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A community-based, cross-sectional study of hrHPV DNA self-sampling-based cervical cancer screening in rural Karnataka, India

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Abstract

Objective: To examine the feasibility of implementing a high-risk HPV (hrHPV) DNA-based screening program for cervical cancer and the prevalence of hrHPV DNA-positive women in a community setting in rural India.

Methods: A cross-sectional study was conducted at the community level in the Hunsur taluk of the Mysore district from January to August 2016. Cervical cancer screening was conducted with self-collected vaginal samples that were analyzed using the Hybrid Capture 2 (HC2) assay (Qiagen, USA).

Results: The majority of participants were aged 30–39 years, with no formal schooling, from a lower caste, and lived below an annual household income of US\$1499. After group health education and one-on-one counseling, a total of 473 women underwent self-sampling. Of these, 36 (7.6%) were positive for hrHPV and only 24 (66.6%) underwent follow-up diagnostic triaging. Cancer was detected in two women, who were referred to appropriate healthcare facilities for further treatment.

Conclusion: Implementation of hrHPV DNA-based screening tests using self-sampling can be feasible in rural settings in India. However, substantial resources are required for providing health education and one-on-one counseling to inform asymptomatic women about the benefits of testing and, more importantly, to improve compliance with follow-up.

KEYWORDS

Cervical cancer; Cross-sectional study; Demonstration study; HPV DNA; Implementation; Screening; Self-sampling

1 | INTRODUCTION

According to WHO 2014 estimates, approximately 122 844 new cases and 67 477 deaths in India were due to cervical cancer, accounting for nearly one-quarter of the global cervical burden.¹ A persistent infection with HPV causes most cases of cervical cancer; for many women who have an existing HPV infection or do not have access to HPV

vaccination, improved screening for early detection and treatment remains the best option for reducing the cervical cancer burden.²

Several screening tests have been effective in this context, including the most widely used cervical smears, visual inspection methods that use acetic acid or Lugol's iodine, liquid-based cytology, and HPV DNA-based tests. Of these, high-risk HPV (hrHPV) DNA-based screening tests have been shown to provide 60%–70% greater effectiveness

in detecting invasive cervical carcinomas compared with cytology in several large-scale randomized trials.³ In a cluster randomized trial in India, a single round of hrHPV testing was associated with a significant reduction in the number of advanced cervical cancers and deaths due to cervical cancer.⁴

The impact of screening on mortality reduction is contingent on achieving high screening coverage and ensuring that screen-positive women receive appropriate diagnostic and treatment services. Country level estimates, however, suggest that the coverage of cervical cancer screening in developing countries is on average 19% compared with 63% in developed countries.⁵ Studies from India have identified barriers on several socioecological levels such as lack of knowledge, personal disbelief in prevention of cancer, lack of care-seeking when asymptomatic, lack of money for treatment, and reduced access to healthcare services.^{6–8} There is evidence that women in low-resource settings find pelvic exams to be embarrassing, painful, and uncomfortable; therefore, they prefer the self-sampling option.⁹

For hrHPV DNA testing, self-collected vaginal samples are an acceptable strategy and have shown comparable sensitivity and specificity to clinician-collected samples.¹⁰ Furthermore, a systematic review of studies that included the option for self-sampling has shown improved participation among women who do not routinely attend screening programs.¹¹ The self-collection option also offers the distinct advantage of moving primary screening activities from the clinic into the community.¹² The hrHPV DNA test has been considered a very cost-effective option for low- and middle-income countries and is generally considered feasible if all screen-positive women receive treatment.¹³ However, there are limited studies that have implemented hrHPV testing using self-sampling in a community-based setting in India.

The aim of this study is to report on the feasibility of implementing a screening program that involves educating and encouraging women about cervical cancer prevention using the self-sampling option for hrHPV testing in the community, logistics of the conducting the test, and follow-up strategies. A secondary aim is to determine the community prevalence of hrHPV in the Hunsur *taluk* of Mysore district in the state of Karnataka, India.

2 | METHODS

This project was carried out in collaboration with the Public Health Research Institute of India (PHRII), a non-governmental organization located in Mysore, India. PHRII was established in 2007 with a goal to improve the health of Indian women through research and health care on issues that affect women's lives from birth through old age. To carry out its work, PHRII has more than 23 full-time employees including physicians, nurses, administrators, laboratory technicians, health educators, and community outreach workers. Through this clinical and community work, PHRII has been able to establish relationships with the primary, secondary, and tertiary public health and private healthcare organizations serving this community. For the purposes of this project, the study team consisted of a physician, a

nurse, laboratory personnel, and several health educators and community outreach workers.

The study was conducted in the Hunsur *taluk* of the Mysore district, in the South Indian state of Karnataka between January and August 2016, with a follow-up period until December 2017. Twenty-five villages were chosen as community sites for the implementation of the project based on two criteria: (1) accessibility by road (within the Hunsur *taluk*), and (2) availability of a community center or a primary healthcare center with toilet facilities and access to running water.

The Hunsur Town Municipal Council has a population of 50 865, of which 25 435 (50.0%) were women, based on a report released by Census India 2011.¹⁴ Based on the national census, we estimated that 33% of the women would be in the eligible age group of 30–59 years. Hence, the sampling frame was 8 394 women aged 30–59 years, residing in Hunsur *taluk*. Using this information, we estimated a sample size for a prevalence study with a finite population correction as follows: at a 5% precision level, 95% confidence interval, an unknown prevalence of HPV infection at 50% for a population of 8 400, the estimated sample size was 368. With 20% oversampling for missing data, we calculated the final sample size to be 450.

Cervical cancer screening was conducted with self-collected vaginal samples and analyzed using the hrHPV DNA Hybrid Capture 2 (HC2) assay (Qiagen, Gaithersburg, MD, USA). This is a nucleic acid hybridization assay with signal amplification using microplate chemiluminescence for the qualitative detection of 13 high-risk HPV types (16, 18, 31, 33, 35, 39, 45, 51, 52, 56, 58, 59, 68) in the vaginal swab specimens. Compared to other tests such as CareHPV, HC2 has been widely used in previous studies and has been recommended for primary screening.^{4,15} In addition, in the context of this study, both tests presented comparable costs in discussion with the regional office of the manufacturer, since CareHPV and HC2 are products of the same company. All samples were collected using the cytobrush provided in the manufacturer's kit and stored in Specimen Transport Medium. Specimens collected in the community were transported to the PHRII laboratory on the same day at room temperature. At the laboratory, specimens were stored at 2–8°C (35.6–46.4°F) and analyzed within 1 week of collection. Quality control procedures per the manufacturer's instructions for the equipment and the kits were followed.

Utilizing previously established relationships in the community, dates for the screening clinics were decided based several weeks before the day of screening clinics and advertised in the community. During the week before the clinics, the PHRII study team partnered with community workers that are employed by the Government to conduct group education sessions using visual and print communication materials (adapted from Jhpiego resources available at www.jhpiego.org) to help raise awareness about cervical cancer and availability of screening clinics. The institutional review boards of Florida International University and PHRII reviewed and approved the study protocol. Before being used in the study, all study materials, including the consent form, were translated into the local language of Kannada and pilot tested with a small group of women from the same community.

On the day of the clinic, the community centers were set up to provide privacy for specimen collection and administer a brief survey. On the day of the screening clinic, women were invited to the community center by the PHRII staff and the Government community workers. The PHRII study team and the community workers held a second group education session on cervical cancer prevention including the screening process and answered any questions that women had about the procedures and follow-up. Women were eligible to participate if they were aged 30–59 years, not pregnant, and did not have a history of cancer or hysterectomy. Once eligibility was determined, the woman met with a member of the study team for one-on-one counseling as a part of the informed consent process where the consent form was read out verbatim and any questions were answered. Women were given as much time as they needed before deciding on whether they wanted to participate in the study.

Both the group health education and the counseling sessions were conducted using visual pictures, pamphlets, and verbal communication, which ensured that even illiterate women could understand the information. Study team members used the teach-back method to check women's understanding. If the woman decided to participate, she provided consent by either signing or providing a thumb impression (for women who could not read or write) on an informed consent form. To ensure follow-up, we collected the names of partners or next of kin and a phone number, and maintained these data separate from their health data which was connected through a patient identification number. Once the participant provided consent, the nurse provided the self-sampling cytobrush and assisted, when needed, in the sample collection process.

All data and specimens were transported back to the PHRII laboratory on the same day of collection. Survey data were collected on the Qualtrics platform displayed on tablets that were subsequently encrypted and uploaded to an encrypted web storage space to protect the health information submitted by the study participants. A folder with tailored health education messages, including screening results, was created and hand-delivered to the participants within 2–3 weeks of the screening clinic along with an explanation of future steps for follow-up.

If a woman screened positive, she was asked to attend follow-up at the PHRII walk-in clinic (located approximately 18 miles from the community sites) where she underwent visual inspection with acetic acid (VIA) and cervical smears, according to WHO guidelines.¹⁶ Details of the follow-up algorithm are shown in Figure 1. The staff physician and nurses had been trained in performing VIA and cervical smears previously and had been delivering these services in the community for the previous 8 years. Outcomes for VIA were recorded based on the definitions published by the International Agency for Research on Cancer (IARC) and considered positive if there were distinct, well-defined, dense (opaque, dull- or oyster-white) acetowhite areas with regular or irregular margins, close to or abutting the squamocolumnar junction in the transformation zone or close to the external os if the squamocolumnar junction was not visible.¹⁷ Cervical smears were collected by trained nurses under the supervision of a gynecologist and sent to the pathology lab on the same day as specimen collection. The pathology laboratory used the 2001 Bethesda system for

FIGURE 1 Follow-up algorithm for cervical cancer screening.

reporting results of cervical cytology and followed standard quality control procedures per the National Accreditation Board for Testing and Calibration Laboratories.¹⁸

If the woman tested positive on either cervical smear test or VIA, they were referred to the tertiary care hospital for further treatment. Several women needed assistance in the form of transportation to the hospital and/or help with the physician appointments, which were provided free of charge by the program. Demographics were analyzed to describe the study participants, and statistical analyses were conducted using IBM SPSS v. 21 (IBM Corp, Armonk, NY, USA).

3 | RESULTS

All women who showed interest received a health education session about cervical cancer prevention and approximately 30–40 women showed up at each screening clinic. A few women (less than 2% of the eligible women) refused participation and opted out of the study for reasons of modesty. A total of 473 women aged 30–59 years, not pregnant, and without a history of cancer or hysterectomy were included in the study. Overall, each screening clinic had approximately 20–25 women that agreed to participate in the study. As shown in Table 1, the majority of the participants were aged 30–39 years, with no formal schooling, belonging to a lower caste (considered as a socio-economic indicator), and lived in a household that earned an annual household income of approximately US\$1499 (₹104 930).

Of the 473 women, 36 (7.6%) tested positive for presence of hrHPV DNA in the self-collected vaginal swab samples. Of the screen-positive women, 18 (50.0%) were aged 30–39 years, 11 (30.5%) were aged 40–49 years, and seven (19.4%) were aged 50 years and over. Table 2 presents the details of follow-up for the 36 women who tested positive, including the reason for the lack of follow-up. Of the 36 screen-positive women, nine (25%) women were unwilling to undergo a pelvic examination due to a lack of symptoms despite one-on-one counseling by the physician and the nurses on the study team. Three (8.3%) women could not be traced in the villages as they had since migrated away from the villages for farm work, despite three separate attempts to reach them over the 1-year follow-up period.

TABLE 1 Characteristics of high-risk HPV (hrHPV)-positive and negative women in Hunsur taluk in India (time period: January to August 2016) (n=473).^a

Characteristics	hrHPV DNA		Total (n=473)
	Negative (n=437)	Positive (n=36)	
Age, y			
30–39	200 (45.8)	18 (50.0)	218 (46.1)
40–49	140 (32.0)	11 (30.6)	151 (31.9)
50–65	97 (22.1)	7 (19.4)	104 (21.9)
Education ^b			
No formal schooling	250 (57.2)	21 (58.3)	271 (57.2)
Some primary school	113 (25.8)	12 (33.3)	125 (26.4)
Secondary school and above	74 (16.9)	3 (8.3)	77 (16.3)
Religion			
Hindu	431 (98.6)	36 (100.0)	467 (98.7)
Muslim	5 (1.1)	0 (0.0)	5 (1.1)
Christian	1 (0.02)	0 (0.0)	1 (0.02)
Caste ^c			
Upper	119 (27.2)	8 (22.2)	127 (26.8)
Low	311 (71.1)	26 (72.2)	337 (71.2)
Missing	7 (1.6)	2 (5.5)	9 (1.9)
Annual income			
≤\$1499	245 (56.1)	23 (63.8)	268 (56.6)
>\$1500	179 (40.1)	12 (33.3)	191 (40.3)
Missing	13 (3.0)	1 (2.7)	14 (2.9)
Previous cervical smear/VIA			
Yes	22 (5.0)	5 (13.8)	27 (5.7)
No	415 (94.9)	31 (86.1)	446 (94.3)
Age of sexual debut, y			
≤18	320 (73.2)	27 (75.0)	347 (73.4)
>18	114 (26.1)	9 (25.0)	123 (26.0)
Pregnancies, n			
0	46 (10.5)	4 (11.1)	50 (10.6)
1–2	150 (34.3)	17 (47.2)	167 (35.3)
≥3	241 (55.1)	15 (41.6)	256 (54.1)
Total	437 (92.4)	36 (7.6)	473 (100.0)

Abbreviations: VIA, visual inspection using acetic acid.

^aValues are given as n (%).^bEducation categories: primary school is up to the seventh grade; secondary school is seventh grade and beyond.^cCaste is representative of class in India and considered as a socioeconomic indicator.

The remaining 24 (66.6%) women were invited and, in some cases, provided with transport to the PHRII clinic (located on average 18 miles from the villages) for follow-up. To improve the negative predictive value of the screening strategy, we employed a combination of two tests for follow-up of hrHPV-positive women: VIA and cervical smear. Five

(20.8%) women tested positive for VIA. A total of 19 women (79.2%) tested negative on cervical smear, three (12.5%) had atypical glandular cells, one had low-grade and one had high-grade lesion reported on the cervical smear tests. Nine women (37.5%) who tested positive for VIA and/or an had abnormal cervical smear test results were referred to the tertiary care center for further diagnostic follow-up and management.

4 | DISCUSSION

This study is a cross-sectional, descriptive study that used a large sample representative of the Hunsur taluk population for estimating the prevalence of hrHPV in rural Indian women. Of the 473 women recruited in the study, 36 women (7.6%) tested positive for the presence of hrHPV DNA in the self-collected vaginal specimens. Studies from other parts of India have shown a prevalence of 4.7% in demonstration projects in primary care settings,¹⁹ 5.9% in a community-based study using self-samples,²⁰ and 3% in a rural population in north India.²¹

A secondary aim is to demonstrate the feasibility and highlight the operational logistics of conducting community-based screening of eligible women and follow-up of screened women—vital information that is often missing from surveillance studies.⁸ The team conducting the screening clinics were trained in overseeing and managing community-based work and were composed of several members, each with a distinct role. Prior training and knowledge of community logistics helped effective functioning of the screening. Involving laboratory personnel in the study team was instrumental in specimen collection and transportation to the lab for testing. Ensuring follow-up of women who were hrHPV-positive, however, was the most challenging aspect of the study and required considerable resources, including time.

As resources are invested into a national screening program in India,²² information presented in this study can help fill the gap on feasible screening strategies for cervical cancer relevant to the local context for women residing in underserved areas of the country. A community-engaged research approach, highlighted in our work, can often lead to valuable insights into the perceptions and behaviors of the community members, and most importantly lead to increased community participation in health initiatives.²³ Working in marginalized communities can also bring forward several unanticipated challenges. This study targeted women with limited literacy from marginalized groups residing in medically underserved areas and in impoverished families. At three of the community sites, women did not attend screening clinics because they had heard that women had complained about pain and discomfort after undergoing the screening test. Overcoming this challenge took several additional hours of counseling and resulted in modifications of our health education materials and approach.

Compliance with follow-up in our study was approximately 66.6%, which was lower compared with a study reporting follow-up rates of 78% when screening was implemented in primary healthcare centers.¹⁹ The most common reason for loss to follow-up was the woman's unwillingness to undergo pelvic examination as a follow-up test when they were not experiencing any symptoms. The study staff invested up to 16 additional months in conducting health education sessions

TABLE 2 Follow-up results for 36 cases that tested positive for high-risk HPV (hrHPV) DNA testing in Hunsur taluk, India.

No.	Age, y	Via result	Cervical smear test result	Reason for refusal/follow-up
1.	30	Positive	AGC—endo/reactive	Referred to tertiary care
2.	45	—	—	Unwilling to undergo pelvic exam
3.	50	—	—	Unwilling to undergo pelvic exam
4.	35	Negative	LSIL	Referred to tertiary care
5.	40	Positive	NILM	Referred to tertiary care
6.	30	Negative	NILM	Follow-up in 5 y
7.	50	Negative	AGC—endo/reactive	Referred to tertiary care
8.	40	Negative	NILM	Referred to tertiary care
9.	45	—	—	Unwilling to undergo pelvic exam
10.	51	Negative	NILM	Referred to tertiary care
11.	39	—	—	Unwilling to undergo pelvic exam
12.	40	Negative	AGC—endo/reactive	Referred to tertiary care
13.	37	—	—	Unwilling to undergo pelvic exam
14.	54	—	—	Unwilling to undergo pelvic exam
15.	30	Negative	NILM	Follow-up in 5 y
16.	50	Negative	Unsatisfactory	Repeat cervical smear in 6 mo
17.	30	Negative	NILM	Referred to tertiary care
18.	40	Negative	NILM	Follow-up in 5 y
19.	40	—	—	Untraceable (migrant worker)
20.	33	Negative	NILM	Follow-up in 5 y
21.	55	Negative	NILM	Follow-up in 5 y
22.	30	Negative	NILM	Referred to tertiary care
23.	38	Negative	NILM	Follow-up in 5 y
24.	46	Positive	NILM	Referred to tertiary care
25.	45	—	—	Unwilling to undergo pelvic exam
26.	30	—	—	Untraceable (migrant worker)
27.	30	Negative	NILM	Follow-up in 5 y
28.	45	—	—	Untraceable (migrant worker)
29.	35	—	—	Unwilling to undergo pelvic exam
30.	37	Negative	HSIL	Referred to tertiary care
31.	45	Negative	NILM	Follow-up in 5 y
32.	38	Negative	NILM	Follow-up in 5 y
33.	35	Positive	NILM	Referred to tertiary care
34.	33	—	—	Unwilling to undergo pelvic exam
35.	54	Negative	NILM	Follow-up in 5 y
36.	30	Positive	NILM	Referred to tertiary care

Abbreviations: AGC—endo/reactive, atypical glandular cells endocervical reactive; HSIL, high-grade squamous intraepithelial lesion; LSIL, low-grade squamous intraepithelial lesion; NILM, negative for intraepithelial lesion/malignancy; VIA, visual inspection using acetic acid; VILI, visual inspection using Lugol's iodine.

and counseling women to complete their follow-up visits. From anecdotal evidence, several of these women sought second opinions from gynecologists practicing in the private sector, often resulting in a preference for hysterectomies. This is an important consideration since radical hysterectomies have been regarded as overtreatment for cervical cancer patients with low-volume disease.

The study has some limitations. Although recruitment took place over a 6-month period, the prevalence noted in this study is

representative of only a single point in time among the participants. Longitudinal studies of cohorts are needed to understand trends in prevalence. A cross-sectional study design is also prone to a non-response bias, in that participants consenting to participate may be different from the ones who do not participate. Furthermore, this work has limited generalizability and cannot be considered as representative for all of India. The Hybrid Capture 2 assay is based on signal amplification techniques and considered less sensitive and specific

when used on self-collected samples.¹⁰ Despite these limitations, this demonstration study was one of the first attempts at studying the feasibility of conducting a screening program in rural India using hrHPV DNA tests as a primary screening strategy. The study provides important contextual information that needs to be considered when implementing a screening program in low- and middle-income countries.²⁴ The option of self-sampling may be essential to improving the effectiveness of the program in hard-to-reach populations.²⁵ Uptake of screening, however, is only the first step in the process. With these considerations, the focus of future research should be on improving access to screening with self-sampling, and systematic coverage of the populations along with improvements in diagnostic triage, follow-up, and treatment.

In summary, this study is one of the few from India that used self-collection with the Hybrid Capture 2 assay in a community-based rural setting. Implementation of a molecular test for cervical cancer screening can increase the opportunities for cervical cancer screening in communities where it is needed the most.

AUTHOR CONTRIBUTIONS

PA, PM, and VS were responsible for study design and execution, preparation of institutional review board materials, questionnaire design, data analysis, and drafting the manuscript. VS and PJ were responsible for study design, data interpretation, and manuscript revisions. PJ, SG, SN, and RP were responsible for data collection and manuscripts revisions. KC and AK were responsible for laboratory testing for specimens and data collection. All authors have been involved in drafting the work or revising it critically for intellectual content. All authors provided final approval of the submitted manuscript and agreed to be accountable for all aspects of the work.

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CONFLICTS OF INTEREST

The authors have no conflicts of interest.

REFERENCES

1. Ferlay J, Soerjomataram I, Dikshit R, et al. Cancer incidence and mortality worldwide: Sources, methods and major patterns in GLOBOCAN 2012. *Int J Cancer*. 2015;136:E359–E386.

2. Gravitt PE, Rositch AF. HPV self-testing and cervical cancer screening coverage. *Lancet Oncol*. 2014;15:128–129.
3. Ronco G, Dillner J, Elfström KM, et al. Efficacy of HPV-based screening for prevention of invasive cervical cancer: Follow-up of four European randomised controlled trials. *Lancet*. 2014;383:524–532.
4. Sankaranarayanan R, Nene BM, Shastri SS, et al. HPV screening for cervical cancer in rural India. *N Engl J Med*. 2009;360:1385–1394.
5. Gakidou E, Nordhagen S, Obermeyer Z. Coverage of cervical cancer screening in 57 countries: Low average levels and large inequalities. *PLoS Med*. 2008;5:e132.
6. Nene B, Jayant K, Arrossi S, et al. Determinants of women's participation in cervical cancer screening trial, Maharashtra, India. *Bull World Health Organ*. 2007;85:264–272.
7. Aswathy S, Quereshi MA, Kurian B, Leelamoni K. Cervical cancer screening: Current knowledge & practice among women in a rural population of Kerala, India. *Indian J Med Res*. 2012;136:205–210.
8. Adsul P, Manjunath N, Srinivas V, Arun A, Madhivanan P. Implementing community-based cervical cancer screening programs using visual inspection with acetic acid in India: A systematic review. *Cancer Epidemiol*. 2017;49:161–174.
9. Dzuba IG, Díaz EY, Allen B, et al. The acceptability of self-collected samples for HPV testing vs. the pap test as alternatives in cervical cancer screening. *J Womens Health Gend Based Med*. 2002;11:265–275.
10. Arbyn M, Verdoodt F, Snijders PJ, et al. Accuracy of human papillomavirus testing on self-collected versus clinician-collected samples: A meta-analysis. *Lancet Oncol*. 2014;15:172–183.
11. Racey CS, Diana RW, Dionne G. Self-collected HPV testing improves participation in cervical cancer screening: A systematic review and meta-analysis. *Can J Public Health*. 2013;104:e159–e166.
12. Gravitt PE, Belinson JL, Salmeron J, Shah KV. Looking ahead: A case for HPV testing of self-sampled vaginal specimens as a cervical cancer screening strategy. *Int J Cancer*. 2011;129:517–527.
13. Denny L, de Sanjose S, Mutebi M. Interventions to close the divide for women with breast and cervical cancer between low-income and middle-income countries and high-income countries. *Lancet*. 2017;389:861–870.
14. Registrar General I. Census of India 2011: provisional population totals-India data sheet. Office of the Registrar General Census Commissioner, India. Indian Census Bureau; 2011. New Delhi, India.
15. Arbyn M, Snijders PJ, Meijer CJ, et al. Which high-risk HPV assays fulfil criteria for use in primary cervical cancer screening? *Clin Microbiol Infect*. 2015;21:817–826.
16. World Health Organization. *WHO Guidelines for Screening and Treatment of Precancerous Lesions for Cervical Cancer Prevention*. Geneva, Switzerland: World Health Organization; 2013.
17. Sankaranarayanan R, Wesley RS, eds. *A practical manual on visual screening for cervical neoplasia*. Lyon: International Agency for Research on Cancer; 2003.
18. Solomon D, Davey D, Kurman R, et al. The 2001 Bethesda System: Terminology for reporting results of cervical cytology. *JAMA*. 2002;287:2114–2119.
19. Mittal S, Mandal R, Banerjee D, et al. HPV detection-based cervical cancer screening program in low-resource setting: Lessons learnt from a community-based demonstration project in India. *Cancer Causes Control*. 2016;27:351–358.
20. Peedicayil A, Abraham P, Prasad J, et al. Community prevalence of human papillomavirus by self-collected samples in South India. *Indian J Gynecol Oncol*. 2016;14:16.
21. Labani S, Asthana S, Sodhani P, et al. CareHPV cervical cancer screening demonstration in a rural population of north India. *Eur J Obstet Gynecol Reprod Biol*. 2014;176:75–79.
22. Ministry of Health and Family Welfare India. Operational Framework: Management of Common Cancers. 2016. http://cancerindia.org.in/wp-content/uploads/2017/11/Operational_Framework_Management_of_Common_Cancers.pdf. Accessed May 20, 2019.

23. Wells KJ, Preuss C, Pathak Y, Kosambiya JK, Kumar A. Engaging the community in health research in India. *Technol Innov.* 2012;13:305–319.
24. Maza M, Gage JC. Considerations for HPV primary screening in lower-middle income countries. *Prev Med.* 2017;98:39–41.
25. Lazcano-Ponce E, Lorincz AT, Cruz-Valdez A, et al. Self-collection of vaginal specimens for human papillomavirus testing in cervical cancer prevention (MARCH): A community-based randomised controlled trial. *Lancet.* 2011;378:1868–1873.