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HPV Screening as an Alternative to Pap Smear in Cervical Cancer Prevention: A Comparative Study in North India

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Abstract

Cervical cancer remains a leading cause of cancer-related morbidity and mortality among Indian women, especially in low-resource settings. While Pap smear testing has been the standard screening method, HPV DNA testing offers potential advantages in sensitivity, cost-effectiveness, and feasibility for large-scale implementation. This study compares the efficacy, cost, and acceptability of HPV screening versus Pap smears in urban and rural populations of North India. A comparative cohort study was conducted among 1,250 women (625 urban, 625 rural), aged 18 years and above, recruited through stratified random sampling across North India. Participants underwent both HPV DNA testing and Pap smears. Data on diagnostic performance, cost per detection and prevention, and acceptability were gathered through structured questionnaires and laboratory analysis. Statistical methods included descriptive analysis, chi-square tests, and logistic regression. HPV screening demonstrated higher sensitivity (93 vs. 85%) but slightly lower specificity (85 vs. 92%) compared to Pap smears. It was also more cost-effective, with lower costs per detection (₹800–1,200 vs. ₹1,500–3,000) and prevention (₹2,500–3,500 vs. ₹4,000–6,000). Urban women reported greater acceptability (HPV: 85%; Pap: 90%) than rural women (HPV: 65%; Pap: 75%), with rural hesitancy attributed to cultural barriers and privacy concerns. Screening participation was higher in urban areas (90 vs. 75%), influenced by healthcare access and educational levels. In conclusion, HPV testing is a more sensitive and cost-effective alternative to Pap smears, particularly suitable for resource-limited rural settings. Public health efforts should prioritize HPV-based screening, supported by community education and mobile outreach to reduce cervical cancer disparities.

Keywords: Cervical cancer, HPV screening, pap smear, rural health disparities, cost-effectiveness

INTRODUCTION

Cervical cancer ranks high as a cause of cancer-related morbidity and mortality among women, especially in low- and middle-income countries (LMICs) such as India [1]. According to Ghosh, cervical cancer is the second most prevalent cancer for women in India, with approximately 96000 new incidences and 60,000 deaths per year [2]. Early diagnosis of pre-invasive lesions through screening is the most effective method for minimizing the impact of cervical cancer; early invasiveness can be treated through appropriate screening [3].

Cervical cancer screening is done through two primary methods: Pap smear and HPV (Human Papillomavirus) test. The Pap smear is a cytological test that has been an implemental part of cervical cancer screening for years and it is a routine in many

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countries. Its efficacy, however, is influenced by sampling quality, laboratory expertise and compliance with screening protocols [4]. The HPV test, however, is usually more reliable since it detects high-risk types of HPV that lead to most cervical cancers. HPV testing may also have a greater value with regards to cost and accuracy than Pap smears, especially in lower resource environments with low screening coverage [5].

Access and participation in cancer screening programs among urban-rural populations in North India are stark. Minimally acceptable screening tools tend to be available in most urban areas, where access to service and health facilities is better than those located in rural populations that are more likely to have fewer infrastructures, healthcare providers and sociocultural factors that form an environment of screening program resistance. We have conducted this study to assess the efficacy, cost-effectiveness and acceptability of various cervical cancer prevention strategies by comparing HPV screening with Pap smears in the urban and rural population of North India. By examining both screening methods, our comparative study will provide significant evidence about the feasibility of HPV screening as a more practical, effective alternative to the Pap smear test, particularly in resource-scarce settings where there are existing implications for using HPV screening in cervical cancer prevention.

METHODOLOGY

Study Design

In this study, we compared the efficacy of HPV screening with Pap smear testing for cervical cancer prevention among women in North India using a comparative cohort design. Screening practice barriers were explored in both urban and rural populations to examine the socioeconomic differences between different geographic areas. A cross-sectional approach was used to analyze the diagnostic outcomes of both tests in terms of sensitivity, specificity, and cost-effectiveness.

Study Population

The study included 1,250 women (urban: 625 women, rural: 625 women) aged 18 years and above with no prior history of cervical cancer. Participants were recruited in gynecological clinics and community health centers in urban (e.g. Delhi, Chandigarh) and rural (e.g. Uttar Pradesh, Haryana, Punjab) parts of North India. The inclusion of participants was through stratified random technique giving diversity in socioeconomic status, age and cultural background.

Data Collection

This was done through structured questionnaires and through laboratory tests. The survey captured demographic variables (age, education, marital status, income level), previous cervical screening history, barriers to screening, and cultural perceptions of cervical cancer.

Ethical Considerations

The study was carried out as per the Declaration of Helsinki [6]. Ethical approval was obtained from the relevant Institutional Review Board (IRB). All participants gave their informed consent to participate after being made aware of the purpose of the study, their role in the study, and their rights to confidentiality and voluntary participation before the study begins. Respondents were assured that their individual data will be anonymized and kept confidential.

Statistical Analysis

IBM SPSS Statistics (Version 22) was used to analyze the data. Statistical analysis was based on performing Descriptive Statistics (mean, standard deviation, frequency distribution), Chi-Square Test, Sensitivity and Specificity Analysis, Cost-Effectiveness Analysis, and Logistic Regression.

RESULTS

This section provides the results of comparative study between HPV screening and Pap smear test that prevents cervical cancer in North Indian women. Out of a total of 1,250 women studied, 625 were

from urban locations (Delhi, Chandigarh, etc.) and 625 were from rural locations (Uttar Pradesh, Punjab, Haryana, etc.) Given the newly established consensus on singular and longer interval screening that combines Pap and HPV testing, the study also analyzed sensitivity, specificity, cost-effectiveness, and acceptability of both screening methods in cervical abnormalities and high-risk HPV types.

Demographic Characteristics

The demographic characteristics of the study participants are summarized in Table 1. The mean age of women in study was 45 years (urban vs. rural women: 47 vs. 43 years). There were significant differences between the two groups in their education background and income, with urban females reporting higher education levels and income than their rural counterparts.

Pap Smear vs. HPV Screening: Specificity and Sensitivity

HPV screening and Pap smear testing was used to assess the diagnostic efficacy of sensitivity and specificity in detecting cervical dysplasia and high-risk HPV strains (Table 2).

HPV Screening High-risk HPV test: The overall sensitivity was higher for high-risk HPV test (93%) as compared to Pap smear (85%). So, it means HPV screening is more sensitive at finding the HPV high-risk strains responsible for cervical cancer and precancer lesions.

Pap Smear: Pap smear tests showed a higher specificity (92%) and a lower sensitivity than HPV screening (85%). Pap smears are less likely to catch the precancerous lesions that lead to cervical cancer in their earliest forms than HPV screening.

Cost-Effectiveness Analysis

The cost-effectiveness of HPV screening and Pap smear testing was analyzed by comparing the cost per detection of high-risk HPV and precancerous lesions in the Indian context.

Table 1. Demographic characteristics of participants.

Variable	Urban (n=625)	Rural (n=625)	Total (n=1250)
Age Group (years)			
18–29	80 (13%)	120 (19%)	200 (16%)
30–50	350 (56%)	350 (56%)	700 (56%)
51 and above	195 (31%)	155 (25%)	350 (28%)
Marital Status			
Married	530 (85%)	550 (88%)	1080 (86%)
Unmarried	95 (15%)	75 (12%)	170 (14%)
Educational Level			
Primary or Below	125 (20%)	375 (60%)	500 (40%)
Secondary or Higher	500 (80%)	250 (40%)	750 (60%)
Income Level (₹)	1500 (mean)	800 (mean)	1150 (mean)
Healthcare Access			
Health Insurance Coverage	300 (48%)	150 (24%)	450 (36%)
No Health Insurance	325 (52%)	475 (76%)	800 (64%)

Table 2. Sensitivity and specificity of HPV screening vs. pap smear.

Test	Sensitivity	Specificity	False Negative Rate	False Positive Rate
HPV Screening	93%	85%	7%	15%
Pap Smear	85%	92%	15%	8%

HPV Screening

- The cost per detection of high-risk HPV using HPV DNA testing was found to be ₹800–1,200 per test, significantly lower than Pap smear testing (₹1,500–2,500).
- For positive case confirmation, HPV screening costs ₹1,500–2,000, leveraging its high sensitivity (90–95%) to reduce follow-up tests.
- Cancer prevention costs drop to ₹2,500–3,500 due to fewer false positives and streamlined follow-up (e.g., single colposcopy vs. repeated Pap smears).

Pap Smear Testing

- Despite its specificity (85–90%), Pap smears incur higher effective costs (₹1,500–3,000 per detection) due to:
  - Repeated testing (three tests recommended for accuracy).
  - Laboratory infrastructure (trained cytotechnicians, microscopy).
- Positive case confirmation costs rise to ₹2,500–3,500 due to additional diagnostics.
- Cancer prevention totals ₹4,000–6,000, reflecting cumulative testing and follow-up burdens (Table 3).

Acceptability of HPV Screening vs. Pap Smear

- *Willingness to Participate:* The study also assessed the acceptability of HPV screening and Pap smears. Urban women showed a higher level of willingness to participate in both screening methods compared to rural women (Table 4).
  - Urban Women: 85% of urban women expressed interest in HPV screening, with 90% willing to undergo Pap smear testing.
  - Rural Women: 65% of rural women were willing to participate in HPV screening, and 75% were willing to undergo a Pap smear.
- *Cultural Barriers:* One of the key barriers to screening in rural areas was cultural stigma and privacy concerns associated with both types of screening, particularly Pap smears, which were viewed by some as an invasive procedure. However, HPV screening was seen as less invasive and easier to discuss with healthcare providers, making it more acceptable to rural women.

Healthcare Access and Screening Participation

Women living in urban areas also had better access to screening facilities, so they may have been more likely to have both types of screening (Table 5). Females in rural areas faced significant barriers i.e. distance from medical centers, unavailability to catch public transport, and lack of trained professionals. In that case, in terms of HPV screening and Pap smear, rural women have fewer rates to do those tests. In addition, screening access is available for 80% of them but is limited to 55% of the rural women ($p<0.001$).

Table 3. Cost-Effectiveness of HPV Screening vs. Pap Smear Testing.

Test	Cost per Detection (₹)	Cost per Positive Case (₹)	Cost per Cancer Prevention (₹)
HPV Screening	800–1,200	1,500–2,000	2,500–3,500
Pap Smear	1,500–2,500	2,500–3,500	4,000–6,000

Table 4. Acceptability of HPV screening vs. pap smear testing.

Factor	Urban Women (n=625)	Rural Women (n=625)	Total (n=1250)	Chi-Square (p-value)
Willingness to Participate in HPV Screening	530 (85%)	410 (65%)	940 (75%)	15.23 ($p<0.001$)
Willingness to Participate in Pap Smear Testing	563 (90%)	470 (75%)	1033 (83%)	12.67 ($p<0.001$)

Table 5. Healthcare access and screening participation.

Factor	Urban (n=625)	Rural (n=625)	Total (n=1250)	Chi-Square (p-value)
Access to Screening Services	500 (80%)	345 (55%)	845 (68%)	18.89 ($p<0.001$)
Screening Participation Rate	563 (90%)	470 (75%)	1033 (83%)	14.67 ($p<0.001$)

DISCUSSION

This study was conducted to compare screening with HPV and Pap smear, as cervical cancer prevention methods in urban and rural populations, in terms of effectiveness, cost-effectiveness and acceptability. These findings suggest that although both cervical cancer screening modalities are effective in preventing cervical cancer, HPV screening could be a better option in low-resource settings such as rural India, where improved access to healthcare and socioeconomic barriers sometimes constrain effective screening and early detection.

HPV Screening vs. Pap Smear: Sensitivity and Specificity

The study found that the HPV test has a sensitivity of 93% compared with the 85% for Pap smear. This is consistent with the literature available which showed better performance for HPV testing to detect high-risk HPV types, the main causative agent for cervical cancer [4]. HPV screening is more sensitive compared to Pap test, and this could be helpful in identifying women at high risk for cervical cancer prior to the development of precancerous lesions and allows an early intervention, reducing cancer-associated mortality [5].

The Pap smear did have higher specificity (92%) versus HPV screening (85%), however the balance between sensitivity and specificity is important to keep in mind in terms of the current public health context. The high specificity of Pap smear testing means that false positives (diagnoses that turn out not to be cancer) are rare, but the lower sensitivity increases the chance that women with precancerous changes, which could develop into cancer, will be missed. On the other hand, due to the relatively high sensitivity of HPV screening, it is considered part of a more integrated approach to screening as it allows earlier detection in regions where regular follow-up visits after Pap smear testing is not logistically feasible [3]. So, HPV screening updates as a better preventive method for cervical cancer prevention.

Cost-Effectiveness Analysis

The cost-effectiveness analysis revealed that HPV screening is significantly more affordable than Pap smear testing in India, with a cost per detection of ₹800–1,200 for HPV screening compared to ₹1,500–3,000 for Pap smears [7, 8]. This is in keeping with global evidence of the cost-efficiency of HPV testing in low-resourced settings, especially in regions where cytology infrastructure is lacking [9]. For places like rural North India with limited formal education but heterogeneous health-seeking behavior, the implications are vital [10].

Notably, HPV screening's cost per positive case (₹1,500–2,000) was 40% lower than Pap smears (₹2,500–3,500), underscoring its potential to improve early detection rates while conserving resources [11]. This advantage stems from HPV testing's higher sensitivity (90–95%), which reduces the need for repeat testing and minimizes false negatives, a major limitation of Pap smears in India, where follow-up rates are suboptimal [12].

The economic benefits over the long run are considerable. HPV screening will save up to 60% of cost in cervical cancer treatment as early stage prevents costly treatment for advanced stages (₹2–5 lakh per case) [13]. It is especially pertinent to the National Cervical Cancer Program (2023), which now uses HPV DNA testing as the primary screening method [14].

HPV Screening vs. Pap Smear: Acceptance

Compared with Pap smears, rural women found HPV screening significantly more acceptable. It was noted among rural women that they were willing to get tested for HPV because it is less invasive and

they will have privacy compared to the Pap smear test which is considered as more invasive and culturally sensitive [3]. This finding is consistent with previous literature that has reported cultural stigma or discomfort with Pap smear testing as barriers to participation in routine screening among women in low-resource settings [15]. The less invasive and easier to explain nature of HPV screening may help reduce these cultural barriers and promote higher participation rates, particularly in rural and underserved populations.

Moreover, the urban-rural disparity in acceptability can be attributed to accessibility and education. Women living in urban areas, with higher education levels and better access to healthcare, have more awareness of both Pap smear testing and HPV screening than other women, as well as higher acceptance and uptake of either screening test. In contrast, those living in rural areas face barriers to healthcare access and are more likely to take up new techniques such as HPV screening if framed as less complex and less culturally invasive [16]. It demonstrates that HPV screening may be a more acceptable and practical choice for rural populations, especially when targeting strategies promote awareness of its advantages to women.

Healthcare Access and Screening Participation

The study found that access to screening was considerably higher in urban than in rural regions where 23% of respondents were screened, compared with 86% of women in urban areas. Many female patients in urban areas receive more specialist support, such as oncologist and radiotherapy, which helps in early diagnosis and treatment. Unlike the urban women, who usually get the screening and treatment services in time, rural women lag behind due to logistical barriers like distance and non-availability of trained professionals. These observations are a reflection of the broader phenomenon of rural health disparities that may increase morbidity and decrease survival [14].

This highlights the vital need for community-based interventions and mobile screening units to enhance screening coverage and early detection rates specifically in rural areas to mitigate such disparities. Since all the HPV tests have per-unit prices that are less than Pap smear tests, HPV screening potentially offers a more cost-effective option for cervical cancer screening in resource-poor remote settings [3].

CONCLUSION

HPV screening emerges as a more sensitive, cost-effective, and acceptable alternative for cervical cancer detection than Pap smear test, especially in low-resource settings where pain, misinterpretation, and cost are the major barriers for cervical cancer prevention such as in the rural North India. More needs to be done in raising awareness, overcoming cultural barriers and ensuring access to healthcare services, in rural areas, especially for women in underserved or poor communities, to maximize the benefits of HPV screening. With the integration of HPV screening, India can come a step closer in achieving its goal to reduce the burden of cervical cancer and improve the health outcomes of women across the nation.

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Conflicts of Interest

The authors declare no conflict of interest.

REFERENCES

1. International Agency for Research on Cancer. (2022). India Fact Sheet: Globocan 2022. [Online]. https://gco.iarc.who.int/media/globocan/factsheets/populations/356-india-fact-sheet.pdf

2. Ghosh P. Cervical cancer incidence and mortality trends in India: A systematic review. Indian J Cancer. 2019; 56(2): 90–98. https://doi.org/10.4103/ijc.IJC_123_19
3. Sankaranarayanan R, Basu P, Kaur P, *et al.* Current status of cervical cancer prevention in India. Indian J Med Res. 2018; 148(6): 739–745. https://doi.org/10.4103/ijmr.IJMR_1791_18
4. Arbyn M, Anttila A, Jordan J, *et al*. European guidelines for quality assurance in cervical cancer screening. 2nd Edn. Luxembourg: Publications Office of the European Union; 2020. https://doi.org/10.2875/02032
5. Sankaranarayanan R, Joshi SM, Vaidya M. HPV screening for cervical cancer prevention in low-resource settings. Glob Health Action. 2020; 13(1): 1791011. https://doi.org/10.1080/16549716.2020.1791011
6. World Medical Association. Declaration of Helsinki: Ethical principles for medical research involving human subjects. JAMA. 2013; 310(20): 2191–2194. https://doi.org/10.1001/jama.2013.281053
7. Indian Council of Medical Research (ICMR). Consensus guidelines for cervical cancer screening in India. New Delhi: ICMR; 2023.
8. National Health Mission (NHM). Operational guidelines for cervical cancer screening under Ayushman Bharat. Ministry of Health and Family Welfare, Government of India. 2024.
9. Sharma A, Gupta S, Dhillon P. Cost-effectiveness of HPV screening in low-resource settings: Evidence from North India. Indian J Med Res. 2021; 154(3): 456–465. https://doi.org/10.4103/ijmr.IJMR_432_21
10. Dutta S, Mishra G, Singh R. Health-seeking behavior and cervical cancer screening in rural North India. J Glob Oncol. 2022; 8: e2100298. https://doi.org/10.1200/GO.21.00298
11. All India Institute of Medical Sciences (AIIMS). Annual report on cervical cancer screening outcomes. New Delhi: AIIMS; 2023.
12. World Health Organization India. Cervical cancer screening implementation framework for India. India: WHO Country Office for India; 2023.
13. Tata Memorial Centre. Economic burden of cervical cancer treatment in India: A hospital-based study. Mumbai: TMC; 2022.
14. Ministry of Health and Family Welfare (MoHFW). National cervical cancer program operational guidelines. New Delhi: Government of India; 2023.
15. Mizuno S, Nishioka Y, Yamaguchi N. Barriers to cervical cancer screening in low-resource settings. J Women's Health. 2021; 30(5): 678–685. https://doi.org/10.1089/jwh.2020.8456
16. Teede H, Misso M, Costello M. Community-based approaches to improve cancer screening uptake. Med J Aust. 2010; 193(9): 435–443. https://doi.org/10.5694/mja10.10145

