Clinician practices, knowledge, and attitudes regarding primary human papillomavirus testing for cervical cancer screening: A mixed-methods study in Indiana

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ABSTRACT

Primary human papillomavirus (HPV) testing, in which a high-risk HPV test is administered without cytology, was first included in 2018 US cervical cancer screening guidelines. Subsequent guidelines endorsed primary HPV testing as the preferred method for cervical cancer screening following evidence of its clinical and economic benefits, although many sources still indicate it as an option along with cytology and HPV/Pap co-testing. Primary HPV testing could be key to improving the declining cervical cancer screening rates in the US; however its adoption has been slow as clinicians are hesitant to make the change. Indiana ranks in the top ten states for cervical cancer mortality, with marked race-ethnic disparities in cervical cancer screening and low HPV vaccination rates. To examine clinician practices, knowledge, and attitudes regarding primary HPV testing, in 2021 we conducted an online cross-sectional survey (n = 224) and in-depth interviews (n = 20) with Indiana clinicians practicing cervical cancer screening. Only 3% reported using primary HPV testing for eligible patients, and only 50% were willing to adopt it as the preferred cervical cancer screening method for the recommended patient group. In a multivariable logistic regression model, knowledge of the effectiveness (aOR 2.58 [1.41–4.72]) and perceived benefit (aOR 7.35 [3.65–14.81]) of primary HPV testing predicted willingness to adopt. In-depth interviews revealed knowledge gaps, uncertainty, and perceived limitations of this method as the reasons for limited uptake of primary HPV testing. Targeted messages about the benefits and effectiveness may enhance clinician knowledge, acceptance, and adoption.

1. Introduction

In 2018, the United States Preventive Services Task Force (USPSTF) updated their recommendations for cervical cancer screening guidelines to include the option for primary human papillomavirus (HPV) testing every 5 years for women aged 30–65 years (US Preventive Services Task Force et al., 2018). The endorsement of this screening method, in which a high-risk HPV DNA test is administered alone without cytology, was based on evidence from a growing number of randomized controlled trials demonstrating that primary HPV testing had higher specificity than HPV/Pap co-testing, higher negative-predictive value than cytology alone and led to increased detection of cervical dysplasia (Ronco et al., 2010; Ogilvie et al., 2018). The economic benefit of primary HPV testing compared to co-testing has evidence-based research support, since the combination of HPV and cytology increases cost with minimal improvement in cancer prevention (Lew et al., 2017; Lew et al., 2016; Kitchener et al., 2014). Furthermore, the clinical and economic benefits of primary HPV testing will only continue to increase as HPV vaccination reduces the prevalence of cervical cancer and cytology becomes less cost-effective (Franco et al., 2006). Other countries including the Netherlands, Turkey, and Australia have transitioned to primary HPV testing, and modeling studies project improved cost-effectiveness and simplified clinical care processes as a result of these shifts (Lew et al., 2017; Jansen et al., 2021; Gultekin et al., 2018).

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Professional organizations including the American College of Obstetrics and Gynecology (ACOG), American Society for Colposcopy and Cervical Pathology (ASCCP), and American Academy of Family Physicians (AAFP) endorse USPSTF guidelines and have each issued statements in support of primary HPV testing whenever possible, while still supporting the option for cytology or co-testing (Marcus et al., 2021). In 2020, the American Cancer Society (ACS) issued updated guidelines making primary HPV testing the preferred method for women aged 25–65 years (Fontham et al., 2020). In 2021, the World Health Organization (WHO) also recommended an HPV DNA-based test as the preferred method (WHO, 2022). This transition towards primary HPV testing represents a paradigm shift in cervical cancer screening from a clinical perspective of identifying cervical dysplasia in a patient, to a public health perspective of ruling out pre-cancerous lesions in a healthy population and identifying a smaller sub-group of high-risk patients to undergo additional testing such as cytology (Castle and Cremer, 2013).

Coupled with the timing of this transition in cervical cancer screening guidelines was the COVID-19 pandemic, which caused major healthcare disruptions and declines in cancer screening rates (Corley et al., 2021). However, even before the pandemic, cervical cancer screening rates had been declining in the US, with the proportion of women overdue for cervical cancer screening significantly increasing from 14% in 2005 to 23% in 2019 (Suk et al., 2022). Having failed to meet the US Department of Health and Human Services’ Healthy People 2020 (Healthy People - Healthy People Homepage [Internet], 2022) cervical cancer screening coverage target of 93%, the 2030 target was surprisingly lowered to 84.3% as experts expect coverage to continue to be difficult to improve (Increase the proportion of females who get screened for cervical cancer — C-09 - Healthy People 2017). Screening innovations such as patient-collected vaginal samples (Aarnio et al., 2021; Yeh et al., 2019; Madzima et al., 2017; Carraquillo et al., 2018; Malone et al., 2020; Ilangoavan et al., 2016; Nelson et al., 2017; Bishop et al., 2019), rapid testing for HPV (Rodríguez, 2021), and other strategies to reach persistently underscreened populations are needed and would be enabled by adoption of primary HPV testing.

In the US, the decision to adopt new clinical practice guidelines is made by individual health systems rather than implemented on a national level. A 2020 report of the US President’s Cancer Panel on “Improving resilience and equity in cervical cancer screening beyond COVID-19” emphasized the need to shift to primary HPV testing while highlighting key challenges surrounding its implementation, stating that “the evidence indicates primary HPV testing is the best approach, with follow-up as needed via cytology... However, many clinicians do not feel comfortable doing only an HPV test for the initial screen” (National Cancer Institute. President’s Cancer Panel, 2020). Thus, understanding the clinician’s perspectives surrounding primary HPV testing is key to its adoption.

Indiana ranks in the top ten states with the highest rates of cervical cancer mortality in the US (State Cancer Profiles, 2022), coupled with marked disparities in screening and incidence rates among underserved race-ethnic groups. In 2019, Indiana reported a cervical cancer incidence rate of 8.1 per 100,000 women, death rate of 2.8 per 100,000 women, and screening prevalence among women aged 21–65 years of 76% (U.S. Cancer Statistics Working Group. U.S. Cancer Statistics Data Visualizations Tool, 2021). Up-to-date HPV vaccination coverage rates among adolescents in Indiana (53.4% in 2020) are lower than national and regional averages (National, 2020), thus HPV screening is especially important as a first front for prevention. In this context, we conducted an online cross-sectional survey in 2021, coupled with in-depth interviews among clinicians practicing cervical cancer screening. The objective of this study is to examine current Indiana clinician practices, knowledge and attitudes regarding primary HPV testing as a cervical cancer screening method. This mixed-methods study has the following objectives: 1) to assess and estimate factors associated with clinician practices, awareness, knowledge, perceived benefit, and willingness to adopt primary HPV testing; and 2) to identify qualitative insights about clinician attitudes regarding primary HPV testing including reasons for willingness or unwillingness to adopt and specific perceived benefits and limitations of this cervical cancer screening method.

2. Methods

This convergent mixed-methods study was designed as an online cross-sectional survey and qualitative interviews with clinicians who conduct cervical cancer screening in Indiana. As the first study to examine clinician perspectives on primary HPV testing in Indiana, a specific hypothesis was not being tested; instead, the quantitative survey items explored clinician practices, awareness, knowledge, perceived benefit, and willingness to adopt primary HPV testing, and the qualitative interviews provided details that enriched the understanding about perceived benefits and limitations of this screening method and reasons why clinicians were willing or unwilling to adopt it. Recruitment occurred in two waves, and the sample was restricted to Indiana clinicians who performed cervical cancer screening on at least one asymptomatic average-risk woman aged 21–65 years in the past month. The online survey was programmed into Qualtrics and advertised to the research team’s network of contacts that practice among underserved groups by posting in the Indiana Cancer Consortium and the ACOG district V newsletters, and emailing invitations through the Indiana University Simon Comprehensive Cancer Center’s Office of Community Outreach and Engagement, federally qualified health center (FQHC) partners, and Planned Parenthood clinicians in Indiana. This first wave (n = 59) began May 5th, 2021 and closed October 5th, 2021. In order to increase our sample size and collect responses from a broader sample of Indiana physicians and nurse practitioners in OB/GYN, family practice, and internal medicine specialties, a second wave (n = 165) was launched October 11, 2021 and closed November 17, 2021, where the same Qualtrics survey was distributed by Dynata, a market research firm. All survey respondents volunteered and were compensated upon completion of the survey with a $20 electronic gift card. This study was approved by the Institutional Review Board at Purdue University (protocols: IRB-2019-132; IRB-2021-12; IRB-2021-617).

2.1. Survey questionnaire design

The survey items addressed practices, knowledge, and attitudes regarding primary HPV testing, among other topics as part of a larger study about cervical cancer screening. Questionnaire items addressed in this paper are included in the supplementary files. A literature search was conducted for other surveys of clinician perspectives on cervical cancer screening, and adaptations of previously validated survey items (Townsend et al., 2014; Kim et al., 2016; Trope et al., 2009; Roland et al., 2013; Katz et al., 2017; Mao et al., 2017) were used whenever possible. In the absence of validated items, the investigator-generated questions were developed with two iterations of survey drafts, tested among a group of clinicians in the sampling frame population, and pilot tested for clarity, clinical accuracy, and to ensure that the items were measuring the intended concept.

The final survey instrument had 77 questions and took approximately 15 min to complete. We collected information about respondent demographics (e.g. gender, race, education, specialty), and clinic and patient population characteristics (e.g. clinic type, geographic location). Respondents were asked about their current screening practices, including the frequency of screenings per month, the method they typically use to screen asymptomatic, average-risk women ages 21–29 and 30–65 years, and primary source for cervical cancer screening guidelines (Townsend et al., 2014).

Respondents were asked about cervical cancer screening practices using the clinical scenario of “a 35-year-old asymptomatic patient that had a normal last screening test (normal Pap/HPV-negative) 5 years ago, like all of her previous screening tests.” Primary HPV testing was defined as “when a patient is screened for cervical cancer first using an FDA-
approved laboratory-based HPV DNA test, and then only positive cases evaluated by Pap smear.” Respondents rated their familiarity with this method, using a 5-point Likert scale from “This is my first time hearing about it” to “I currently use this frequently”. (Townsend et al., 2014). Knowledge of primary HPV testing was assessed using a True/False/Uncertain question, on the statement, “Primary HPV testing is an effective cervical cancer screening method for asymptomatic women ages 30–65 of average-risk”. Based on 2018 USPSTF recommendations that include primary high-risk HPV testing alone as an effective cervical cancer screening method for women in this age group (US Preventive Services Task Force et al., 2018), the guideline-consistent correct answer is ‘True’.

To gauge user-perceived benefit, respondents were asked the extent to which they believed primary HPV testing would improve or not improve cervical cancer screening, on a 4-point scale ranging from ‘Would not improve’ to ‘Would greatly improve’ (Townsend et al., 2014). Finally, to assess willingness to adopt primary HPV testing, respondents were asked to rate their agreement on a 5-point Likert scale with the statement “I would support adopting primary HPV testing in my practice as the preferred cervical cancer screening method for asymptomatic average-risk women ages 30–65” (Townsend et al., 2014).

2.2. Quantitative data analysis

Both waves were combined for the analysis. Of 310 total eligible respondents who initiated the survey, 271 completed it; however, 47 clinicians practiced outside of the state of Indiana and were excluded from the analysis, yielding 224 total responses. Given our final sample size of 224 and the fact that half of the sample (n = 111) was willing to adopt primary HPV testing, we used methods described by Hsieh et al. to estimate we have 80% power to detect an odds ratio of ~1.4 (Hsieh, 1989). Descriptive statistics of frequencies and percentages, or means and standard deviations were reported as appropriate. Associations between each variable and our outcome variables of knowledge (dichotomized as true versus false/uncertain), perceived benefit (dichotomized as improve versus not improve/unsure), and willingness to adopt primary HPV testing (dichotomized as willing versus unwilling to adopt) were tested using 2-sided Chi-squared tests, with 2-sided Fishers Exact Tests for the categorical variables that did not fulfill the conditions of the Chi-squared test. Only significant factors (p < 0.05) were included in bivariable and multivariable logistic regression analyses with the outcome variable of willingness to adopt. Variables with <5 observations were excluded due to small sample size, concern for identification of participants, and limited statistical power. All analyses were performed using Python open-source packages and IBM SPSS v26.

2.3. Qualitative interviews

Semi-structured in-depth interviews were conducted to glean additional qualitative insights on clinician practices, experiences, perceived benefits and limitations, and reasons for their willingness or unwillingness to adopt primary HPV testing in clinical practice, among other topics as part of a larger study about cervical cancer screening. Interview guide questions were generated by investigators (not hypothesis driven) and those addressed in this paper are listed in the supplemental file. Recruitment for the interviews initially occurred through email invitations sent to our team’s network of clinicians in Indiana, and survey respondents who consented to being contacted for a follow-up interview were invited to interview by the study team. We conducted virtual interviews via Zoom with 20 clinicians from September to October 2021. The number of interviews was not decided a priori; the study team recruited as many interviewees as possible as there were numerous topics included in the larger study. Interviews lasted 30 to 60 min and were audio recorded and transcribed verbatim using a digital transcribing platform, Otter.ai. Transcripts were reviewed and edited for accuracy by research assistants.

2.4. Qualitative coding and analysis

The transcripts were thematically analyzed applying a combination of deductive and inductive coding by two independent coders using NVivo software. The interview guide was used for deductive analysis of major themes and to create the initial codebook. Open coding was conducted whereby keywords and phrases in the codebook were assigned to interview sections, followed by axial coding, where patterns between and within interviews were mapped and inductive analysis was used to identify emerging subthemes (The Coding Manual for Qualitative Researchers [Internet]. SAGE Publications Inc., 2022). The two coders met and discussed their coding to ensure for intercoder consistency and to reach consensus on coding. Any differences in coding or theme definitions were discussed among the full study team until consensus was reached.

3. Results

3.1. Clinician sample

A total of n = 224 Indiana clinicians completed the full survey. Survey respondents included: physicians (n = 110, 49 %), nurse practitioners (n = 107, 48 %), medical assistants and physician assistants (n = 7, 3 %) (Table 1). Clinical specialties represented were family medicine (n = 150, 67 %), obstetrics/gynecology (n = 36, 16 %), and internal medicine (n = 26, 12 %). Most respondents were female (n = 162, 72 %) and non-Hispanic white (n = 175, 78 %). The average years in clinical practice was 14.6 years (SD = 10.3). One third of respondents practiced at a federally qualified health center (FQHC, n = 74) and 44 % (n = 99) served majority Medicaid patients.

The subsample of survey respondents who participated in interviews included physicians (n = 11, 55 %) and nurse practitioners (n = 9, 45 %) representing clinical specialties of family medicine (n = 11, 55 %), obstetrics/gynecology (n = 2, 10 %), internal medicine (n = 2, 10 %) and other (family planning, adolescent medicine, n = 5, 25 %). Seven (35 %) interviewees practiced at a FQHC (n = 12 (60 %). Most interviewees (n = 13, 65 %) were female and non-Hispanic white (n = 12, 60 %).

3.2. Cervical cancer screening practices

Clinicians reported their primary sources for cervical cancer screening guidelines (Figure S1), with 33 % following ACOG, 32 % ASCCP, 17 % USPSTF, 12 % AAPF, 4 % ACS, and 1 % WHO or other.

The reported cervical cancer screening methods for asymptomatic patients of average risk aged 21–29 and 30–65 years are presented in Fig. 1. For patients ages 30–65 years, the majority of clinicians reported using HPV/Pap co-testing (n = 164, 73 %), followed by reflex HPV testing whereby a Pap smear is performed first and only abnormal or unclear results are followed up with an HPV test, (n = 44, 20 %). For patients ages 21–29 years, nearly half of respondents reported using reflex HPV testing (n = 108, 48 %), followed by HPV/Pap co-testing (n = 80, 36 %), and Pap smear only (n = 27, 12 %). Only six respondents (3 %) reported typically using primary HPV testing for either patient age group.

3.3. Awareness and knowledge of primary HPV testing

Among the survey respondents, 21 % reported never having heard of primary HPV screening prior to taking the survey, 55 % were familiar but did not use it in their clinical practice, 6 % had used it a few times in past clinical practice or training, and 18 % reported currently using primary HPV testing either occasionally or frequently (Fig. 2a). Approximately 56 % of clinicians responded correctly (guideline-consistent response of ‘True’) to the true/false knowledge question,
while 5% responded ‘False’, and 39% responded ‘Uncertain’ (Fig. 2b). There were no significant differences in knowledge across clinician demographics (Table S1). Clinicians who were more familiar with primary HPV testing, defined as currently using it either occasionally or frequently, were more likely to respond correctly to the knowledge question (p < 0.001, Table S1).

### 3.4. Attitudes towards primary HPV testing

Overall, 68% of respondents reported that primary HPV testing would improve cervical cancer screening, (20% greatly and 48% somewhat); 18% stated it would not improve screening, and 15% were uncertain (Fig. 2c). The only significant difference in extent of perceived benefit among clinician demographics was observed by clinical specialty, with less than half of OB/GYNs believing primary HPV testing would improve screening compared to 68% and 84% of Family Medicine and Internal Medicine clinicians respectively (p = 0.009, Table S1).

Respondents who currently use primary HPV testing (either occasionally or frequently) and those who answered the knowledge question correctly (‘true’), were more likely to report primary HPV testing would improve cervical cancer screening (p < 0.001, Table S1).

When asked whether they agree with the statement ‘I would support adopting primary HPV testing in my practice as the preferred cervical cancer screening method for asymptomatic average-risk women ages 30–65’, the largest percentage (45%, n = 100) were ‘uncertain’, 18% (n = 41) strongly agreed, 31% (n = 70) agreed, 6% (n = 13) disagreed, and none strongly disagreed (Fig. 2d). Combining strongly agree and agree, 50% expressed a willingness to adopt primary HPV testing as the preferred cervical cancer screening method. No statistically significant differences in willingness to adopt were observed by demographics (Table S1). Responding correctly to the guideline-based knowledge question (aOR 2.58 [1.41–4.72]) and perceived benefit (aOR 7.35 [3.65–14.81]) were significant predictors of willingness to adopt primary HPV testing in the regression model (Table 2).

Qualitative data from in-depth interviews provided insights about clinicians’ perceptions and reasons for their willingness or unwillingness to adopt primary HPV testing (Table 3). None of the interviewees reported conducting primary HPV testing as their typical cervical cancer screening method. Deductive analysis using the interview guide questions pertinent to primary HPV testing led to three major themes: Lack of awareness, Perceived benefits, and Perceived limitations; and all sub-themes were generated inductively. Participants expressed a lack of familiarity with the latest guidelines on this relatively new method of cervical cancer screening, as well as a desire to learn more about the evidence. Some clinicians spoke positively about a potential transition to primary HPV testing as the preferred cervical cancer screening method, mentioning several key benefits such as being less invasive, less costly, more accurate and easier for patients to understand than cytology, and providing opportunities to increase access to screening in low-resource settings. As far as the perceived limitations of primary HPV testing, clinicians largely focused on the importance of detecting cellular changes directly and how primary HPV testing would limit their ability to do so. The basis of screening for a “risk factor” (presence of high-risk HPV) rather than “the disease itself” was less appealing to clinicians and some also felt that patients may not act as quickly or urgently on a positive HPV result than they would on abnormal cytology results.

### 4. Discussion

This study was designed as a cross-sectional survey combined with in-depth interviews among Indiana clinicians to examine practices, knowledge and attitudes regarding primary HPV testing, and predictors of willingness to adopt this cervical cancer screening method. Despite multiple randomized controlled trials demonstrating its effectiveness (Ronco et al., 2010), its inclusion in 2018 USPSTF guidelines (US Preventive Services Task Force et al., 2018), and subsequent endorsement by all major professional organizations, it was in our sample of 224 clinicians practicing cervical cancer screening across the state of Indiana, only 3% reported using primary HPV testing. While the majority of clinicians surveyed had never used primary HPV testing in clinical practice, most were at least familiar with this screening method, although nearly a quarter of respondents had never heard of it prior to taking the survey. Nearly half the surveyed clinicians responded incorrectly or were uncertain about the efficacy of primary HPV testing, and only half were willing to adopt it as the preferred cervical cancer screening method for the recommended patient group of asymptomatic...
average-risk women ages 30–65 years. Knowledge of the effectiveness of primary HPV and perceived benefit of this method among surveyed clinicians were the predictors of willingness to adopt primary HPV testing.

Our quantitative findings are in accord with previous studies that have highlighted substantial delays among US primary care providers in adopting and low levels of compliance with other cervical cancer screening guideline updates including screening frequency, test type, and patient age (Roland et al., 2013; Min et al., 2020; King et al., 2014). Clinician perspectives regarding primary HPV screening have also revealed substantial knowledge gaps regarding the efficacy of HPV testing (Roland et al., 2013; Tatar et al., 2020). Recent studies examining clinician practices found that primary HPV testing is underutilized in the US (Min et al., 2020), and that clinicians are resistant to substitution of the Pap test (Hahn et al., 2021). A 2020 review of psychosocial determinants of HPV test acceptability in primary cervical cancer screening found healthcare provider knowledge gaps related to the superior sensitivity of the HPV test and reported provider perceptions that the HPV test alone is less effective than cytology in detecting pre-cancerous lesions (Tatar et al., 2020). Discordant from a 2015 study reporting findings from 2009 and 2012 predating FDA approval of primary HPV tests in which most clinicians agreed that the HPV test administered alone was effective, Cooper and Saraiya, 2015 only 56 % of clinicians in our study believed this to be true.

This study also contributes important qualitative insights about the reasons for limited uptake of primary HPV testing, which have implications for efforts to increase clinician knowledge, acceptance, and buy-in. Interviewees shared how numerous recent updates to cervical cancer screening guidelines have contributed to provider confusion and uncertainty as well as institutional lethargy in embracing this relatively new approach to screening. The ACS and WHO were the least cited sources of screening guidelines among surveyed clinicians and are currently the only guidelines that specify primary HPV testing as the preferred cervical cancer screening method, while other guideline sources list primary HPV testing every 5 years as one of three effective methods along with co-testing every 5 years and cytology alone every 3 years. Alignment of US screening guidelines to reflect the President Cancer Panel’s emphasis on shifting to primary HPV testing as the preferred method may be a critical next step in clinician acceptance and uptake (National Cancer Institute. President’s Cancer Panel. In: Definitions [Internet]. Qeios;2020; Williams, xxxx).

Participants expressed a strong desire to learn more about existing evidence for the clinical and economic benefits of primary HPV testing. Most of the clinicians’ perceived limitations of primary HPV testing focused on an assumed need to screen for cervical cellular changes directly, rather than the etiological agent (HPV), revealing limited understanding of both the superior sensitivity of testing for high-risk HPV DNA as well as on how HPV testing fits into the broader screening paradigm. These concerns could be addressed in future communication with clinicians by emphasizing that primary HPV is a triage method, whereby HPV-positive patients then do go on to cytology for detection of cellular changes, and by highlighting the clinical and economic benefits of first identifying those at-risk. As trusted sources of information for patients, addressing clinician concerns and uncertainties around primary HPV testing are critical to patient acceptance.

Clinicians’ insights about their perceived benefits and relative advantage of this screening strategy, included health system cost savings, increased access to screening for low resource settings and improved acceptability of this less invasive test, which could be emphasized in both targeted messages to clinicians and in clinician-patient communication to encourage cervical cancer screening among underscreened groups. Compared with OB/GYNs, Family Medicine and Internal Medicine clinicians were more likely to believe primary HPV testing would improve cervical cancer screening, suggesting a stronger role for this screening method in primary care settings than in specialized gynecological care settings where pelvic exams are more likely to

Fig. 1. Cervical cancer screening method typically used by Indiana clinicians for asymptomatic women of average risk. HPV/Pap Co-testing: Both Pap smear and HPV test in the same visit; Reflex HPV testing: Pap smear and confirm abnormal or unclear results with HPV test; Primary HPV testing: HPV test and confirm high risk HPV-positive results with a Pap smear; Pap smear only: no HPV testing performed at all.
remain necessary. With cervical cancer screening rates declining in the US (Suk et al., 2022), strategies to improve access to screening and reduce existing disparities are needed. Adoption of primary HPV testing would allow for emerging screening strategies such as patient-collected samples and remote, rapid HPV testing in low-resource settings, which are key to enhancing coverage among hard-to-reach, underscreened populations and are increasingly important as an alternative to in person screening visits during the COVID-19 pandemic (Corley et al., 2021;
Table 3
Qualitative data on clinician attitudes regarding primary HPV testing.

| Theme                     | Subtheme                                  | Representative Participant Quote                                                                                                                                                                                                 |
|---------------------------|-------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Lack of awareness         | Limited familiarity with latest guidelines | “This is something I know I need to look at a little bit more closely, I just haven’t found time. I know that there are some new recommendations out there that I just haven’t evaluated closely enough to make that change.” - Physician, Family Med, female  |
|                           |                                            | “I have not done a lot of reading on it. I’ve started… and I think that it might be useful in kind of low resource areas, but we have not made the shift yet, because ACOG has not changed their recommendation to go to just primary HPV at this point.” - Physician, OB/GYN, male |
|                           |                                            | “When I was in my clinics, [primary HPV testing] was not in the current guidelines, and so we only followed those protocols. And now I think it is kind of more of an option in terms of the ASCCP guidelines, but we have to follow our clinical protocols, and it’s not approved by my organization to do that.” - Nurse practitioner, Family Med, female |
| Desire to learn more about evidence |                                            | “I just want to read more about it, you know, I just want to learn more… So, you would only do like a Pap test on someone who was HPV positive?” - Nurse practitioner, Family Med, female |
| Perceived benefits        | Less invasive procedure                    | “I recently did a conference and they were talking about the guidelines are in the process of changing where we will have more focus on HPV at first and then follow up with a pap smear and I think that completely makes sense. It’s science, the more we learn about things the better, and the less invasive we can be early on, that might increase screening and decrease procedures and things like that maybe we don’t need to do, so I think it would be definitely an interesting thing to consider and I would love to see our affiliate look at the current research for that and see if that’s a possibility for implementation.” - Nurse practitioner, Family Med, female |
|                           | Less costly                                | “It would just be easy and cheaper… cytology is an extra expense. Now, patients aren’t paying for it necessarily, but the system itself would save money.” - Physician, Family Med, male |
|                           | Improved accuracy                           | “I suspect the HPV screening is probably more accurate than the cytology. And so therefore if you get a patient with a positive HPV and a negative cytology we screen them again, more quickly.” - Physician, OB/GYN, male |
|                           | Easier for patients to understand          | “I think it will have a lot of positives… a lot of our young patients end up with ASCUS path and that’s usually because they probably have HPV we’re just not testing for it.” - Physician, OB/GYN, female |
|                           | Increased access to screening for low-resource settings | “In the areas of low resources, you know, and clearly in low income countries, they a) can’t afford that kind of material and b) they don’t have the labs to do it. And so the populations don’t get screened. And I think that’s where HPV testing really has a role, especially if women can self-swab and do their tests…” - Physician, Family Med, female |
| Perceived limitations     | Inability to detect cellular changes       | “I still need the pap because I need to know whether or not there’s any dysplasia.” - Physician, Internal Med, female |
|                           |                                            | “I mean there’s something about seeing the cells themselves and seeing, like how abnormal they are, that I think you don’t get that sense if you just know ‘okay this person’s like, type 16 positive’. But we don’t know how did their cervix look, you know how did the cells look, how abnormal did they look?” - Nurse practitioner, Family Med, female |
|                           | Only detects risk factor, not disease      | “I would probably prefer to continue getting the cytology. I mean maybe for the younger patients, it might be reasonable to just follow HPV, but I think I like having the cytology because HPV is just your risk factor and then the cytology actually tells you if there’s something that you need to be following and looking at more closely.” - Physician, Family Med, female |
|                           | Reduced sense of urgency for patients      | “I think, for some patients the severity of the diagnosis or maybe the urgency like, ‘oh my gosh, I have to go in I have to have follow up.’ You know that sounds a lot scarier if you say ‘hey, I have high grade lesion on my cervix.’ This is really close to invasive cervical cancer… oh my gosh, I need to follow up for this. If the options are just hearing HPV positive or negative that I think might not be as, cause as high of a sense of urgency, especially with a high prevalence of HPV.” - Physician, Family Med, female |

Ajenifuja et al., 2020; Feldman and Haas, 2021; Ginsburg et al., 2021; Poljak et al., 2021; Smith et al., 2021).

This study had several limitations. First, the data are from Indiana clinicians only, and not clinicians across the US. Our sample was predominantly non-Hispanic white, which is representative of Indiana clinicians and similar to the US workforce as a whole based on the latest report from the Association of American Medical Colleges (Diversity in Medicine: Facts and Figures, 2019) se), but future work would be improved by oversampling for minority populations that may have a different perspective on adopting a new screening modality. It was not possible to calculate a survey response rate due to our recruitment strategy, which included posting in newsletters and e-mail blasts from professional organizations. While we did not calculate an a priori sample size, given our aORs, our sample size was adequate to detect meaningful differences. As the survey included other topics as part of a larger study about cervical cancer screening, to restrict questionnaire length only a single item was administered to measure each outcome (perceived benefits, knowledge, and willingness to adopt). Furthermore, this study did not explore clinician practices or perspectives around screening intervals. Nonetheless, this mixed-methods study provides attitudinal insights from clinicians that could improve implementation and adoption of primary HPV testing. Future studies will examine the patient perspective, as well as both patient and provider perspectives on emerging cervical cancer screening modalities enabled by primary HPV, such as patient self-sampling and rapid diagnostic tests.

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**CRediT authorship contribution statement**

Natalia M. Rodriguez: Conceptualization, Methodology, Investigation, Formal analysis, Writing – original draft, Writing – review & editing, Funding acquisition. Luke P. Brennan: Methodology, Investigation, Formal analysis, Writing – original draft, Writing – review & editing. LaylaClaure: Formal analysis, Writing – review & editing. Victoria L. Champion: Supervision, Writing – review & editing. Michele R. For- man: Supervision, Writing – review & editing.
Declaration of Competing Interest

The authors declare the following financial interests/personal relationships which may be considered as potential competing interests: Monica Kasting has received investigator-initiated research funding from Merck administered through Purdue University. The rest of the authors declare no competing interests.

Data availability

Data will be made available on request.

Appendix A. Supplementary data

Supplementary data to this article can be found at https://doi.org/10.1016/j.pmedr.2022.102070.

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