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Diagnostic Performance of Colposcopy in Detecting High-Grade Cervical Lesions among HPV DNA-Positive Women in Tertiary Care Centre of Nepal

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ABSTRACT

Background: Cervical cancer remains a significant public health concern, particularly in low- and middle-income countries. Colposcopy is a vital diagnostic modality for detecting cervical intraepithelial neoplasia (CIN) in women testing positive for high-risk human papillomavirus (HPV). However, its diagnostic accuracy for identifying high-grade lesions (CIN II and above) warrants further evaluation. This study aimed to assess the diagnostic performance of colposcopy among HPV DNA–positive women and correlate its findings with histopathology.

Methods: A hospital-based cross-sectional study was conducted among 93 HPV DNA–positive women undergoing colposcopic evaluation at a tertiary care centre. Histopathological examination was used as the gold standard. The sensitivity, specificity, positive predictive value (PPV), negative predictive value (NPV), and overall diagnostic accuracy of colposcopy were calculated. Associations between colposcopic findings and sociodemographic or clinical variables were analyzed using Chi-square or Fisher's Exact tests.

Results: Colposcopy showed a sensitivity of 83.3%, specificity of 63.6%, PPV of 71.4%, NPV of 77.8%, and a diagnostic accuracy of 73.3%. Statistically significant associations were found between colposcopic findings and age ($p = 0.016$), participation in cervical screening programs ($p = 0.022$), and history of postcoital bleeding ($p = 0.045$). A fair correlation ($\chi^2=23.34$, $p<0.001$) was observed between colposcopy and histopathology findings.

Conclusion: Colposcopy demonstrates moderate diagnostic accuracy in identifying high-grade cervical lesions among HPV-positive women. While it remains an essential component of cervical cancer screening and management, its performance can vary based on patient age and screening history. Integration with cytology and histopathological confirmation improves diagnostic precision. Strengthening colposcopy training and referral systems is crucial for enhancing reliability and reducing false interpretations.

Keywords: colposcopy; HPV DNA; cervical intraepithelial neoplasia; diagnostic accuracy; sensitivity; specificity.

INTRODUCTION

Cervical cancer remains a major public health burden globally, particularly in low- and middle-income countries, despite being largely preventable through HPV vaccination and other effective screening[1] Human papillomavirus (HPV) is one of the most common sexually transmitted infections, with nearly 600 million people affected worldwide and 75–80% acquiring it during their lifetime. Persistent infection with high-risk HPV (hrHPV) genotypes is the primary cause of cervical cancer.[2-4] hrHPV DNA testing has demonstrated higher sensitivity than cytology for detecting CIN2+, and co-testing offers the highest negative predictive value.[5, 6] Colposcopy, introduced in 1925, enables magnified cervical examination and is crucial for detecting precancerous lesions. Once used to exclude invasive cancer, its role has evolved to diagnose preinvasive disease, complementing cytology and histopathology in patient management.[7] In routine clinical settings, colposcopy findings are interpreted alongside cytological and histopathological results to inform appropriate patient management. Rather than serving as alternatives, colposcopy and cytology are complementary diagnostic approaches. The use of colposcopy in combination with targeted biopsy has significantly decreased the reliance on

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unnecessary conization and other invasive surgical procedures.[8] In Nepal, cervical cancer ranks as the second most prevalent cancer among women, comprising around 11.1% of all female cancer cases and contributing to 9.1% of cancer-related deaths in women.[9] In this context, the present study aims to assess the diagnostic accuracy of colposcopy in identifying high-grade cervical lesions in women who test positive for hrHPV DNA.

METHODS

This hospital-based cross-sectional study was conducted among 93 HPV DNA–positive women who attended the Gynecology Department of B.P. Koirala Memorial Cancer Hospital, Bharatpur, Chitwan, between July to December 2024. Ethical approval was obtained from the Nepal Health Research Council (NHRC) (Ref. No. 53_2024). Written informed consent was obtained from all participants before enrollment. The primary objective of this study was to evaluate the diagnostic performance of colposcopy in detecting high-grade cervical lesions, using histopathological examination as the reference standard. The outcome variable was the result of colposcopy, classified as either positive or negative. A positive colposcopy was defined as the detection of high-grade cervical lesions, including cervical intraepithelial neoplasia grade II (CIN II), grade III (CIN III), or adenocarcinoma in situ. A negative result indicated the absence of such lesions. Histopathological evaluation, considered the gold standard, was used to determine the diagnostic accuracy of colposcopy. Independent variables included sociodemographic and clinical factors such as age, body mass index (BMI), menopausal status, occupation, family history of cancer, and participation in cervical cancer screening programs, history of postcoital bleeding. These variables were collected through structured interviews using pretested questionnaires administered during the hospital visit. Colposcopy examinations were performed and recorded by trained gynaecologists. Histopathological reports were obtained from institutional laboratory records.

Data were first reviewed for completeness and assigned serial numbers to maintain confidentiality. The data were entered into Microsoft Excel and subsequently analysed using appropriate statistical software. Descriptive statistics (frequency and percentage) were used to summarize the demographic characteristics, colposcopy results, and histopathological outcomes. These findings were presented in tabular and graphical formats. Inferential statistics were applied to explore associations between independent variables and colposcopy results. Chi-square test and Fisher's Exact test were employed for categorical variables, with the latter used where cell counts were small to ensure accuracy. A p-value < 0.05 was considered statistically significant.

The diagnostic performance of colposcopy was assessed by calculating sensitivity, specificity, positive predictive value (PPV), negative predictive value (NPV), and diagnostic accuracy. Standard diagnostic test formulas were used:

- Sensitivity: proportion of true positives correctly identified by colposcopy
- Specificity: proportion of true negatives correctly identified
- PPV: probability that a positive colposcopy corresponds to a histologically confirmed high-grade lesion
- NPV: probability that a negative colposcopy corresponds to the absence of a high-grade lesion
- Accuracy: proportion of correctly classified cases (both true positives and true negatives.

RESULTS

Among the 100 HPV DNA–positive women who underwent colposcopy examination, the majority (64%) were diagnosed as having normal cervical findings. Low-grade cervical intraepithelial neoplasia (CIN I), indicating mild dysplastic changes, was identified in 24% of the participants. High-grade CIN lesions (CIN II or III), which are considered precancerous and clinically significant, were observed in 6% of cases. Additionally, 6% of the women were categorized as defaulters due to loss to follow-up or incomplete diagnostic workup (Table 1).

Excluding six defaulters, a total of 93 HPV DNA-

Table 1. Colposcopy diagnosis among HPV DNA positive women. (n=100)	
Colposcopy Diagnosis	**Frequency (%)**
Normal	64 (64)
Low-grade cervical intraepithelial neoplasia	24 (24)
High-grade cervical intraepithelial neoplasia	6 (6)
Defaulter	6 (6)

positive women completed the colposcopy procedure and were included in the final analysis. Among them, 63 women (67.7%) had negative colposcopy findings, indicating no visible evidence of cervical lesions. Similarly,30 women (32.3%) demonstrated positive colposcopy results suggestive of cervical abnormalities. This distribution illustrates that approximately one-third of HPV-positive women had colposcopy abnormalities, reinforcing the utility of colposcopy as a triage tool in the early detection of cervical neoplasia among high-risk populations (Table 2).

Table 2. Colposcopy result among HPV DNA positive women. (n=93)	
Colposcopy result	**Frequency (%)**
Negative	63(67.7)
Positive	30(32.3)

Analysis of the 93 women who completed colposcopy revealed significant associations between certain sociodemographic and clinical variables and colposcopy results. Age showed a statistically significant relationship (p = 0.016), with the highest proportion of colposcopy-positive cases (43%) observed among women aged 45-50 years, suggesting increased risk of cervical abnormalities in the perimenopausal age group. Participation in cervical cancer screening programs was also significantly associated with colposcopy positivity (p = 0.022), indicating that women with prior screening history were more likely to be detected with cervical lesions, possibly due to more regular health-seeking behaviour and follow-up. A borderline association was observed for sexual bleeding (p = 0.055), though counterintuitively, a greater number of positive findings were recorded among women without reported sexual bleeding, highlighting the limitations of relying solely on symptomatic presentation for clinical triage.

Table 3. Association between Colposcopy finding with selected sociodemographic variables. (n=93)				
Characteristics	**Overall (n = 93)[1]**	**Colposcopy finding**		**p-value[2]**
		Positive (n = 30)[1]	**Negative (n = 63)[1]**	
Age (years)				
30-35	19 (20%)	5 (17%)	14 (22%)	0.016
35-40	28 (30%)	5 (17%)	23 (37%)	
40-45	24 (26%)	7 (23%)	17 (27%)	
45-50	22 (24%)	13 (43%)	9 (14%)	
Age at marriage (years)				
<15	3 (3.2%)	1 (3.3%)	2 (3.2%)	>0.9
>15	90 (97%)	29 (97%)	61 (97%)	
BMI				
<18.5	1 (1.1%)	0 (0%)	1 (1.6%)	0.2
18.5-24.99	48 (52%)	16 (53%)	32 (51%)	
25-29.99	28 (30%)	6 (20%)	22 (35%)	
30-34.99	15 (16%)	7 (23%)	8 (13%)	
35-39.99	1 (1.1%)	1 (3.3%)	0 (0%)	
Menopausal				
No	89 (96%)	29 (100%)	60 (95%)	0.2
Yes	4 (3.2%)	0 (0%)	4 (5%)	
Occupation				
Unemployed	9 (9.7%)	3 (10%)	6 (9.5%)	0.2
Farmer	14 (15%)	8 (27%)	6 (9.5%)	
Job	3 (3.2%)	1 (3.3%)	2 (3.2%)	
Worker	9 (9.7%)	1 (3.3%)	8 (13%)	
Others	24 (26%)	9 (30%)	15 (24%)	
Enterprise	34 (37%)	8 (27%)	26 (41%)	
LBC				
Negative	64 (69%)	18 (60%)	46 (73%)	0.2
Positive	29 (31%)	12 (40%)	17 (27%)	
Participate screening				
Yes	43 (46%)	19 (63%)	24 (38%)	0.022
No	50 (54%)	11 (37%)	39 (62%)	
Sexual bleeding				
Yes	13 (14%)	1 (3.3%)	12 (19%)	0.055
No	80 (86%)	29 (97%)	51 (81%)	
Marital status				
Married	89 (96%)	28 (93%)	61 (97%)	0.4
Divorced	2 (2.2%)	1 (3.3%)	1 (1.6%)	
Widowed	2 (1.1%)	2 (3.3%)	0 (0%)	
Family history of cancer				
No	76 (82%)	24 (80%)	52 (83%)	0.8
Yes	17 (18%)	6 (20%)	11 (17%)	

Other variables such as age at marriage, BMI, menopausal status, occupation, liquid-based cytology results, marital status, and family history of cervical cancer did not show statistically significant

associations with colposcopy results ($p > 0.05$). These findings suggest that while some factors like age and screening behaviour may influence detection of cervical lesions, many sociodemographic parameters alone are not reliable predictors of abnormal colposcopy findings (Table 3).

Among the 93 women who underwent colposcopy, a total of 20 participants with positive colposcopy findings were confirmed to have high-grade cervical lesions on histopathological examination (true positives), while 7 cases were false positives. Conversely, 4 women with negative colposcopy findings were later diagnosed with high-grade lesions on histopathology (false negatives), and 7 cases were true negatives.

The association between colposcopy impression and histopathological diagnosis was statistically significant, with a Fisher's exact test p-value < 0.001 and a test statistic of 23.34, indicating a strong correlation between the two diagnostic modalities. This underscores the clinical utility of colposcopy in accurately identifying high-grade cervical lesions among HPV DNA–positive women, though the presence of both false positives and false negatives suggests the need for histopathological confirmation in all suspected cases (Table 4).

Table 4. Relationship between colposcopy and histopathological findings.

Colposcopy finding	Pathology finding		Fisher exact	p-value
	Positive	Negative		
Positive	20	7	23.34	<0.001
Negative	4	7		

Using histopathology as the reference standard, the diagnostic performance of colposcopy in detecting high-grade cervical lesions was evaluated. The sensitivity of colposcopy was 83.33% (95% CI: 62.62%–95.26%), indicating a high ability to correctly identify women with true disease. However, the specificity was relatively low at 50.00% (95% CI: 23.04%–76.96%), suggesting a moderate rate of false positives. The positive predictive value (PPV) was 74.07%, while the negative predictive value (NPV) was 63.64%, reflecting the likelihood of correct classification based on colposcopy results in this population with a disease prevalence of 63.16%.

The positive likelihood ratio (LR+) was 1.67 and the negative likelihood ratio (LR−) was 0.33, indicating limited power to confirm disease but moderate ability to rule it out when colposcopy is negative. The overall diagnostic accuracy was 71.05% (95% CI: 54.10%–84.58%), supporting the use of colposcopy as a valuable screening tool, although its diagnostic limitations necessitate confirmation through histopathological examination (Table 5).

Table 5. Diagnostic accuracy of Colposcopy finding.

Statistic	Value	95% CI
Sensitivity	83.33%	62.62% to 95.26%
Specificity	50.00%	23.04% to 76.96%
Disease prevalence	63.16%	45.99% to 78.19%
Positive predictive value	74.07%	62.16% to 83.25%
Negative predictive value	63.64%	38.29% to 83.15%
Positive likelihood ratio	1.67	0.96 to 2.90
Negative likelihood ratio	0.33	0.12 to 0.94
Diagnostic accuracy	71.05%	54.10% to 84.58%

DISCUSSION

Colposcopy, currently recommended by the WHO as a triage method for HPV-positive women, remains the reference standard for guiding biopsy to confirm cervical precancer and cancer, as well as for determining appropriate treatment strategies.[10] In our study, colposcopy positivity was significantly higher among women in the perimenopausal age group of 45–50 years. A similar age category was reported by Li et al., who analysed 2,007 women and found a median age of 42.4 ± 12.8 years[11] and Habeshian et al, where mean age was 42.9 years.[12] In contrast, Gupta et al. observed a higher prevalence of colposcopy abnormalities in a younger age group, particularly between 31–40 years.[13] Unlike the findings of Gasper et al., who observed significant associations between HPV lesion types and factors like age, education, marital status, and economic status, our study did not find any such statistically significant correlations. This difference may be due to variations in population or study design.[2] Similarly, post-coital bleeding did not demonstrate statistically significant associations in our study. This aligns with the findings of Godfrey et al.[14], who evaluated 635 women presenting with post-coital bleeding and

found that only 2% were diagnosed with HSIL.In contrast, a study by Valasoulis et al., which included 336 women with a median age of 28.8 ± 6.3 years, reported that increasing age was associated with a lower likelihood of HPV infection. Additionally, having more than 4.2 sexual partners and a change in sexual partner within the year prior to HPV DNA testing were found to increase 2.5 times likelihood of having positive result.[15] In the present study, LBC showed a 40% association with colposcopy-positive findings; however, this correlation was not statistically significant. Similar findings were reported by Akhter et al.[16], where only 33.5% of abnormal LBC results corresponded to positive colposcopy. In contrast, Spinillo et al. observed a significant association between abnormal Pap smear results and colposcopy abnormalities, highlighting variability in the diagnostic relationship between cytology and colposcopy across different studies.[17] Similarly, Hemel et al.[18] evaluated 592 cervical smear cases, identifying squamous epithelial abnormalities in the majority and glandular abnormalities in 40 cases. Among those with squamous abnormalities, the sensitivity and specificity for detecting LSIL were 39.7% and 89.2%, respectively. For the broader LSIL+ category (comprising LSIL and more severe lesions), the sensitivity increased to 89.4% and specificity to 91.4%. The current study demonstrated a statistically significant correlation between colposcopy findings and histopathological outcomes, in concordance with previous research. The notable sensitivity of colposcopy reinforces the value of its use alongside histopathological assessment to achieve more reliable diagnostic outcomes.[19, 20]

In our study, colposcopy demonstrated a sensitivity of 83.33% and a specificity of 50.00%, with an overall diagnostic accuracy of 71.05% for detecting high-grade cervical lesions, using histopathology as the gold standard. These findings are comparable to those reported by Gupta et al.[13], where colposcopy achieved a sensitivity of 86.84% and specificity of 84.32%, closely aligning with HPV DNA testing, which had the highest sensitivity (90%) but slightly lower specificity (84.61%). Our sensitivity value also closely mirrors the 91.2% sensitivity for CIN3+ reported by Vallas et al.[10]Although their study noted decreased sensitivity in older women and those with negative cytology. Conversely, Alan et al.[8] reported an exceptionally high sensitivity of 99.2%, which may reflect methodological or population differences, while also noting a PPV of 74.1%, comparable to our study's PPV of 74.07%. The relatively low NPV (63.64%) and specificity in our study suggest a moderate rate of false positives and emphasize the importance of histopathological confirmation. Collectively, these comparisons reinforce the role of colposcopy as a valuable screening tool, particularly in resource-limited settings, but highlight the necessity of combining it with cytology or HPV testing to enhance diagnostic precision.

CONCLUSIONS

Our study shows that colposcopy remains a valuable diagnostic tool for identifying high-grade cervical lesions among HPV DNA-positive women, demonstrating that the test is sensitive and a moderate diagnostic accuracy. Although the moderate specificity indicates a potential for overdiagnosis, colposcopy continues to serve as a practical and effective triage method, particularly in resource-constrained settings such as Nepal. Statistically significant associations with age, cervical cancer screening participation, and sexual bleeding underscore the importance of individualized risk assessment. The integration of colposcopy with histopathological confirmation and comprehensive screening programs is essential to improving early detection and reducing cervical cancer burden in high-risk populations.

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