DOI: 10.7860/JCDR/2025/82008.21856

Review Article

Obstetrics and Gynaecology Section

Diagnostic Value of Papanicolaou Smear versus Colposcopy in Reproductive age Women with Clinically Unhealthy Cervix: A Narrative Review

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ABSTRACT

Cervical cancer is the second most common cancer among Indian women, and timely detection of premalignant lesions is key to reducing its burden.The Papanicolaou (Pap) smear and colposcopy are two widely used methods for the same. However, the diagnostic performance of each method varies significantly, particularly in symptomatic or high-risk populations. Pap smears offer a low-cost, specific screening tool, while colposcopy is a resource-intensive procedure that requires trained specialists. Colposcopy has demonstrated higher sensitivity and correlation with histopathological outcomes than the Pap smear in high-risk women. A combined approach, especially in symptomatic women, may improve early detection rates. This narrative review evaluates the diagnostic role of Pap smear and colposcopy in reproductive-age women with a clinically unhealthy cervix, with emphasis on their accuracy, limitations, and complementary use.

Keywords: Colposcopy, Early detection of cancer, Uterine cervical dysplasia

INTRODUCTION

Cervical cancer is largely a preventable disease. Globally, cervical cancer ranks as the fourth most common cancer among women. Nearly 660,000 new cases and 350,000 deaths were reported worldwide in 2022 [1]. India contributed to 19% cervical cancer cases and 23% of assosciated deaths [2]. The threshold for cervical cancer elimination as a public health problem is 4 per 100,000 women-years [3]. To progress towards the path of cervical elimination, countries must ensure that 70% of women are screened using a high-performance test by 35 years of age [3]. The premalignant stage, known as Cervical Intraepithelial Neoplasia (CIN), offers an opportunity for early detection and prevention.

The American College of Obstetricians and Gynaecologists (ACOG) currently recommends cervical cancer screening from 21 to 65 years of age. Cytological examination every three years is for women aged 21 to 29 years. For women aged 30-65 years, high-risk HPV DNA co-testing is recommended along with a Pap smear, every five years [4]. The same guidelines have been endorsed by the Indian Council of Medical Research (ICMR) [5].

Erosion, hypertrophy, bleeding on contact, or suspicious growth indicate a clinically unhealthy cervix that needs assessment for precancerous or cancerous changes [6].

The Pap smear continues to be the backbone of cervical cancer screening, both in community and hospital-based screening. Several other diagnostic tests are available for cervical screening, and each carries its own method of interpretation along with certain limitations. Alternatives to Pap smear are

1. **Liquid-Based Cytology (LBC):** This technique enhances sample preparation quality compared to conventional Pap smears and with comparable levels of sensitivity and specificity. Its results, however, still depend on careful microscopic evaluation by trained cytopathologists, making interpretation susceptible to observer variability [7].
2. **HPV DNA/RNA Testing:** Detecting high-risk Human Papilloma Virus (HPV) sub types provides an objective means to identify women at increased risk for precancerous lesions. Unlike cytology, HPV testing yields reproducible positive or negative outcomes and offers better sensitivity for high-grade disease, though it may generate higher false-positive rates, especially in younger populations [8-10].
3. **Visual Inspection with Acetic Acid (VIA) and Lugol's Iodine (VILI):** These techniques involve direct application of reagents to the cervix to accentuate abnormal epithelial changes. Both are low cost and suitable for settings with limited resources, but are heavily dependent on examiner expertise and can have significant rates of false positives due to subjective assessment [7,11].

Histopathologic examination of colposcopy-guided biopsies remains the gold standard for diagnosing CIN. Pap smear testing alone missed up to 30% of histologically confirmed CIN2+ lesions in women with a clinically unhealthy cervix [12]. Pap smear has greater specificity but lacks sensitivity in detecting high-grade CIN, especially in the presence of inflammation or bleeding [13]. Colposcopy, despite some false positives, improves early detection when integrated with Pap smear or histopathology [14].

Therefore, the present study was undertaken to compare the efficacy of the Pap smear and colposcopy in cervical cancer screening as each modality offers distinct advantages over other screening methods.

REVIEW OF LITERATURE

Since its introduction in the 1940s by George Papanicolaou, the Pap smear has resulted in a significant reduction in cervical cancer burden in areas where it is widely used [15]. The Pap smear is one of the most widespread used tests in cancer screening programme across the globe.

Apart from the general limiting factors related to patients (low awareness about cervical cancer, hesitance among nullipara or unmarried women, etc.), and health system related (clinicians/technicians not taking adequate smear, inadequate counselling of the patients, lack of trained pathologists for correct interpretation, etc.), the Pap smear also has technical shortcomings. Even in the best laboratories, false negative rate is about 5%. No amount of capacity building may reduce this rate to near zero [16].

Krishnegowda S and Ms V evaluated Pap smear in conjunction with colposcopy against histopathology and reported a sensitivity of 94% and specificity of 91% for the combined approach. [14]. The diagnostic performances of the Pap smear and colposcopy tests have been given in [Table/Fig-1].

In women with cervicitis, ectropion, or bleeding on touch, the Pap smear may yield insufficient or obscured samples, decreasing sensitivity [16]. Inter-observer variation is an important factor affecting the results of Pap smear. In a Latin American study conducted across 26 laboratories, moderate agreement (median kappa ~0.51, range 0.16-0.70) was seen in conventional Pap smear interpretation. Total of 31% false positives and 11% false negatives were noted, showing a significant variation between laboratories [31]. Inter and Intra-observer variations were also noted in squamous cell carcinoma grading and differentiating benign from suspicious cancerous lesions [32].

Colposcopy is more sensitive in identifying unhealthy cervical parts and enables sampling from these areas. Colposcopy may lead to false positive interpretations especially in the presence of inflammation, immature metaplasia, or atrophy. Colposcopy is more time-consuming, resource-intensive and requires trained specialists. It is highly dependent upon colposcopist's experience. In a study on observer agreement on interpreting colposcopic images of CIN, 23 experienced colposcopists were asked to assess the colsposcopic images and selection of biopsy site. Intraobserver agreement was ~67% (kappa ~0.54), and interobserver agreement ~52% (kappa ~0.33-0.41). Consistency in selecting biopsy sites was higher (~77%) [33].

			Pap Smear				Colposcopy			
S. No.	Authors and Year	Type of study and Sample size	Sensitivity	Specificity	Positive Predictive Value (PPV)	Negative Predictive Value (NPV)	Sensitivity	Specificity	Positive Predictive Value (PPV)	Negative Predictive Value (NPV)
1.	Sherwani RK et al, (2007) [12]	Prospective comparative study, 160	53.70%	50%	--	--	--	--	--	--
2.	Gandavaram J and Pamulapati BR (2019) [17]	Prospective study, 250	Lesions above LSIL 28%	99.32%	93.47%	76.21%	80.02%	82.14%	67%	86.78%
3.	Cobucci et al., (2016) [18]	Cross-sectional study, 3194	CIN-1 or less serious lesion- 93%, CIN2+ 64%	CIN-1 or less serious lesion- 73%, CIN2+84%	CIN-1 or less serious lesion- 90%, CIN2+99%	CIN-1 or less serious lesion- 73%, CIN2+99%	--	--	--	--
4.	Nanda K. et al., (2000) [19]	Systemic review	CIN 2+ lesions- 30-87%	CIN 2+ lesions- 86-100%	Not specifically reported overall	Not specifically reported overall	--	--	--	--
5.	Vidyadhar S. et al., (2017) [20]	Cross-sectional study, 100	29.7% for CIN 2+ lesions	94.4% for CIN 2+ lesions	70.40%	75.10%	85.90%	74.30%		
6.	Ibrahim A. et al., (2012) [21]	Cross-sectional study, 934	72.90%	83.80%	--	--	--	--	--	--
7.	Pimple SA et.al., (2010) [22]	Prospective cohort of VAI-positive women	57.4% or CIN 2+ lesions	99.4% or CIN 2+ lesions	--	--	CIN1+ or CIN2+ 58.0-74.7%	CIN1+ or CIN2+ 57.5-92.9%.	--	--
8.	Gullota G et al., (1997) [23]	Diagnostic correlation study, 190	CIN- 70%. Low grade lesion- 61.2%, High grade lesion- 88.5%	--	--	--	--	--	--	--
9.	Wojceich R. (2011) [24]	Cross-sectional study	58.02%	63.28%	75.38%	43.75%	89.21%	98.87%	99.35%	82.55%
10.	Khodakarami N et al., (2011) [25]	Diagnostic comparison study, 100	23.50%	100%	100%	86.50%	--	--	--	--
11.	Najib SF et al., (2020) [26]	Diagnostic accuracy study	47.19%	64.79%	88.69%	38.46%	64.70%	52.74%	76.32%	95.41%
12.	Abulafia O et a.l, (2003) [27]	Meta-analysis	68%	79%	--	--	--	--	--	--
13.	Hol K et al., (2019) [28]	Prospective comparative study, 180	--	--	--	--	83.3% for CIN1, 90.9% for CIN 2+	78.5% for CIN 1, 95.2% for CIN 2+	68.9% for CIN 1, 83.3% for CIN 2+	--
14.	Li X et al., (2024) [29]	Retrospective cohort	--	--	--	--	51.20%	96.50%	64.20%	94.10%
15.	Qin D et al, (2023) [30]	Systematic review and Meta-analysis, 22764	--	--	--	--	LSIL + 92%, HSIL + 68%	LSIL + 51%, HSIL + 93%	--	--

[Table/Fig-1]: Comparison of Diagnostic Accuracy of Pap Smear and Colposcopy.
LSIL and HSIL: Low-grade and High-grade Squamous Intraepithelial Lesions; CIN: Cervical Intraepithelial Neoplasia

DISCUSSION

The Pap smear, a cytological screening method, has played a critical role in reducing cervical cancer incidence and mortality, particularly where systematic programs are in place. Its value lies in detecting precancerous changes, which, if recognised during the premalignant stage—such as atypical squamous cells, Low-grade (LSIL), or High-grade (HSIL) Squamous Intraepithelial Lesions—allow for timely intervention and prevent progression to invasive cancer. The classic process involves microscopic assessment of cervical cells, staged according to the Bethesda System, clarifying the transition from reactive or inflammatory changes to progressively severe dysplasia and carcinoma in-situ [34].

Colposcopy, by contrast, provides a real-time, magnified, and illuminated view of the cervix. This allows for direct visualisation of subclinical lesions and the capacity to target abnormal regions for biopsy, dramatically improving detection rates—especially for higher-grade changes [35].

In settings like India, where cervical cancer screening coverage is still below optimal (less than 30% of eligible women screened), [36], Pap smear is ideal for mass screening from a public health standpoint while colposcopy is essential for diagnostic confirmation in women with a clinically unhealthy cervix or persistent symptoms.

CONCLUSION

In reproductive age women with a clinically unhealthy cervix, colposcopy outperforms Pap smear in detecting premalignant lesions due to its higher sensitivity and ability to guide targeted biopsy. While Pap smear remains useful for population-level screening, it is less reliable when the cervix appears abnormal on examination. A combined approach—using Pap smear for initial screening and colposcopy for detailed assessment in high-risk cases is the most effective and evidence-based strategy for early detection of cervical precancerous lesions in this subgroup.

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PLAGIARISM CHECKING METHODS: [Jain H et al.]
- Plagiarism X-checker: Jul 21, 2025
- Manual Googling: Aug 29, 2025
- iThenticate Software: Sep 01, 2025 (11%)

ETYMOLOGY: Author Origin

EMENDATIONS: 6

AUTHOR DECLARATION:
- Financial or Other Competing Interests: None
- Was informed consent obtained from the subjects involved in the study? No
- For any images presented appropriate consent has been obtained from the subjects. No

Date of Submission: **Jul 13, 2025**
Date of Peer Review: **Jul 24, 2025**
Date of Acceptance: **Sep 03, 2025**
Date of Publishing: **Oct 01, 2025**