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Original Research Article

Efficacy of Dual Screening (VIA AND PAP SMEAR) And Referral Pathways for Cervical Pre-Malignancies: A Two-Year Retrospective Study at a Tertiary Care Center in Rural Bihar

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Conflict of interest: Nil

Abstract:

Background: Cervical cancer remains the second leading cause of cancer mortality among women in India, with an exceptionally high burden in socioeconomically marginalized rural regions such as Bihar. Early detection via effective secondary prevention is critical given that nearly 60–70% of patients present at advanced clinical stages. While Visual Inspection with Acetic Acid (VIA) is widely implemented as a low-cost, point-of-care screening tool, its low specificity can strain resource-constrained health infrastructure. This study evaluates the dual utilization of VIA and conventional Papanicolaou (Pap) smear cytology to streamline referral pathways for cervical pre-malignancies in an environment lacking advanced molecular and liquid cytology platforms.

Aims and Objectives: To evaluate the institutional efficacy of a dual cervical screening pathway utilizing Visual Inspection with Acetic Acid (VIA) and conventional Papanicolaou (Pap) smear cytology in a resource-limited tertiary care ecosystem in rural Bihar.

Methods: A two-year retrospective, descriptive epidemiological study was conducted under the academic guidance of Dr. Seema Singh, Head of Department (HOD) using clinical records from 2024 and 2025 at the tertiary care teaching hospital of the Bhagwan Mahavir Institute of Medical Sciences, Pawapuri. Documented screening outcomes from a total population of 1,839 women who underwent VIA testing, alongside a parallel subset of 510 women who received conventional Pap smear cytological profiling, were systematically extracted from institutional datasets. Advanced testing modalities such as Liquid-Based Cytology (LBC) and high-risk Human Papillomavirus (hr-HPV) DNA testing were entirely unavailable due to resource limitations. Data were analyzed for cytological grading via the Bethesda system and correlated with VIA positive findings.

Results: Data compiled over the 24-month study period revealed a notable increase in clinical screening volume from 2024 to 2025. Out of 1,839 women screened via VIA, 67 tested positive (VIA+), yielding an overall visual screen-positive rate of 3.64%. Year-on-year analysis showed a rising detection trend: 2024 recorded 24 VIA+ cases out of 870 (2.76%), while 2025 recorded 43 VIA+ cases out of 969 (4.44%). Parallel conventional Pap smear cytology performed on 510 symptomatic or high-risk women classified
482 cases as Negative for Intraepithelial Lesion or Malignancy (NIELM; 94.51%). Pre-malignant
transformations were caught across a stratified spectrum: 24 cases of Atypical Squamous Cells of Undetermined Significance (ASCUS; 4.71%), 3 cases of Low-Grade Squamous Intraepithelial Lesion (LSIL; 0.59%), and 1 case of High-Grade Squamous Intraepithelial Lesion (HSIL; 0.20%). Baseline profiling showed that 77.92% of the screened population belonged to low socioeconomic brackets, and 54.27% presented with multi-parity (≥3 children).

Conclusion: Dual screening strategies utilizing low-cost VIA for mass population-level triage, reinforced by reflex conventional Pap smears, significantly optimize the early capture of high-risk cervical pre-malignancies in infrastructure-limited settings. The lack of advanced molecular tools (HPV DNA) and LBC limits precise, single-visit risk stratification and results in an increased clinical burden for ambiguous cytological findings (ASCUS). However, a structured, tiered referral pathway combining conventional modalities remains foundational to mitigating advanced oncological mortality in rural India.

Keywords: Cervical Cancer Screening, Visual Inspection with Acetic Acid (VIA), Conventional Pap Smear, Bhagwan Mahavir Institute of Medical Sciences, Rural Healthcare, Bihar.

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Introduction

Cervical cancer represents a profound public health challenge in developing nations, remaining the second leading cause of cancer-related mortality among women in India [1]. This disease burden is disproportionately distributed, falling heavily upon socioeconomically marginalized rural populations, particularly within regions like Bihar [1,2]. Due to a pervasive lack of awareness, localized stigma, and systemic deficits in healthcare delivery, approximately 60% to 70% of oncology patients present at advanced, incurable clinical stages [2]. Consequently, establishing robust secondary prevention networks via routine screening is paramount to reducing down-stage mortality [2,12].

In low- and middle-income countries (LMICs), the World Health Organization historically advocated for low-cost, point-of-care screening modalities [3]. Visual Inspection with Acetic Acid (VIA) has gained widespread implementation due to its immediate, real-time results, minimal infrastructure demands, and high sensitivity for high-grade lesions [3,4]. However, VIA exhibits significantly low specificity, frequently generating false-positive results that can overwhelm scarce secondary referral structures and induce unnecessary patient anxiety [4,7].

While high-resource settings have transitioned entirely toward high-risk Human Papillomavirus (hr-HPV) molecular testing and Liquid-Based Cytology (LBC), these platforms remain financially and logistically unfeasible for rural tertiary care centers in India [5]. This paper evaluates how pairing mass VIA screening with reflex conventional Papanicolaou (Pap) smear cytology can effectively optimize tiered referral pathways and balance resource allocation in a resource-limited environment [4,10]. Furthermore, this study maps critical demographic indices—namely age, obstetric parity, and socioeconomic status—to evaluate their compounding impact on screening behaviors within the local catchment population of Pawapuri and surrounding rural districts.

Aims and Objectives: The primary aim of this study is to evaluate the institutional efficacy of a dual cervical screening pathway utilizing Visual Inspection with Acetic Acid (VIA) and conventional Papanicolaou (Pap) smear cytology in a resource-limited tertiary care ecosystem in rural Bihar. The specific research objectives are as follows:

- To Quantify Screening Yield: To determine the overall and year-on-year screen-positive prevalence rates of cervical abnormalities among women evaluated via VIA over a 24-month clinical window (2024–2025).
- To Profile Cytological Spectrum: To stratify and map the specific cytological classifications of cervical pre-malignancies (ASCUS, LSIL, HSIL) using the standardized Bethesda system among a baseline symptomatic and high-risk screening subgroup.
- To Correlate Socio-Demographic Co-factors: To analyze the distribution of age, obstetric grand-parity, and socioeconomic brackets among screened patients to better contextualize patient vulnerability profiles within the local population catchment.
- To Optimize Referral Pathways: To evaluate how combining primary visual screening tools with low-cost cytological testing can serve as a dependable clinical mechanism to optimize risk stratification and structural referral in environments lacking molecular HPV DNA assays or liquid cytology.

Materials and Methods

A two-year retrospective, descriptive epidemiological study was executed under the academic guidance of Dr. Seema Singh, Head of Department (HOD), utilizing institutional clinical records from the tertiary care teaching hospital at the Bhagwan Mahavir Institute of Medical Sciences, Pawapuri, Bihar, India. The study reviewed clinical data gathered across a 24-month period spanning the calendar years 2024 and 2025.

Study Population and Triage Protocols: The total screening cohort comprised 1,839 women who underwent primary screening via VIA at our outpatient department or specialized community outreach clinics. VIA was performed by trained clinical personnel using application of 3–5% dilute acetic acid, with results categorized as positive or negative based on the appearance of distinct acetowhite lesions near the squamocolumnar junction (3). Parallel to this primary group, a high-risk or symptomatic subset of 510 women received conventional Pap smear cytological profiling.

Demographic and Baseline Stratification: Baseline descriptive variables were systematically compiled from institutional intake registers to contextualize the patient landscape:

- Age Distribution: Stratified into four specific cohorts (≤30, 31–40, 41–50, and >50 years) to evaluate age-linked vulnerability profiles.
- Obstetric Parity: Segmented into low parity (0–1 childbirths), multiparous (2 childbirths), and grand multiparous (≥3 childbirths), which serves as an established clinical cofactor for persistent tissue exposure and minor cervical traumas.
- Socioeconomic Status: Classified utilizing the Modified BG Prasad socioeconomic index,

adapted to contemporary regional inflation and income dynamics.

Cytological and Data Analysis: Exfoliated cervical cells for the 510 subset patients were collected using an Ayre's spatula and cytobrush, smeared onto glass slides, immediately fixed in 95% ethanol, and stained using the conventional Papanicolaou method [5]. Cytological reporting was strictly standardized according to the Bethesda System for Reporting Cervical Cytology [6]. Due to persistent logistical and structural limitations, molecular assays (such as hr-HPV DNA testing) and automated liquid cytology (LBC) platforms were entirely unavailable at our center [11]. Institutional data registries were systematically reviewed to correlate cytological grades with corresponding VIA positive findings [6].

Results

Baseline Demographic Distribution: The baseline epidemiological characteristics showed a high concentration of high-parity and low-income demographics within the institutional screening cohort. The majority of the screened patients fell into the 31–40 age bracket (38.72%), representing the vital window for secondary prevention. Notably, 54.27% of women were grand multiparous (≥3 childbirths), and an overwhelming 77.92% fell within the lowest socioeconomic strata (Classes IV and V).

Table 1: Baseline Socio-Demographic Distribution of Total Triage Cohort (N = 1,839)

Demographic Indicator	Subcategory Stratification	Case Count (N)	Percentage (%)
Age Profile (Years)	≤30	386	20.99%
	31–40	712	38.72%
	41–50	524	28.49%
	>50	217	11.80%
Obstetric Parity	Low Parity (0–1)	243	13.21%
	Multiparous (2)	598	32.52%
	Grand Multiparous (≥3)	998	54.27%
Socioeconomic Status (Modified BG Prasad)	High (Class I & II)	94	5.11%
	Middle (Class III)	312	16.97%
	Low / Poor (Class IV & V)	1,433	77.92%

Screening Modality & Cytological Findings: Of the 1,839 women who underwent visual screening at our facility, 67 individuals returned positive results (VIA+), establishing an overall visual screen-positive rate of 3.64%. Stratified annual trends showed an escalation in cases: In 2024, 24 VIA+ cases were identified out of 870 women screened (2.76%). In 2025, the screening volume expanded to 969 women, yielding 43 VIA+ cases (4.44%).

Among the parallel cohort of 510 symptomatic or high-risk women evaluated via conventional Pap smear, 482 cases were classified as Negative for Intraepithelial Lesion or Malignancy (NIELM; 94.51%). Pre-malignant transformations were caught across a stratified spectrum: 24 cases of Atypical Squamous Cells of Undetermined Significance (ASCUS; 4.71%), 3 cases of Low-Grade Squamous Intraepithelial Lesion (LSIL; 0.59%), and 1 case of High-Grade Squamous Intraepithelial Lesion (HSIL; 0.20%).

Table 2: Clinical Screening Performance Matrix & Diagnostics

Screening Modality & Cohort	Bethesda / Clinical Diagnosis Category	Case Count (N)	Percentage (%)
Visual Inspection (VIA) Total Screened: N = 1,839	Overall VIA Positive (VIA+)	67	3.64%
	— 2024 Subcohort (n = 870)	24	2.76%
	— 2025 Subcohort (n = 969)	43	4.44%
Pap Smear Cytology Total Screened: N = 510	Negative for Lesions/Malignancy (NIELM)	482	94.51%
	Atypical Squamous Cells (ASCUS)	24	4.71%
	Low-Grade Lesions (LSIL)	3	0.59%
	High-Grade Lesions (HSIL)	1	0.20%

Discussion

The findings compiled at the Bhagwan Mahavir Institute of Medical Sciences, Pawapuri, emphasize that dual-modality screening represents a vital interim strategy for regions facing extreme resource constraints. Primary triage using VIA allows clinical teams to immediately isolate visual abnormalities within rural populations [2,4]. However, relying exclusively on VIA causes diagnostic challenges due to its variable specificity, which frequently triggers excessive colposcopic referrals and strains tertiary care centers [7].

Integrating demographic indicators reveals a compounding public health narrative. The massive concentration of our screened cohort within socioeconomic Classes IV and V (77.92%)

highlights why highly centralized LBC or HPV molecular assays fail to penetrate rural regions—the capital cost, infrastructure requirements, and necessity for multiple return visits create an unbridgeable delivery gap [12]. Furthermore, grand multiparity (54.27%) is strongly correlated with early rural marriages and subsequent recurring cervical trauma, which underpins the absolute necessity for accessible, localized secondary screening tools near low-income residential sectors within the Pawapuri catchment area.

By reinforcing an initial visual screen with reflex conventional Pap smears, clinical teams can significantly improve diagnostic specificity without incurring steep capital costs [4,10]. To contextualize the screening yields and cytological distributions observed at our center, a formal comparative matrix was compiled against prominent peer-reviewed regional and national cervical screening investigations in India (Table 3).

Table 3: Comparative Analysis of Screening Cohorts and Diagnostic Yields across Indian Studies

Study & Setting	Screening Modalities Evaluated	Cohort Size (N)	Via Positive Rate (%)	Abnormal Cytology Spectrum (Parallel Yield)
Present Study (Pawapuri, Rural Bihar)	VIA + Conventional Pap Smear	1,839 (VIA) / 510 (Pap)	3.64%	ASCUS: 4.71% | LSIL: 0.59% | HSIL: 0.20%
Shrivastava et al. (Low-Resource Setup) [2]	Primary VIA Triage	Cross-sectional Registry	4.10%	Not systematically correlated via parallel cytology
Sankaranarayanan et al. (multi-centric) [4]	VIA vs Cytology vs HPV DNA	Population Cluster Cohorts	5.20% – 6.80%	High baseline variability; verified via direct biopsy
Aswathy et al. (Rural Southern India) [9]	Community Pap / VIA Triage	Community Cohort	2.10%	ASCUS/LSIL combined: < 2.5% (high baseline awareness)

As demonstrated in Table 3, our overall VIA positivity rate of 3.64% aligns closely with the 4.10% reported by Shrivastava et al. in similar resource-constrained setups [2], yet remains lower than the large-scale multi-centric trials by Sankaranarayanan et al. (5.20%–6.80%) [4]. This minor variance is heavily attributable to differences in clinical provider training, community awareness thresholds, and the strictness of visual criteria used to mark minor acetowhite changes near the transformation zone. Crucially, our cytological catch-rate for ambiguous lesions (ASCUS: 4.71%) highlights a pronounced diagnostic gray area that is significantly higher than that observed in well-screened cohorts like those in southern India (Aswathy et al.) [9]. This variance underscores the compounding public health threat of persistent mucosal inflammation, multi-parity (54.27%), and unmanaged reproductive tract infections prevalent within rural Bihar, which often mask or simulate low-grade dysplastic alterations on conventional cytological smears.

Property-tracking markers emphasize distinct systemic vulnerabilities. The absence of advanced molecular testing limits single-visit "see-and-treat" strategies and generates a substantial clinical burden for managing ambiguous cytological outcomes, such as the 24 ASCUS cases (4.71%) identified in this cohort [8,11]. Patients with ambiguous results require strict, longitudinal tracking to prevent loss-to-follow-up, which remains a primary challenge in rural public health management [9].

Conclusion

In infrastructure-limited healthcare environments like rural Bihar, combining low-cost VIA mass population triage with conventional Pap smear cytology provides an actionable pathway for capturing high-risk cervical pre-malignancies before they progress to invasive stages. While the absence of advanced molecular platforms prevents rapid single-visit risk stratification and increases the diagnostic burden for borderline cytological findings, a structured, tiered referral system tailored to the region's low-income, high-parity demographic remains foundational to mitigating cervical cancer mortality across rural Indian populations.

Declarations

Ethics Approval and Consent to Participate: The study protocol was reviewed and approved by the Institutional Ethics Committee (IEC) of the Bhagwan Mahavir Institute of Medical Sciences, Pawapuri. As this was a retrospective study utilizing de-identified, aggregated registry data from archived medical files, individual patient consent was waived by the committee.

Consent for Publication: Not applicable, as the manuscript contains no individual person's data, videos, or identifiable images.

Conflict of Interest Statement: The authors declare that carry no competing financial, professional, or personal interests that could be perceived to influence the work, analysis, or conclusions presented in this paper.

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