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Review article

Identifying Healthcare Professionals With Lower Human Papillomavirus (HPV) Vaccine Recommendation Quality: A Systematic Review

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A B S T R A C T

Purpose: Strengthening healthcare professionals' (HCPs) communication is an evidence-based approach to increasing human papillomavirus (HPV) vaccine uptake among adolescents. To better target future interventions, we sought to synthesize evidence on HCP subgroups who most need to improve their HPV vaccine recommendation quality.
Methods: We searched five databases for quantitative studies published from 2012 to 2022 on HPV vaccine recommendation quality, including recommendation consistency and strength, for United States adolescents. Two coders independently abstracted data from each eligible study, following the Preferred Reporting Items for Systematic Reviews and Meta-Analyses guidelines. We summarized variation in recommendation quality by clinical and HCP characteristics.
Results: The 28 eligible studies indicated that relatively low proportions of HCPs used higher-quality recommendation practices (median: 61% across 30 measures) and that recommendation quality varied across HCP subgroups. The most consistent findings were that more pediatric HCPs used higher-quality recommendations than family medicine HCPs (8 of 11 studies, 2–60 percentage point difference) and that HPV-related knowledge was associated with higher recommendation quality (four of seven studies). Most studies observed no differences in recommendation quality by clinical role (e.g., provider vs. nurse) or HCP demographics (e.g., gender, age, race/ethnicity).
Discussion: Studies suggest a substantial need to improve HCPs' recommendation quality, with opportunities for targeting future interventions.

IMPLICATIONS AND CONTRIBUTION

To inform future communication interventions, this systematic review of 28 studies examined clinical and healthcare professional (HCP) characteristics associated with human papillomavirus vaccine recommendation quality. Studies consistently found lower recommendation quality among family medicine versus pediatric HCPs. Quality was consistent across HCPs' demographic factors, including gender and race/ethnicity.

Conflicts of interest: Noel T. Brewer has served as a paid advisor for the Centers for Disease Control and Prevention, Merck & Co, Moderna, Novavax, Sanofi, and the World Health Organization. The remaining authors declare no potential conflicts of interest.

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Persistent infection with human papillomavirus (HPV) is responsible for approximately 37,000 cancer cases diagnosed in the United States (US) every year [1]. Human papillomavirus (HPV) vaccination can prevent about 90% of these cancers [2], and two doses of the vaccine are recommended for children ages 9–12 years as part of the routine immunization schedule [3]. However, only half (50%) of 13-year-olds had completed the series by 2022 [4], indicating that guideline-consistent HPV vaccination remains a challenge. Continued efforts are needed if we are to achieve the national goal of 80% coverage [5].

Receipt of a healthcare professionals' (HCP) recommendation is the single largest influence on HPV vaccine uptake [6]. Healthcare professionals' (HCPs') recommendation is associated with about nine times higher odds of HPV vaccine initiation among adolescents ages 11–17 years [7]. Yet the most recently available data indicate that almost one-quarter of parents (23%) do not receive a recommendation for their age-eligible adolescents [8]. Furthermore, recommendations that parents do receive are not always strong, consistent, and timely [9], which is problematic because these recommendation qualities are associated with HPV vaccine uptake [10]. Leading public health authorities, including the Centers for Disease Control and Prevention, National Cancer Institute, and President's Cancer Panel, have emphasized the need for HCPs to improve their HPV vaccine recommendations [11].

Fortunately, research in the last decade has yielded evidence-based interventions for improving HPV vaccine communication and uptake. Most notably, several randomized clinical trials have found that training HCPs to improve their communication, including by more consistently recommending HPV vaccination for all age-eligible adolescents, is effective [12,13]. Strong national investment in HCP communication training has likely contributed to improvements in HPV vaccine communication, but the impact has been uneven with the proportion of parents reporting receipt of a recommendation ranging from 91% in Massachusetts to just 60% in Mississippi [8]. Given the high direct and indirect costs of HCP communication training [14,15], targeting future trainings to HCPs with lower recommendation quality may help to maximize the impact of these interventions. Thus, we conducted a systematic review of quantitative evidence on which clinical and HCP characteristics are associated with HCPs' vaccine recommendation quality.

Methods

We followed the Preferred Reporting Items for Systematic Reviews and Meta-Analyses guidelines [16] in reporting a systematic review of studies on HCP recommendations of HPV vaccination. This systematic review was prospectively registered on International Prospective Register of Systematic Reviews (CRD42022329054) [17].

Data sources and searches

We searched Cumulative Index to Nursing and Allied Health Literature Plus, Embase, PsycINFO, PubMed, and Scopus databases on June 2, 2022, for relevant studies published since January 1, 2012. We started the search period at 2012 because the Advisory Committee on Immunization Practices extended their recommendations for routine HPV vaccination to male adolescents in October 2011 [18]. A medical librarian (RC) developed search strings for each database that included terms related to human papillomavirus, vaccine, and communication (Supplemental Table 1). After the initial search, we removed duplicated studies using EndNote (Clarivate, Philadelphia, PA) and Covidence (Veritas Health Innovation, Melbourne, Australia). We also manually searched the reference list of each included study to identify other relevant studies.

Study selection

Pairs of reviewers (KLK, MBG, NLO, WYK) independently screened studies in two steps using Covidence. We first reviewed each title and abstract for eligibility. For potentially eligible studies, we then conducted full-text reviews. We resolved disagreements at each stage by discussing studies with the remaining reviewers.

Eligible papers were peer-reviewed quantitative studies published in English that stratified findings on HPV vaccine recommendation quality for adolescent patients in US clinical contexts by clinical or HCP characteristics. We defined *HPV vaccine recommendation* as verbal communication in which the HCP advised, or intended to advise, the adolescent to be vaccinated. Included measures operationalized this concept with words such as "recommend," "advise," or "offer," while excluded measures used less directive words such as "talk about" or "discuss." We focused on *recommendation quality* given its association with vaccine initiation [10]. To characterize higher-quality recommendation, this concept included measures of recommendation strength (emphasizing the importance of vaccination), consistency (recommending for all age-eligible adolescents), timeliness (starting recommendation at ages 9–12 years vs. later), and urgency (recommending getting vaccinated on the same day) [19].

We defined *healthcare professionals* as including physicians, nurse practitioners, physician assistants, nurses, and medical assistants who deliver primary care to adolescents, while excluding community health workers, dentists, and pharmacists. *Adolescents* were children ages 9–17 years, and we excluded studies with a patient population entirely outside of this age range. *Clinical contexts* included medical encounters in public or private medical practices and school-located health centers, and excluded alternative vaccination settings, such as emergency departments and pharmacies, as well as events, such as mass vaccine campaigns in community settings. Given variations in healthcare systems as well as HPV vaccination guidelines and access across countries, we included only US studies. We included quantitative, peer-reviewed journal articles and excluded qualitative studies, commentaries, conference abstracts and proceedings, meta-analyses, and narrative, rapid, scoping, or systematic reviews.

Data abstraction

Pairs of reviewers (WYK with KLK or NLO) independently conducted data abstraction using a standardized form and resolved disagreements through discussion. Abstracted data centered on findings about variation in HPV vaccine recommendation quality based on clinical or HCP characteristics. Clinical characteristics included specialty (e.g., pediatrics or family medicine), clinical setting (e.g., private or public practice, urban or suburban, or rural clinic location), and other characteristics (e.g., patient volume, vaccine delivery system strategies). HCP characteristics included clinical role (e.g., physician, nurse),

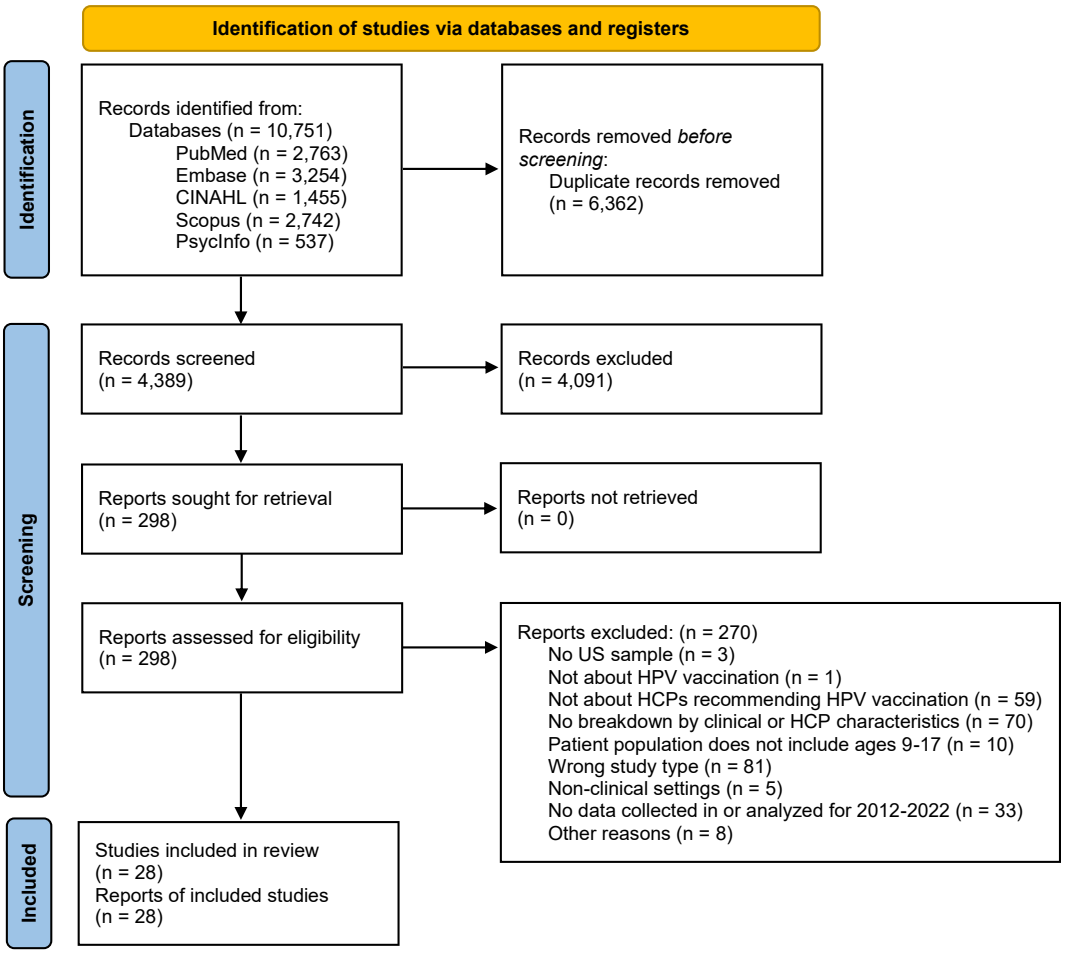

Figure 1. Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) flow diagram of studies reviewed.

vaccine cognitions (e.g., HPV knowledge, vaccine concerns), and other demographic and professional characteristics (e.g., gender, age, years in practice).

Reviewers also abstracted data on study characteristics, including study design, data source, and sample size and description. We contacted authors for unreported study information, such as study period and sampling approach. Reviewers also assessed study quality using eight indicators from Sirriyeh et al.'s Quality Assessment Tool for Studies with Diverse Designs, such as on sample representativeness and size, description of participant recruitment and data collection processes, and appropriateness of data analysis [20]. Reviewers scored these quality indicators on a four-point scale from "not at all" (coded as 0) to "complete" (3), and we summed the scores into an overall score that could range from 0 (lowest study quality) to 24 (highest study quality).

Data synthesis

We qualitatively summarized variation in recommendation quality by each clinical and HCP characteristic. We report absolute percentage point (pp) differences in the proportion of HCPs using higher-quality recommendations by each characteristic (e.g., HCPs in public vs. private practices, female vs. male HCPs). We denote our unit of analysis (i.e., studies) with k.

Results

Our search yielded 4,389 unique records, with 28 studies meeting eligibility criteria (Figure 1). All eligible studies used cross-sectional data, with most analyzing data collected from HCP versus parent reports ($k = 27$ vs. 1, Supplemental Table 2). Over half of the included studies used regional versus national samples ($k = 16$ vs. 12). Study quality scores ranged from 12 to 24 on the Quality Assessment Tool for Studies with Diverse Design index (median = 22.5). Some studies assessed discrete aspects of recommendation quality in terms of recommendation consistency ($k = 14$), strength ($k = 5$), timeliness ($k = 1$), or intention to recommend ($k = 1$). Other studies assessed multiple aspects of recommendation quality combined ($k = 7$).

Recommendation quality in overall samples

Of the 28 included studies, 20 studies provided data on the overall proportion of HCPs who used higher-quality recommendations. Across 30 measures, a median of 61% of HCPs used higher-quality recommendation practices (range: 21%–97%,

Supplemental Table 2) [21,22]. In only five of these measures did over 80% of HCPs use the higher-quality practice.

Variation in recommendation quality by clinical characteristics

Specialty (17 studies [21–37]). Most studies that compared medical specialties on recommendation quality found that more HCPs in pediatric specialties used higher-quality recommendations, compared to those in nonpediatric specialties. For example, 11 studies compared pediatrics to family medicine [21–23,27–31,34–36]. Eight of these studies found higher proportions of pediatrics HCPs used higher-quality recommendations compared to family medicine HCPs (difference in proportion: 2–60 pp, Table 1) [22,23,27–31,34], and the remaining three studies found no statistically significant differences [21,35,36]. Similarly, studies that compared pediatrics to other nonpediatric specialties, such as internal medicine and obstetrics/gynecology [24,26,29,31,33,35,37], found more HCPs in pediatrics used higher-quality recommendations (four of seven studies, 32–93 pp) [24,26,29,31] or found no statistically significant differences (three of seven studies) [33,35,37]. Other studies assessed recommendation quality among HCPs in specialties outside of primary care and found higher-quality recommendations in pediatric subspecialties such as hematology/oncology versus rheumatology [32], but no differences among gynecology subspecialties [25].

Clinical setting (nine studies [21,23,25,28,32,37–40]). Studies did not find consistent differences in recommendation quality by clinical setting. For example, seven studies compared clinics in urban, suburban, and rural areas on recommendation quality [21,23,25,32,37,38,40]. Three of these studies found no statistically significant differences between urban, suburban, or rural clinics [23,32,40], two studies found more HCPs in urban versus nonurban (i.e., rural and suburban) clinics used higher-quality recommendations (5–8 pp) [21,37], one study found more HCPs in suburban versus nonsuburban (i.e., rural and urban) clinics used higher-quality recommendations (5–31 pp) [25], and one study found more HCPs in nonsuburban (i.e., rural and urban) versus suburban clinics used higher-quality recommendations (13 pp) [38]. An additional two studies found no statistically significant differences in recommendation quality by US Census regions [21,32].

A total of seven studies compared practice types, such as private practices, health system-affiliated practices, and federally qualified health centers, on recommendation quality [21,23,25,28,32,37,39]. Three of these studies found more HCPs in publicly funded versus private or other practices used higher-quality recommendations (6–14 pp) [21,28,37], one study found more HCPs in private versus publicly funded practices used higher-quality recommendations (12 pp) [39], and three studies found no statistically significant differences [23,25,32].

Other clinical characteristics (seven studies [21,25,32,33,36,37,40]). Findings about differences in recommendation quality across other clinical characteristics were mixed or limited in number. For example, two studies found a positive correlation between Vaccine for Children affiliation and recommendation quality [33,37]. Another six studies compared patient volume on recommendation quality [21,32,33,36,37,40]. Four of these studies found no statistically significant differences [21,33,36,37], and two studies found more HCPs with higher versus lower patient volume used higher-quality recommendations (5–18 pp) [32,40]. An additional three studies found no statistically significant differences in recommendation quality associated with the use of most vaccine delivery system strategies such as electronic medical record prompts [25,33,37].

Variation in recommendation quality by HCP characteristics

Clinical role (nine studies [21,28,29,34,35,41–44]). Studies that compared clinical role on recommendation quality found few consistent differences among physicians, advanced practitioners (nurse practitioners and physician assistants), and nursing staff. For example, five studies compared the recommendation quality of providers (physicians and advanced practitioners) versus other clinical staff (nursing staff and other HCPs) [21,35,41,42,44]. Four of these studies found no statistically significant differences [21,35,41,44]. An additional five studies compared recommendation quality among different provider types (physicians vs. advanced practitioners) [21,28,29,34,43]. Three of these studies found no statistically significant differences [28,29,34], one study found more physicians versus advanced practitioners used higher-quality recommendations (7 pp) [21], and one study found more advanced practitioners versus physicians used higher-quality recommendations (12 pp) [43].

Vaccine cognitions (11 studies [23,25,26,32,34,36,37,45–48]). Most studies that compared vaccine cognitions on recommendation quality found that quality correlated with HPV-related knowledge but less consistently with other cognitions. Seven studies compared recommendation quality by HCPs' knowledge of HPV (e.g., infection, associated cancers) or HPV vaccination (e.g., effectiveness, vaccination guidelines) [23,25,26,32,37,46,47]. Four of these studies found more HCPs with higher versus lower levels of knowledge used higher-quality recommendations (27–38 pp) [25,26,46,47], and the other three studies found no statistically significant differences. [23,32,37].

A total of 10 studies compared HCPs' other cognitions on recommendation quality [23,25,26,32,34,36,37,45,46,48]. Of these, two studies found positive associations of HCPs' confidence in addressing parental concerns [34] and descriptive norms about other obstetricians/gynecologists' HPV vaccine recommendation practices [25] with recommendation quality. Another three studies found that perceived parental hesitancy was positively (two of three studies, 31–36 pp) [36,46] or negatively (one of three studies) associated with recommendation quality [37]. Few studies found statistically significant differences in recommendation quality by HCPs' discomfort with discussing sex (two of five studies) [23,32,36,37,46], vaccine efficacy concerns (one of five studies) [23,26,32,37,46], vaccine safety concerns (one of three studies) [36,37,46], perceived increase in sexual behavior (one of three studies) [36,37,48], or other perceived barriers in communicating with parents about HPV vaccine (zero of one study) [26].

Other HCP demographic and professional characteristics (11 studies [21,23,25,28,29,32,33,36–38,41]). Very few studies found statistically significant differences in recommendation quality by HCPs' gender (1 of 11 studies), [21,23,25,28,29,32,33,36–38,41] age (one of eight studies), [25,29,32,33,36–38,41] or race/ethnicity (one of six studies). [21,25,29,33,37,38] No studies found statistically significant differences in recommendation quality by years in practice (zero of seven studies). [21,25,28,29,36–38].

Table 1
Summary of studies on HPV vaccine recommendation quality ($k = 28$ studies)

Author, year	HPV vaccine recommendation quality measure	Key findings by clinical and HCP characteristics	
		Higher recommendation quality among:	No difference in recommendation quality by:
Alcalá, 2018 [41]	Consistent recommendation for female patients ages 11–12 (74% of the time) and male patients ages 11–12 (67% of the time)	• Female versus male HCPs for male patients (83% vs. 39%, $p = .02$) • Younger versus older HCPs for male patients (82% vs. 34%, $p = .02$)	• Physicians versus other clinical staff for female or male patients • HCP gender or age for female patients
Allison, 2016 [23]	Strong recommendation for female and male patients ages 11–12	• Pediatricians versus family physicians for male patients • HCPs with more versus less HPV vaccine efficacy concerns for female patients	• Pediatricians versus family physicians for female patients • HCPs with more versus less HPV vaccine efficacy concerns for male patients • Locale (urbanicity), practice type (e.g., private clinics vs. hospitals), HPV vaccine knowledge and other cognitions (e.g., discussing sex), and HCP gender for female or male patients
Ayres, 2022 [42]	Consistent recommendation or urgent recommendation ("almost always") for patients ages 11–12	Consistent recommendations: • Clinicians versus nurses and other HCPs (OR = 3.31, 95% CI 1.11–9.88) Urgent recommendations: • Clinicians versus nurses and other HCPs (OR = 3.55, 95% CI 1.29–9.72)	
Berkowitz, 2015 [24]	Consistent recommendation for female patients ages 11–12	• Pediatricians versus internists (74% vs. 30%, $p < .001$)	
Bonville, 2017 [43]	Consistent recommendation ("always") for patients ages 13–18	• Advanced practitioners versus physicians (95% vs. 83%, $p < .05$)	
Brennan, 2022 [25]	Strong and consistent recommendation for patients ages 9–26	• HCPs with more versus less positive HPV vaccination beliefs (61% vs. 31%, $p = .01$) • HCPs with more versus less HPV knowledge (mean = 5.4 vs. 4.9, $p = .002$) • HCPs with high versus low descriptive norms about other OB-GYNs' recommendation practice (aOR = 24.33, 95% CI 2.56–231.14) • HCPs in suburban versus urban and rural clinics (64% vs. 59% and 33%, $p <0$ .05)	• OB-GYN versus other gynecology specialty, FQHC status, EHR prompt, descriptive norms about other primary care providers, and HCP demographics (gender, age, race/ethnicity, or years in practice)
Btoush, 2022 [26]	Consistent recommendation ("always") for patients ages 11–13	• HCPs in pediatrics versus nonpediatrics specialty (aOR = 1.98, 95% CI 1.09–3.57) • HCPs with more versus less HPV vaccine knowledge (aOR = 6.86, 95% CI 2.30–20.43) • HCPs with fewer versus more HPV vaccine concerns	• Perceived HPV vaccine effectiveness, facilitators, or barriers
Cataldi, 2021 [27]	Consistent recommendation for female and male patients ages 11–12	• Pediatricians versus family physicians for female patients in 2018 (99% vs. 96%) and for male patients in 2013–2014 (90% vs. 86%) and 2018 (99% vs. 94%, all $p < .05$)	• Pediatrics versus family medicine specialty for female patients in 2013–2014
Chopp, 2016 [45]	Intention to recommend for female and male patients ages 11–12	• HCPs with more positive HPV vaccine attitudes for female patients (t-test value = 4.69, $p < .0001$) • HCPs with more positive self-efficacy for female patients (t-test value = 9.63) and male patients (t-test value = 8.32, all $p <$ .0001)	• HPV vaccine attitudes for male patients
Dempsey, 2016 [28]	Strong recommendation for patients ages 11–12	• HCPs in pediatrics versus family medicine specialty (58% vs. 32%, $p = .03$) • HCPs in publicly funded versus private practices (54% vs. 46%, $p < .01$)	• Physicians versus nurse practitioners versus physician assistants, and HCP demographics (gender or years in practice)
Deupree, 2017 [46]	Consistent recommendation for female and male patients ages 11–26	• HCPs with versus without HPV cancer knowledge for male patients (37% vs. 3%, $p < .05$) • HCPs with versus without HPV vaccine knowledge for male patients (39% vs. 1%, $p < .05$) • HCPs with versus without perceived parental barrier for male patients (36% vs. 5%, $p < .05$)	• HPV cancer or vaccine knowledge and perceived parental barrier for female patients • Other HPV vaccine cognitions (e.g., vaccine efficacy and safety concerns) for female or male patients

Table 1
Continued

Author, year	HPV vaccine recommendation quality measure	Key findings by clinical and HCP characteristics	
		Higher recommendation quality among:	No difference in recommendation quality by:
Finny Rutten, 2017 [29]	Strong recommendation or consistent recommendation for female and male patients ages 11–12	Strong recommendations: • HCPs in pediatrics versus family medicine versus OB-GYN or internal medicine clinics for female patients (95% vs. 67% vs. 50%) and male patients (88% vs. 52% vs. 25%, all $p < .001$) • HCPs with pediatrics versus family medicine board certification for female patients (95% vs. 67%) and male patients (87% vs. 53%, all $p < .01$) Consistent recommendations: • HCPs in pediatrics versus family medicine versus OB-GYN or internal medicine clinics for female patients (98% vs. 76% vs. 20%) and male patients (93% vs. 57% vs. 0%, all $p < .001$) • HCPs with pediatrics versus family medicine board certification for female patients (97% vs. 75%) and male patients (95% vs. 55%, all $p < .01$)	• Physicians versus advanced practitioners, and HCP demographics (gender, age, race/ethnicity, or years in practice) for female or male patients
Gilkey, 2015 [30]	Strong recommendation ("extremely" or "very" important) for patients ages 11–12	• Pediatricians versus family physicians (77% vs. 69%, $p < .05$)	
Hansen, 2020 [31]	Consistent recommendation ("always") for female and male patients ages 11–12	• Pediatrics versus family medicine versus OB-GYN residents for female patients (76% vs. 16% vs. 0%, $p < .05$) • Pediatrics versus family medicine residents for male patients (67% vs. 10%, $p < .05$)	• Residency year for female or male patients
Hofstetter, 2017 [32]	Consistent recommendation ("always" or "sometimes") for adolescent patients with chronic medical conditions (patient age range not specified)	• HCPs in hematology/oncology versus rheumatology, pulmonology, and endocrinology (66% vs. 46%, 31% and 26%, $p < .001$) • HCPs without versus with discomfort discussing sex • HCPs without versus with adequate HPV vaccine information • HCPs with higher versus lower patient volume (aOR = 1.01, 95% CI 1.00, 1.02)	• Locale (urbanicity or US region), practice type (e.g., private clinics vs. community health centers), HPV knowledge, HPV vaccine efficacy beliefs, and HCP demographics (gender, age, or years in practice)
Hopfer, 2019 [38]	Strong and urgent recommendation by "engagers" and "protocol followers" (patient age range not specified)	• HCPs in suburban versus nonsuburban clinics (64% vs. 77%, $p < .05$)	• HCP demographics (gender, age, race/ethnicity, or years in practice)
Hswen, 2017 [47]	Strong, consistent, timely, and urgent recommendation for female and male patients ages 11–12	• HCPs who were versus were not aware of their professional organizations' HPV vaccination guidelines for female patients (52% vs. 25%) and male patients (54% vs. 26%, both $p < .001$)	
Kempe, 2019 [22]	Consistent recommendation for female and male patients ages 11–12	• Pediatricians versus family physicians for female patients (99% vs. 96%) and male patients (99% vs. 94%, both $p < .05$)	
Kong, 2022 [21]	Timely recommendation for patients ages 9–10	• Physicians versus advanced practitioners (23% vs. 16%, $p < .05$) • HCPs who were black versus Asian and white (32% vs. 29% and 20%, $p < .05$) • HCPs in publicly funded practices versus hospitals, solo and group practices (32% vs. 26%, 20% and 18%, $p < .05$) • HCPs in urban versus rural and suburban clinics (26% vs. 21% and 18%, $p < .05$)	• Physicians versus nurses, pediatrics versus family medicine specialty, locale (US region), practice/system size (with vs. without affiliation with health systems), patient volume, and HCP demographics (gender or years in practice)
Lake, 2019 [33]	Strong recommendation or consistent recommendation for patients ages 11–12	Strong recommendations: • HCPs who were versus were not VFC providers (aOR = 2.62, 95% CI 1.23, 5.59) Consistent recommendations: • HCPs who were versus were not VFC providers (aOR = 2.84, 95% CI 1.26, 6.39) • HCPs who received versus did not receive reminders from healthcare team members (aOR = 2.26, 95% CI 1.23, 4.16)	• Specialty (e.g., pediatrics vs. family medicine), patient volume, other vaccine-related quality improvement strategies (e.g., EHR reminders), and HCP demographics (gender, age, or race/ethnicity)

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Table 1
Continued

Author, year	HPV vaccine recommendation quality measure	Key findings by clinical and HCP characteristics	
		Higher recommendation quality among:	No difference in recommendation quality by:
Lu, 2019 [39]	Receipt of a provider recommendation	• Parents visiting private versus publicly funded clinics (67% vs. 55%, $p < .05$)	• Private clinics versus hospitals
McRee, 2014 [34]	Consistent recommendation ("most of the time") for female and male patients ages 11–12	• Pediatricians versus family physicians and nurse practitioners for male patients (67% vs. 42% and 41%, $p < .001$) • HCPs with more versus less positive self-efficacy for female and male patients	• Clinical role/specialty for female patients
Mills, 2016 [35]	Strong recommendation ("very strong" or "somewhat strong") for patients (patient age range not specified)		• Pediatrics versus family/internal medicine versus OB-GYN, and physicians versus nonphysicians
Roberts, 2020 [44]	Consistent recommendation ("75%" or ">90%" of the time) for patients (patient age range not specified)		• Clinicians versus nurses
Rohrbach, 2017 [40]	Consistent recommendation ("always") for eligible patients (patient age range not specified)	• HCPs who see ≥21 patients/week versus 11–20, 6–10, and 1–5 patients/week (74% vs. 70%, 60% and 56%, $p = .01$)	• Locale (urbanicity)
Soon, 2015 [36]	Strong recommendation for female and male patients ages 11–12	• HCPs who did not versus did perceive parental or patient concern about HPV vaccine efficacy as a barrier for female patients (64% vs. 100%, $p = .025$) • HCPs who did not versus did perceive the need to discuss sexuality before recommending for male patients (78% vs. 42%, $p = .005$)	• Pediatrician versus family physicians, patient volume, other HPV vaccine cognitions (e.g., association with sex, vaccine safety concerns), and HCP demographics (gender, age, or years in practice) for female or male patients
Suryadevara, 2015 [48]	Consistent recommendation for adolescent patients (patient age range not specified)	• HCPs without versus with HPV vaccine misperception of increased risky sexual behavior (figures not reported, $p = .002$)	
Vadaparampil, 2016 [37]	Strong and consistent recommendation for male patients ages 11–12	• HCPs who were versus were not VFC providers (aOR = 3.80, 95% CI 1.70–8.54) • HCPs in urban versus nonurban clinics (aOR = 2.08, 95% CI 1.08–4.02) • HCPs with fewer versus more HPV vaccine safety concerns • HCPs in nonprivate versus private practices	• Pediatrics versus nonpediatrics specialty, practice/system size (e.g., single vs. multispecialty practices), patient volume, vaccine-related quality improvement strategies (e.g., EHR prompts), HPV knowledge, other HPV vaccine cognitions (e.g., vaccine efficacy concerns, associations with sex, perceived parental barriers), and HCP demographics (gender, age, race/ethnicity, or years in practice)

aOR = adjusted odds ratio, CI = confidence interval, EHR = electronic health record, FQHC = Federally Qualified Health Center, HCPs = healthcare professionals, HPV = human papillomavirus, OB-GYNs = obstetricians/gynecologists, VFC = Vaccines for Children.

Discussion

Our systematic review of 28 studies sought to characterize variation in HCPs' HPV vaccine recommendation quality for US adolescents. Across these studies, the overall proportion of HCPs who reported delivering higher-quality recommendations was low. Consistent with earlier reviews [49,50], recommendation quality was even lower among HCPs in nonpediatric specialties, such as family medicine, compared to pediatrics. Studies in our review observed this recommendation deficit despite family physicians serving as a key source of primary care for adolescents [51], and professional health organizations, including the American Academy of Family Physicians, encouraging HPV vaccine recommendations [52]. Lower adolescent patient volume [34,51] and the broader range of health conditions seen in family medicine practices [53] may be contributing to lower recommendation quality. Future studies should identify and address recommendation barriers, such as not having adequate adolescent medicine subspecialty knowledge that HCPs in family medicine may face more often than those in pediatrics. At the same time, our findings suggest that family medicine HCPs could benefit from evidence-based communication training interventions to improve their recommendations. Because not all family medicine HCPs serve adolescents, targeting efforts to those with higher adolescent patient volumes may be needed to ensure that interventions achieve sufficient reach.

Interestingly, studies did not consistently find lower recommendation quality in rural versus nonrural areas, despite persistent rural disparities in HPV vaccination coverage [4,54]. This finding also contrasts parents' report of receiving fewer recommendations for adolescents residing in rural areas [9]. Reasons for this divergence in HCP and parent reports of recommendations are unclear, but could reflect rural families' lower access to healthcare services. Indeed, national data indicate that adolescents living in nonmetropolitan versus metropolitan areas have fewer preventive care visits [55]. Tsai and colleagues also recently found having a low number of primary care providers was a barrier to vaccination for low-income families in rural settings [56]. Thus, rural adolescents could receive fewer recommendations due to having fewer interactions with HCPs, even if rural-serving HCPs recommend HPV vaccination with comparable quality to those serving nonrural areas. In this case,

interventions seeking to reduce the rural disparity in HPV vaccination may benefit from concomitantly targeting more distal environmental factors, such as transportation and community outreach, to improve vaccine uptake. An alternative explanation for the divergence in HCP versus parent reports could be due to differences in how recommendation quality is measured in each population; parents are typically asked whether they have ever received a recommendation for their children with dichotomous, yes/no response options [9], while HCPs are often asked more complex questions about recommendation consistency, strength, or timeliness across their patient populations. As such, more consistent measures of recommendation quality may be needed to triangulate findings on recommendation delivery and receipt. Given the narrower differences in rural–urban coverage for other adolescent vaccinations, greater hesitancy toward HPV vaccination among rural parents could also be contributing to the difference between HPV vaccine recommendation quality and coverage in rural areas [4]. Future studies should consider examining parental barriers to HPV vaccination in rural areas to further inform multilevel approaches in increasing vaccine uptake.

Most studies found that recommendation quality did not vary by HCPs' gender, age, race/ethnicity, or years in practice. These findings suggest that targeting interventions to HCPs based solely on their demographic and professional characteristics is unlikely to contribute to significant increases in HPV vaccination rates via recommendation delivery. Most notably, our findings on years in practice suggest that communication training should be implemented among HCPs at every career stage, including medical school for physicians in training and continuing education for HCPs who are already in practice.

Our findings highlight additional practice-based and research-based implications for increasing HPV vaccine recommendation quality. First, similar recommendation quality found across clinical roles points to the potential of employing a team-based approach in HPV vaccine recommendations. For example, the Community Preventive Services Task Force highlights standing orders as a promising strategy in increasing vaccination rates [57], suggesting that nursing staff should be empowered to deliver vaccine recommendations to support and extend provider recommendations. Second, variation in recommendation quality by HCPs' vaccine cognitions further highlights the opportunity of increasing high-quality recommendations, such as via clinical education, to improve HPV-related knowledge and, in turn, recommendations from both providers and other clinical staff. Finally, our review found wide variation in how recommendation quality is measured, with half of included studies assessing only recommendation consistency. This finding suggests an opportunity for future studies to measure recommendation quality more comprehensively, including consistency, strength, timeliness, *and* urgency [19], and to more specifically identify which aspects of quality that communication trainings should address.

Our findings should be interpreted in light of several limitations, including in the quality and scope of the eligible studies. First, all 28 studies included in this review analyzed cross-sectional data, thereby limiting our ability to understand the extent to which factors, such as HPV-related knowledge, foster versus merely coexist with recommendation quality. Second, all available data relied on HCPs' self-report which is vulnerable to biases, including social desirability. Future research should consider including objective measures of recommendation quality, such as from recordings [58–63], to minimize such biases. Studies could also employ more rigorous designs such as randomized trials to demonstrate the impact of strategies aimed at improving HPV vaccine communication and uptake. Third, the clinical and HCP characteristics presented in this review are not comprehensive, but rather reflect what is available in the literature. Assessing the association of other place-based factors, such as school entry requirements and other vaccine-related policy, with HCP recommendations could yield further insights for future intervention targets and help to explain why recommendation receipt and HPV vaccination coverage vary so widely by state. Lastly, most eligible studies used nonprobability samples that may have generated biased prevalence estimates but externally valid statistical associations [64], hence the generalizability of the percentage point differences reported for each HCP subgroup across studies in this review is unclear. Our review findings nonetheless offer usable insights on the associations of clinical and HCP characteristics with HPV vaccine recommendation quality to guide future intervention studies.

Conclusion

Our review found overall low HPV vaccine recommendation quality across studies and consistently lower recommendation quality among HCPs in nonpediatric specialties, such as family medicine. Communication interventions should identify family medicine HCPs who see higher adolescent patient volumes and explore the mechanisms of their recommendation practices to increase their delivery of high-quality recommendations. Given no variation in recommendation quality by clinical role, interventionists should also consider making use of team-based approaches to HPV vaccine recommendations that engage providers and other clinical staff. In summary, continued efforts to promote strong, consistent, timely, and urgent recommendations are needed to increase HPV vaccine uptake among adolescents. Targeting those efforts to where they are most needed may help to make the best use of limited time and resources available for interventions around HCP recommendations for HPV vaccine uptake.

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Supplementary Data

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