

Sociodemographic and clinical correlates of human papillomavirus vaccine attitudes and receipt among Wisconsin adolescents

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ABSTRACT

Few studies have assessed adolescent human papillomavirus (HPV) vaccine attitudes and whether they are associated with vaccination uptake. This study characterized HPV vaccine attitudes among male and female adolescents, identified factors associated with attitude changes, and examined associations between attitudes and vaccination receipt. Surveys were administered to adolescents aged 15–16 years who had not completed the HPV vaccine series. A modified version of the Carolina HPV Immunization Attitudes and Beliefs Scale (CHIAS) was employed to assess barriers, harms, ineffectiveness, and uncertainties scores. Surveys were available from 108 participants; 63% were male and 33% had initiated the HPV vaccine series at baseline. CHIAS scores significantly decreased (i.e., became more favorable) between baseline and follow-up for barriers ($p = 0.01$) and uncertainties ($p < 0.01$). At least one sociodemographic/clinical factor was associated with changes in each score. Attitude changes were not associated with receipt of HPV vaccine, although adolescents with higher baseline harms scores were significantly less likely to receive an HPV vaccine dose ($OR = 0.67$). Adolescents' HPV vaccine attitudes slightly improved over a one-year period during which an intervention was implemented. More research is needed to learn how parent and adolescent HPV vaccine attitudes form, and how best to address concerns about vaccine harms.

1. Introduction

Nearly all sexually active men and women can expect to be infected with human papillomavirus (HPV) in their lifetime. The Centers for Disease Control and Prevention (CDC) estimates that over 14 million new infections occur each year in the United States and that half of these infections occur among 15–24 year olds [1]. While most infections are asymptomatic and transient, persistent HPV infection, especially with high-risk virus types, may result in the development of cancer. Vaccines to prevent HPV-associated outcomes have been licensed for use in 9–26 year olds in the United States since 2006 [2], and since this time there has been an estimated 71% reduction in the prevalence of HPV infections among adolescent girls [3].

Despite routine recommendations and evidence that the vaccine is safe and effective at preventing HPV infection, HPV vaccination rates remain low and show limited signs of improvement. A 2017 national survey showed that only about 49% of adolescents were considered to be up-to-date with HPV vaccine recommendations [4]. Vaccination rates in Wisconsin are similar to national estimates, with 69% of adolescents having initiated the HPV vaccine series and 52% considered up-to-date in 2017 [4]; rates for Marshfield Clinic Health System were 63% and 42%, respectively, for 13–17 year old patients in 2016 (unpublished). Multiple factors contribute to low coverage with the HPV vaccine, including parental and adolescent attitudes and beliefs regarding the HPV vaccine's safety and effectiveness [5]. Previous surveys suggest that parents and young adults are generally knowledgeable

Abbreviations: CDC, Centers for Disease Control and Prevention; CHIAS, Carolina HPV Immunization Attitudes and Beliefs Scale; CI, confidence interval; EHR, Electronic health record; HPV, Human papillomavirus; MCHS, Marshfield Clinic Health System; OR, Odds ratio; RUCA, Rural Urban Commuting Area Codes; Tdap, Tetanus, diphtheria, and acellular pertussis

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about the HPV vaccine, but knowledge levels are not strongly correlated with intent to vaccinate [5–7]. Other factors that may reduce HPV vaccine acceptance include concerns about HPV vaccine side effects, doubts about underlying susceptibility to HPV infection (and thus the necessity of the vaccine), and absence of a provider recommendation for vaccination [8–10].

Most previous studies of HPV vaccine knowledge, attitudes, and beliefs have focused on select subgroups such as a particular parent, gender, or population with limited access to medical care [5–11]. Less commonly studied are the views of adolescents, who experience the benefits and potential risks of HPV vaccination. Recent studies in Europe indicate that female adolescents share many of the same concerns as parents about HPV vaccine side effects [12,13]. Adolescents in general have a passive attitude toward vaccine decisions [14,15], but their role in vaccine decision-making may become more prominent at older ages [16]. To our knowledge, no U.S. studies have simultaneously assessed HPV vaccine attitudes and beliefs from both female and male adolescents, and linked these to future HPV vaccine decisions. The purpose of this study was to characterize HPV vaccine attitudes among adolescents in a north-central Wisconsin healthcare system, identify factors associated with changes in HPV vaccine attitudes, and evaluate the association between attitudes and vaccine receipt.

2. Methods

2.1. Design and setting

Surveys of adolescents' HPV vaccine attitudes were conducted as part of a broader study to implement and evaluate both system-level and provider-based strategies for improving HPV vaccination rates in the Marshfield Clinic Health System (MCHS) [17], an integrated care system that serves residents of north-central Wisconsin regardless of insurance status. Baseline surveys were completed in spring 2015, before major HPV vaccine coverage improvement activities began, and follow-up surveys were completed approximately one year later, in spring 2016, after intervention activities had been implemented. Intervention activities included department-level education and support, individualized provider feedback on adolescent vaccination coverage, and initiation of mailed HPV vaccine reminder/recall notices to parents of 12 year olds.

2.2. Participants

Data from the MCHS electronic health record (EHR) was used to identify potential participants. Adolescents were eligible if they were 15 or 16 years old at the time of sample selection, had not completed the HPV vaccination series (i.e. had not received ≥ 3 vaccine doses, the recommended schedule at the time), and received routine primary care at one of eight participating MCHS medical centers in central and northern Wisconsin. Each adolescent was linked to one of these eight centers as the medical home based on assigned primary care provider, ≥ 1 preventive care visit at the site in the past year, or ≥ 2 qualifying visits at the site for diagnosis and treatment in the past three years.

2.3. Survey procedures

Stratified random sampling by clinic location was used to select survey eligible adolescents. Baseline survey invitations, including cover letter, survey instrument, and return mailer, were mailed to the parent/guardian of enumerated adolescents in two batches over a 3-month period in spring 2015; nonrespondents received a reminder letter about one month after the initial mailing. Parents/guardians were asked to permit their adolescent child to complete the survey and were also informed that returned survey responses would be linked to other data in the MCHS EHR. Participants that completed the baseline survey were invited via mail to complete a follow-up survey in spring 2016; mailed

invitations included a cover letter, survey instrument, return mailer, and \$2 cash incentive. Individuals that did not respond to the initial follow-up invitation were called up to four times over a period of several weeks by trained interviewers and given the option to complete the survey over the telephone. A final mailed reminder was also sent to nonrespondents. All study procedures were approved by the Marshfield Clinic Institutional Review Board, with a request to waive documentation of informed consent and HIPAA authorization procedures.

2.4. Measures

2.4.1. HPV vaccine attitudes

The Carolina HPV Immunization Attitudes and Beliefs Scale (CHIAS) was adapted to measure participants' HPV vaccine attitudes [18]. The CHIAS was originally developed as a 16-item self-report instrument that assesses four subfactors related to parents' opinions about HPV vaccination for their children, including perceived barriers, harms, effectiveness, and uncertainties. It has demonstrated good internal consistency and test/retest reliability [18,19] and prediction of HPV vaccine intent and receipt in both parents [18,20,21] and young adults [19]. The most recent Cronbach's alphas were estimated as 0.92 for barriers, 0.81 for harms, 0.74 for effectiveness, and 0.43 for uncertainty [19]. For use in adolescents, we adapted a modified 17-item version of the survey recently validated among vaccine-naïve young women [19]. We reduced the number of CHIAS items from 17 to 13 by eliminating a question on pap smears and three (of five) questions on access barriers since, by definition, all adolescents in our sample had some access to primary care. In addition, a midrange, neutral option ("neither agree nor disagree") was added to the original 4-point Likert response scale (which ranged from "strongly agree" to "strongly disagree") for each CHIAS item in an effort to reduce nonresponse. The same 13 questions were asked on both the baseline and follow-up surveys (see Appendix A).

For analysis, Likert scale response options were standardized on a 0 to 10 point scale for greater interpretability, as has been done previously [19]. The most favorable response option was coded as 0, the least favorable attitude as 10, and intermediary attitudes as 2.5, 5 (neutral) and 7.5, respectively. Also as done previously [18], CHIAS items with missing responses were imputed with sample mean values. Mean scores were generated for each of the four subfactors. These procedures were conducted separately for baseline and follow up surveys. Change scores for each subfactor were also calculated by subtracting the corresponding follow up scores from baseline scores.

2.4.2. Covariates

Several sociodemographic and clinical variables were also captured based on their suspected association with HPV vaccine attitudes. Covariates collected in the baseline survey included household size (number of members), highest level of parental education, any prior healthcare provider recommendation of HPV vaccine, and any prior discussion of HPV vaccine with one's parents. Covariates collected in the follow-up survey included healthcare provider recommendation of HPV vaccine in the last year, discussion of HPV vaccine with one's parents in the last year, and trusted sources of information regarding HPV vaccine. Additional information on adolescents was extracted from the EHR at time of sample selection, including age, gender, race/ethnicity, health insurance status, number of ambulatory care encounters in the last three years, vaccination records (HPV; meningococcal (MenACWY); tetanus, diphtheria, and acellular pertussis (Tdap); and influenza vaccines), rural vs. non-rural residence (based on ZIP code Rural Urban Commuting Area Codes (RUCAs) [22]), and community (based on MCHS medical center). For analytical purposes, two centers that work closely together and serve the same area were combined into a single community. Missing exposure variables were treated as potentially informative and were included in the analysis by creating an 'unknown' response category. Given their high vaccination rates,

receipt of meningococcal and Tdap vaccines were combined into a single categorical variable in the analysis. HPV vaccination records were also extracted from the EHR at the time of follow-up.

2.5. Statistical analyses

Using available EHR data, chi-square and t-tests were used to compare characteristics of survey respondents (completed baseline and follow-up surveys) vs. nonrespondents (completed neither survey). Paired t-tests were used to compare changes in CHIAS scores between baseline and follow-up surveys and McNemar's tests were used to compare changes in categorical variables measured at both baseline and follow-up. Regression modeling was used to assess the association between covariates and CHIAS subfactor scores at follow-up, as well as to assess the association between covariates and receipt of the next scheduled HPV vaccine dose between baseline and follow-up. Specifically, bivariate linear regression models were initially generated to assess the crude association between each covariate and CHIAS subfactor score at follow-up (separately for each subfactor). Covariate associations with a $p < 0.10$ association were candidates for multivariable modeling. Manual forward selection was used to fit a final multivariable model that retained all covariates with a statistically significant ($p < 0.05$) association with each CHIAS subfactor score. For the next dose analysis, logistic regression models were generated to assess the crude association between CHIAS subfactor scores (change and baseline) and statistically significant covariates from the attitude change analysis. As in the previous analysis, a screening threshold was set at $p < 0.10$ and forward model selection was used to generate the final multivariable model where all variables were statistically significant at the $p < 0.05$ level. All analytic procedures were conducted using SAS Version 9.4 (Cary, NC).

3. Results

Baseline surveys were completed by 146 (9%) of 1553 invited adolescents. Of those that completed the baseline survey, 108 (74%) also completed the follow-up survey the next year and were included in this analysis; 94% completed the follow-up survey via mail (vs. over the phone). Characteristics of respondents ($n = 108$) and nonrespondents ($n = 1407$) were similar except respondents were significantly more likely to have private health insurance and have a history of influenza vaccination in the prior year. Most respondents were previously vaccinated with both Tdap and MenACWY vaccines (90%), white, non-Hispanic (93%), male (63%) and 15 years old at baseline (66%); about half lived in a rural area (49%) (Table 1). At the time of the initial survey, 36 (33%) had initiated (but not completed) the HPV vaccine series. At follow-up, 70 (65%) reported receiving an HPV vaccine recommendation from a healthcare provider in the past year, 60 (56%) reported discussing HPV vaccine with their parents in the past year, and 59 (55%) had initiated the HPV vaccine series (Table 2). Commonly reported trusted sources of information regarding HPV vaccine included healthcare providers (82%), family (55%), and the internet (42%). At baseline, mean CHIAS subfactor scores ranged from 2.8 (barriers) to 4.8 (uncertainties) on a scale of 0–10 (Fig. 1). All mean CHIAS subfactor scores were lower at the 1-year follow-up, indicating a generally favorable shift in HPV vaccine attitudes over time, with statistically significant decreases noted for barriers (difference = 0.7, $p = 0.01$) and uncertainties (difference = 0.4, $p < 0.01$) scores.

3.1. Attitude change analysis

Model results for barriers and other CHIAS subfactor scores are shown in Table 3.

Table 1
Sociodemographic and clinical characteristics of adolescent survey respondents compared to nonrespondents

| Characteristic ^b | Respondents ^a | Nonrespondents | p value ^c |
|---------------------------------------|--------------------------|--------------------------|----------------------|
| | (N = 108) | (N = 1407) | |
| | No. (%) or Mean \pm SD | No. (%) or Mean \pm SD | |
| Age | | | 0.445 |
| 15 Years | 71 (65.7) | 873 (62.0) | |
| 16 Years | 37 (34.3) | 534 (38.0) | |
| Gender | | | 0.999 |
| Male | 68 (63.0) | 886 (63.0) | |
| Female | 40 (37.0) | 521 (37.0) | |
| Race/Ethnicity | | | 0.102 |
| White, Non-Hispanic | 100 (92.6) | 1223 (86.9) | |
| Other | 2 (1.8) | 101 (7.2) | |
| Unknown | 6 (5.6) | 83 (5.9) | |
| Health Insurance | | | 0.040 |
| Private | 58 (53.7) | 595 (42.3) | |
| Public | 48 (44.4) | 798 (56.7) | |
| None/Unknown | 2 (1.9) | 14 (1.0) | |
| Residence | | | 0.938 |
| Rural | 53 (49.1) | 685 (48.7) | |
| Non-Rural | 55 (50.9) | 722 (51.3) | |
| Community | | | 0.595 |
| A | 11 (10.2) | 173 (12.3) | |
| B | 17 (15.7) | 285 (20.3) | |
| C | 29 (26.9) | 387 (27.5) | |
| D | 6 (5.6) | 48 (3.4) | |
| E | 6 (5.6) | 87 (6.2) | |
| F | 17 (15.7) | 215 (15.3) | |
| G | 22 (20.4) | 212 (15.1) | |
| Prior Season Influenza Vaccine | | | 0.002 |
| Yes | 38 (35.2) | 314 (22.3) | |
| No | 70 (64.8) | 1093 (77.7) | |
| Tdap and Meningococcal Vaccine | | | 0.691 |
| Yes | 97 (89.8) | 1246 (88.6) | |
| No | 11 (10.2) | 161 (11.4) | |
| HPV Vaccine (≥ 1 dose) | | | 0.666 |
| Yes | 36 (33.3) | 498 (35.4) | |
| No | 72 (66.7) | 909 (64.6) | |
| No. Clinic Visits in the Last 3 Years | 4.0 \pm 2.7 | 3.9 \pm 3.1 | 0.882 |
| Household Size | | | – |
| Small (2–3 members) | 22 (20.4) | N/A | |
| Medium (4–5 members) | 67 (62.0) | N/A | |
| Large (6 + members) | 15 (13.9) | N/A | |
| Unknown | 4 (3.7) | N/A | |
| Parental Education | | | – |
| Less than Bachelor's Degree | 53 (49.1) | N/A | |
| Bachelor's Degree or Higher | 51 (47.2) | N/A | |
| Unknown | 4 (3.7) | N/A | |

No = frequency; % = percentage; SD = standard deviation; Tdap = tetanus, diphtheria, and acellular pertussis; HPV = human papillomavirus; N/A = not available.

^a Respondents include those that completed both baseline and follow-up surveys; those that only completed the baseline survey are excluded from this comparison.

^b Characteristics at the time of sampling and/or baseline.

^c P values were derived using chi-square tests for categorical variables and t-tests for continuous variables.

3.1.1. Barriers

Adolescents who discussed the HPV vaccine with their parents in the last year had significantly lower (–1.3) mean barriers scores at follow-up compared to those who had not discussed the topic ($p < 0.01$). The barriers score was not associated with a prior healthcare provider recommendation for HPV vaccination.

Table 2
HPV vaccine uptake and associated characteristics of respondents (N = 108)

| Characteristic | Baseline | | Follow-Up | p value ^a |
|---|-----------|-----------|-----------|----------------------|
| | No. (%) | No. (%) | | |
| HPV Vaccine (≥ 1 dose) | | | | < 0.001 |
| Yes | 36 (33.3) | 59 (54.6) | | |
| No | 72 (66.7) | 49 (45.4) | | |
| Healthcare Provider Recommended HPV Vaccine | | | | 0.700 |
| Yes | 71 (65.7) | 70 (64.8) | | |
| No | 18 (16.7) | 14 (13.0) | | |
| Unknown | 19 (17.6) | 24 (22.2) | | |
| Discussed HPV Vaccine with Parents | | | | 0.744 |
| Yes | 56 (51.8) | 60 (55.6) | | |
| No | 46 (42.6) | 40 (37.0) | | |
| Unknown | 6 (5.6) | 8 (7.4) | | |
| Trusted Sources of Information on HPV Vaccine | | | | - |
| Healthcare Providers | N/A | 88 (81.5) | | |
| Family | N/A | 59 (54.6) | | |
| Internet | N/A | 45 (41.7) | | |
| Books/Printed Literature | N/A | 19 (17.6) | | |
| Teachers/School | N/A | 10 (9.3) | | |
| Other (friends, church, TV, radio, etc.) | N/A | 17 (15.7) | | |

No = frequency; % = percentage; HPV = human papillomavirus; N/A = not available.

^a P values were derived using McNemar's test.

3.1.2. Harms

Adolescents that reported receiving an HPV vaccination recommendation from a healthcare provider in the last year had significantly lower (-1.1) mean harms scores at follow-up compared to adolescents that had not received a recommendation (p = 0.02). Additionally, adolescents with at least one dose of HPV vaccine at follow-up (compared to no doses) had significantly lower (-0.8) mean harms scores (p = 0.02). Discussion of HPV vaccination with parents was not associated with the harms scores.

3.1.3. Ineffectiveness

Adolescents that reported living in a small household (2-3 members) had significantly higher (1.2) mean ineffectiveness scores at follow-up compared to adolescents living in a medium-sized household (4-5 members) (p < 0.01). No other factors were associated with the CHIAS score for ineffectiveness.

3.1.4. Uncertainties

Multiple factors were significantly associated with the uncertainties subfactor score in the follow-up survey. Adolescents that reported receiving a provider recommendation had significantly lower (-1.6) mean uncertainties scores (p < 0.01). Those who had initiated the HPV vaccine series also had significantly lower (-0.8) mean scores (p < 0.01). Conversely, adolescents who were 15 (vs. 16) years of age at sampling had significantly higher (0.6) mean uncertainties scores at follow-up (p = 0.04). Higher uncertainties scores were also associated with reporting that the internet was a trusted source of information (0.6, p = 0.03) and living in a large household (6 + members) as compared to a medium-sized household (4-5 members) (1.2, p < 0.01).

3.2. Next dose analysis

Almost half of the adolescents that completed both surveys (49%) received at least one dose of HPV vaccine between baseline and follow-up. No changes in CHIAS subfactor scores were associated with receiving the next HPV vaccine dose. Only baseline mean CHIAS harms score and prior parental discussion were retained in the final multi-variable model of next HPV vaccine dose (not shown). Specifically, adolescents with higher mean baseline harms scores (i.e., more negative HPV vaccine attitudes) were significantly less likely to receive at least one additional dose of HPV vaccine (OR = 0.67 per 1-point increase in baseline score, 95% CI = (0.54-0.85)), while adolescents that reported discussing HPV vaccine with their parents in the past year were significantly more likely to receive at least one additional dose (OR = 3.2, 95% CI = (1.33-7.80)).

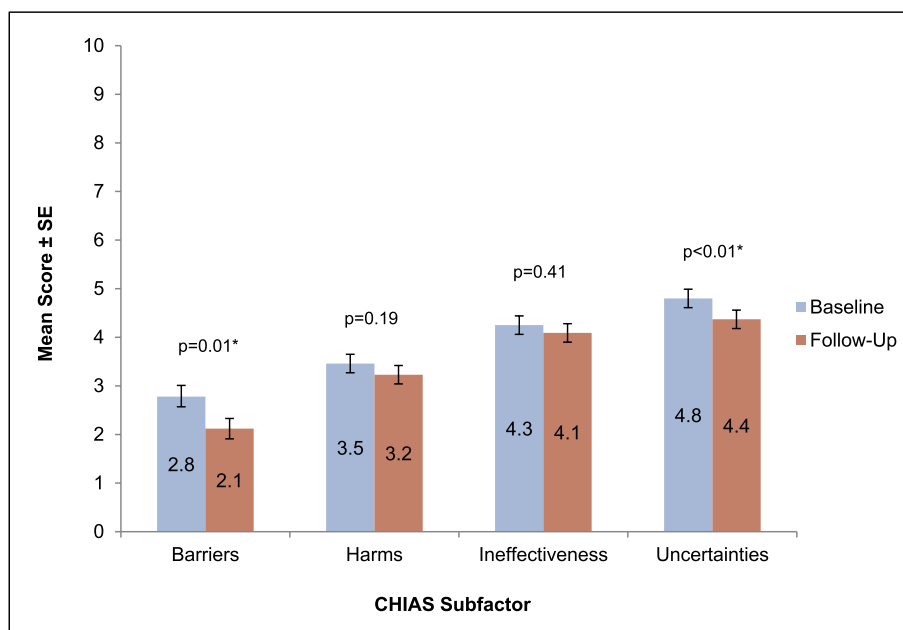


Fig. 1. Mean CHIAS subfactor scores at baseline and follow up.

Abbreviations: SE = standard error.

Lower scores represent more favorable attitudes. P values were derived using paired t-tests.

Table 3
Clinical and sociodemographic correlates of follow-up CHIAS scores by subfactor^a.

| Covariate | CHIAS Score (Points) ^b | | | |
|--|-----------------------------------|----------------------|---------------------|----------------------|
| | Barriers | Harms | Ineffectiveness | Uncertainties |
| Baseline Subfactor Score | 0.3 (0.1), p < 0.01 | 0.5 (0.1), p < 0.01 | 0.4 (0.1), p < 0.01 | 0.5 (0.1), p < 0.01 |
| Age at Sampling | | | | |
| 15 Years vs. 16 Years | – ^c | – | – | 0.6 (0.3), p = 0.04 |
| Household Size at Baseline ^d | | | | |
| Small vs. Medium | – | – | 1.2 (0.4), p < 0.01 | 0.3 (0.3), p = 0.46 |
| Large vs. Medium | – | – | 0.2 (0.5), p = 0.64 | 1.2 (0.4), p < 0.01 |
| Unknown vs. Medium | – | – | 0.4 (0.9), p = 0.64 | -0.7 (0.7), p = 0.38 |
| ≥ 1 Prior HPV Vaccine | | | | |
| Yes vs. No | – | -0.8 (0.3), p = 0.02 | – | -0.8 (0.3), p < 0.01 |
| Healthcare Provider Recommendation of HPV Vaccine in the Last Year | | | | |
| Yes vs. No | – | -1.1 (0.5), p = 0.02 | – | -1.6 (0.4), p < 0.01 |
| Unknown vs. No | – | -1.3 (0.5), p = 0.02 | – | -1.3 (0.5), p = 0.01 |
| Discussed HPV Vaccine with Parents in the Last Year | | | | |
| Yes vs. No | -1.3 (0.4), p < 0.01 | – | – | – |
| Unknown vs. No | 0.5 (0.8), p = 0.56 | – | – | – |
| Internet, Trusted Source of Information on HPV Vaccine | | | | |
| Yes vs. No | – | – | – | 0.6 (0.3), p = 0.03 |

^a Manual forward model selection was used to generate a single multivariable linear regression model from covariates that met a p < 0.10 threshold in bivariate models.

^b Values are reported as point estimate (SE), p value. Compared to the reference category, or a 1-unit increase for continuous predictor variables, positive values indicate a higher CHIAS subfactor score and negative values indicate a lower (more favorable) CHIAS subfactor score. For example, 15 year old adolescents had a mean CHIAS uncertainties score that was 0.6 (0.3) points higher than 16 year old adolescents.

^c “–” indicates variable excluded from final multivariable model.

^d Household size was categorized as follows: small (2–3 members), medium (4–5 members), large (6+ members), and unknown.

4. Discussion

In this study, we used a modified version of the CHIAS to examine changes in HPV attitudes and the relationship between subfactor scores and documented HPV vaccination in both male and female adolescents over a one-year period during which systematic interventions to increase HPV vaccination rates took place. Participants in our study had generally favorable attitudes about the HPV vaccine. The mean score for each CHIAS subfactor was below the midpoint of the range (i.e., < 5), and the mean score for barriers was below 3. Scores improved modestly over one year, with significant improvement observed for barriers and uncertainties subfactors. Mean CHIAS uncertainty scores were the highest (least favorable) and barriers were the lowest (most favorable) attitudes at both time points. A similar pattern was observed in a survey of parents in the same geographic area and time frame [23].

Several sociodemographic and clinical characteristics were associated with improvement in mean CHIAS subfactor scores, particularly the uncertainties subfactor. Prior HPV vaccination and/or provider recommendation was significantly associated with lower (more favorable) mean scores for 2 of 4 CHIAS subfactors. Other studies have identified these factors as predictors of vaccine uptake in different age groups and populations [24,25]. No significant differences were found by adolescent gender. The influence of household size on HPV attitudes is unclear as we observed trends in opposite directions; smaller household size was associated with higher (less favorable) mean ineffectiveness scores whereas larger household size was associated with higher mean uncertainties scores. Interestingly, adolescents who reported the internet as a trusted source of information about vaccines had higher uncertainties scores; this may be an area worth further investigating in adolescents as several studies have found that parents are more likely to refuse or delay vaccination for their children if they rely on the internet as a source of vaccine information [26,27].

Improvements in adolescents' HPV vaccine attitudes may have little or no impact on actual HPV vaccine uptake. We found that changes in mean CHIAS subfactor scores were not significantly related to receipt of the next HPV vaccine dose. Only higher mean baseline harms score and

discussing HPV vaccination with parents were associated with receipt of the next dose. This finding is consistent with a parental survey that also found a significant association between baseline harms score and receipt of a subsequent HPV vaccine dose and series completion in their adolescent [23]. The importance of perceived harms suggests that patient and public education should emphasize the safety profile of HPV vaccine and address misconceptions regarding risks [28,29]. Public concerns about HPV vaccine harms can change quickly due to social media and unreliable internet sources, and more intense or targeted public awareness efforts may be needed on this topic during formative periods of HPV attitude development. The point at which adolescents have meaningful agency regarding vaccine decisions is ambiguous. Some parents (or providers) welcome adolescent input during the HPV vaccine decision-making process, but others do not consider their adolescent child's attitudes on this topic [15,16,30,31], particularly if the adolescents are younger and/or their attitudes do not align with the parents' own [32,33]. Future studies should consider exploring the concordance of HPV vaccine attitudes among adolescent and parent dyads, as well as peer-social norms, and how that may influence vaccination decisions.

This study has several strengths and weaknesses. The utility was strengthened by the systematic sampling of both female and male adolescents who receive primary care within an integrated regional healthcare system, a level at which system-wide quality improvement initiatives can be implemented. The use of linked EHR and vaccination data reduced misclassification of vaccination status and number of doses received.

Weaknesses include the low response rate, lack of comparability with other CHIAS surveys, and lack of racial/ethnic diversity in the study population. Survey work in adolescent populations poses several challenges and the low response rate is not surprising, although it is comparable to that observed in a survey of parents conducted in the same population during the same time period [23]. Our comparison of respondents vs. nonrespondents found no apparent differences in receipt of routinely recommended adolescent vaccines, but respondents were more likely to be privately insured and receive the seasonal influenza vaccine. These could be mitigating factors of HPV vaccination

worth exploring in future research. Nonrespondents, however, may also have differed from respondents on unmeasured characteristics. The CHIAS was modified from its original version to improve clarity and relevance with our adolescent sample, including the addition of neutral response options. However, this limits our ability to compare results with other CHIAS surveys. It is also important to note that the CHIAS focuses on general attitudes about the HPV vaccine rather than specific reasons why a given adolescent chooses to get it or not. Finally, the study results represent a largely rural Midwestern source population, and other factors may influence CHIAS subscore scores in more urban and racially diverse groups.

5. Conclusions

In this sample of north-central Wisconsin adolescents, HPV vaccine attitudes appeared generally favorable and improved slightly over time, but were not associated with vaccine receipt. This may reflect limited adolescent agency in the decision-making process for the HPV vaccine. Future research could focus on periods when and how opinions related to HPV vaccine harms are formed among both adolescents and their parents, and investigate effective ways in which healthcare providers, public health practitioners, and others can positively influence these attitudes.

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Declarations of interest

The authors report no conflicts of interest.

Data statement

The survey data that support the study conclusions are unavailable for public access because informed consent to share said data (beyond the research team) was not obtained from study participants.

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Appendix A. Supplementary data

Supplementary data related to this article can be found at <https://doi.org/10.1016/j.pvr.2019.05.001>.

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