Factors affecting children’s HPV vaccination in Austria: Evidence from a parent survey
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ABSTRACT
Human papillomavirus (HPV) is a sexually transmitted infection that causes cervical cancer, head and neck cancer, other urogenital cancers, and genital warts. In Austria, where HPV vaccination is free for children, the vaccination rate nevertheless remains insufficient for herd immunity against HPV. Using a cross-sectional survey of parents (N = 334) in the state of Tyrol, Austria, we examined parents’ reasons for rejecting children’s HPV vaccination and key predictors of vaccination intention for their children, including knowledge about HPV, attitude toward vaccination, sources of information about the HPV vaccine, socioeconomic factors, and HPV vaccination intention. Data analyzed using descriptive statistics and logistic regression modeling revealed an overall 81.9% acceptance rate of HPV vaccination. The most common reasons for vaccine hesitancy were a fear of side effects, a perceived lack of information, and the perception that children are too young to be vaccinated. A high level of knowledge about HPV was significantly associated with vaccine acceptance for female but not male children. Negative attitude toward vaccination was significantly related to lower vaccine acceptance, and parents who reported informing themselves about HPV vaccination from online sources were less likely to accept vaccination. Such results call for more educational measures to reduce misinformation about HPV vaccination and thereby reduce the fear of its side effects and promote early vaccination. More information is also needed to improve parents’ attitude toward and their knowledge about vaccination, the dissemination of which should focus on the benefits of vaccines for children of both sexes.

Introduction
Human papillomavirus (HPV) is a common sexually transmitted disease that infects approximately 80% of the world’s population at least once.1 Although the vast majority of HPV infections (70–80%) are asymptomatic and resolve by themselves without treatment,2 persistent infections with oncogenic types of HPV can cause cervical cancer among women as well as other urogenital cancers and head and neck cancers among both women and men. In fact, HPV infections account for approximately 4.5% of all new cases of cancer worldwide—8.6% among women and 0.8% among men—and, of all types of cancer, cervical cancer constitutes approximately 80% of cases derived from HPV infection.3 Virtually all cases of cervical cancer are ascribable to precancerous lesions caused by persistent infections with high-risk types of HPV.2,4 To date, more than 150 types of HPV have been identified, at least 14 of which have been categorized as oncogenic (i.e., HPV16, 18, 31, 33, 35, 39, 45, 51, 52, 56, 58, 59, 66, and 68).5,6 Studies have also suggested that HPV16 and HPV18 are the most carcinogenic types, whereas some lower-risk types (e.g., HPV6 and HPV11) have been observed to trigger genital warts.2 HPV16, the most frequently diagnosed type of HPV in women with normal cervical cytology or cervical precancerous lesions,7 is presumed to cause approximately 60.5% of all cases of cervical cancer globally.8 Most infections follow shortly after sexual debut, which explains why HPV’s prevalence is highest among adolescents (<25 years) and declines with age.2

The nonavalent HPV vaccine effectively prevents the infection of nine types of HPV: HPV6, 11, 16, 18, 31, 33, 45, 52, and 58.8 Its safety and efficiency in decreasing HPV infection and associated cellular changes and diseases have been proven on multiple occasions.9,10 Among the findings of a recent register-based observational study in the United Kingdom, vaccinating female children at the age of 12–13 years resulted in a 87% reduction in the rate of cervical cancer compared with the unvaccinated cohort, while vaccinating adolescents of both sexes at the ages of 14–16 years and 16–18 years showed relative reductions of 62% and 34%, respectively.11 Those results indicate that HPV vaccination is more effective at an earlier age. In addition, Lei et al.12 found that receiving the quadrivalent HPV vaccine before the age of 17 years resulted in an 88% reduction in the risk of developing cervical cancer compared with the unvaccinated cohort. Other studies have revealed similar results.13,14 Beyond that, the HPV vaccine has been shown to lower the number of abnormal screening results, excisions, precancerous lesions, and coloscopies and, in turn, lower the psychological burden of HPV-associated diagnoses.15,16

The European Center for the Disease Prevention and Control recommends administering the HPV vaccine to preadolescents, given that a higher vaccine efficacy is achieved when given to individuals who have not yet been exposed to HPV.17 It also endorses a sex-neutral vaccination strategy for increased protection within the population.18 Whereas female-only vaccination is more cost-effective considering current
vaccine costs, a sex-neutral approach not only creates more resilient herd immunity but also ensures protection among all at-risk groups (e.g., men who have sex with men). However, due to the limited cost-effectiveness of a sex-neutral HPV vaccine, the World Health Organization (WHO) currently recommends a female-only vaccination strategy. According to Brisson et al., a vaccination rate of at least 80% among both male and female adults is necessary to attain herd immunity. Although Drolet et al. have shown that high vaccination coverage (>50%) within the female population can facilitate cross-protection within the general population, a female-only vaccination strategy would exclude men who have sex with men from cross-protection. At present, children 9–14 years old are recommended to receive two doses of the HPV vaccine, whereas adolescents more than 15 years old and adults are recommended to receive three doses.

The Austrian context

Despite the availability of the HPV vaccine in Austria’s national school-based immunization program and its proven safety and efficacy, the country’s vaccination rate, estimated to be below 50%, is insufficient for herd immunity against HPV. According to Austria’s Ministry of Health, each year approximately 400 new cases of cervical cancer are registered in the country, and approximately 120 to 180 deaths are ascribable to cervical cancer. Every year, approximately 60,000 cervical colposcopies and 6,000 conisisions (i.e., the surgical removal of abnormal cervical cells) are also performed following abnormal Pap smear screenings indicating cellular changes associated with HPV infection. Those procedures not only cause psychological distress but also increase the risk of premature birth and infant mortality in future pregnancies.

In Austria, the HPV vaccine is available at no charge to all children 9–12 years old. For adolescents aged 12–15 years, the vaccine can be purchased at a reduced cost of approximately 60 € per vaccine. For adolescents over the age of 15 years and adults, the cost is paid by the individual entirely out-of-pocket and amounts to approximately 624 €. Regardless of the vaccine’s availability in the school-based immunization program, a significant number of children in Austria fail to receive the HPV vaccine.

Given the target of eliminating cervical cancer in Austria by 2030, which aligns with the global strategy set by the WHO, increased efforts are needed to raise HPV vaccination rates among children. Therefore, exploring parents’ intention to vaccinate their children against HPV and their reasons for refusing to vaccinate them can shed light on the trends underlying HPV vaccine hesitancy and rejection in Austria.

In Austria, it is important to examine individual states, each of which is responsible for administrating local compulsory educational institutions. In our study, we investigated the state of Tyrol, which comprises rural and urban areas and represents a similar demographic composition as Austria overall. Beginning in Tyrol during the 2017–2018 school year, local officials pushed back the age at which the HPV vaccine is administered from the fourth grade (i.e., age of 9–10 years) to the fifth grade (i.e., age of 10–11 years), primarily because a significant portion of parents (29.2%) voiced concerns about children’s being too young to receive the vaccine in the fourth grade. Indeed, according to a 2014 study, common reasons for refusing HPV vaccination in Tyrol included the perception that the child was too young to be vaccinated, as well as a fear of temporary or permanent side effects, a perceived lack of information, having read discouraging information about the vaccine online, refusing vaccination in general, and the vaccine’s relative newness. As for that last reason, nearly 18% of parents in 2015 refused to have their children vaccinated against HPV due to concerns that the vaccine was too new. Against that background, in our study we aimed to investigate the current status of HPV vaccination intention and associated factors contributing to it, particularly in Tyrol, Austria.

Objective and contribution of the study

In our study, we sought to investigate the current status of HPV vaccination intention in Austria, as well as associated influencing factors, using a cross-sectional survey addressing parents of vaccine-eligible children in Tyrol, a Western state in Austria with a population of approximately 760,000. As such, our study was intended as an update and extension of a 2016 study conducted in Austria by Borena et al., which addressed parents’ HPV vaccination intention for their children shortly after the vaccine’s introduction to the national immunization scheme in 2014. Because HPV vaccination rates in Austria continue to be insufficient, an updated investigation into parents’ HPV vaccination intention for their children is needed in order to identify potential causes of HPV vaccine hesitancy and rejection.

The novelty of our study rested on its unprecedentedly comprehensive analysis of parental vaccination intention in Austria and its obvious necessity given insufficient vaccination rates against HPV in the country. Given our aim to assess parental HPV vaccination intentions, as well as the most important reasons for vaccine rejection, the factors that we assessed included knowledge about HPV, attitude toward vaccination, sources of information about the HPV vaccine, HPV vaccination practices (i.e., acceptance or rejection), and socioeconomic characteristics. Associations between socioeconomic factors, knowledge about HPV, and attitude toward vaccination were also investigated in relation to HPV vaccination intention. Altogether, our results provide a firm basis for deriving implications and potential strategies for optimizing HPV vaccine uptake in Austria.

Materials and methods

Empirical data were collected with a cross-sectional survey of parents of vaccine-eligible children attending the fifth grade in Tyrol, Austria. The survey gathered information regarding parents’ knowledge about HPV infection, attitude toward vaccination, sources of information about the HPV vaccine, socioeconomic background, and HPV vaccination intention for their children. The survey was conducted online and distributed with the support of principals of all 123 eligible schools in Tyrol—102 middle schools (Mittelschulen) and 21 educational grammar schools (Allgemeinbildende höhere Schulen)—who
were contacted twice and voluntarily forwarded a link to the survey to members of their school communities. The link to the survey was also shared with parents via Landeselternverband Tirol ("Parents’ Association of Tyrol"). In any case, the survey was accessible from March 11 to 25 April 2021. Our particular target group was parents of children attending the fifth grade (i.e., aged 10–11 years), when the HPV vaccine is administered as part of Austria’s national school-based vaccination program.

Ethical clearance for our study was obtained from the Management Center Innsbruck’s Research Ethics Committee prior to its implementation, and survey respondents’ informed consent was obtained at the beginning of the survey.

**Study design**

For our questionnaire, we adapted items used in Borea et al.’s 2016 study, and to gain broader insight into the reasons behind parental vaccination intentions, the questionnaire was extended with items addressing knowledge about HPV and attitude toward vaccination.\(^29-32\) Meanwhile, other items assessed sociodemographic characteristics, socioeconomic status, sources of information about the HPV vaccine, and political orientation. The questionnaire consisted of seven sections:

1. **Informed consent**, which asked respondents to confirm their consent to participate in the survey;
2. **HPV awareness**, which included items addressing the respondents’ awareness of HPV and awareness of the availability of Austria’s national school-based vaccination program;
3. **Knowledge about HPV**, which included items addressing respondents’ knowledge of (i) the prevalence of HPV infection in the population, (ii) HPV-related diseases, (iii) potential preventive measures, and (iv) the estimated effectiveness of the HPV vaccine;
4. **HPV vaccination behavior**, which addressed whether respondents’ daughter(s) and/or son(s) had received or will receive the HPV vaccine, as well as their reasons for not vaccinating their children against HPV and their perception of the appropriate age to get vaccinated against HPV;
5. **Sources of information about the HPV vaccine**, which asked respondents to indicate which source(s) of information have informed their understanding of the HPV vaccine;
6. **Attitude toward vaccination**, which included items addressing attitude toward vaccination or the belief in common misconceptions or misinformation regarding vaccines in general; and
7. **General items**, which inquired into respondents’ sociodemographic and socioeconomic characteristics, including age and level of education.

**Measures**

Response to items concerning knowledge and attitudes were merged to create two respective index variables by assigning scores to individual items, which resulted in overall knowledge and attitude scores for each respondent. Those index variables were not weighted, and all items were weighted equally, as similarly done in comparable studies.\(^31,33,34\) Three items were included in the knowledge index: (1) “HPV can cause cancer …,” with response options of only in women, only in men, both, or neither; (2) “HPV infections are …,” with response options of very frequent, frequent, infrequent, or very infrequent; and (3) “The effectiveness of the HPV vaccine is …,” with response options of very high, high, mediocre, or low. Each correct answer was assigned 1 point, while each incorrect answer resulted in 0 points. Along with those items, four other items had response options of I agree, I am unsure, and I disagree: (1) “An existing HPV infection can be treated easily with medication,” (2) “Using condoms fully prevents HPV infection,” (3) “I can be infected with HPV and not notice,” and (4) “HPV is a preliminary stage of HIV – AIDS.” Each correct answer was assigned 1 point, with “I am unsure” treated as an incorrect answer, for a final total knowledge score ranging from 0 to 7.

To measure attitude toward vaccination, nine items also with the answer options I agree, I am unsure, and I disagree were included: (1) “Vaccines contain harmful amounts of toxic chemicals such as formaldehyde, carbolic acid, or mercury, which cause persistent damage and diseases;” (2) “Vaccines can cause autism in children;” (3) “Vaccines weaken children’s immune system;” (4) “Vaccines cause allergies in children;” (5) “Only pharmaceutical companies benefit from vaccines;” (6) “Alternative therapies (e.g., homeopathy) are preferable to conventional medicine;” (7) “It’s better to let nature run its course and to have children fall sick with diseases (e.g., measles);” (8) “Before I decide for or against vaccination, I reflect upon the risk of the disease and the risk of the vaccine;” and (9) “I vaccinate my child so that other children who cannot be vaccinated (e.g., due to allergies or diseases such as cancer) are protected.” Answers indicating negative attitude or uncertainty toward vaccination were assigned 1 point, for an overall attitude score ranging from 0 to 9.

Parental HPV vaccination intention (yes or no) was assessed separately for female and male children, while overall HPV vaccine acceptance indicated whether the HPV vaccine was accepted for all eligible children.

Sources of information about the HPV vaccine had multiple response options (i.e., physician, health authorities of Tyrol, friends or acquaintances, and Internet or social media). Each source was a dichotomous variable (i.e., yes or no). Reasons for rejecting HPV vaccination also had multiple response options.

Attitude toward the appropriate age for HPV vaccination was assessed with the item “If you think that your child is now (in the fifth grade) too young for the vaccine, then would you vaccinate your child later?” Response options included yes, no, and I do not think my child is too young for the HPV vaccine now. Beyond that, respondents indicated the appropriate age for HPV vaccination from among five age ranges.

Several sociodemographic and socioeconomic factors of the surveyed parents were also assessed, including gender, age, marital status (i.e., married, in a partnership, single, or divorced), personal or parents’ migration history (i.e., yes or no), and religious affiliation. The variables of level of education and partner’s level of education were divided into two categories (i.e., university degree and no university degree) for
Table 1. Overview of variables in each section of the questionnaire.

| 1. Awareness of human papillomavirus (HPV) | Yes or no |
| Awareness of HPV and its ability to cause diseases |  |
| HPV-associated illness in the family | Yes or no |
| 2. Knowledge about HPV | Score ranging from 0 to 7 |
| The composition of the score variable appears in the section of the questionnaire. |
| 3. HPV vaccination behavior | Yes or no |
| HPV vaccine acceptance for female children, if applicable |  |
| HPV vaccine acceptance for male children, if applicable |  |
| Appropriate age for HPV vaccination | <10 years, 10–12 years, 13–15 years, 16–18 years, or > 18 years |
| HPV vaccine acceptance after the fifth grade | Yes, no, or The fifth grade is appropriate |
| 4. Sources of information about HPV vaccination | Yes or no |
| Doctor or health professional |  |
| Health authorities of Tyrol |  |
| Friends or acquaintances |  |
| Internet or social media |  |
| Informational flyer about the HPV vaccine |  |
| 5. Attitude toward vaccination | Score ranging from 0 to 9 |
| The composition of the score variable appears in the section of the questionnaire. |
| 6. General questions |  |
| Gender | Woman or man |
| Age |  |
| Marital status | Married, in a partnership, single, or divorced |
| Personal and parents’ migration history | Yes or no |
| Religious affiliation |  |
| Level of education | University degree or no university degree |
| Partner’s level of education | University degree or no university degree |
| Employment status | Employed or unemployed |
| Partner’s employment status | Employed or unemployed |
| Child has already received vaccination(s) in school | Yes or no |

Table 2. Baseline characteristics of survey respondents (N = 334).

| Age (in years) | Mean (SD) |
|---------------|-----------|
| Respondent, n (%) |  |
| Mother or maternal guardian | 310 (92.8) |
| Father or paternal guardian | 22 (6.6) |
| Number of children |  |
| Median (IQR) | 2 (1) |
| Married or in a partnership, n (%) |  |
| Religious affiliation, n (%) |  |
| Roman Catholic | 260 (77.8) |
| No religious affiliation | 39 (11.6) |
| Level of education, n (%) |  |
| No university degree | 205 (61.4) |
| University degree | 124 (37.1) |
| Partner’s level of education, n (%) |  |
| No university degree | 206 (61.7) |
| University degree | 103 (30.8) |
| Employment status, n (%) |  |
| Partner’s employment status, n (%) |  |
| Migration history, n (%) | 28 (8.4) |

SD = standard deviation; IQR = interquartile range.

Analysis

Data analysis was performed using descriptive analyses as well as logistic and linear regression models. First, descriptive analyses were performed to provide an overview of the demographic characteristics of the respondents as a means to identify the most common reasons for HPV vaccine rejection and reported sources of information about the vaccine. Second, logistic regression was performed by calculating odds ratios (OR) with corresponding 95% confidence intervals (CI) for HPV vaccination intention (yes or no) across socioeconomic variables, reported sources of information about the HPV vaccine, factors associated with knowledge about HPV, and attitude toward vaccination. Statistical analysis was conducted using R, and p values less than .05 were considered to indicate statistical significance.

Results

Of the 448 questionnaires received, 114 were incomplete, meaning that 334 parents with 492 vaccine-eligible children completed the survey. Considering the approximately 6,900 fifth-graders in Tyrol,35 we achieved a response rate of approximately 7.1%. Parents who failed to complete the survey may have abstained or quit the questionnaire due to a lack of incentive or overly sensitive questions (e.g., regarding income and political affiliation).

Table 2 illustrates the sociodemographic characteristics of the respondents, who were 43.1 years old on average. The vast majority of respondents were mothers or maternal guardians, and most were either married or in a partnership. The level of education and employment status of all respondents and their partners were comparable.

Descriptive results

The reported acceptance rate of the HPV vaccine for both male and female children amounted to 81.9% but was higher for female children (see Table 3). As illustrated in Table 4, 61% of respondents agreed that the fifth grade was an appropriate time for HPV vaccination, whereas 24.0% of respondents were to vaccinate their children later.

As shown in Table 5, the primary reasons for refusing the HPV vaccine were a fear of permanent side effects, children’s being too young to be vaccinated, and not being adequately informed about the vaccine.

Table 6 summarizes reported sources of information about the HPV vaccine. Most respondents reported being informed by the health authorities in Tyrol or via schools (44.3%), followed by physicians (42.8%); 26.9% reported friends or acquaintances as their source of information; and 25.4% reported obtaining information online. Last, regarding parents’ HPV-related knowledge and their attitude toward vaccination,
knowledge scores ranged from 0 to 7 (M = 5.17, SD = 1.34), while attitude scores ranged from 0 to 9 (M = 2.64, SD = 2.34).

Factors of HPV vaccination intention

Table 7 illustrates the results of the second regression model, in which the dependent variable was HPV vaccination intention (i.e., yes or no) for female children, male children, and overall. First, parents who used the Internet or social media to gather information about HPV were less likely to accept HPV vaccination overall ($OR = 0.33$, CI = 0.15–0.74) and for their male children ($OR = 0.18$, CI = 0.06–0.51). The comparable finding for the acceptance of HPV vaccination for female children was not significant, however. Second, being informed by a trustworthy source, including a physician or the state of Tyrol or the school, did not significantly increase acceptance of the HPV vaccine. Third, parents with higher knowledge scores were more likely to accept the HPV vaccine for female children ($OR = 1.92$, CI = 1.21–3.04). Fourth, a negative attitude toward vaccination among parents decreased the odds of vaccinating their children against HPV, and that result was significant for female children ($OR = 0.57$, CI = 0.45–0.72), male children ($OR = 0.55$, CI = 0.43–0.70), and overall ($OR = 0.63$, CI = 0.53–0.74). Fifth,
Table 7. Model 2–multivariate adjusted factors affecting human papillomavirus (HPV) vaccination intention.

| Factor | Overall | Female children | Male children |
|--------|---------|-----------------|---------------|
|        | $b$ (SE) | OR (95% CI)     | $b$ (SE) | OR (95% CI) | $b$ (SE) | OR (95% CI) |
| Level of education | | | | | | |
| No university degree | | | | | | |
| University degree | $-0.28$ (0.44) | 0.76 (0.32–1.79) | $-0.62$ (0.63) | 0.54 (0.15–1.86) | $-0.45$ (0.58) | 0.63 (0.21–1.96) |
| Partner’s level of education | | | | | | |
| No university degree | | | | | | |
| University degree | $0.61$ (0.49) | 1.48 (0.71–2.78) | $0.21$ (0.71) | 1.24 (0.31–5.00) | $0.63$ (0.62) | 1.88 (0.56–6.31) |
| Employment status | | | | | | |
| Unemployed | | | | | | |
| Employed | $0.38$ (0.60) | 1.47 (0.45–4.79) | $0.52$ (0.82) | 1.69 (0.34–8.36) | $-0.46$ (0.77) | 0.63 (0.14–2.87) |
| Immigrant status | | | | | | |
| Non-immigrant | | | | | | |
| Immigrant | $-0.61$ (0.65) | 0.55 (0.15–1.95) | $-0.83$ (0.89) | 0.44 (0.08–2.49) | $-0.71$ (0.76) | 0.49 (0.11–2.21) |
| Source(s) of information | | | | | | |
| Physician | $0.42$ (0.41) | 1.52 (0.68–3.38) | $0.91$ (0.62) | 2.49 (0.73–8.44) | $0.46$ (0.55) | 1.58 (0.54–4.64) |
| State of Tyrol or school | $-0.04$ (0.42) | 0.96 (0.42–2.20) | $0.74$ (0.64) | 2.10 (0.60–7.36) | $0.07$ (0.56) | 1.07 (0.36–3.20) |
| Friends or acquaintances | $0.01$ (0.42) | 1.01 (0.45–2.29) | $0.25$ (0.61) | 1.28 (0.39–4.20) | $-0.37$ (0.54) | 0.69 (0.24–2.01) |
| Internet or social media | $-1.11$ (0.41) | $0.33$ (0.15–0.74)** | $-0.90$ (0.59) | 0.41 (0.13–1.29) | $-1.72$ (0.54) | $0.18$ (0.06–0.51)** |
| Knowledge about HPV | $0.08$ (0.15) | 1.08 (0.80–1.46) | $0.65$ (0.23) | 1.92 (1.21–3.04)** | $-0.17$ (0.21) | 0.85 (0.56–1.28) |
| Negative attitude toward vaccination awareness of HPV | $-0.47$ (0.08) | $0.63$ (0.53–0.74)** | $-0.57$ (0.12) | $0.57$ (0.45–0.72)** | $-0.60$ (0.12) | $0.55$ (0.43–0.70)** |
| Family history of HPV-related diseases | | | | | | |
| No | | | | | | |
| Yes | $0.90$ (0.82) | 2.46 (0.50–12.25) | $0.33$ (1.04) | 1.39 (0.18–10.62) | $3.85$ (1.31) | $46.76$ (3.60–907.19)** |
| Received an informational flyer about the HPV vaccine | | | | | | |
| No | | | | | | |
| Yes | $0.04$ (0.45) | 1.04 (0.43–2.50) | $0.23$ (0.66) | 1.26 (0.35–4.57) | $-0.27$ (0.54) | 0.76 (0.27–2.19) |
| Awareness of school-based vaccination program | | | | | | |
| No | | | | | | |
| Yes | $1.05$ (0.45) | 2.85 (1.19–6.83)* | $1.26$ (0.62) | 3.51 (1.04–11.87)* | $0.90$ (0.59) | 2.46 (0.78–7.80) |
| Child has previously been vaccinated in school | | | | | | |
| No | | | | | | |
| Yes | $-0.67$ (0.69) | 0.51 (0.13–1.98) | $-1.29$ (0.98) | 0.27 (0.04–1.87) | $0.08$ (1.07) | 1.08 (0.13–8.73) |
| Age of parent | | | | | | |
| No | | | | | | |
| Yes | $0.99$ (0.45) | 2.69 (1.12–6.43)* | $1.34$ (0.60) | 3.83 (1.18–12.47)* | $1.44$ (0.59) | 4.22 (1.33–13.41)* |

The control variable “Number of children per family” was omitted from the table. $b$ = beta coefficient; SE = standard error; OR = odds ratio; CI = confidence interval. * $p < .05$; ** $p < .01$; *** $p < .001$.

awareness of HPV and its ability to cause diseases increased the odds of accepting the HPV vaccine for male children by a factor of 47; however, that large effect had a high range of uncertainty ($OR = 46.76$, CI = 3.60–907.19). Sixth, receiving an informational flyer about the HPV vaccine increased parents’ odds of vaccinating their female children by a factor of 3.5 ($OR = 3.51$, CI = 1.04–11.87) and the odds of vaccinating all of their children by a factor of 2.8 ($OR = 2.85$, CI 1.19–6.83). Seventh, if the child had already received any vaccine as part of the school-based vaccination program, then the odds of their parents’ accepting the HPV vaccine increased significantly for female children ($OR = 3.83$, CI = 1.18–12.47), male children ($OR = 4.22$, CI = 1.33–13.41), and overall ($OR = 2.69$, CI = 1.12–6.43). None of the socioeconomic factors examined were significant in affecting HPV vaccination intention.

Discussion

Our empirical findings suggest that parents’ HPV vaccine acceptance for their male children is slightly lower than for their female children. The primary reasons for refusing vaccination for their children among vaccine-hesitant parents were a fear of permanent or temporary side effects, not being adequately informed about the vaccine, and the child’s being too young to be vaccinated. A non-negligible number of parents reported delaying HPV vaccination given their perception that vaccination before the age of 12 years is too early. Socioeconomic factors did not achieve any significance concerning HPV vaccination intention. Parents who reported using the Internet (i.e., social media and websites) as a source of information about the HPV vaccine were less likely to accept HPV vaccination for their children. By contrast, parents who received an informational flyer about the vaccine from the school issued by local health
authorities were more likely to accept HPV vaccination. A negative attitude toward vaccination was associated with a low acceptance of the HPV vaccine, which indicates that inherent beliefs about vaccination are significant predictors of vaccination behavior. Last, higher HPV knowledge scores were associated with increased HPV vaccination acceptance for female children, thereby indicating the need to disseminate updated information on the benefits of HPV vaccination for both sexes (e.g., an information campaign).

**Reported HPV vaccination intention**

The results showed that 81.9% of the surveyed parents would accept the HPV vaccination of their children. That acceptance rate was substantially higher than the estimated national vaccination rate of less than 50%.

Among other results, the vaccination rate that we observed considerably exceeded those found in other studies, including by Borena et al.,

Studies investigating HPV vaccination intention and subsequent vaccination rates have revealed that only 38–57% of parents realize their intention to vaccinate their children.

Thus, despite parents’ voicing an acceptance to vaccinate their children, their actual behavior may deviate from their intentions. That gap between intention and behavior may be overcome by minimizing barriers, including by providing reminders, facilitating access to ease vaccine initiation for parents, and offering opportunities for vaccination later on.

HPV vaccine uptake may have particularly suffered following the cancelation of school-based vaccinations as part of the measures put in place to contain the COVID-19 pandemic in 2020–2021, which required parents to be proactive in initiating vaccination at alternative vaccination sites. A reliable system for monitoring and documenting vaccination uptake has also become mandatory. Owing to the novel implementation of electronic health records (i.e., ELGA) in Austria, including electronic vaccination documentation, the surveillance of national vaccination rates is expected to be facilitated in the coming years.

Reported acceptance of the HPV vaccine was approximately 8% less for male than for female children, a finding that is consistent with comparable studies. The lower acceptance for vaccinating male children also corresponded with our finding that knowledge about HPV was a significant predictor for vaccinating female but not male children. The gap in the acceptance of the HPV vaccine among male and female children can be attributed to the fact that HPV infection continues to be thought to primarily affect females; however, the incidence of HPV is in fact largely similar between the sexes, and HPV-related cancers and diseases affect both adult males and females. Even so, the HPV vaccine was initially advertised as “the vaccine against cervical cancer” in Austria, which suggests that boys or men are not necessarily affected. Later, a sex-neutral approach in advertising the vaccine was implemented. The deviation in vaccination intention may thus have been partly caused by the belief that females are the primary target of HPV infection and HPV-related diseases.

**Children’s age as a factor of parents’ HPV vaccination intention for their children**

Approximately 49% of respondents disagreed that the fifth grade (i.e., at approximately 10–12 years old) is appropriate for HPV vaccination. That finding is interesting, for a previous study revealed similar skepticism of vaccines being administered in the fourth grade. In particular, Borena et al. found that approximately 30% of parents reported fourth-grade children as being too young for vaccination. Although Austria’s amendment to the vaccination schedule has been implemented, the proportion of parents who voiced concerns about their children’s being too young remained largely unaffected. Meanwhile, 24% of parents indicated being willing to vaccinate their children once they are older; most of them reported that the age of 13–15 years was more appropriate for HPV vaccination. Only a minority of parents indicated an overall rejection of the HPV vaccine. The underlying problem may be that HPV vaccination remains associated with the sexual nature of HPV infection, such that vaccinating children against a sexually transmitted disease at an age years before sexual debut may seem unintelligible to parents. Thus, fighting stereotypes and explaining the preventive approach of HPV vaccination may be an important task for containing HPV transmission.

Furthermore, because the HPV vaccine is only offered free to children aged 9–12 years in Austria, postponing vaccination until a later age requires out-of-pocket payment, which generates a financial barrier against vaccination initiation. For children aged 12–15 years, the total amount for two doses is approximately 125.40 €, whereas vaccination after 15 years old requires three doses costing 624 € in total. Extending the age of eligibility for free HPV vaccination, accompanied by a campaign for early vaccination, may therefore facilitate access and uptake for children above the threshold age. Information campaigns should emphasize the importance of earlier vaccination, because effectiveness in preventing cancer declines as the age at vaccination increases. Although extending the age of eligibility for free vaccination may improve vaccine acceptance among hesitant parents, the vaccine’s effectiveness in preventing HPV-associated diseases (e.g., cervical cancer) is less among children who are vaccinated at an older age. For that reason, extending the eligibility for free HPV vaccination to older age groups may not be cost-effective.

**Reasons for rejecting HPV vaccination**

Our descriptive analysis revealed that the most commonly cited reasons for rejecting HPV vaccination were a fear of permanent side effects, the child’s being too young to be vaccinated, not being adequately informed about the vaccine, and a fear of temporary side effects. Those findings are largely consistent the results of comparable studies. In fact, according to a comprehensive systematic literature review investigating HPV vaccination hesitancy in all European countries, information-related issues constituted the primary reason for vaccine
rejection, followed by concerns about the vaccine’s safety voiced via concerns about a fear of side effects.36

The primary reasons for rejecting HPV vaccination (i.e., a fear of permanent side effects and the child’s being too young to be vaccinated) have remained stable since Borena et al.’s 2016 study.27 However, the rate of respondents who felt inadequately informed was slightly higher in our study, while fewer respondents reported encountering discouraging information about the vaccine online. Furthermore, fewer vaccine-rejecting parents reported being against vaccination in general. Overall, issues of vaccine safety represent a tenacious cause of HPV vaccination hesitancy, and attempting to increase trust in vaccine safety and undermine misinformation by providing factual information is not suggested to be particularly effective, for emotionally appealing information (e.g., stories about side effects) tend to have more impact in affecting attitude toward vaccination.48

**Attitude toward vaccination**

According to our findings, a negative attitude toward vaccines in general had the strongest and most robust negative effect on HPV vaccination intention. In fact, parents who tended to believe in misinformation—for instance, that vaccines cause allergies, diseases (e.g., autism), and weakened immune systems—were less likely to accept vaccination for their children. That finding aligns with past observations that feelings of vaccine-related risks tend to have a stronger effect on behavior than knowledge does.49,50 Beyond that, risk amplification reinforces common beliefs about adverse events caused by vaccines, because negative stories receive more (media) attention than factual information about vaccine safety.51 According to the WHO, developing trust in vaccines and vaccine safety requires building long-term resilience against vaccine misinformation, effectively monitoring public opinion (e.g., media monitoring), and immediately responding when adverse events spread. Furthermore, continuous communication, both informative as well as emotional, to the intended audience contributes to building vaccine confidence.52

**Sources of information about the HPV vaccine**

Another concerning result of our study is that parents who reported obtaining information about HPV online appeared to be less willing to initiate HPV vaccination overall but particularly for male children. The reason might be that online environments provide a vast space for misinformation about vaccines,46 as well as that more emotionally loaded negative information gains more attention and is often shared by less trustworthy sources.48 Obtaining information from trustworthy sources (i.e., a physician or local health authorities) did not show any significant results in regard to improving vaccine acceptance, which contrasts past findings.27,53 Receiving an informational flyer about the HPV vaccine issued by local health authorities prompted a significant increase in the acceptance of the HPV vaccine, however, as is consistent with comparable studies conducted in other countries.54–56

**Knowledge about HPV**

Higher scores for knowledge about HPV were expected to increase the acceptance of the HPV vaccine according to the literature. Our findings support that hypothesis for the acceptance of vaccination for female children, for respondents who exhibited greater knowledge about HPV were more likely to accept HPV vaccination for such children. Knowledge about HPV’s transmission, prevalence, and risks, as well as about HPV-related diseases, for both sexes may thus prompt the increased acceptance of vaccination for female children. Knowledge about HPV as a contributing factor of accepting HPV vaccination has been found in comparable studies.46 Based on those findings, educating parents about HPV infection may enhance vaccine uptake for female children. The fact that knowledge about HPV increased vaccination efforts for female children only can be explained by the fact that HPV has been framed as a problem for females, not males. Thus, updating current knowledge to focus on male children may be required.

Parents who reported that their children had received other vaccines in school showed an increased likelihood of accepting the HPV vaccine. Supporting that finding is literature showing that past vaccination behavior constitutes a reliable predictor of future vaccination intention.27,57 Therefore, resolving reservations about vaccines in general might help to build a stronger sense of vaccinating children out of habit.

**Socioeconomic factors**

Unlike the findings of Borena et al.,27 and several other studies,30,58,59 socioeconomic factors did not have any significance in affecting HPV vaccination intention. According to the findings of Borena et al.,27 paternal level of education positively influences HPV vaccine acceptance for male children. Thus, a higher level of education was expected to increase the acceptance of the HPV vaccine. Our findings, however, do not support that assumption. Therefore, socioeconomic disparities did not seem to explain any variance in the acceptance of the HPV vaccine in our sample.

**Policy recommendations**

Based on our findings, several recommendations for health policy can be made. Extending eligibility for free HPV vaccination for children more than 12 years old seems to be reasonable in order to remove any financial barriers for delayed vaccine initiation. That recommendation aligns with a statement issued by Austrian Cancer Aid,54 which suggests extending the free vaccine program until the age of 18 years. Even so, it is essential to stress that vaccination at an earlier age results in substantially better vaccine effectiveness in reducing cervical cancer.11–14 The reduced effectiveness for older age groups may result in the vaccine’s reduced cost-effectiveness, which may complicate extending the age of eligibility for free vaccines. Furthermore, strengthened communication about HPV infection, risks, routes of transmission, vaccine safety, and vaccine efficacy would be a reasonable strategy for increasing knowledge about HPV and acceptance of the vaccine, as well as to potentially debunk
misinformation circulating online. Reinforced public communication by the state of Tyrol or the national government (e.g., via informational flyers distributed in schools) is recommended; Austrian Cancer Aid\textsuperscript{24} particularly recommends using social media channels for communicating and educating citizens about the HPV vaccine. For example, a social media campaign in Denmark successfully improved the image of HPV vaccination using emotional storytelling.\textsuperscript{66} Meanwhile, in the U.S. state of North Carolina, a comprehensive social marketing campaign focused on raising HPV awareness among parents of children 11–12 years old achieved positive results in increasing HPV vaccine uptake. Those examples could be adapted and implemented in the Austrian context.\textsuperscript{61} By extension, vaccine-administering physicians constitute important communication players in advocating HPV vaccination; thus, to facilitate access to such vaccination, enabling all physicians to vaccinate would be reasonable, for the HPV vaccine’s administration is currently limited to only certain physicians.

Another opportunity to increase HPV vaccine uptake may be to replace the current in-school opt-in system with an opt-out system. HPV vaccine administration should be the default option, and vaccine-rejecting parents should be able to opt-out. In that way, parents would receive an informational flyer about HPV vaccination at school, and if they do not consent, then they are free to opt-out via signature. As present, parents need to actively opt-in via signature to have their child receive the HPV vaccine. Of course, enabling HPV vaccination for children less than 14 years old without parental consent would presuppose changes in the current Austrian legal framework, which permits vaccination without parental consent for adolescents only older than 14 years.

Last, HPV vaccine uptake should be monitored via Austria’s ELGA system, including its electronic vaccination passes, to ensure sufficient rates of vaccination. That action, however, presupposes the quick implementation of the infrastructure required for ELGA and the electronic passes.

**Limitations**

Because the cross-sectional design of our study provided data for only a single point in time, no conclusion on the temporal relation of HPV vaccination intention and their influencing factors can be drawn. Causal inferences are susceptible to confounding factors, which we did not assess, and could have led to potential distortions in the associations of our dependent and independent variables.\textsuperscript{62} Selection bias constitutes another limitation to be considered. For one, the school principals voluntarily shared the link to the survey with parents, and given the low response rate, some self-selection bias may have emerged because some principals may have been more inclined to share the link—for example, principals from schools with an above-average focus on HPV vaccination. For another, because participation was voluntary and based on an e-mail invitation featuring an introductory text about the survey’s purpose, parents or guardians with negative attitudes toward vaccination may have been reluctant to complete the survey, whereas ones with positive attitudes may have been more eager to participate. Thus, the sample’s representativeness as well as the applicability of the conclusions drawn may be limited.

As in all survey-based studies, self-report bias (i.e., the deviation between reported data and actual behavior or true values) was another likely limitation. Participants may have given inaccurate responses to comply with social desirability, thereby distorting the outcome of data analyses.\textsuperscript{63} Furthermore, the small sample investigated may have contributed to a lack of statistical significance for some factors that were significant in affecting HPV vaccination intention in comparable studies conducted on a larger scale. That dynamic may especially be the case for sociodemographic factors. Because our study focused exclusively on the Austrian state of Tyrol, inferences drawn to reflect Austria overall may be biased. Further research is therefore needed in other Austrian states and/or across Austria to validate our findings and gather more accurate, more representative data.

Moreover, as a measure to contain COVID-19 infection, the in-school HPV vaccination program was canceled in 2021, which may have significantly affected HPV vaccine uptake. Even so, HPV vaccination remains available at public vaccination centers and from select medical practitioners. Last, an additional limitation might be that variables addressing political affiliation and income had to be excluded from our analyses due to low response rates for those variables. However, income level, as an indicator of socioeconomic status, and political party affiliation may be informative additional predictors of vaccination intention and associated attitudes.

**Outlook**

Our study revealed novel insights into parents’ HPV vaccination intention for their children in the Austrian state of Tyrol. In particular, the study revealed a need to raise awareness of the benefits of vaccines for children of both sexes and that common misperceptions perpetuate (e.g., fear of permanent side effects). Our study also showed that positive attitudes and more knowledge can promote vaccine intentions, while relying on online information sources may dampen such intentions. Thus, governments and public health institutions need to help citizens navigate increasingly complex information environments. Because we focused exclusively on Tyrol, further investigation on HPV vaccination intention in other Austrian states would be valuable for gaining insight into potential disparities in attitude toward HPV vaccination between states and across the entire country. Conducting a comparable survey with a larger sample could also reveal additional associated factors of vaccination intention and allow testing the influence of additional socioeconomic factors (e.g., income). Last, we investigated self-reported and theoretical HPV vaccination intention, whereas collecting data on vaccine uptake would yield greater insights into the gap between vaccination intention and behavior.

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