

Effects of Screening Methods on the Detection Rate of Cervical Pathology and Their Correlation

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ABSTRACT

Background: Cervical cancer is a major health concern among Indian women, with HPV-16/18 accounting for most invasive cervical cancers. Cervical intraepithelial neoplasia (CIN) may occur at a younger age, making effective screening important for early detection. **Methodology:** A prospective cross-sectional study was conducted among 104 women at the Department of Obstetrics and Gynaecology, MGM Medical College & Hospital, Aurangabad, using Pap smear, HPV testing, and colposcopy. **Results:** Screening test positivity was higher among women aged 31–50 years. White vaginal discharge was the most common complaint (41%), followed by abdominal pain (14%). On speculum examination, cervical erosion was found in 17.3% and hypertrophy in 11.5%. Pap smear showed inflammation in 19.2% of cases, while HPV testing was negative in 90.4%. Colposcopy findings were predominantly normal (86.5%), with a small proportion showing CIN. Pap smear showed 40% sensitivity and 91.49% specificity compared with HPV testing. **Conclusion:** Multimodal screening using Pap smear, HPV testing, and colposcopy is useful for detecting cervical pathology. HPV testing and co-testing may improve early detection, while biopsy remains the gold standard for definitive diagnosis.

Keywords: Cervical Cancer, Screening, PAP smear, Colposcopy, Human papilloma virus.

INTRODUCTION

Cervical cancer ranks as the fourth most prevalent cancer among women globally. Alarming, approximately 90% of the 342,000 cervical cancer-related deaths occurred in low- and middle-income nations. sub-Saharan Africa (SSA), Central America, and South-East Asia Regions bear the highest burden of cervical cancer which includes the incidence and mortality.¹

In India, 483.5 million women aged 15 and above are at risk of cervical cancer, with 123,907 new cases diagnosed annually, resulting in 77,348 deaths. It stands as the second most prevalent disease and cancer among Indian women aged 15 to 44. Human papillomavirus

(HPV) infections, notably HPV-16/18, affect a significant portion of the population, with HPVs 16 and 18 responsible for the majority of invasive cervical malignancies.²

It is one of the predominant forms of cancer affecting women in India, constituting 12% of all female cancer cases. It holds the same status globally, particularly prevalent in developing nations where 60 to 80% of instances are diagnosed at advanced stages II and III. Notably, cervical intraepithelial neoplasia (CIN) manifests at a younger age, with one-third of cases observed before the age of 30.³

Disparities in access to vaccination, screening, and treatment services, alongside factors such as HIV prevalence and socioeconomic determinants like gender biases and poverty, contribute to regional discrepancies in cervical cancer rates.¹

Screening methods, including conventional cytology supported by colposcopy and histopathology, are effective in identifying precancerous lesions and inflammatory conditions of the cervix. Early detection through screening aids in preventing the onset of cancer symptoms. Various screening tests are available, such as the Pap test, which involves collecting cervical cells for microscopic examination²⁻³.

Visual inspection with acetic acid (VIA) offers a simple, inexpensive screening method suitable for low-resource settings. Colposcopy allows for detailed examination and biopsy of suspicious lesions. Additionally, HPV testing can identify high-risk strains associated with cervical cancer, aiding in preventive measures such as vaccination. The Papanicolaou test (Pap test) serves as the gold standard for detecting cervical cancer and its precancerous lesions, initially exhibiting a sensitivity of 51%, which rises to 86.8% after three tests⁴. Colposcopy enhances diagnostic accuracy by pinpointing suspicious lesions for histopathological examination through directed biopsies, successfully predicting histopathology in 85% of cases⁵.

Screening programs incorporating multiple diagnostic modalities play a pivotal role in early detection and prevention efforts against cervical cancer, particularly in regions with limited resources. The current study aims to further investigate the effects of different screening methods on the detection rate of cervical pathology and their correlation. By doing so, it hopes to contribute to the body of knowledge that informs cervical cancer screening guidelines and ultimately, improve health outcomes for women worldwide. The current study was under taken to determine whether these different methods are mutually exclusive or complimentary.

MATERIALS AND METHODOLOGY

The current study is a Prospective Cross-sectional Study with aim of studying the effect of screening methods on detection rate of cervical pathology and their correlation and to obtain cytology of cervix having abnormal findings, To collect sample for HPV Gene 16, 18, To do Colposcopic examination and to take histopathology if biopsy and correlate the findings of all these screening tests. The current study is a single centre study which was conducted on 104 women in MGM Medical College & Hospital Aurangabad .the study was done from Sept 2022 to March2024.

SAMPLE SIZE

The sample size was calculated using open epi2.3.1, according to study by Bhatla et al⁶ the 15.6% had cervical cytological findings , with 95% confidence level , the sample size was calculated to be 104 . The samples were collected by simple Random sampling method.

INCLUSION AND EXCLUSION CRITERIA

Women above 18 years presenting with symptoms like vaginal discharge, postcoital bleeding, postmenopausal bleeding, inter-menstrual bleeding, itching vulva and persistent leucorrhoea not responding to antibiotics etc. and Women with normal looking cervix but persistent symptoms were included in the study.

Pregnant women, women with Cervix having growth, Prior hysterectomy, Women with clinical evidence of acute pelvic infection, Women who had been previously treated for carcinoma cervix, Women with bleeding at the time of examination were excluded from the study

STUDY TOOLS

A pre-tested validated proforma was developed in line with study objectives to collect data sciodemographic data was used .After obtaining the Ethical clearance, the study was initiated.

informed consent was taken from the participants satisfying inclusion criteria. The data regarding the clinical profile was recorded in the study proforma of consenting individuals. A thorough history including demographic data like age, residential address, socioeconomic status, parity, age at marriage of the patient, was taken. Detailed history of the patient chief complaints, number of pregnancies, menstrual history was taken. Per speculum examination was done and findings were noted. Pap smear was taken, prepared Pap smear slides were fixed in 95% ethyl alcohol and ether and sent for staining and cytological examination by expert cytopathologist. Slides were stained with modified Papanicolaou staining method and examined under light microscope. Cytological interpretation of the smears were made according to the Bethesda system 2014⁵³ .Then patients were subjected for examination with colposcopy. Colposcopy was done and findings were noted. , any identified abnormalities like acetowhite areas, their margins and surface features, atypical vessels, and abnormal iodine staining were documented and analyzed using the Swede Score System (2005)⁷⁶ for colposcopy. Biopsy wherever indicated, was also done. Biopsy specimen were received in 10% formalin fixative. Histopathological slides were prepared and stained with haematoxylin and eosin stain and examined under light microscope by senior pathologist. Biopsy results were categorized as chronic cervicitis, cervical intraepithelial neoplasia I (CIN I), CIN II, CIN III, carcinoma in situ and squamous cell carcinoma

according to WHO. In colposcopy test positive patients, colposcopy directed biopsy was taken from significant lesion area. For Per speculum examination of the cervix the procedure was explained to the women and done The cervix was examined for any irregularities. The following observations were documented as potential signs of an unhealthy cervix like erosions , Enlargement (hypertrophy) of the cervix, Bleeding upon gentle touch Simple Leukoplakia, Ulceration, Keratinization (thickening of the surface layer). If any abnormalities were visible during the initial examination, a Pap smear followed by a visual inspection with acetic acid (VIA) was performed to gather more information.

In LBC Liquid-based cytology , samples were collected by completely immersing the sampling device into the company vial containing preservative unlike conventional smears where the sample is smeared on the slide and fixed separately. The results were interpreted according to the Bethesda system 2014 and categorized as negative (normal or inflammatory), positive (atypical squamous cells of undetermined significance - ASC, low-grade squamous intraepithelial lesion - LSIL, high-grade squamous intraepithelial lesion - HSIL), or suggestive of invasive carcinoma. The patient was typically contacted ten days later for follow-up with the Pap smear report.

ETHICAL CLEARANCE AND WRITTEN INFORMED CONSENT

Ethical clearance was obtained from the Institutional Ethics Committee. Written informed consent for participation in this study was taken from all participants. The confidentiality of the patient's data was ensured. As this is an observational study with no active intervention from the researcher's side the probability of complications or risk to them due to this study was nil. All the investigations done in this study were part of the standard treatment protocol.

DATA ENTRY AND ANALYSIS

Data entry was done in Microsoft Excel 2016 and analyzed using SPSS version 21.0 (IBM). Descriptive statistics included measures like frequency and proportions. Sensitivity, specificity, positive predictive value, negative predictive value and accuracy were calculated for Pap smear with colposcopy and also with histopathology as a gold standard. The results were

represented in tabular and graphical formats. P value of <0.05 was considered as level of significance.

RESULTS

In the current study majority i.e (36.5%) of the study population was in the age group of 31-40 years. 70% of the study population belonged to lower socioeconomic class i.e group IV & V of Kuppuswamy socioeconomic class. 48% of total study population was married at the age between 18 to 25 years. 55% of women were resident from rural area and 49% of the total women was of grandmultipara. Overall incidence of screening test positive cases was more in 31-50 years suggesting that incidence of premalignant lesion is more in 3rd and 4th decade and screening test must target to screen this high risk population for diagnosis of premalignant lesion of cervix. Table no 1

White discharge pervaginum was the most common chief complaint of study population in 41% followed by pain in abdomen in 14% cases. The perspeculum examination findings among 104 individuals reveal that the majority have a normal cervix(59.6%),Erosion is present in 17.3% of cases followed by hypertrophy(11.5%), bleeding on touch(9.7%) .Pap smear results showed that 69.2% had normal findings, and 19.2% exhibited inflammation. HPV testing revealed that 90.4% were negative for HPV. Table No 2.Colposcopy findings were predominantly normal (86.5%), with a small percentage showing cervical intraepithelial neoplasia (CIN) at various stages.

Comparative analysis demonstrated the Pap smear had a sensitivity of 40% and specificity of 91.49% (Table no 3) when compared to HPV test results, and a sensitivity of 42.86% with a specificity of 93.33% against colposcopy findings (Table no 4). Colposcopy compared to HPV tests showed a sensitivity of 40% and a specificity of 89.36% (Table no 5). The positive predictive value (PPV) of the Pap smear was 33.33%, with a negative predictive value (NPV) of 93.48%. For colposcopy, the PPV was 28.57% and the NPV was 93.33%. The sensitivity of co-testing (PAP plus Colposcopy) for detecting HPV was 60.00%. (Table No 6).The combined approach of using both PAP smears and colposcopy (co-testing) for detecting HPV shows a notable improvement in sensitivity (60%) compared to the use of either test alone (Table no 7)

Table 1: Age Distribution of the study participants across three diagnostic tests

Age Distribution (years)	PAP positive (n=12)		HPV positive (n=10)		Colposcopy positive(n=14)		Total (n=104)	
	Number	%	Number	%	Number	%	Number	%
20-30	1	8.33	0	0	0	0	13	12.5
31-40	5	41.66	4	40.0	7	50.0	38	36.5
41-50	4	33.33	3	30.0	4	28.57	35	33.7

51-60	1	8.33	2	20.0	1	7.14	11	10.6
>60	1	8.33	1	10.0	2	14.28	7	6.7
Total	12	100.	10	100.	14	100.	104	100
Socio-economic status		Frequency (n=104)				Percent		
I		1				1.0		
II		7				6.7		
III		20				19.2		
IV		34				32.7		
V		42				40.4		
Total		104				100.0		
Age at marriage (years)	PAP Positive (n=12)		HPV Positive(n=10)		Colposcopy Positive(n=14)		Total (n=104)	
	Number	%	Number	%	Number	%	Number	%
<18	6	50.0	3	30.0	7	50.0	44	42.3
18-25	5	41.7	5	50.0	6	42.85	50	48.1
>25	1	8.33	2	20.0	1	7.14	10	9.6
Total	12	100.0	10	100.0	14	100.0	104	100.0
Address		Frequency(n=104)				Percent(100%)		
Urban		46				44.2		
Rural		58				55.8		
Total		104				100.0		
Parity	PAP Positive (n=12)		HPV Postive (n=10)		Colposcopy Positive (n=14)		Total(n=104)	
	Number	%	Number	%	Number	%	Number	%
Primipara	0	0	0	0	0	0	14	13.5
Multipara	4	33.3	3	30.0	6	42.9	39	37.5
Grandmultipara	8	66.7	7	70.0	8	57.1	51	49.0
Total	12	100.0	10	100.0	14	100.0	104	100.0

Table no 2 showing Per speculum examination findings and pap smear findings of the study participants

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Per speculum examination findings	PAP Postive (n=12)		HPV Positive (n=10)		Colposcopy Positive (n=14)		Total (n=104)	
	Number	%	Number	%	Number	%	Number	%
Normal cervix	2	16.67	3	30	4	28.57	62	59.6
Erosion	4	33.3	3	30	3	21.42	18	17.3
Hypertrophy	1	8.33	0	0	2	14.28	12	11.5
Bleeds on touch.	4	33.33	2	20	3	21.43	10	9.6
Polyp	1	8.33	2	20	2	14.28	2	1.92
Total	12	100.0	10	100.0	14	100.0	104	100.0
Pap Smear findings		Frequency(n=104)				Percent(100%)		
Normal		72				69.2		
Inflammatory		20				19.2		
ASCUS		2				1.9		
LSIL		7				6.7		
HSIL		3				2.9		
Total		104				100.0		
HPV testing		Frequency(n=104)				Percent(!00%)		
Negative		94				90.4		
Positive		10				9.6		
Total		104				100.0		
HPV								

		Positive (n=10)	Negative (94)	Total(n=104)
Pap smear	Abnormal	4	8	12
	Normal	6	86	92
Total		10	94	104

Table no 3 showing Values for PAP smear

Statistic	Value	95% CI
Sensitivity	40.00%	12.16% to 73.76%
Specificity	91.49%	83.92% to 96.25%
Positive Likelihood Ratio	4.70	1.72 to 12.88
Negative Likelihood Ratio	0.66	0.39 to 1.09
Disease prevalence (*)	9.62%	4.71% to 16.97%
Positive Predictive Value (*)	33.33%	15.43% to 57.80%
Negative Predictive Value (*)	93.48%	89.59% to 95.98%
Accuracy (*)	86.54%	78.45% to 92.44%

Table 4 showing PAP smear vs Colposcopy findings

		Colposcopy		Total(n=104)
		Positive (n=14)	Negative (n=90)	
Pap smear	Abnormal	6	6	12
	Normal	8	84	92
Total		14	90	104
Values for PAP smear with colposcopy as the standard				
Statistic	Value	95% CI		
Sensitivity	42.86%	17.66% to 71.14%		
Specificity	93.33%	86.05% to 97.51%		
Positive Likelihood Ratio	6.43	2.41 to 17.16		
Negative Likelihood Ratio	0.61	0.39 to 0.97		
Disease prevalence (*)	13.46%	7.56% to 21.55%		
Positive Predictive Value (*)	50.00%	27.26% to 72.74%		
Negative Predictive Value (*)	91.30%	86.93% to 94.31%		
Accuracy (*)	86.54%	78.45% to 92.44%		

Table 5 showing Colposcopy vs HPV test results

		HPV		Total(n=104)
		Positive(n=10)	Negative(n=94)	
colposcopy	Abnormal	4	10	14
	Normal	6	84	90
Total		10	94	104
Values for Colposcopy				
Statistic	Value	95% CI		
Sensitivity	40.00%	12.16% to 73.76%		
Specificity	89.36%	81.30% to 94.78%		
Positive Likelihood Ratio	3.76	1.44 to 9.81		
Negative Likelihood Ratio	0.67	0.40 to 1.12		
Disease prevalence (*)	9.62%	4.71% to 16.97%		
Positive Predictive Value (*)	28.57%	13.29% to 51.07%		
Negative Predictive Value (*)	93.33%	89.36% to 95.89%		
Accuracy (*)	84.62%	76.22% to 90.94%		

Table 6 showing Co-testing (PAP and Colposcopy) vs HPV test results

		HPV		Total(n=104)
		Positive(n=10)	Negative(n=94)	
Co-testing (PAP and Colposcopy)	Abnormal	6	14	20
	Normal	4	80	84
Total		10	94	104
Statistic		Value	95% CI	
Sensitivity		60.00%	26.24% to 87.84%	
Specificity		81.63%	72.53% to 88.74%	
Positive Likelihood Ratio		3.27	1.70 to 6.30	
Negative Likelihood Ratio		0.49	0.23 to 1.05	
Disease prevalence (*)		9.26%	4.53% to 16.37%	
Positive Predictive Value (*)		25.00%	14.75% to 39.11%	
Negative Predictive Value (*)		95.24%	90.30% to 97.73%	
Accuracy (*)		79.63%	70.80% to 86.77%	

Table 7: Showing Test characteristics of PAP, Colposcopy, Co-testing

Diagnostic test	Sensitivity	Specificity	PPV	NPV	Accuracy
PAP	40.00%	91.49%	33.33%	93.48%	86.54%
Colposcopy	40.00%	89.36%	28.57%	93.33%	84.62%
Co-testing	60.00%	81.63%	25.00%	95.24%	79.63%

DISCUSSION

In the current study the age distribution of our study sample reveals a significant representation of middle-aged individuals, with the majority falling within the 31-40 years (36.5%) and 41-50 years (33.7%) age groups. This aligns closely with the study by Ramadevi et al.⁸ where 70.5% of CIN cases occurred in women aged 30-49 years, indicating that middle-aged women are significantly represented in both studies. Similarly, the study by Sachan et al.⁹ found the majority of participants were between 30 and 50 years old. Gandavaram J et al.¹⁰ also reported that 31-40 years age group was the most common. A study by Winer et al.¹¹ found that women aged 30-45 were more likely to participate in cervical screening due to increased awareness and medical recommendations.

The current study indicates a higher prevalence of cervical abnormalities among individuals in the lower socio-economic strata, with 40.4% belonging to category V and 32.7% to category IV. Ramadevi et al.⁸ also observed a high incidence of CIN (88.2%) in the lower-income group, highlighting the socio-economic influence on cervical health. This trend is further supported by the study by Sachan et al.⁹ which noted that Pap smear abnormalities were more common among women from rural areas, typically associated with lower socio-economic status. These results highlight the importance of addressing socio-economic barriers to screening and treatment, including improving access to healthcare services and providing education on cervical

health. As lower socioeconomic people have lack of awareness about sexual health.

In the current study The age at marriage showed majority of participants in 18-25 years (48.1%), with a notable 42.3% marrying under 18 years which is similar to the findings by Bhalerao et al.¹² where the mean age at marriage was 21 years. As early as 1995, Prabhakar et al.¹³ reported that reduction in early marriages decreased incidence of cervical cancer. Khalaf et al.,¹⁴ reported early age of marriage to be strongly associated with abnormal PAP results. This factor is crucial as early marriage is a recognized risk factor for cervical cancer, corroborated by both studies.

Majority of the participants belonged to the rural areas (55.8%) in the sample, compared to urban residents (44.2%), underscores the disparity in healthcare access between rural and urban areas. This is consistent with findings from Ramadevi et al.⁸ and Sachan et al.⁹, who noted higher incidences of cervical abnormalities in lower socio-economic and rural populations.

The study shows a high proportion of grand multiparas (49.0%), indicating a significant representation of individuals with multiple pregnancies. Similarly, Ramadevi et al.,⁸ where high incidence rates of CIN were found among multiparous women and Sachan et al.⁹ found multiparity to be a significant risk factor for cervical carcinoma. Gandavaram J et al.¹⁰ also reported that multiparous women constituted major (51.2%) of the study population.

The most prevalent clinical symptom observed was white PV discharge (41.3%), followed by pain abdomen (13.5%). Other findings were inter-menstrual bleeding (9.6%), post-menopausal bleeding (9.6%), and low backache (9.6%). Itching vulva (7.7%), post-coital bleeding (6.7%), and foul-smelling P/V discharge (2.9%) are less common symptoms. This is comparable to the findings by Ramadevi et al.,⁸ where 70% of participants complained of excessive vaginal discharge. Bhalerao et al.¹² also reported vaginal discharge as the most common symptom (71%). Gandavaram J et al (2019)¹⁰ also reported that White discharge was the most common symptom in our study (55.2%). Upadhaya and Garg¹⁵ also reported White discharge PV (74%) to be the commonest symptoms followed by irregular bleeding (21%), mass per vagina (6%), post-menopausal bleeding (4%) and pain abdomen (4%). The presence of these symptoms promptly requires clinical evaluation and screening for cervical cancer to ensure early detection and treatment.

Current study indicated that 59.6% of the individuals had a normal cervix, 17.3% had erosion, 11.5% exhibited hypertrophy, 9.6% experienced bleeding on touch, and 1.92% had polyps. Comparatively, Bhalerao et al.¹² observed cervical erosion in 78% of cases, which is higher than our findings. Similarly, Saxena et al.⁵ found significant abnormalities through speculum examinations, supporting its value in initial cervical health assessments. Similar patterns were observed in studies by McCredie et al.¹⁶ and Wright et al.¹⁷ which indicated higher screening rates among women with visible cervical abnormalities.

In our study, the Pap smear findings revealed that 69.2% of the individuals had normal results, 19.2% showed inflammatory findings, 6.7% were diagnosed with low-grade squamous intraepithelial lesions (LSIL), 2.9% with high-grade squamous intraepithelial lesions (HSIL), and 1.9% with atypical squamous cells of undetermined significance (ASCUS). Gandavaram J et al.¹⁰ also reported Pap smear results predominantly indicated negative for intraepithelial lesion or malignancy (67.2%), with malignant cases accounting for 3.2%, LSIL for 9.6%, and HSIL for 6.4%. These results are also comparable to other studies, such as those by Sachan et al.,⁹ who reported 48.84% negative for malignancy and 42.66% indicating infection or inflammation, and Saxena et al.,⁵ who found 67.18% normal results.

In our study, the Pap smear showed a sensitivity of 40.00% (95% CI: 12.16% to 73.76%) and a specificity of 91.49% (95% CI: 83.92% to 96.25%) when compared to HPV test results. This high specificity indicates that the Pap smear is effective in correctly identifying individuals without HPV infection, reducing the likelihood of false positives. However, the relatively low

sensitivity suggests that the Pap smear misses a significant number of true positive cases, failing to detect some individuals who actually have HPV or cervical abnormalities. This pattern of high specificity but low sensitivity is consistent with findings from other studies. For instance, Sankaranarayanan et al.¹⁸ reported similar trends, emphasizing that while the Pap smear is highly specific, it has limitations in sensitivity, particularly in low-resource settings where cytological screening quality may vary. Our study's sensitivity and specificity figures align with those reported in previous research. Saxena et al.⁵ who reported a sensitivity of 33.33% and specificity of 92.59%. Gezer et al.¹⁹ also highlighted the Pap smear's lower sensitivity (47.4%) compared to HPV testing. Najib et al.²⁰ found a sensitivity of 47.19%. A systematic review by Nanda et al.²¹ showed a wide variation of sensitivity of Pap smear ranging from as low as 30% to 70%. In our study, the PPV of the Pap smear was 33.33% (95% CI: 15.43% to 57.80%), and the NPV was 93.48% (95% CI: 89.59% to 95.98%). These values indicate that a normal Pap smear result is highly reliable in predicting the absence of HPV, making it a valuable tool for excluding significant cervical pathology. However, an abnormal Pap smear result is less reliable in predicting the presence of HPV, necessitating follow-up. With more sensitive diagnostic tools. The PLR of 4.70 (95% CI: 1.72 to 12.88) suggests that a positive Pap smear result moderately increases the probability of having HPV, while the NLR of 0.66 (95% CI: 0.39 to 1.09) indicates a somewhat limited ability to rule out HPV when the Pap smear result is normal.

Several studies like Nwesar et al.,²² Terzi et al.²³ also advocate use of both cytology and HPV testing in cervical cancer screening. It indicates different definitive treatment for different grades of lesions. The HPV testing results showed that 90.4% of individuals tested negative, while 9.6% tested positive. This finding is somewhat lower than other studies, such as Gezer et al.¹⁹ who found a 23.7% prevalence of HPV type 16. Sachan et al.⁹ emphasized the critical role of HPV testing in detecting high-risk cases, which aligns with our observation of its importance in screening programs. Higher sensitivity of HPV testing compared to Pap smears makes it essential for early detection of cervical abnormalities and emphasizes the importance of HPV testing as a primary screening tool. The lower positivity rate in our study might reflect differences in the population or screening methods but underscores the necessity of including HPV testing in comprehensive screening protocols. The high negative predictive value (93.48%) indicates that a negative HPV test is highly reliable in excluding cervical cancer, supporting the integration of HPV testing into screening protocols.

In our study, colposcopy findings showed that 86.5% of the individuals had normal results, while 6.7% were

diagnosed with cervical intraepithelial neoplasia grade I (CIN I), 3.8% with CIN II, and 2.9% with CIN III. These results are in line with other studies, such as those by Ramadevi et al.⁸ and Bhalerao et al.,¹² which both highlighted colposcopy's higher sensitivity compared to cytology. Saxena et al.⁵ also underscored the importance of colposcopy in the diagnostic process. Our study reported a sensitivity of 40% and a specificity of 89.36%, which is consistent with findings from Saxena et al.⁵ that showed similar specificity (93.33%) but varying sensitivity rates (42.86%). In contrast to our study, Gandavaram J et al.¹⁰ reported that, Colposcopy exhibited a sensitivity of 80.2% in detecting low-grade lesions and above, with high specificity, positive predictive value, negative predictive value, and accuracy. These results affirm colposcopy as an effective tool for detecting cervical intraepithelial neoplasia and other abnormalities, particularly when used alongside other diagnostic methods like HPV testing.

In our study, the sensitivity of colposcopy was found to be 40% when compared to HPV test results, and its specificity was 89.36%. This pattern of high specificity but lower sensitivity is consistent with other findings in the literature, including those from Saxena et al.⁵ and Gezer et al.¹⁹ Najib et al.²⁰ reported a sensitivity of 64.72% for colposcopy. The PLR of colposcopy in our study was 3.76, and the NLR was 0.67. These likelihood ratios suggest that an abnormal colposcopy finding moderately increases the probability of having HPV, whereas a normal result moderately decreases it. The Positive Predictive Value (PPV) was 28.57%, and the Negative Predictive Value (NPV) was 93.33%, indicating that a normal colposcopy result is highly reliable in predicting the absence of significant cervical abnormalities, whereas an abnormal result is less reliable in predicting the presence of such abnormalities. The findings from our study, underscore the role of colposcopy as a critical component of cervical cancer screening and diagnosis. Despite its lower sensitivity, colposcopy's high specificity makes it a valuable tool for confirming negative cases and for further evaluating abnormal findings from other screening methods, such as the Pap smear. The lower sensitivity observed in colposcopy highlights the necessity of incorporating it as part of a multi-modal screening approach rather than relying on it in isolation. Combining colposcopy with HPV testing, which has shown higher sensitivity in numerous studies, can enhance the overall detection rates of cervical abnormalities. HPV testing is particularly valuable in identifying high-risk individuals who may require closer monitoring and more frequent colposcopic examinations. A systematic review by Jansen et al.²⁴ supports the importance of organized screening programs, including HPV testing, to reduce cervical cancer mortality. By combining these diagnostic

methods in screening protocols, early detection can be enhanced, leading to better management of cervical health and improved patient outcomes. The combined approach of using both PAP smears and colposcopy (co-testing) for detecting HPV shows a notable improvement in sensitivity compared to the use of either test alone. With a sensitivity of 60%, co-testing is better at identifying individuals who are truly HPV positive, thereby reducing the risk of missed cases. This improvement is crucial because early detection of HPV can lead to better management and treatment outcomes for individuals at risk of cervical abnormalities. However, the specificity of co-testing decreases to 85.11%, which means that there are more false positives compared to when using PAP smears or colposcopy alone. Despite this reduction in specificity, the benefit of increased sensitivity often outweighs the drawback of additional false positives, particularly in a screening context where the goal is to identify as many true cases as possible. The high NPV of 95.24% further supports the reliability of co-testing in ruling out HPV infections. Individuals with normal results from both tests can be more confidently assured that they are not infected with HPV, which can reduce unnecessary anxiety and follow-up procedures.

CONCLUSIONS

In the current study a multimodal screening approach including liquid based cytology HPV gene detection test, Colposcopy is essential for optimizing cervical cancer detection and management. Integrating Co testing of HPV with pap smear and colposcopy is complimentary to each other for detecting preinvasive cervical cancer. It enhance early detection and provide more comprehensive care to individual risk. Additionally biopsy remains the gold standard for diagnosing the cervical pathology providing definitive histopathological confirmation. While colposcopy and other screening methods are critical for initial detection and evaluation. We cannot comment on which test is ideal for all but the screening test should be individualised depending upon the signs and symptoms of the individual. In case of persistent symptoms and high suspicion findings of cervix CO-testing are always helpful and advisable. In each case screening test to be individualised and if needed biopsy to be done and extensive treatment should be offered i/v/o high prevalence of carcinoma of cervix. The low sensitivity of pap smear and colposcopy indicates that these test should not be solely relied upon for detecting cervical abnormalities however their high specificity make them valuable in confirming negative cases. Incorporating HPV testing which has higher sensitivity into screening programs is essential for improving detection rates. The choice of testing strategy depends on the clinical context and the relative

importance of minimizing false negatives versus false positives. Co-testing appears advantageous in scenarios where missing a positive case would have significant consequences, despite the increased rate of false positives.

DECLARATIONS

Ethics Approval

The study was conducted in accordance with the ethical standards of the institution. Ethical approval was obtained from the Institutional Ethics Committee of MGM Medical College & Hospital, Chhatrapati Sambhajanagar, Maharashtra, India.

Consent to Participate

Written informed consent was obtained from all participants before their participation in the study.

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Conflict of Interest

The authors declare that they have no conflict of interest.

Authors' Contributions

All authors contributed to the conception and design of the study, data collection, analysis and interpretation of results, drafting and revision of the manuscript, and approved the final version.

Data Availability Statement

The data supporting the findings of this study are available from the corresponding author upon reasonable request.

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REFERENCES

1. Sung H, Ferlay J, Siegel RL, Laversanne M, Soerjomataram I, Jemal A, et al. Global Cancer Statistics 2020: GLOBOCAN Estimates of Incidence and Mortality Worldwide for 36 Cancers in 185 Countries. *CA Cancer J Clin*. 2021 May;71(3):209–49.
2. Human Papillomavirus and Related Cancers, Fact Sheet 2023 [Internet]. Available from: https://hpvcentre.net/statistics/reports/IND_FS.pdf
3. Poudel A, Dahal P. Cytohistological correlation of conventional Papanicolaou smears in cervical neoplasia at a tertiary care hospital of Nepal. *J*

Pathol Nepal [Internet]. 2019 Mar 29 [cited 2024 Feb 27];9(1):1475–9. Available from: <https://nepjol.info/index.php/JPN/article/view/23372>

4. Satija A, Khanna P, GUpta R, Gill B, Malhotra V. Colposcopic evaluation of patients with abnormal cervical cytology. *Obstet Gynecol Surv*. 1976;31(11):815–7.

5. Saxena R, Agrawal A, Agarwal N, Gupta M, Shubham D, Rathore P. Comparative evaluation of colposcopy, cytology and histopathology for diagnosis of cervical lesions. *Int J Reprod Contraception, Obstet Gynecol* [Internet]. 2019 Aug 26 [cited 2024 Feb 27];8(9):3584–9. Available from:

<https://www.ijrcog.org/index.php/ijrcog/article/view/6843>

6. Bhatla N, Gulati A, Mathur SR, Rani S, Anand K, Muwonge R, Sankaranarayanan R. Evaluation of cervical screening in rural North India. *International Journal of Gynecology & Obstetrics*. 2009 May 1;105(2):145–9.

7. Bowring J, Strander B, Young M, Evans H, Walker P. The Swede score: evaluation of a scoring system designed to improve the predictive value of colposcopy. *Journal of lower genital tract disease*. 2010 Oct 1;14(4):301–5.

8. Ramadevi E, Mamata N, Madhavi GB, Rani V S, Padmalatha R, Shamili G. a Study of Correlation Between Cytology and Histopathology With Colposcopic Findings. *Int J Integr Med Sci*. 2017;4(4):477–83.

9. Sachan P, Singh M, Patel M, Sachan R. A Study on Cervical Cancer Screening Using Pap Smear Test and Clinical Correlation. *Asia-Pacific J Oncol Nurs* [Internet]. 2018 Jul 1 [cited 2024 Feb 27];5(3):337. Available from: <https://pubmed.ncbi.nlm.nih.gov/35996593/>

10. . Gandavaram J, Pamulapati BR. Correlation of Pap smear and colposcopic findings in relation to histopathological findings among women attending a tertiary care hospital: a two year study. *Int J Reprod Contraception, Obstet Gynecol*. 2019;8(6):2163

11. Winer RL, Lee SK, Hughes JP, Adam DE, Kiviat NB, Koutsky LA. Genital human papillomavirus infection: incidence and risk factors in a cohort of female university students. *Am J Epidemiol* [Internet]. 2003 Feb 1 [cited 2024 Jun 21];157(3):218–26. Available from: <https://pubmed.ncbi.nlm.nih.gov/12543621/>

12. Bhalerao A, Kulkarni S, Ghike S, Kawthalkar A, Joshi S. Correlation of pap smear, colposcopy and histopathology in women with unhealthy cervix. *J SAFOG*. 2012;4(2):97–8.
13. Prabhakar AK, Menon GR. Age at marriage and cervical cancer incidence. *Indian J Cancer*. 1995 Jun;32(2):63–8.
14. Khalaf MK, Rasheed FA, Hussain SA, Khalaf MK, Rasheed FA, Hussain SA. Association between Early Marriage and Other Sociomedical Characteristics with the Cervical Pap Smear Results in Iraqi Women. *Adv Sex Med* [Internet]. 2015 Sep 23 [cited 2024 Jun 23];5(4):73–82. Available from: <http://www.scirp.org/journal/PaperInformation.aspx?PaperID=59843>
15. Upadhyay J, Garg S. View of Correlation of Pap smear and colposcopic finding with directed biopsy in detection of cervical neoplasm | *Tropical Journal of Pathology and Microbiology*. *Pathol Updat J Path Micro* [Internet]. 2017 [cited 2024 Jun 2];3(4):396–400. Available from: <https://pathology.medresearch.in/index.php/jopm/article/view/108/215>
16. McCredie MR, Sharples KJ, Paul C, Baranyai J, Medley G, Jones RW, et al. Natural history of cervical neoplasia and risk of invasive cancer in women with cervical intraepithelial neoplasia 3: a retrospective cohort study. *Lancet Oncol* [Internet]. 2008 May [cited 2024 Jun 21];9(5):425–34. Available from: <https://pubmed.ncbi.nlm.nih.gov/18407790/>
17. Wright TC, Thomas Cox J, Stewart Massad L, Twiggs LB, Wilkinson EJ. 2001 Consensus Guidelines for the management of women with cervical cytological abnormalities. *JAMA* [Internet]. 2002 Apr 24 [cited 2024 Jun 21];287(16):2120–9. Available from: <https://pubmed.ncbi.nlm.nih.gov/11966387/>
18. Sankaranarayanan R, Chatterji R, Shastri SS, Wesley RS, Basu P, Mahei C, et al. Accuracy of human papillomavirus testing in primary screening of cervical neoplasia: results from a multicenter study in India. *Int J cancer* [Internet]. 2004 Nov 1 [cited 2024 Feb 28];112(2):341–7. Available from: <https://pubmed.ncbi.nlm.nih.gov/15352050/>
19. Gezer S, Ozturk SK, Balci S, Yucesoy I. The concordance between colposcopic biopsy and loop electrosurgical excision procedures in patients with known smear cytology and human papillomavirus results. *North Clin Istanbul* [Internet]. 2021 [cited 2024 Feb 29];8(6):588. Available from: </pmc/articles/PMC8848493/>
20. Najib F sadat, Hashemi M, Shiravani Z, Poordast T, Sharifi S, Askary E. Diagnostic Accuracy of Cervical Pap Smear and Colposcopy in Detecting Premalignant and Malignant Lesions of Cervix. *Indian J Surg Oncol* [Internet]. 2020 Sep 1 [cited 2024 Jun 2];11(3):453. Available from: </pmc/articles/PMC7501362/>
21. Nanda K, McCrory DC, Myers ER, Bastian LA, Hasselblad V, Hickey JD, et al. Accuracy of the Papanicolaou test in screening for and follow-up of cervical cytologic abnormalities: a systematic review. *Ann Intern Med* [Internet]. 2000 May 16 [cited 2024 Jun 2];132(10):810–9. Available from: <https://pubmed.ncbi.nlm.nih.gov/10819705/>
22. Nwesar FA, Salam T. TA, M. MH, Younis LK, Abou-Zeid ZS, Elkaffash DMN. The use of HPV-DNA testing combined with Pap smear in detection of pre-invasive disease of the cervix. *Int J Reprod Contraception, Obstet Gynecol*. 2017;6(12):5192.
23. Kaya Terzi N, Yulek O. Assessment of Cervicovaginal Smear and HPV DNA Co-Test for Cervical Cancer Screening: Implications for Diagnosis and Follow-Up Strategies. *Diagnostics*. 2024 Mar 1;14(6).
24. Jansen EEL, Zielonke N, Gini A, Anttila A, Segnan N, Vokó Z, et al. Effect of organised cervical cancer screening on cervical cancer mortality in Europe: a systematic review. *Eur J Cancer*. 2020 Mar 1;127:207–23.