypothetical model of adolescents influencing parental HPV vaccine intentionality? School-based vaccination programmes are effective in increasing vaccine uptake (Grandahl et al., 2016; Rickert et al., 2015; Underwood et al., 2019; Wegwarth et al., 2014), but it is not clear in how far these

programmes should include vaccine promotion specifically towards adolescents. Based on an integrated theoretical model (see **Supplementary material 1**) and assuming that vaccine intention is influenced by vaccine readiness, we evaluated a structured model in which adolescents' vaccine readiness and intention influenced parental intentions to initiate HPV vaccination.

## 1 Methods

### 1.1 Data Collection

This survey used baseline data from the PrevHPV project which was designed as a cluster-randomised controlled trial to evaluate a multicomponent intervention including school-based HPV vaccine promotion and HPV vaccine uptake (first dose) campaigns. A total of 61 middle schools participated in the data collection. Detailed study procedures have been described elsewhere (Bocquier *et al* (2022)). Briefly, for the baseline assessment, a study invitation was emailed by the school administration (through a 'digital workspace', an institutional communication system linking the school, the pupil, and their parents or legal guardians) to all parents and legal guardians of pupils enrolled in the schools, along with the information about the research project and its procedures. In addition, to meet the needs of parents who do not have easy access to digital technology, a printed version of the study invitation and information was distributed to the pupils in class. After invitation, both parents and adolescents could refuse to participate, and parents could refuse to have their child participate. Participation of adolescents and parents was voluntary and not compensated.

All pupils were given an anonymous unique 9-digit family code to be entered in the parent and adolescent questionnaire. Pupils were instructed to share this code with their parents along with a printed version of the study invitation. During data analysis, we linked observations from the adolescent and parent databases and considered them as dyads if they had corresponding codes.

Enrolment occurred between 22 November 2021 and 8 February 2022, via a RedCAP online data collection platform, with one reminder e-mail for parents. Invited individuals agreed to participate after reading a study information summary and by starting the online survey. Pupils attending the 4<sup>th</sup>

and 3<sup>rd</sup> grades (typically aged 13–15 years) completed the questionnaires during class sessions under the supervision of a biology teacher or school nurse.

Data was collected through anonymous online surveys in adherence to national and international standards of research ethics (French law, Helsinki Declaration) and data protection regulation (GRPD). The study protocol was approved by the French Ethics Committee 'CPP Sud-Est VI' on 22 December 2020 (ID-RCB: 2020-A02031-38) and registered at Clinical Trial under the identifier: NCT04945655.

## 1.2 Questionnaire

The questionnaire included socio-demographic information and items referring to an integrated theoretical model to understand vaccine behaviour (Oudin Doglioni & Mueller, In preparation; see **Supplementary material 1**). This model integrates, among other determinants, social norms, personal determinants, the seven antecedents of vaccine readiness and vaccination intentions. More specifically for this study, we assumed that vaccine intention is influenced by vaccine readiness. Thus, parental vaccine intention is influenced by both parental vaccine readiness and adolescent vaccine intention. We introduced adolescents' perception of social norms to determine whether other extra-familial factors could contribute to the decision-making process.

We asked questions on respondents' general attitude about vaccination and specific attitudes about HPV vaccination, and specific knowledge items on HPV vaccination. Finally, we assessed the respondents' perception of their social environment's attitude regarding vaccines in general, and HPV vaccination in particular. Questionnaires for parents and adolescents were identical with few wording differences in question about vaccination. For example, for parents, these items referred to 'your child's vaccination against HPV' or similar expressions, and for adolescents, they referred to 'your vaccination against HPV' or equivalent wording.

### 1.2.1 *Evaluation of the Seven Antecedents of Vaccine Readiness*

We used a questionnaire regarding the seven antecedents of HPV vaccine readiness (i.e., a set of intrapersonal dispositions that contribute to vaccine intention), based on attitude and knowledge

items evaluated on 5-point Likert scales as previously described (Moirangthem et al., 2022; Oudin Doglioni et al., 2023). Questionnaire followed those of the 5C-model (Betsch et al., 2018) adapted to HPV vaccination, to which we added two dimensions summarising the influence of the social environment and distinguishing between vaccine-related and confidence in the wider system. Briefly, the seven antecedents and related items were: confidence in the vaccine (perception of the safety of HPV vaccination); convenience (perception of practical barriers to HPV vaccination); complacency (perceptions related to the usefulness of HPV vaccination); calculation (perception of the HPV vaccine's benefit-risk balance); collective responsibility (interest in the protection of others by HPV vaccination); confidence in the system (formulated here as confidence in the wider schooling system); social conformism (perception around HPV vaccine acceptance by others). See **Supplementary material 2** for detailed wording and evaluation. The antecedents were collected only among participants who had declared having heard of HPV vaccination.

Parents and adolescents were categorised based on the concordance of their vaccine readiness scores. Dyads where parents and adolescents did not have the same valence of their vaccine readiness scores were categorised as 'non-concordant' either 'parent positive' if the parents reported a positive score or 'adolescents positive' in the other hand. Those with concordant score were categorised as 'concordant positive' or 'concordant negative' if they had respectively a positive vaccine readiness score or a negative score (**Supplementary material 5**).

### 1.2.2 *Evaluation of the Degree of Intentionality*

We evaluated the degree of intentionality following the Prochaska and DiClemente transtheoretical model of behaviour change (Prochaska & DiClemente, 1984) adapted to vaccination with an intentionality score comprising six levels: ignorance of HPV vaccination (*ignorance*), knowledge but not considering relevant for oneself (*precontemplation*), considering HPV vaccination as relevant for oneself but without expressing intention for vaccination (*contemplation*), intention to get vaccinated or to vaccinate the child (*intention*), planification of the actual vaccination (*preparation*) and already vaccinated whatever the number of doses (*action*). We did not distinguish between first

and second dose, since in France, the gap between the first and second dose receipt of HPV vaccination is relatively small (-4.3%; Santé Publique France, 2022b).

*Ignorance* was assessed by asking respondents if they had ever heard of HPV or the HPV vaccine. *Action* was assessed by asking the adolescent's vaccination status. Responses were 'not vaccinated', 'vaccinated' (with three possible answers: one dose, two doses or don't know the number of doses) and 'don't know'. Only 'vaccinated' responses were considered in the *action* stage. Finally, for the 'not vaccinated' and 'do not know' responses, a final question ('Could you indicate which proposition best applies to your personal situation?') assessed the four remaining stages of change: *precontemplation* (not feeling concerned by HPV vaccination), *contemplation* (feeling concerned about HPV vaccination, but not sure whether being vaccinated'), *intention* (intention to get a medical appointment), and *preparation* (already having a medical appointment or medical prescription). In France, vaccination prescription and administration typically occur on two different appointments, and we assumed that the appointment referred to the second appointment, as the vaccination operationalisation has already started.

### 1.3 Statistical Analysis

Data were collected as the baseline assessment of adolescents and parents who agreed to participate in the PrevHPV trial, prior to any intervention. We compared the characteristics of participants participating in dyads to those not participating in dyads, using chi-square test. (See **Supplementary material 3** for further details).

**Concordance of awareness about HPV vaccination and vaccine status, Knowledge, opinion surrounding vaccination, and intentionality.** We described the concordance of declared HPV vaccination status and general vaccine opinions within dyads using heatmaps showing cell percentages. We also calculated the positive (negative) predictive value (PPV and NPV, respectively) of adolescents' declaration regarding HPV vaccination. A positive (negative) predictive value refers to the percentage of adolescents reporting being vaccinated (unvaccinated) who are indeed vaccinated (unvaccinated) using the parental information as a gold standard.

**Correlation of antecedents of vaccine readiness.** We evaluated the correlation of antecedents of vaccine readiness within dyads using Pearson's  $r$ . In a confirmatory factor analysis, we assessed the adequacy of our sample to the underlying theoretical model (Oudin Doglioni et al., 2023). We generated scores of the seven antecedents and of vaccine readiness using the regression or exact method with Bartlett's correction for bias in factor means (Estabrook & Neale, 2013). Generated scores had a mean of zero and a non-constrained standard deviation. We calculated these scores first within all parents and within all adolescents; and then for the group of parents and adolescents combined but restricted to dyads with unvaccinated adolescents (according to information by both parents and the adolescent).

**Influence of concordance of vaccine readiness on parental vaccine intention.** We excluded dyads in which the parent, the adolescent or both were not aware of HPV vaccination. We employed a chi-square test for homogeneity. We then stratified this analysis according to adolescents' gender (**Supplementary material 5**).

**Structural equation model and path analysis** (Hoyle, 2012). We evaluated with a structural equation model whether vaccine readiness and intentionality among adolescents contributes to vaccine intentionality among parents and how they depend on HPV vaccine attitude from the environment. We introduced adolescents' perception of social norms to determine whether other extra-familial factors could contribute to the decision-making process. As the vaccination of boys was only recommended and reimbursable since 2021 (Ministère des Solidarités et de la Santé, 2021), we stratified the model on the adolescents' gender to gain a better appreciation of the influence of adolescent gender on parental vaccination decisions. Vaccine readiness and intentionality were included as scores, as described above.

As our objective was to understand an intentional process related to vaccination against HPV infection, we excluded dyads in which the parent, the adolescent or both were not aware of HPV vaccination; or where the adolescent was declared to be already vaccinated against HPV, according to

either parental or adolescents' declaration; dyads in which at least the parent or the adolescent indicated that a vaccine appointment was already taken.

Given the small number of unvaccinated dyads (N=191), the structural equation model did not converge when including a multilevel structure on 45 schools. To explore the hypothesis of design effect by school in our data, we estimated the variance-based design effects in linear regression models including dyads' antecedent scores and vaccine readiness scores accounting for cluster sampling (STATA: "svy command"). Design effects in linear regression between parental and adolescent antecedents and vaccine readiness scores (649 dyads from 51 schools) were small for all analyses and did not change the conclusions on significance. The largest design effect appeared for collective responsibility (13%). In the following, we did not account for the multilevel structure in correlation analyses.

## 2 Results

Among the 2003 parents and 7118 adolescents participating in the baseline survey of the trial, we identified 649 parent-adolescent dyads. For four families, the responses of both parents are included among the 649 dyads, representing 1.2% of the responses (8 dyads), and three parents responded for two of their children (0.9%, 6 dyads) belonging to the same educational level (3<sup>rd</sup> grade).

### 2.1 Characteristics of Parents-Adolescent Dyads

Compared to the overall group of baseline participants, parents in dyads were older (39% aged 45 years and over vs. 33.6% in the overall group;  $\chi^2(3) = 21.11, p < .001$ ) and living outside priority education areas (3.4% vs. 6.6%;  $\chi^2(2) = 24.92, p < .001$ ) (**Table 1**). Other sociodemographic data did not differ between the two groups: parents were mostly women (89.7%), working as employee (29.0%), technician (23.3%) or executive (22.3%).

Adolescents in dyads did not differ from the overall surveyed population: about half were girls (53.9% vs. 50.9%) and attending 4<sup>th</sup> grade (55.0% vs. 53.6%). However, they declared more frequently being vaccinated against HPV than the overall group (50.1% vs. 33.8%;  $\chi^2(4) = 69.46, p < .001$ ).

**INSERT:** Table 1. Sample characteristics. Parent-adolescent dyads (n=649) in France, 2021–2022.

## 2.2 Concordance of awareness about HPV vaccination and vaccine status, Knowledge, opinion surrounding vaccination, and intentionality within dyads

HPV vaccination was reported by 50.1% of adolescents and 45.5% of parents, yielding a positive (negative) predictive value (PPV, NPV) of adolescent declaration of 90.2% (NPV 89.9%). Vaccine offer by the referring physician was less frequently reported by adolescents than by parents (46.1% vs. 56.5%;  $\chi^2(1) = 208, p < .001$ ; PPV = 87.9%, NPV = 70.3%).

Parents reported a higher frequency of awareness of HPV vaccination than adolescents (90.3% [n = 586] vs. 79.5% [n = 516];  $\chi^2(1) = 35.31, p < .001$ ). The proportion of adolescents aware of the HPV vaccine was 82.6% and 50.8%, respectively, if parents were aware or unaware of it (OR = 4.60,  $p < .001$ ). Among dyads in which both parents and adolescents were aware but adolescents unvaccinated, the proportion of adolescents declaring vaccine intention was 13.3%, 30.8%, 62.1%, respectively if parents were in precontemplation, contemplation or intention stage (**Figure 1.A**).

**INSERT:** Figure 1. Distribution and concordance of attitudes on HPV vaccination within 649 parent-adolescent dyads in France, 2021–2022.

Two thirds of dyads had similar levels of knowledge about HPV vaccine recommendations to both sexes (65.5% of dyads) and at ages 11–14 years (66.8%). Most had concordant knowledge that cervical cancer is caused by HPV (73.7%) and did not confound HPV and HIV (70.5%). However, 25.3% of adolescents confounded HPV and HIV. Only 42.9% and 7.7% of dyads had equivalent levels of knowledge on higher immunogenicity before age 14 and the >10-year experience with HPV vaccine pharmacovigilance. (See **Supplementary material 4** for further details.)

Most dyads had a similar level of favourable attitude on vaccination in general (75.8%, **Figure 1.B**). They also demonstrated concordance on the importance not to transmit infection to others (82.7%), on HPV vaccination being useful (76.7%), easy to access (68%), and that adolescents



were not too young to be vaccinated (65.3%). Equivalent levels of agreement were found in less than two thirds of dyads on vaccines being safe (61.6%) and having more benefits than risks (56.9%), communication being easy between relatives (60.1%) and with healthcare professionals (56.8%) (See **Supplementary material 4** for further details). Two thirds (66.6%) of dyads agreed on a close supportive social environment for vaccination in general, but only 48.9% for HPV vaccination (**Figure 1.C**).

### 2.3 Correlation of Vaccine Readiness and its Antecedents Within Dyads

We found significant correlations within dyads for most individual antecedents, with the exception of confidence in the vaccine (evaluated by distinct questionnaire items, see **Supplementary material 2**) and social conformism (**Table 2**). The highest correlation coefficients were found for Convenience (Pearson's  $r(481) = .35, p < .001$ ) and Complacency ( $r(481) = .33, p < .001$ ) and the weakest for Collective responsibility ( $r(479) = .17, p < .001$ ). Vaccine readiness scores correlated moderately within dyads ( $r(479) = .39, p < .001$ ), including within unvaccinated dyads ( $r(207) = .38, p < .001$ ).

**INSERT:** [Table 2. Pairwise correlations of antecedents of vaccine readiness within parent-adolescent dyads \(n=649\) in France, 2020–2021.](#)

### 2.4 Concordance of vaccine readiness score and parental vaccine intentionality

Among 479 dyads (see **Supplementary material 5** for further details), 34.0% ( $n = 163$ ) exhibited non-concordant vaccine readiness score (parent positive: 12.5%,  $n = 60$ ; adolescent positive: 21.5%,  $n = 103$ ), while 48.6% ( $n = 233$ ) demonstrated positive concordant scores, and 17.3% ( $n = 83$ ) displayed concordant negative scores.

The distribution of dyads across these four categories diverged depending on the adolescent's gender ( $\chi^2(3) = 17.7, p < .001$ ): most dyads involving an adolescent girl displayed concordant positive scores (53.65%,  $n = 156$ ). Interestingly, a disproportionate number of boys were found in non-concordant dyads where parents expressed a positive vaccine readiness score (18.6%,  $n = 35$ ).

2.5 The distribution also differed based on the parental intention to vaccinate their adolescent against HPV ( $\chi^2(12) = 171; p < .001$ ). The level of concordance between the dyads increased with the degree of intentionality, from precontemplation (76.5% of dyads in negative concordance) to vaccination (66.4% of dyads in positive concordance). The gender stratification of adolescents yielded almost the same distribution pattern of dyads ( $\chi^2_{Boys}(12) = 82.1, p < .001; \chi^2_{Girls}(12) = 98.5, p < .001$ ). Hypothetical model of adolescents influencing parental HPV vaccine intentionality

The main model, based on the responses of 191 dyads meeting the inclusion criteria, showed a fair data fit (CFI=.96 and TLI=.88), which was improved following stratification by adolescents' gender (CFI=.97 and TLI=.90) (**Table 3a**). According to R-squared, the global model explained 49% of variance in parental intention, with 45% for girls and 55% for boys (**Table 3b**).

**INSERT:** [Table 3. Summary of the path analysis model found among 191 parent-adolescent dyads in France, 2021–2022.](#)

Vaccine intentionality among parents of girls depended both on their own vaccine readiness ( $\beta=.53, p < .001$ ) and on their daughters' vaccine intention ( $\beta=.25, p < .001$ ) (**Table 3c** and **Figure 2**). By contrast, vaccine intentionality among parents of boys depended only on their own vaccine readiness ( $\beta=.72, p < .001$ ) and not on their sons' intentionality ( $\beta=.07, p > .05$ ).

For both girls and boys, their vaccine intentionality depended on their own vaccine readiness ( $\beta=.52, p < .001$  for girls and  $\beta=.62, p < .001$  for boys), but not on their parents' vaccine readiness ( $\beta=.16, p > .05$  for girls and  $\beta=.03, p > .05$  for boys).

Adolescents' vaccine readiness depended on both parental vaccine readiness ( $\beta=.34, p < .001$  for girls and  $\beta=.18, p=.02$  for boys) and on their perception of the social environment's attitude regarding HPV vaccination. This latter association appeared stronger among boys ( $\beta=.54, p < .01$ ) than

among girls ( $\beta=.34, p < .01$ ). Adolescents' perception of the social environment's attitude was to some extent associated with parental vaccine readiness (coefficients between .32 and .36).

**INSERT:** Figure 2. Path diagrams of the stratified path models found among 191 parent-adolescent dyads in France, 2021–2022.

### 3 Discussion

In this cross-sectional study of 649 dyads of parents and their adolescent child aged 13–15 years in France, we found that awareness and information on HPV vaccination status was largely concordant between parents and adolescents. Although parents and adolescents shared relatively positive attitudes overall, vaccine readiness and each of its seven antecedents were moderately or poorly correlated within dyads. Furthermore, parental degree of HPV vaccine intentionality appeared to some extent influenced by the adolescents' vaccine intentionality for girls, but not for boys. Vaccine readiness of girls depended to equal extent on parental readiness and the attitudes of their social environment, while for boys, vaccine readiness depended on the social environment's attitudes.

We found a high level of concordance between adolescents and parents on their declared vaccination status. In particular, adolescents remembered well when the vaccine was offered by the referring physician – confirming that adolescents observe vaccine discussions during medical visits and retain information. Referring physicians, mostly general practitioners, are the gatekeepers to HPV vaccination in France. The fact that only just over half of parents reported a vaccine offer from the referring physician calls for action to facilitate medical visits, mobilise general practitioners to promote vaccination and diversify sources of vaccine offer.

General knowledge about the vaccine recommendation was well shared within the dyads, but not specific knowledge, such as the reasons for vaccination before the age of 14 or the duration of global monitoring of HPV vaccines. In addition, while almost all parents knew about cervical cancer and its distinction from HIV/AIDS, a quarter of adolescents did not. This suggests that adolescents should receive information on these basic facts outside the family, e.g. in schools. However, in France,

the presence and extent of school curriculum on infectious diseases and vaccination in middle schools depends on each school administration, as they involve voluntary staff. Interventions that provide HPV-related education by authoritative sources and involve parents (e.g. with specific targeted education programmes) were previously found to improve HPV vaccination rates among adolescents (Rani et al., 2022). Our findings argue for a more systematic implementation of these sessions and their inclusion in the official curriculum.

In the 649 dyads included, overall attitudes toward vaccination, in general, and HPV vaccination, in particular, were mostly positive, and adolescents were less likely to have negative attitudes than their parents. Individuals participating in dyads reported a HPV vaccination more frequently (50.1%) than non-dyad responders, and their coverage appears higher than the official estimate of this age group in France (37.4%) (Santé Publique France, 2022a). In contrast, the discordance of negative attitudes within dyads (i.e., between adolescents and their parents) could be related to age or generational differences.

Overall, the attitudes and the seven antecedents of parent-adolescent dyads' vaccine readiness correlated only weakly, suggesting that parents and adolescents have little communication – or frequently disagree – on issues such as usefulness and safety of HPV vaccination. We are not aware of comparable quantitative evaluation of the correlation of antecedents between parents and young adolescents, and our findings should be replicated in other settings.

A significant majority of parent-adolescent dyads demonstrated positively concordant vaccine readiness scores or a non-concordant score. Notably, only a small proportion (a third) exhibited negative concordant vaccine readiness scores. This pattern aligns with the observed concordance between parents and adolescents in their reported vaccination status, knowledge about HPV, and positive attitudes towards HPV vaccination.

When we modelled family vaccination intention, we found that girls were more influential than boys in the parental intentionality. This finding is substantiated by the distribution of dyads based on the concordance between their vaccine readiness scores and parental intention levels. In dyads with

non-concordant scores, parents appeared to drive the decision-making process (positive vaccine readiness score) for adolescent boys, while adolescent girls were more influential in the other cases. This could correspond to previous studies that described that for adolescent boys, parents' beliefs about HPV vaccination were more important in the decision-making process than their sons' (Alexander et al., 2012; Moss et al., 2015). Sons' involvement in the decision-making process was reported by more than 67% of parents as null or moderate, and influenced by age, with higher involvement from older sons (Perez et al., 2017). On the other hand, our finding of a gender difference may be explained by the fact that at the time of the study, HPV vaccination had been recommended and reimbursed for boys only for twelve months, and that families still rarely were exposed to a vaccine offer and decision. In this sense, families could have the potential for similar decision-making processes for girls and boys, if vaccine promotion was equal. This interpretation is supported by the fact that awareness and intention to be vaccinated against HPV were similar among parents and adolescents in our study, regardless of the child's gender. A qualitative dyadic study suggested some level of joint parental and adolescent involvement in most families, irrespective of gender (Chang et al., 2018). Also, some studies reported that just 30% of adolescent girls were involved in the vaccination decision making (Berenson et al., 2014; Jongen et al., 2021). It is thus not possible to conclude on true gender differences in decision-making involvement and parenting styles. A related observation in our study is that the influence of the social environment tended to weight more for boys' vaccine readiness than for girls'. Again, given little interaction with parents and little official information and messages regarding boys' HPV vaccination, boys may depend more strongly on social influences.

Overall, our findings for families in France are in coherence with findings in the international literature, mainly North America. The originality of our study lies in the application of the integrated theoretical model to understand vaccination behaviour, and in the use of the seven psychological antecedents of vaccine readiness to parent-adolescent dyads in a large sample size.

Taken together, our findings speak in favour of HPV vaccine promotion directly to adolescents, combined with incitation for family communication on HPV vaccination. Empowering adolescents to

discuss with their parents HPV vaccination could represent an important lever for vaccine promotion and likely requires design in qualitative studies. The finding of substantial influence of the social environment beyond parental attitudes opens the perspective on informal peer-education, which could be stimulated by appropriate interventions (Gobbo et al., 2023).

Targeted school-based interventions probably provide the appropriate frame for acting simultaneously on the social environment, individual adolescents, and family interactions. At the time of the study, there was no national programme for school-based vaccination against HPV in France, only local initiatives designed as vaccine campaigns with little educational activity and evaluation. Starting fall 2023, all pupils in 2<sup>nd</sup> years of French schools will be targeted by vaccine campaigns, but educational programs still need to be defined.

Our study has several limitations. First, families participating in dyads (which included the effort for parents to obtain from their children the family code distributed in class) were a select group of all participating parents and adolescents, as evidenced by the relatively high vaccination coverage. Our results therefore arise from families with a high level of parent-adolescent cooperation and with older parents, with possibly some overestimation of the influence adolescents have on parental vaccine intention. Results should be replicated in other groups before generalising the results to other populations. However, the antecedent correlations were poor to moderate even in these selected groups of families, suggesting that they would be even poorer in the general population. Second, the path model explaining the decision process, which is constructed with cross-sectional data, cannot be interpreted as causality. The resulting empirical evidence can help better understanding the decision process within families. Third, our study is based on data collected among young adolescents, which may have a limited validity, especially when answering conceptual questions. For example, responses may have been given without a deeper understanding of the question. However, specifically for vaccination status on which the path model is based, there was a high level of agreement between adolescents and parents, suggesting a reasonable quality of adolescent responses. Finally, we did not assess parenting style of families. To our knowledge, there is no quantitative study linking parenting

style as defined by Baumrind (1991) and vaccination decision-making processes in France, as available for the US (e.g. Leykin & DeRubeis, 2010). The distinction of positive, negative parenting style, and adaptive, and maladaptive decision-making process, as illustrated by Davids *et al.* (2016) would be worthwhile in future dyads studies on HPV vaccine decision-making.

## 4 Conclusion

In this dyadic study, we explored quantitatively and in a larger sample the extent to which young adolescents in France contribute to HPV vaccine decision-making and influence their parents' intention. The results suggest that improving vaccine perception in the adolescents' social environment, vaccine promotion targeting adolescents and interventions stimulating communication on HPV vaccination within families, can contribute to a higher HPV vaccine uptake, despite parental consent being required for vaccination. Targeted school-based interventions probably provide the appropriate frame for acting simultaneously on the social environment, individual adolescents and family interactions.

Our study also illustrates that dyadic studies can provide an empirical basis for the development of evidence-based interventions, as supported by the WHO (World Health Organisation, 2013; World Health Organisation & Regional Office for Europe, 2019).

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## Tables and figures

Table 1. Dyad participant characteristics (n=649 parents and n=649 adolescents) compared to the overall samples of parents and adolescents. France, 2021–2022.

			Overall population		Participating in dyad		p-value <sup>a</sup>
			n	%	n	%	
Parents	Gender	female	1799	89.8%	582	89.7%	.89
	Age	under 35 years	119	5.9%	22	3.4%	<.001
		35–44years	1211	60.5%	374	57.6%	
		45–54years	645	32.2%	240	37.0%	
		55 years and over	28	1.4%	13	2.0%	
	Profession <sup>b</sup>	Independent	106	5.3%	35	5.4%	.78
		Executive	423	21.1%	145	22.3%	
		Technician	444	22.2%	151	23.3%	
		Employee	604	30.2%	188	29.0%	
Worker		80	4.0%	23	3.5%		
Priority education area <sup>c</sup>	Other	345	17.2%	107	16.5%	<.001	
	Yes	130	6.6%	22	3.4%		
Adolescents	Gender	Girls	3621	50.9%	346	53.9%	.11
	Level	4th	3813	53.6%	353	55.0%	.45
	Vaccinated	Yes	1593	33.8%	251	50.1%	<.001

<sup>a</sup> P-value obtained after  $\chi^2$  test between dyad and no-dyad participants.

<sup>b</sup> French administrative classification established by the National Institute for Statistics and Economic Studies (INSEE). ‘Employee’ is an intermediate level of qualification.

<sup>c</sup> Areas with reinforced teaching and educational actions to reduce inequalities in educational achievement related to socio-economic inequalities.

Table 2. Pairwise correlations of antecedents of vaccine readiness within dyads with both parents and adolescent aware of HPV vaccination ( $n = 484$ ) in France, 2021–2022.

	Pairwise correlation		
	Pearson's $r$	$p$ -value	n
Confidence system	<b>0.17</b>	<.001	<b>484</b>
Confidence vaccine	<b>0.12</b>	1.00	<b>482</b>
Convenience	<b>0.35</b>	<.001	<b>481</b>
Complacency	<b>0.33</b>	<.001	<b>481</b>
Calculation	<b>0.24</b>	<.001	<b>480</b>
Collective responsibility	<b>0.17</b>	<.001	<b>479</b>
Social conformism	<b>0.05</b>	.254	<b>479</b>
Vaccine readiness score	<b>0.39</b>	<.001	<b>479</b>

Table 3. Summary of the path analysis model found among 191 parent-adolescent dyads in France, 2021–2022.

Table 3a. Indices of fit

	CFI	TLI	SRMR	RMSEA			Adj. BIC
				Value	95% CI lower	95% CI upper	
Initial model	.96	.88	.03	.15	.08	.22	1092.80
Model stratified: adolescents' gender	.97	.90	.03	.13	.05	.21	1083.53

Table 3b. Variance explained by the path analysis models.

Model	Variables	R <sup>2</sup>	95% CI Lower	95% CI Upper	Wald test	df	p-value
Initial model	Parental intentionality	.49	.39	.59	184.97	2	<.001
	Adolescents' intentionality	.40	.29	.50	125.55	2	<.001
	Adolescents' VR	.34	.23	.45	97.85	2	<.001
Stratified: Gender=boys	Parental intentionality	.55	.45	.64	136.34	2	<.001
	Adolescents' intentionality	.40	.29	.50	74.29	2	<.001
	Adolescents' VR	.39	.28	.49	70.56	2	<.001
Stratified: Gender=Girls	Parental intentionality	.45	.34	.55	64.18	2	<.001
	Adolescents' intentionality	.38	.27	.49	48.54	2	<.001
	Adolescents' VR	.32	.21	.43	37.16	2	<.001

Table 3c. Parameter estimates of the path analysis models.

Model	Dependent variable	Predictor	SE	95% CI Lower	95% CI Upper	β	Wald test	p-value
Initial	Parental intentionality	Parental VR	.03	.31	.43	.65	12.21	<.001
	Parental intentionality	Adolescents' intentionality	.04	.03	.21	.15	2.75	.006
	Adolescents' intentionality	Adolescents' VR	.04	.36	.53	.62	10.29	<.001
	Adolescents' intentionality	Parental VR	.04	-.07	.10	.02	0.38	.701
	Adolescents' VR	Parental VR	.06	.09	.33	.21	3.42	<.001
	Adolescents' VR	Perceived social norms	.07	.41	.70	.48	7.72	<.001
Boys	Parental intentionality	Parental VR	.04	.35	.5	.72	11.01	<.001
	Parental intentionality	Adolescents' intentionality	.05	-.05	.16	.07	1.06	.29
	Adolescents' intentionality	Adolescents' VR	.06	.35	.57	.62	7.94	<.001
	Adolescents' intentionality	Parental VR	.06	-.09	.13	.03	0.34	.735



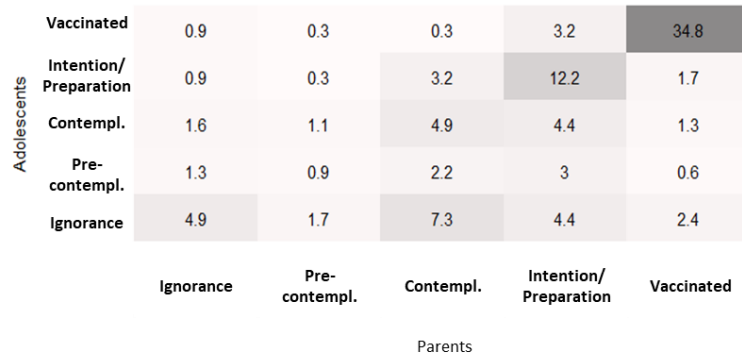
	Adolescents' VR	Parental VR	.08	.03	.34	.18	2.32	.02
	Adolescents' VR	Perceived social norms	.10	.48	.85	.54	6.93	<.001
Girls	Parental intentionality	Parental VR	.05	.20	.41	.53	5.80	<.001
	Parental intentionality	Adolescents' intentionality	.09	.06	.41	.25	2.68	.007
	Adolescents' intentionality	Adolescents' VR	.06	.21	.46	.52	5.23	<.001
	Adolescents' intentionality	Parental VR	.06	-.02	.21	.16	1.64	.10
	Adolescents' VR	Parental VR	.09	.14	.50	.34	3.45	<.001
	Adolescents' VR	Perceived social norms	.10	.16	.56	.34	3.46	<.001

**CFI:** Comparative fit index | **TLI:** Tucker-Lewis's index | **SRMR:** standardised root mean square residual | **RMSEA:** Root mean square error of approximation | **Adj. BIC:** sample size adjusted Bayesian information criterion | **CI:** confidence interval | **df:** degree of freedom | **β:** completely standardized effect size

Figure 1. Distribution and concordance of attitudes on HPV vaccination within 649 parent-adolescent dyads in France, 2021–2022.

**A. States of intentionality:**

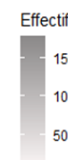
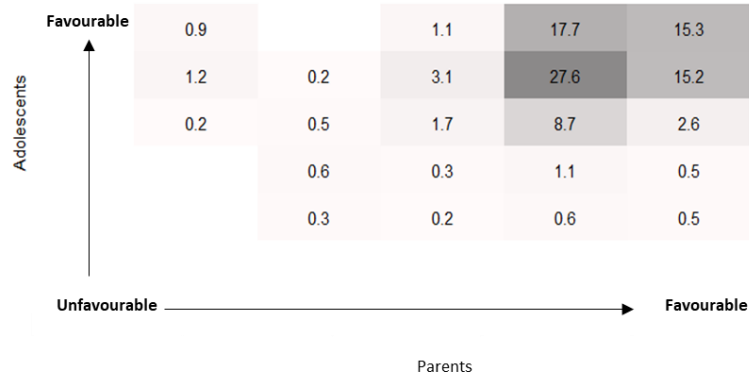
(Percentage of parent-adolescent couples in given combinations of levels)



**B. General attitudes on vaccination**

**Concerning vaccines in general, you are:**

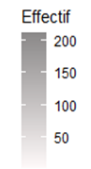
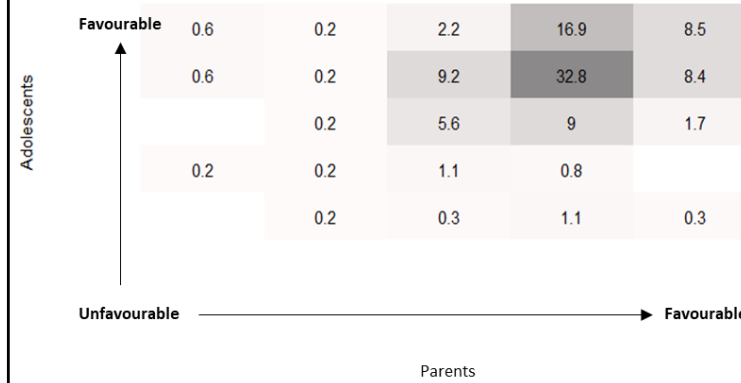
(Percentage of parents and adolescents sharing an equivalent level)



**C. Perceived social norms (general & specific to HPV vaccination)**

**Overall, are your relatives in support of vaccination?**

(Percentage of parents and adolescents sharing an equivalent level)



**In your close social environment, how would you describe the majority opinion on HPV vaccination?**

(Percentage of parents and adolescents sharing an equivalent level)

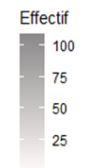
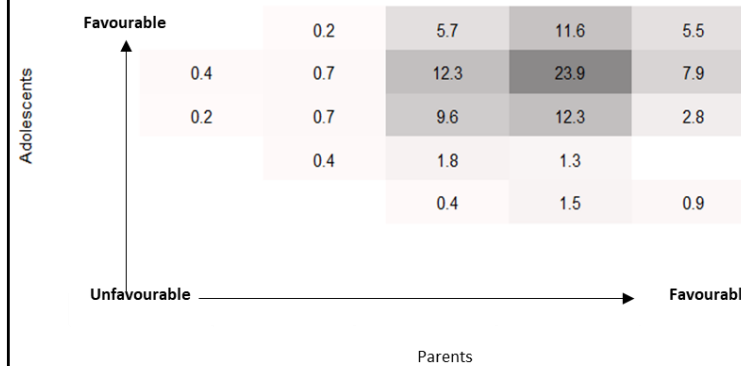


Figure 2. Path diagrams of the stratified path models found among 191 parent-adolescent dyads in France, 2021–2022.

