ORIGINAL RESEARCH PAPER
Volume - 15 | Issue - 09 | September - 2026 | PRINT ISSN No. 2277 - 8179 | DOI : 10.36106/ijsr
INTERNATIONAL JOURNAL OF SCIENTIFIC RESEARCH

DIAGNOSTIC ACCURACY OF THE ABCD CRITERIA FOR VISUAL INSPECTION WITH ACETIC ACID IN DETECTING CERVICAL INTRAEPITHELIAL NEOPLASIA GRADE 2 OR WORSE: A PROSPECTIVE OBSERVATIONAL STUDY FROM A TERTIARY CARE HOSPITAL IN NORTHWEST INDIA

Obstetrics & Gynaecology

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ABSTRACT

Background: Visual inspection with acetic acid (VIA) underpins cervical cancer screening across low- and middle-income countries, but its interpretation is subjective and inter-observer agreement is variable. The ABCD criteria-acetowhiteness, bleeding on touch, colouring with Lugol's iodine and lesion diameter were devised to standardise VIA reporting. Their performance has been reported chiefly from HPV-positive triage cohorts in sub-Saharan Africa and has not been evaluated in an Indian hospital screening population. **Methods:** We conducted a prospective observational study of diagnostic accuracy in the Department of Obstetrics and Gynaecology, SMS Medical College, Jaipur, between March 2024 and February 2025. Two hundred and seventeen women aged 30–65 years undergoing cervical cancer screening were assessed by VIA and VILI using the ABCD criteria, and all underwent cervical biopsy as the reference standard. Sensitivity, specificity, predictive values, likelihood ratios and Cohen's kappa were calculated for the detection of CIN 2 or worse (CIN 2+), with 95% confidence intervals by the Wilson method. Determinants of CIN 2+ were examined by chi-square testing and logistic regression. **Results:** The mean age was 45.2 ± 8.7 years and the ABCD criteria were positive in 75 women (34.6%). Histopathology showed no abnormality in 112 (51.6%), CIN 1 in 40 (18.4%), CIN 2 or 3 in 45 (20.7%) and invasive carcinoma in 20 (9.2%), giving a CIN 2+ prevalence of 30.0%. The ABCD criteria yielded a sensitivity of 76.9% (95% CI 65.4–85.5), specificity of 83.6% (76.8–88.6), positive predictive value of 66.7% (55.4–76.3), negative predictive value of 89.4% (83.3–93.5) and overall accuracy of 81.6% (75.9–86.2), with moderate agreement with histology ($\kappa = 0.58$; $\chi^2 = 81.9$, $p < 0.001$). Women with CIN 2+ were older (48.5 ± 7.2 versus 43.2 ± 6.8 years, $p < 0.001$), and prevalence rose from 24.4% at 30–40 years to 38.5% above 50 years. Grand multiparity was associated with CIN 2+ (60.0% versus 27.3% at parity 0–2; $p = 0.002$). Age above 50 years (OR 1.8, 95% CI 1.2–2.7) and ABCD positivity (OR 3.5, 95% CI 2.1–5.8) independently predicted CIN 2+. VIA was acceptable to 92.6% of participants and 94% of screen-positive women completed colposcopic referral.**Conclusion:** In a hospital-based Indian screening population with a high underlying prevalence of disease, the ABCD criteria delivered a substantially better balance of sensitivity and specificity than has been reported from HPV-triage cohorts, missing roughly one CIN 2+ lesion in four while correctly reassuring nearly nine in ten screen-negative women. Structured ABCD reporting is a low-cost means of improving the reproducibility of VIA and is well suited to single-visit screen-and-treat pathways, provided that screen-negative women with high-risk profiles remain within a defined re-screening interval.

KEYWORDS

Cervical Cancer Screening; Visual Inspection With Acetic Acid; ABCD Criteria; Cervical Intraepithelial Neoplasia; Diagnostic Accuracy; India

INTRODUCTION

Cervical cancer is almost uniquely preventable among common malignancies, because invasion is preceded by a prolonged and detectable precancerous phase. Where organised cytology or human papillomavirus (HPV) based screening has been established, incidence and mortality have fallen substantially.[1,2] Yet the global burden remains heavily concentrated in low- and middle-income countries: of an estimated 662,000 new cases and 349,000 deaths worldwide in 2022, India alone accounted for approximately 127,500 cases and 79,900 deaths, making cervical cancer the second commonest malignancy among Indian women.[3]

The World Health Organization's global strategy for elimination sets a threshold of four cases per 100,000 women-years and the 90-70-90 targets: 90% of girls vaccinated against HPV by age 15, 70% of women screened with a high-performance test by 35 and again by 45 years, and 90% of women with cervical disease receiving treatment.[4] India remains far from the screening target; national survey data indicate that fewer than 2% of women aged 30–49 years have ever been screened.[3] Cytology and HPV testing both require laboratory infrastructure, trained cytotechnologists or molecular platforms, and at least two clinic visits — barriers that are decisive in settings where loss to follow-up is the dominant programmatic failure.

Visual inspection with acetic acid (VIA) circumvents these constraints. It is inexpensive, requires no laboratory, produces an immediate result and can be performed by trained nurses or midwives, making single-visit screen-and-treat strategies feasible.[5] Large cluster-randomised trials in India have demonstrated that VIA-based screening reduces cervical cancer mortality: the Mumbai trial conducted by primary health workers reported a 31% reduction in cervical cancer mortality,[6] and the Tamil Nadu trial showed reductions in both incidence and mortality.[7] VIA is consequently the backbone of India's operational framework for cervical cancer screening.

The principal weakness of VIA is interpretive. Acetowhitening is a non-specific epithelial response that also occurs with immature squamous metaplasia, cervicitis and regenerating epithelium, and judgement of what constitutes a "positive" test rests on the individual examiner. Pooled estimates of VIA accuracy therefore span a wide range, with sensitivity for CIN 2+ reported between roughly 40% and 80% and specificity between 60% and 90%, and inter-observer agreement is only moderate.[8,9] Variability of this magnitude undermines quality assurance and makes programme performance difficult to predict.

The ABCD criteria were developed to address exactly this problem by converting a global visual impression into four explicit, teachable components: **A** for acetowhiteness of an area contiguous with the transformation zone, **B** for bleeding on contact, **C** for colouring after application of Lugol's iodine, and **D** for a lesion diameter greater than 5 mm.[10] In the derivation study, conducted among 340 HPV-positive women in the Dschang health district of West Cameroon, the criteria achieved a sensitivity of 77.5% and a negative predictive value of 93.3% but a specificity of only 42.0% and a positive predictive value of 15.1%, implying considerable overtreatment when applied as a triage test after primary HPV screening.[10]

Whether this performance transfers to a different epidemiological context is an open question. Diagnostic indices are not properties of a test alone: predictive values depend on the prevalence of disease, and both sensitivity and specificity are sensitive to spectrum effects, to the age structure of the population and to the proportion of women with a fully visible transformation zone. An Indian hospital screening population differs from a Cameroonian HPV-positive triage cohort in all of these respects. We therefore undertook this study to determine the accuracy of the ABCD criteria for the detection of histologically confirmed CIN 2+ among women undergoing cervical cancer screening at a tertiary care teaching hospital in Jaipur, and to identify

demographic and clinical determinants of high-grade disease in this population.

MATERIALS AND METHODS

Study design and setting

This prospective observational study of diagnostic accuracy was conducted in the Department of Obstetrics and Gynaecology, SMS Medical College and Attached Group of Hospitals, Jaipur, a tertiary care teaching hospital serving Rajasthan and adjoining states. Recruitment ran from March 2024 to February 2025.

Participants

Women aged 30–65 years attending the gynaecology outpatient department and willing to undergo cervical cancer screening were eligible, provided they gave written informed consent and were not enrolled in another study. Women were excluded if they had previously been treated for CIN or cervical carcinoma, had undergone hysterectomy, were menstruating or within four days of delivery or abortion, had acute genital infection such as vulvovaginitis or cervicitis, or had a cervix that could not be adequately visualised because of severe atrophy or other technical difficulty. Recruitment was by convenience sampling. The sample size of 217 was derived from an expected sensitivity of the ABCD criteria of 77%, an anticipated underlying HPV positivity of 30%, 95% confidence and 80% power, with 10% added for attrition.

Screening procedure and index test

After a bimanual examination, the cervix was exposed with a Cusco speculum and inspected under a bright light source. Three to five per cent acetic acid was applied and the cervix re-inspected after one minute; Lugol's iodine was then applied and the appearance recorded. Each cervix was classified according to the four ABCD components: acetowhiteness of an area touching the transformation zone, bleeding on touch, colouring after Lugol's iodine, and lesion diameter exceeding 5 mm. The transformation zone was documented as type 1, 2 or 3. The overall ABCD result was codified as positive or negative before the biopsy result was known.

Reference standard

All participants underwent cervical biopsy, directed at any visible lesion and otherwise taken from the squamocolumnar junction, and the specimens were reported by the Department of Pathology without knowledge of the screening result. Histopathology was categorised as no abnormality, CIN 1, CIN 2 or 3, or invasive carcinoma. The target condition, CIN 2+, comprised CIN 2, CIN 3 and invasive carcinoma. Colposcopy was performed as part of the diagnostic pathway and its findings recorded separately. Demographic and reproductive data, HIV status, acceptability of the procedure and adverse events were recorded on a structured proforma, and the interval to colposcopy and to the histopathology report was documented.

Statistical analysis

Data were entered in Microsoft Excel and analysed using SPSS version 25.

RESULTS

Participant characteristics

Two hundred and seventeen women were enrolled. The mean age was 45.2 ± 8.7 years; 90 women (41.5%) were aged 30–40 years, 75 (34.6%) were 41–50 years and 52 (24.0%) were older than 50 years. Half the cohort (110 women, 50.7%) had parity 0–2, 82 (37.8%) had three or four births and 25 (11.5%) were grand multiparous with more than four births. Just over half had secondary or tertiary education (116, 53.5%). Sexual debut at or before 17 years was reported by 63 women (29.0%), and 42 (19.3%) reported more than four lifetime partners. Nine women (4.1%) were HIV-positive. The transformation zone was type 1 in 143 women (65.8%), type 2 in 48 (22.0%) and type 3 in 26 (12.2%) (Table 1).

Table 1. Baseline characteristics of study participants (N = 217)

Characteristic	Category	n (%)
Age (years)	30–40	90 (41.5)
	41–50	75 (34.6)
	> 50	52 (24.0)
Parity	0–2	110 (50.7)
	3–4	82 (37.8)
	> 4	25 (11.5)
Education	Unschooled / primary	101 (46.5)
	Secondary / tertiary	116 (53.5)
Age at first intercourse (years)	≤ 17	63 (29.0)
	≥ 18	154 (71.0)
Lifetime sexual partners	1	98 (45.2)
	2–4	77 (35.5)
	> 4	42 (19.3)
Contraceptive use	Yes	143 (65.9)
HIV status	Positive	9 (4.1)
Transformation zone	Type 1	143 (65.8)
	Type 2	48 (22.0)
	Type 3	26 (12.2)

Screening and histopathological findings

The ABCD criteria were positive in 75 women (34.6%) and negative in 142 (65.4%). Histopathology of the cervical biopsy showed no abnormality in 112 women (51.6%), CIN 1 in 40 (18.4%), CIN 2 or CIN 3 in 45 (20.7%) and invasive carcinoma in 20 (9.2%). The target condition, CIN 2+, was therefore present in 65 women, a prevalence of 30.0% (95% CI 24.3–36.4) in this hospital-based screening population (Table 2).

Table 2. Index test result and histopathological diagnosis (N = 217)

Result	n (%)
ABCD criteria	
Positive	75 (34.6)
Negative	142 (65.4)
Histopathology	
No abnormality	112 (51.6)
CIN 1	40 (18.4)
CIN 2 / CIN 3	45 (20.7)
Invasive carcinoma	20 (9.2)
CIN 2+ (target condition)	65 (30.0)

Diagnostic accuracy of the ABCD criteria

Of the 65 women with CIN 2+, 50 were correctly identified as ABCD-positive and 15 were missed. Of the 152 women without CIN 2+, 127 were correctly classified as ABCD-negative and 25 were false positives, of whom 14 had CIN 1 and 11 had a histologically normal cervix (Table 3). The association between the index test and the reference standard was highly significant ($\chi^2 = 81.9$, df = 2, $p < 0.001$).

Table 3. Cross-tabulation of ABCD result against histopathology (N = 217)

Histopathology	ABCD positive	ABCD negative	Total
CIN 2+	50	15	65
CIN 1	14	26	40
No abnormality	11	101	112
Total	75	142	217

Derived indices are shown in Table 4. The ABCD criteria detected roughly three-quarters of high-grade lesions and correctly reassured over four-fifths of women without high-grade disease. A positive likelihood ratio of 4.7 indicates that a positive result raises the probability of CIN 2+ appreciably, while a negative likelihood ratio of 0.28 reduces it substantially without excluding disease. Agreement with histology was moderate ($\kappa = 0.58$), and the odds of CIN 2+ were nearly seventeen-fold higher among screen-positive women (OR 16.9, 95% CI 8.3–34.8).

Table 4. Diagnostic performance of the ABCD criteria for CIN 2+ (N = 217)

Index	Value	95% CI
Sensitivity	76.9%	65.4–85.5
Specificity	83.6%	76.8–88.6
Positive predictive value	66.7%	55.4–76.3
Negative predictive value	89.4%	83.3–93.5
Overall accuracy	81.6%	75.9–86.2
Positive likelihood ratio	4.68	—
Negative likelihood ratio	0.28	—
Youden index	0.61	—
Cohen's kappa	0.58	—

Determinants of CIN 2+

Women with CIN 2+ were significantly older than those without (48.5 ± 7.2 versus 43.2 ± 6.8 years; t = 5.05, p < 0.001). The prevalence of CIN 2+ rose across age strata from 24.4% among women aged 30–40

years to 30.7% at 41–50 years and 38.5% above 50 years, a gradient that did not reach conventional significance on a test for trend in this sample (p = 0.078). ABCD positivity was correspondingly higher in the oldest stratum (40.4%) than in the youngest (33.3%) (Table 5).

Table 5. CIN 2+ prevalence and ABCD positivity by age and parity

Stratum	n	ABCD positive, n (%)	CIN 2+, n (%)
Age (years)			
30–40	90	30 (33.3)	22 (24.4)
41–50	75	24 (32.0)	23 (30.7)
> 50	52	21 (40.4)	20 (38.5)
Parity			
0–2	110	40 (36.4)	30 (27.3)
3–4	82	24 (29.3)	20 (24.4)
> 4	25	11 (44.0)	15 (60.0)

Parity showed a strong association with high-grade disease. CIN 2+ was confirmed in 60.0% of grand multiparous women compared with 27.3% of those with parity 0–2 and 24.4% of those with three or four births ($\chi^2 = 12.34$, df = 2, p = 0.002); the odds of CIN 2+ among women with more than four births were more than four times those of the remainder of the cohort (OR 4.26, p = 0.001).

On binary logistic regression, age above 50 years (OR 1.8, 95% CI 1.2–2.7; p = 0.005) and a positive ABCD result (OR 3.5, 95% CI 2.1–5.8; p < 0.001) were independent predictors of CIN 2+, whereas parity above three was not (OR 1.4, 95% CI 0.9–2.1; p = 0.12). A type 3 transformation zone was strongly associated with discordance between the visual assessment and histology (adjusted OR 6.47, 95% CI 2.59–16.21; p < 0.001).

Comparison with colposcopy, acceptability and pathway timing

Colposcopic assessment performed within the diagnostic pathway showed a sensitivity of 85.4%, specificity of 93.8%, positive predictive value of 78.9% and negative predictive value of 95.2% for CIN 2+, with substantial agreement with histology ($\kappa = 0.78$).

The screening procedure was well tolerated. Of the 217 participants, 150 (69.1%) rated VIA as very acceptable and 51 (23.5%) as acceptable, a combined acceptability of 92.6%, while 16 (7.4%) found it unacceptable. Mild discomfort was reported by 12% of women and no serious adverse events occurred. Among the 75 screen-positive women, 71 (94%) completed colposcopic referral and 4 (6%) were lost to follow-up. VIA results were available immediately; colposcopy was completed at a mean of 7 days (range 5–10) and histopathology reports at a mean of 14 days (range 10–20).

DISCUSSION

In this prospective hospital-based study of 217 women undergoing cervical cancer screening, structured ABCD assessment of VIA and VILI identified 76.9% of histologically confirmed CIN 2+ lesions while correctly classifying 83.6% of women without high-grade disease. Overall accuracy was 81.6% and agreement with histology was moderate. Age above 50 years and a positive ABCD result independently predicted high-grade disease, and grand multiparity was strongly associated with CIN 2+ on unadjusted analysis.

Comparison with the derivation cohort

The most instructive comparison is with the study in which the ABCD criteria were derived, conducted among 340 HPV-positive women in West Cameroon.[10] Sensitivity in that cohort (77.5%) was almost identical to ours (76.9%), which is reassuring: it suggests that the criteria capture the same visual phenomenon with similar reliability in two very different populations. Specificity, however, differed sharply — 42.0% in Cameroon against 83.6% here — as did the predictive values, with a positive predictive value of 15.1% there and 66.7% here, and a negative predictive value of 93.3% there against 89.4% here.

These differences are largely explicable and should not be read as evidence that the criteria perform "better" in India. Three mechanisms operate simultaneously. First, prevalence: CIN 2+ affected 30.0% of our participants against roughly 12% of the Cameroonian triage cohort, and because predictive values move with prevalence, a higher pre-test probability mechanically inflates the positive predictive value and deflates the negative predictive value. Second, spectrum: our cohort was recruited from a gynaecology outpatient department at a referral hospital and included women presenting with symptoms, so lesions were on average larger and more advanced — nearly one in ten women had frank invasive carcinoma and large, unambiguous lesions are easier to classify correctly in both directions. Third, the comparator population: applying the criteria to women already selected for HPV positivity concentrates the difficult cases, since transient HPV infection commonly produces minor acetowhite change without underlying high-grade disease, precisely the situation in which the criteria generate false positives.

The practical implication is that the ABCD criteria behave differently according to where they sit in the screening pathway. Used as a triage test after primary HPV screening, their limiting characteristic is specificity and the dominant risk is overtreatment. Used as a primary screening test in a population with substantial undetected disease, as here, they perform respectably in both directions, and the limiting characteristic becomes sensitivity — the one lesion in four that is missed.

Comparison with the wider VIA literature

Conventional VIA has been evaluated extensively in India. The pooled estimates from meta-analysis place sensitivity for CIN 2+ around 70–80% with specificity between 60% and 90%, with wide variation between studies attributable to examiner training and case mix.[8] Our specificity of 83.6% sits at the upper end of that range, and the moderate kappa of 0.58 suggests that structured reporting achieved consistency without eliminating interpretive uncertainty. The broader value of the ABCD approach is not that it raises accuracy dramatically — the point estimates remain within the range achievable by well-trained examiners using conventional criteria — but that it makes the basis of the decision explicit and therefore teachable, auditable and reproducible across providers. In a national programme delivered largely by auxiliary nurse midwives, that property may matter more than a few percentage points of sensitivity.

The clinical importance of these figures is best appreciated through the trial evidence. VIA screening delivered by primary health workers in Mumbai reduced cervical cancer mortality by 31% over four rounds,[6] and visual screening in Tamil Nadu reduced both incidence and mortality.[7] These benefits were achieved with unstructured VIA of unremarkable accuracy, which underlines a point often lost in diagnostic accuracy studies: programme effectiveness depends at least as much on coverage, on the proportion of screen-positive women who complete treatment, and on the re-screening interval as on the operating characteristics of the test itself. The 94% referral completion observed here is therefore as noteworthy as the sensitivity.

Determinants of high-grade disease

The association of CIN 2+ with older age is consistent with the natural history of HPV infection, in which persistent infection acquired years earlier progresses to high-grade disease with a lag of one to two decades, and with the WHO's rationale for concentrating screening between 30 and 49 years.[4] It also carries a technical corollary that our data illustrate: 12.2% of women had a type 3 transformation zone, which was strongly associated with discordance between visual assessment and histology. Because the squamocolumnar junction recedes into the endocervical canal after the menopause, lesions in older women are systematically less visible, and visual methods lose sensitivity in precisely the age group with the highest disease prevalence. Any programme relying on VIA should recognise that a negative result in a postmenopausal woman with a type 3 transformation zone is weaker evidence of absence than the same result in a woman of 35.

Grand multiparity was associated with a CIN 2+ prevalence of 60.0% in our cohort. High parity is an established co-factor in cervical carcinogenesis, plausibly through hormonal influences on the transformation zone, cervical trauma and prolonged exposure of the metaplastic epithelium; it also correlates strongly with early sexual debut, lower socioeconomic position and reduced access to screening, so the crude association overstates any independent biological effect. That parity was not significant in the adjusted model while remaining strong in unadjusted analysis is consistent with confounding by age and by the other reproductive variables. For screening purposes the distinction matters less than the practical message: grand multiparous women constitute an identifiable high-yield group for targeted outreach.

Comparison with colposcopy

Colposcopy outperformed the ABCD criteria on every index in our data, as expected given magnification and the ability to assess vascular patterns. The margin, however, was modest in sensitivity (85.4% versus 76.9%) relative to the difference in cost, training requirement and availability. Colposcopy in India is largely confined to district and tertiary hospitals, requires a second visit, and in our own pathway added a mean of seven days before diagnosis. Where the alternative to same-day visual assessment is a referral that a substantial fraction of women will not complete, a test that is somewhat less accurate but delivered immediately may prevent more cancers than a better test delivered late or not at all. This comparison should nonetheless be interpreted with caution, since colposcopy was performed within the diagnostic pathway rather than independently and simultaneously in all participants.

Implications for practice

Three implications follow. First, structured ABCD reporting should be incorporated into VIA training and quality assurance, as it converts an impression into recordable components that can be audited and compared between providers. Second, screen-and-treat decisions based on a positive ABCD result in a population resembling ours would result in treatment of a woman without high-grade disease in roughly one case in three; where thermal ablation is the treatment, with its low morbidity, that trade-off is defensible, but it argues for triage by colposcopy or HPV testing wherever the infrastructure permits. Third, and most important, a negative ABCD result reduces but does not eliminate the probability of high-grade disease — 15 of our 65 CIN 2+ lesions, including some invasive cancers, occurred in screen-negative women. Adherence to the recommended re-screening interval, and a low threshold for further evaluation of symptomatic or high-risk screen-negative women, is essential.

Strengths and limitations

The principal strength of this study is that every participant underwent cervical biopsy, so the accuracy estimates are free of the partial verification bias that affects studies in which only screen-positive women are biopsied. Assessment was prospective and the index test was recorded before histology was known. All VIA examinations were performed by a single examiner, which ensured consistency but precludes any estimate of inter-observer agreement the very property the ABCD criteria are designed to improve and limits generalisability to a programme delivered by many providers of varying experience.

CONCLUSION

Structured assessment of the cervix using the ABCD criteria achieved a sensitivity of 76.9% and specificity of 83.6% for histologically confirmed CIN 2+ in a hospital-based Indian screening population with a high prevalence of disease, with an overall accuracy of 81.6% and moderate agreement with histopathology. Performance was substantially more balanced than that reported when the same criteria were applied to HPV-positive triage cohorts, a difference driven mainly by disease prevalence and case spectrum rather than by the criteria themselves. Older age, a type 3 transformation zone and grand multiparity identify women in whom visual screening is least reliable and disease most likely, and in whom additional vigilance is warranted. The ABCD framework offers a low-cost, well-accepted means of making VIA more objective and auditable, and is well suited to single-visit screening pathways in resource-constrained settings — provided that its residual false-negative rate is managed through defined re-screening intervals rather than assumed away.

Acknowledgements: The authors thank the faculty and residents of the Department of Obstetrics and Gynaecology and the staff of the Department of Pathology, SMS Medical College and Hospital, Jaipur, and the women who consented to participate.

Conflicts of interest: None declared.
Funding: None.

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