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Comparative Study of Visual Inspection with Acetic Acid and Pap Smear for Detecting Cervical Dysplasia in Federal University of Lafia Teaching Hospital, Nigeria

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Abstract

Introduction: Cervical cancer continues to be a significant health problem in Nigeria because of poor screening and late diagnosis. The current study compared Visual Inspection with Acetic Acid (VIA) with Pap smear for the detection of cervical dysplasia, with Human Papillomavirus (HPV) DNA test as the gold standard.

Methods: A cross-sectional study of 75 women in Federal University Teaching Hospital, Lafia was conducted. All the subjects were screened with VIA and Pap smear, while HPV DNA was only employed as the validating standard.

Results: Pap smear was more sensitive (33.3%) and accurate (89.3%) than VIA (0.0% and 88.0%, respectively). The two tests had high specificity of 97.0% for Pap smear and 95.7% for VIA.

Conclusion: Pap smear was more sensitive than VIA in diagnosing cervical dysplasia compared to HPV DNA results. VIA may still be employed for screening in low-resource settings, but Pap smear should be given priority where cytology laboratories exist.

Keywords: Cervical dysplasia, Cervical cancer, Human papillomavirus, Screening, Nigeria, HPV DNA testing

Introduction

Traditional cervical cancer screening methods, such as the Papanicolaou (Pap) smear, were underutilized due to several barriers. These included a lack of laboratory infrastructure, inadequate numbers of trained cytologists, religious barriers, and the need for multiple clinic visits [1]. As a result, many women, especially those in underserved and rural areas, were unable to access this gold-standard method, leading to missed opportunities for early detection and treatment. While the Pap smear was highly effective in detecting cervical dysplasia, several limitations [2] necessitated the exploration of alternative screening methods.

VIA emerged as a low-cost, simple, and immediate screening option particularly suitable for low-resource settings [1, 3]. VIA involved the application of acetic acid to the cervix, allowing for visual identification of cervical epithelial changes [4, 19]. Although it gained significant acceptance in some settings, its sensitivity and specificity were questioned, particularly compared to the Pap smear and HPV rapid test [5, 20]. VIA had a sensitivity of 92.8%, specificity of 29.4%, PPV-52%, and NPV-83%, while Pap smear had a sensitivity of 64.2%, specificity of 76.4%, PPV-69.2%, and NPV [21]. Another research showed VIA had sensitivity of 87.64%, specificity of 66.42%, PPV-36.11% and NPV-96.13%, with accuracy of 68.70% while Pap smear had a sensitivity of 37.58% but a specificity of 85.43 % with PPV-31.11% and NPV-86.66% with accuracy of 78.30 % [6].

Cancer of the cervix remained a major cause of cancer-related deaths among women with 662,301 new cases and 348,874 deaths in 2022, affecting younger populations under 45 years old at an alarming rate. It was reported to be the fourth most frequent malignancy in women globally and third in mortality, [5, 6], making it a serious public health concern, especially in LMICs [7]. This persisted because effective screening and treatment that could have prevented invasive cancer were hampered by late detection, which frequently missed a long preventative window period [8]. Women of childbearing age had a depressing story about cervical cancer in Nigeria. Research conducted in 2020 reported 12,075 new cases of cervical cancer, making it the second most frequent malignancy in women [9].

Human papilloma virus, the most prevalent sexually transmitted disease [10,11], is transmitted through direct contact between the skin and mucous membranes. HPV genotypes were classified as "high-risk" or "low-risk" based on the likelihood that cancer would develop following infection. Cervical cancer could result from repeated infection with high-risk HPV serotypes, which were also linked to various mucosal anogenital and head and neck cancers. Genital warts and benign or low-grade cervical tissue alterations were known to result from infection with the low-risk serotypes [12]. An estimated 75% of sexually active men and women contracted the infection at least once in their lives, with people under the age of 25 having the greatest infection rates [12], though they might not experience any negative effects and the infection may be cleared by the immune system in 1-2 years [6,10]. For the squamous epithelium, HPV showed particular tropism. There was mounting evidence that HPV was linked to several squamous cell type cancers, including cervical (99%), anal (88% of cases), penile (50%), vaginal (70%), vulvar (43%), colorectal (35%), and oropharyngeal (12–53%) cancers [9,13,14]. HPV infection in the keratinocytes of the basal stratum of the squamous epithelium occurs years or decades before the patient develops cervical cancer. First, benign low-grade lesions develop which graduate into high-grade squamous cell lesions with a high risk of cancer.

CIN-1 results in 60% of cases of infection with high-risk HPV. It is benign lesion that involves the destruction and involvement of the lowest third of the squamous epithelium, which may regress on its own. CIN-2 results when two-thirds of the squamous epithelium is affected. Lastly, it is referred to as CIN-3 if the aberrant cells impact more than two-thirds of the squamous epithelium. CIN 2 and CIN 3 lesions are both classified as high-grade lesions

There was little published information on HPV infection and risk factors among women in Central Nigeria, although HPV played a crucial role in malignancies, particularly those of the cervix [23]. More than 90% of cervical malignancies worldwide

were thought to be caused by high-risk HPV-16 and HPV-18 [9,12,25,26]. However, because DNA-based tests were expensive and laboratory infrastructure was scarce, HPV testing was rarely incorporated into standard screening programs in Nigeria. The very easy and affordable HPV Rapid Diagnostic Tests (RDTs) presented a viable substitute, particularly as self-testing was feasible without the need for a qualified cytologist or other staff [27].

A vital referral hub for women in Nasarawa state was Federal University Teaching Hospital in Lafia, Nasarawa State; nonetheless, the absence of standardized cervical screening procedures illustrated the larger issues facing Nigeria's healthcare system. This was evident by the absence of HPV DNA-based screening methods in the facility. Cervical cancer had a high morbidity and mortality rate worldwide most probably because many women were misdiagnosed and untreated when evidence-based guidelines were not used to guide management especially in developing countries such as Nigeria.

To determine the best screening approach for the early detection and prevention of cervical cancer in resource-constrained environments, such as Nasarawa State, Nigeria, this study compared visual inspection with acetic acid and pap smear for detecting cervical dysplasia in federal university teaching hospital Lafia, Nasarawa state, Nigeria.

Materials and Methods

This study employed a cross-sectional study design for the examination of all participants.

Study Population

The study population for this research consisted of women visiting the Gynecology Unit of the Federal University Teaching Hospital, Lafia, Nasarawa State, Nigeria, who met the inclusion criteria.

Inclusion criteria

1. Women aged 18 years and above visiting the gynaecology unit of Federal University Teaching Hospital, Lafia.

2. Women who consented to participate in the study.

3. Women who had not undergone treatment for cervical dysplasia or cervical cancer.

4. Women who were not pregnant at the time of the study.

5. Women who were medically fit for a pelvic examination.

Exclusion criteria

1. Women under the age of 18 years.

2. Women who were menstruating at the time of the study.

3. Women who declined to provide consent to participate in the study.

4. Women who were currently undergoing or had completed treatment for cervical dysplasia or cervical cancer.

5. Pregnant women, due to potential risks associated with pelvic examinations.

6. Women with active genital infections.

7. Women with a history of hysterectomy or other procedures that made the cervix inaccessible for examination.

Sample Size Determination and Sampling Technique

In this research, a non-probability sampling method was utilized. Specifically, purposive sampling was implemented to recruit a total of 87 female participants, employing the Cochran formula based on a confidence level of 95% and a prevalence rate of 6%. This approach aligns with methodologies outlined in prior investigations concerning systematic reviews and meta-analyses of high-risk HPV infection among women in Nigeria [37].

Sample Collection and analysis

Samples were aseptically collected and analyzed by trained research assistants—health personnel with at least 10 years of experience in the hospital's gynecology clinic and histopathology laboratory, collecting and testing smears for cancers—following standard procedures.

Pap smear Protocol

The conventional Pap smears during the study period were collected with an Ayre spatula for smearing on a pre-labeled slide. The smear was placed in a Coplin jar with 95% ethanol. It was labeled and sent to the laboratory. The smears obtained during the study period were all stained as per the laboratory standard operating procedure for Papanicolaou stain. Reagents utilized in Pap staining were: Harris hematoxylin as nuclear stain, orange G-6 (OG-6) as cytoplasmic counterstain, and eosin azure (EA) as polychromatic dye, xylene as clearing agent, and DPX as mounting medium. Various concentrations of alcohol (70 to 95%) were utilized for dehydration and hydration. The stained smears were assessed blinded by cytopathologists using the traditional system of the 2014 Bethesda system for cervical cytology reporting [28].

VIA Protocol

5% acetic acid as per study SOP was applied with the help of cotton wool swab on the ectocervix. Cervix was examined for acetowhite lesions after one minute. Negative VIA, as defined by IARC, was if there were no or very few acetowhite lesions in the transformation zone (TZ); positive if any well-defined, dense acetowhite lesions near or adjacent to the squamo-columnar junction (SCJ) in the TZ, or near the external OS if SCJ was not visible. VIA was nonevaluable when the TZ was not visible or if there were other conditions (inflammation or hemorrhage) making the cervix uninspectable [20,29].

HPV Testing Protocol

The method employed was HPV antigen detection in cervical specimens by HPV DNA test cassette. The manufacturer's instructions were strictly followed.

Statistical analysis

The data collected were analyzed using the Statistical Package for the Social Sciences (SPSS), version 25. Descriptive statistics summarized participants' socio-demographic characteristics and other categorical variables, including frequencies and percentages. Results were presented in tables and charts for easy comprehension.

Ethical Consideration

Informed consent was obtained from all study participants and ethical approval (FUTHREC/545) was gotten from the Ethical Review Board of Federal University Teaching Hospital, Lafia, Nasarawa State.

Results

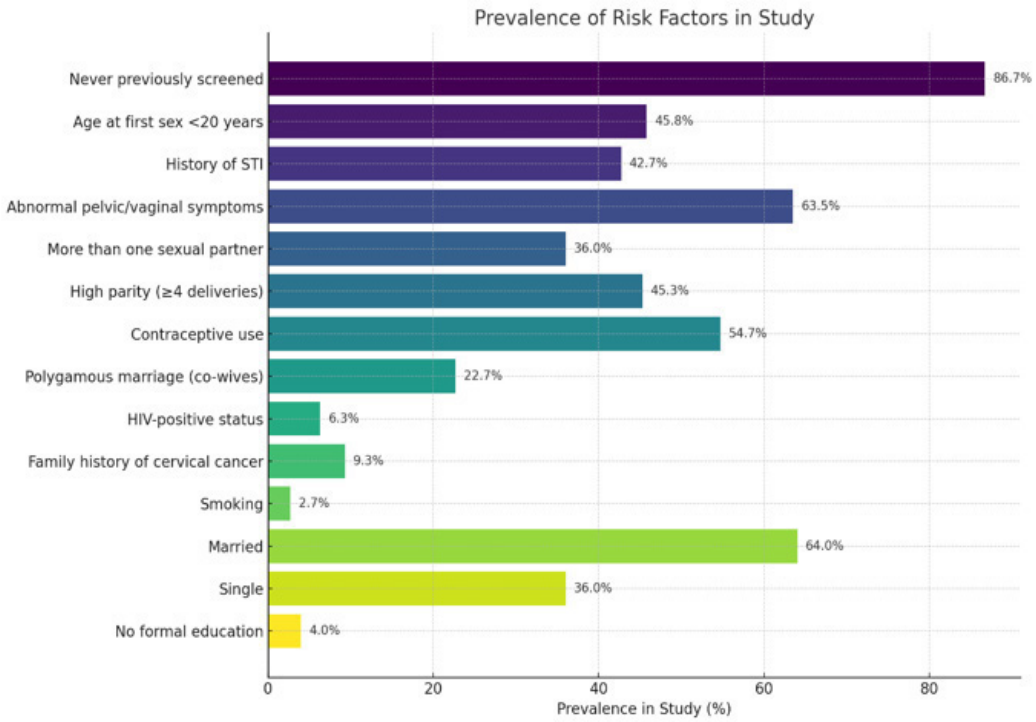

Figure 1: Major risk factors among participants

This bar chart illustrates the prevalence of key behavioral and reproductive risk factors identified among the study population. The most common were lack of previous screening (86.7%), abnormal pelvic or vaginal symptoms (63.5%), contraceptive use (54.7%), and early sexual debut before age 18 (45.8%). Smoking was the least reported risk factor (2.7%). The high burden of multiple overlapping risk exposures suggests increased vulnerability to HPV infection and cervical dysplasia in this population.

Table 1: Cervical dysplasia result after screening with VIA, Pap Smear, and HPV RDT methods

N=75		
Methods	**Frequency**	**Percentage (%)**
VIA		
Positive	3	4
Negative	72	96
HPV test		
Positive	9	12
Negative	66	88
Pap smear test		
Negative	70	93.3
ASCUS	2	2.7
LSIL	3	4

VIA detected cervical abnormalities in only 3 participants (4.0%), Pap smear in 5 (6.7%), while HPV testing identified 9 (12.0%). This emphasizes the superior sensitivity of HPV testing over VIA and Pap smear in detecting potential dysplasia.

$$\text{Prevalence of cervical dysplasia} = \frac{\text{Total positive cases of cervical dysplasia}}{\text{Total number of participants}} \times 100$$
$$= \frac{8}{75} \times \frac{100}{1} = 10.7\%.$$

The overall prevalence of cervical dysplasia was 10.7%.

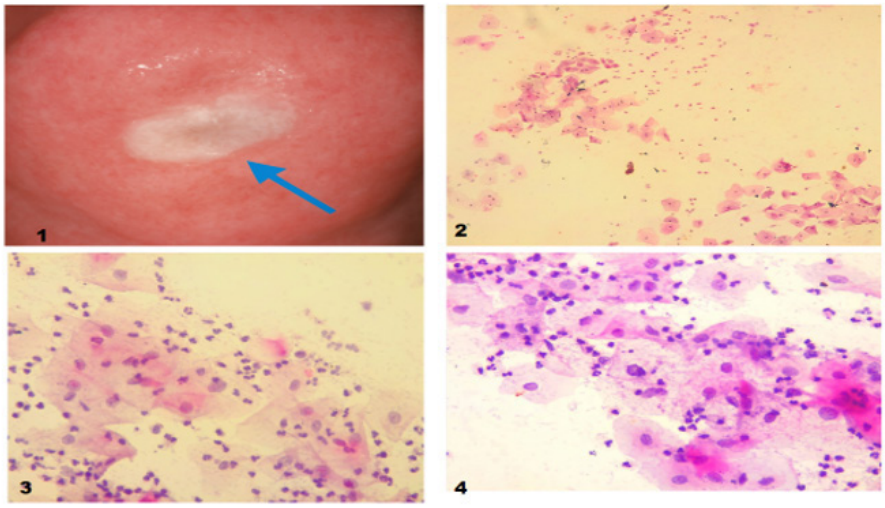

Figure 2: Photomicrographs of VIA and PAP smears

Figure 2 Photomicrographs showing: (1) Acetowhite lesion observed on the cervix after application of 5% acetic acid indicating CIN grade 1. (2). Negative Pap Smear depicting normal cervical cells without signs of dysplasia. (3) Atypical squamous cell of undetermined significance (ASCUS) at Magnification. (4) Low-Grade Squamous Intraepithelial Lesion (LSIL), indicating mild cervical dysplasia. (X400)

Table 2: Overlap of Positive Cases of cervical dysplasia Across VIA, Pap Smear, and HPV Testing

N=72			
VIA Test	**Pap Smear**	**HPV Test**	**Number of Women**
Negative	Negative	Negative	62
Negative	Negative	Positive	6
Negative	Positive (ASCUS or LSIL)	Positive	3
Negative	Positive	Negative	2
Positive	Negative	Negative	3

A total of 62 (82.7%) tested negative across all methods. Notably, 6 (8%) were HPV positive but missed by both VIA and Pap smear, 3 (4%) cases were positive for HPV and Pap smear tests. Pap smear detected 2 (2.6%) that was missed by VIA and HPV test. VIA detected abnormalities in 3(4%) which was missed by Pap smear and HPV testing methods. This reflects the low concordance and limited sensitivity of VIA.

Table 3: Diagnostic Performance of Pap Smear in detecting cervical dysplasia

	Pap Negative	**Pap Positive**	**Total**
HPV Negative	64 (TN)	2 (FP)	66
HPV Positive	6 (FN)	3 (TP)	9
Total	70	5	75

Sensitivity: 3 / (3 + 6) = 33.3%, Specificity: 64 / (64 + 2) = 97.0%, Accuracy: (3 + 64) / 75 = 89.3%

Table 4: Diagnostic Performance of VIA in detecting cervical dysplasia

	VIA Negative	VIA Positive	Total
HPV Negative	66 (TN)	0 (FP)	66
HPV Positive	6 (FN)	3 (FP)	9
Total	72	3	75

Sensitivity: 0 / (0 + 6) = 0.0%, Specificity: 66 / (66 + 3) = 95.7%, Accuracy: (0 + 66) / 75 = 88.0%

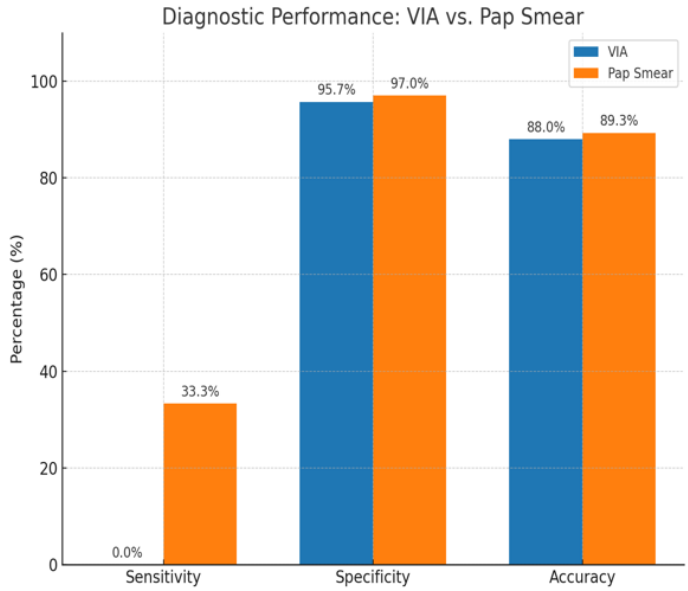

Figure 3: Comparative Summary of VIA and Pap Smear Performance in detecting cervical dysplasia

Fig 2. Shows that Pap smear demonstrated better diagnostic performance than VIA in terms of sensitivity and accuracy, although both tests showed high specificity. VIA failed to detect any of the HPV-positive cases, indicating poor sensitivity. In contrast, Pap smear detected a third of the true HPV-positive cases. However, neither method achieved high sensitivity, highlighting the potential value of HPV DNA testing as a more reliable method for primary screening, mandating it inclusion during routine cervical screening. Overall, VIA had a sensitivity of 0.0% with specificity of 95.7% and accuracy of 88.8%. pap smear on the other hand had sensitivity of 33.3% with specificity of 97.0% and accuracy of 89.3%

$$\text{Prevalence of high-risk HPV} = \frac{\text{Total positive cases of high-risk HPV}}{\text{Total number of participants}} \times \frac{100}{1}$$
$$= \frac{9}{75} \times \frac{100}{1} = 12\%.$$

The overall prevalence of high-risk HPV was 12%.

Discussion

The relative diagnostic validity of VIA and Pap smear as screening tools in the detection of cervical dysplasia, using HPV DNA test result as reference in this study, was comparatively assessed among female outpatients visiting the Federal University Teaching Hospital, Lafia, Nasarawa State, Nigeria. All study subjects were screened with both the modalities and therefore could be compared side by side for relative validity for the same population. This process enabled proper setting of each test's accuracy, specificity, and sensitivity against HPV DNA outcomes.

The total prevalence of cervical dysplasia was 10.7%, i.e., about 1 in every 10 women screened for this research had some indication of dysplasia. Pap smear was more sensitive and specific to VIA when it came to the HPV DNA results employed as the gold standard. Pap smear recorded 5 (6.7%) positive and 3 (4.0%) positive results was the case with VIA (table 1). This demonstrates Pap smears relatively superior performance in cervical epithelial change detection that denotes dysplastic change.

Pap smear was 33.3% sensitive, 97.0% specific, and 89.3% accurate (Table 3). Although low sensitivity, it is in line with evidence by Savitha et al. [32] and Kaufman et al. [33], whose finding was that cytological screening sometimes fails to detect some high--grade lesions, especially when there are a resource limitation and the sample collection and interpretation are compromised. But pap smear's high specificity justifies its application as a confirmatory test for exclusion of disease.

VIA, on the other hand, had 0.0% sensitivity, 95.7% specificity, and 88.0% accuracy (Table 4). The extremely low sensitivity in this study is remarkable and might be explained by factors such as sample size, visualization challenge, subjective interpretation, or inadequate provider experience may contributed to this low sensitivity recorded. According to the findings cited in reference [17,19], limited sample sizes may exacerbate random variation in Visual Inspection with Acetic Acid (VIA) results, particularly in the context of rare precancerous lesions such as CIN2+. This phenomenon can lead to the occurrence of zero detections purely attributable to chance. In a study conducted in India, a significant decrease in VIA sensitivity was observed, dropping to 26.3% within population-based settings. This decline is largely attributable to verification bias and the low prevalence of disease, which raises concerns regarding the potential underpowering of the current study [19,40]. Furthermore, inadequate cervical visualization resulting from factors such as inflammation, discharge, bleeding, or squamous metaplasia can obscure acetowhite changes, leading to false-negative results. Such challenging field conditions are particularly pronounced in developing countries that lack colposcopic magnification, contrasting sharply with controlled trials, where sensitivity rates can reach between 73% and 95% [20]. The effectiveness of VIA is heavily reliant on the provider's ability to discern subtle acetowhite lesions, a skill that varies considerably (with sensitivity ranging from 25% to 95%) depending on the examiner's experience. Less trained practitioners are especially prone to overlooking early lesions, as evidenced by the Multicentric Study of Cervical Cancer Screening and Triage Using Human Papillomavirus Testing (ESTAMPA), where hands-on training alone resulted in the lowest performance metrics. Moreover, inter-observer variability frequently exceeds 30% in several studies, which may account for the observed 0.0% detection rate in this investigation, as opposed to higher rates achieved under expert supervision [39,40]. Similar fluctuations in performance on VIA have been reported in other studies to range from 29% to over 90% [20,22], depending on operator training and adherence to guidelines for screening. The present result thus highlights the challenge of achieving diagnostic consistency in the use of VIA under normal field conditions.

Besides, few cases overlapped between Pap smear and VIA, highlighting the observation that each of the two tests identifies distinct subsets of women at risk of dysplasia. Though two of the Pap smear-positive cases were not identified by VIA, VIA also identified some abnormality that did not have a cytologic correlate (table 2). This means that neither test alone when utilized individually of the other is fully diagnostic but that Pap smear remains the better test.

With HPV DNA test as a reference, this study favors that Pap smear was more accurate and sensitive compared to VIA in general for screening cervical dysplasia. The results are with the implication that, while both methods are practical to use for screening in resource-limited settings, Pap smear is an ideal method to use for final diagnosis of cervical epithelial lesions when available. Human papillomavirus (HPV) rapid tests present significant clinical benefits in terms of speed and accessibility when contrasted with conventional polymerase chain reaction (PCR) assays, especially in settings where resources are limited. These tests facilitate point-of-care diagnoses with results available within 15 to 30 minutes, eliminating the need for intricate laboratory equipment and significantly decreasing the turnaround time from several days to immediate feedback [36]. The operational protocols for these tests are streamlined, requiring minimal infrastructure, and they offer options for self-sampling alongside reduced costs per test. This makes them particularly suitable for rural or economically disadvantaged regions where laboratory fa-

cilities are scarce. Furthermore, HPV rapid tests demonstrate a high sensitivity of 85-95% for high-risk HPV types, which is comparable to that of PCR in the context of triage, despite the latter having a slight advantage in specificity and genotyping capabilities [38,39]. Empirical evidence from clinical studies indicates that the use of rapid tests decreases the rates of loss to follow-up by facilitating prompt decision-making, thereby enhancing the prevention of cervical cancer in high-burden areas without a significant compromise on accuracy [40].

Conclusion

This research indicates that the Pap smear test is more effective than the Visual Inspection with Acetic Acid (VIA) for diagnosing cervical dysplasia when using HPV DNA testing as the gold standard in the Federal University of Lafia Teaching Hospital, Nigeria. The sensitivity and specificity of VIA were found to be lower in comparison to those of the Pap smear in the context of detecting cervical dysplasia at FULTH. Furthermore, despite the Pap smear not exhibiting optimal sensitivity, it may serve as a more dependable screening method for cervical dysplasia in settings with limited resources.

Recommendation

It is recommended that Pap smear should be prioritized over VIA in detection of cervical epithelial abnormalities in low resource setting where there are no access to highly sensitive screening test like PCR. VIA may still be applied as an initial or add-on screening test if cytology is unavailable in primary care centers to enhance diagnostic results and early detection of cervical dysplasia. The sample size should be increased and other screening tests like PCR should be done alomng side the VIA and PAP.

Limitation of study

This work is limited to women visiting the Gynecology Unit of the Federal University Teaching Hospital, Lafia, Nasarawa State. The sample size is small. It did not consider other methods of screening and detecting cervical dysplasia.

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All contributors are duly appreciated

Authors' contributions

The study conception and design were done by Akpulu S.P. and Odeh P.A. Material preparation and data collection were done by Dauda S.M, and Omaku W O. Analysis were performed by Lawal M. Odendiri G.P, Mairiga A.A.The first draft of the manuscript was written by Solomon M.G, Idoko J and Wahab A.O and all authors commented on initial versions of the manuscript. All authors read and approved the final manuscript.

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Data availability

The data sets generated and/or analyzed during the current study are available on request.

Declarations

I, hereby declare that this manuscript entitled submitted is our original work. The manuscript has not been published previously, in whole or in part, and is not under consideration for publication elsewhere. All authors have read and approved the final version of the manuscript and have agreed to its submission. We further declare that all data reported in the manuscript are authentic and were obtained according to recognized ethical and scientific standards.

Ethics approval

Ethics approval was obtained from the Nasarawa Sate Ministry of Health and consent to participate was granted by participants for this study.

Consent for publication

All of the authors agree to the submission and consent for publication of this paper.

Competing interests

The authors declare no conflict of interest

References

1. David J, Joshi V, Aaron DJ, Baghel P. A comparative analysis of visual inspection with acetic acid, cervical cytology, and histopathology in the screening and early detection of premalignant and malignant lesions of the cervix. Cureus. 2022. https://doi.org/10.7759/cureus.29762

2. Mafiana JJ, Dhital S, Halabia M, Wang X. Barriers to uptake of cervical cancer screening among women in Nigeria: A systematic review. Afr Health Sci. 2022;22(2):295-309. https://doi.org/10.4314/ahs.v22i2.33

3. Mehri M, Kakroudi SH, Askari FS, Mohebbi A, Tabarraei A. Prevalence of human papillomavirus genotypes in patients with genital warts in Gorgan, Iran. J Clin Basic Res. 2020;4(3):3-9. https://doi.org/10.52547/jcbr.4.3.3

4. Okunade K, Badmos K, Okoro AC, Ademuyiwa I, Oshodi Y, Adejimi A, et al. Comparative Assessment of p16/Ki-67 Dual Staining Technology for cervical cancer screening in women living with HIV (COMPASS-DUST)–Study protocol. PLoS One. 2022;17(12):e0278077. https://doi.org/10.1371/journal.pone.0278077

5. Okolie EA, Barker D, Nnyanzi LA, Anjorin S, Aluga D, Nwadike BI. Factors influencing cervical cancer screening practice among female health workers in Nigeria: A systematic review. Cancer Rep (Hoboken). 2022;5(5):e1514. https://doi.org/10.1002/cnr2.1514

6. Lince-Deroche N, Phiri J, Michelow P, Smith JS, Firnhaber C. Costs and cost effectiveness of three approaches for cervical cancer screening among HIV-positive women in Johannesburg, South Africa. PLoS One. 2015;10(11):e0141969. https://doi.org/10.1371/journal.pone.0141969

7. Miller J, Dakić A, Spurgeon ME, Saenz F, Kallakury B, Zhao B, et al. AIB1 is a novel target of the high-risk HPV E6 protein and a biomarker of cervical cancer progression. J Med Virol. 2022;94(8):3962-77. https://doi.org/10.1002/jmv.27795

8. Ficht AL, Lapidos-Salaiz I, Phelps BR. Eliminating cervical cancer: Promising developments in primary prevention. Cancer. 2020;126(2):242-6. https://doi.org/10.1002/cncr.32507

9. Ezechi O, Akinsolu F, Salako A, Abodunrin O, Adewole I, Olagunju M, et al. High-risk human papillomavirus infection among Nigerian women: A systematic review and meta-analysis. J Int Med Res. 2023;51(5):3000605231182884. https://doi.org/10.1177/03000605231182884

10. Kombe Kombe AJ, Li B, Zahid A, Mengist HM, Bounda GA, Zhou Y, et al. Epidemiology and burden of human papillomavirus and related diseases, molecular pathogenesis, and vaccine evaluation. Front Public Health. 2021;8:552028. https://doi.org/10.3389/fpubh.2020.552028

11. Ilhan Z, Łaniewski P, Thomas N, Roe D, Chase D, Herbst-Kralovetz M. Deciphering the complex interplay between microbiota, HPV, inflammation and cancer through cervicovaginal metabolic profiling. EBioMedicine. 2019;44:675-90. https://doi.org/10.1016/j.ebiom.2019.04.028

12. Aminu M, Gwafan J, Inabo H, Oguntayo A, Ella EE, Koledade A. Seroprevalence of human papillomavirus immunoglobulin G antibodies among women presenting at the reproductive health clinic of a university teaching hospital in Nigeria. Int J Womens Health. 2014;6:479-87. https://doi.org/10.2147/IJWH.S56388

13. Khan I, Harshithkumar R, More A, Mukherjee A. Human Papilloma Virus: An Unraveled Enigma of Universal Burden of Malignancies. Pathogens. 2023;12(4):564. https://doi.org/10.3390/pathogens12040564

14. Nasiri-Aghdam M, García-Chagollán M, Pereira-Suárez AL, Aguilar-Lemarroy A, Jave-Suárez L. Splicing Characterization and Isoform Switch Events in Human Keratinocytes Carrying Oncogenes from High-Risk HPV-16 and Low-Risk HPV-84. Int J Mol Sci. 2023;24(9):8347. https://doi.org/10.3390/ijms24098347

15. Kamal M. Pap Smear Collection and Preparation: Key Points. Cytojournal. 2022;19:24. https://doi.org/10.25259/C-MAS_03_05_2021

16. Kumar H, Narasimha A, Vasavi B, Sapna M. An Audit of Pap Smear Cytology. J South Asian Feder Obstet Gynaecol. 2011;3(3):121-4. https://doi.org/10.5005/jp-journals-10006-1146

17. Santamaría-Ulloa C, Quirós-Rojas I, Montero-López M, Quesada-Leitón H. Women's Participation in Pap Smear Screening in a Developing Country: Evidence for Improving Health Systems. Front Oncol. 2021;11:642841. https://doi.org/10.3389/-fonc.2021.642841

18. Banerjee D, Mittal S, Mandal R, Basu P. Screening technologies for cervical cancer: Overview. Cytojournal. 2022;19. https://-doi.org/10.25259/cmas_03_04_2021

19. Jeffries A, Beck-Sague CM, Marroquin-Garcia AB, Dean M, McCoy VH, Cordova-Toma DA, et al. Cervical Visual Inspection with Acetic Acid (VIA) and Oncogenic Human Papillomavirus Screening in Rural Indigenous Guatemalan Women: Time to Rethink VIA. Int J Environ Res Public Health. 2021;18(23):12406. https://doi.org/10.3390/ijerph182312406

20. Awolude OA, Oyerinde SO, Ayeni AO, Adewole IF. Human papillomavirus-based cervical precancer screening with visual inspection with acetic acid triage to achieve same-day treatments among women living with human immunodeficiency virus infection: Test-of-concept study in Ibadan, Nigeria. Pan Afr Med J. 2021;40:48. https://doi.org/10.11604/pamj.2021.40.48.28628

21. Basanna SK, Charita U, Anuradha SN. Comparison Of Pap Smear with Visual Inspection with Acetic Acid in Screening of Carcinoma Cervix. J Pharm Negative Results. 2022;13(S09):4923-33. https://doi.org/10.47750/pnr.2022.13.S09.610

22. Mahezabeen, Thobbi VA. Screening of premalignant and malignant lesions of cervix by visual inspection with (acetic acid or Lugol's iodine) and PAP smear. Int J Reprod Contracept Obstet Gynecol. 2024;13(9):2392-7. https://-doi.org/10.18203/2320-1770.ijrcog20242488

23. Adoga M, Reuben R, Abubakar K, Oti V, Zakka AW. Human papillomavirus type 16 (HPV-16) IgG antibody among women of reproductive age presenting at a healthcare facility in Central Nigeria: A pilot study. Pan Afr Med J. 2021;40:203. https://-doi.org/10.11604/pamj.2021.40.203.28804

24. Meza Ramirez CA, Greenop M, Almoshawah YA, Martin Hirsch PL, Rehman IU. Advancing cervical cancer diagnosis and screening with spectroscopy and machine learning. Expert Rev Mol Diagn. 2023;23(5):375-90. https://-doi.org/10.1080/14737159.2023.2203816

25. Olowo Awulu F, Aminu M, Suleiman A, Makolo D. Seroprevalence and risk factors associated with HPV infections among patients in kogi east senatorial zone. Fudma J Sci. 2020;4(3):319-28. https://doi.org/10.33003/FJS-2020-0403-319

26. Joseph J, Demke O, Ameyan L, Bitilinyu-Bango J, Bourgoin B, Diop M, et al. Human papillomavirus testing using existing

nucleic acid testing platforms to screen women for cervical cancer: Implementation studies from five sub-Saharan African countries. BMJ Open. 2023;13(5):e065074. https://doi.org/10.1136/bmjopen-2022-065074

27. Bose A, Acharya M, Pradhan P, Dash K, Senapati U. Comparison of quality parameters in conventional Pap smears made by endocervical brush smear and Ayre spatula. Int J Reprod Contracept Obstet Gynecol. 2020;9(12):4907-12. https://-doi.org/10.18203/2320-1770.ijrcog20205219

28. Baena A, Mesher D, Salgado Y, Martínez S, Villalba G, Amarilla ML, et al. Performance of visual inspection of the cervix with acetic acid (VIA) for triage of HPV screen-positive women: Results from the ESTAMPA study. Int J Cancer. 2022;152(8):1581-92. https://doi.org/10.1002/ijc.34384

29. Bertelsen VM, Tranberg M, Petersen LK, Booth B, Bor P. Improving diagnostic of cervical dysplasia among postmenopausal women aged ≥50 years using local vaginal oestrogen treatment prior to colposcopy: study protocol for a multicentre randomised controlled trial (the IDEAL study). BMJ Open. 2024;14(6):e082833. https://doi.org/10.1136/bmjopen-2023-082833

30. Derbie A, Amare B, Misgan E, Nibret E, Maier M, Woldeamanuel Y, et al. Histopathological profile of cervical punch biopsies and risk factors associated with high-grade cervical precancerous lesions and cancer in northwest Ethiopia. PLoS One. 2022;17(9):e0274466. https://doi.org/10.1371/journal.pone.0274466

31. Abdelmawla YAM, Ali MAA, Ali FH. Assessment of Uterine Cervical Cancer by Means of MR Spectroscopy. QJM. 2020;113(Suppl_1). https://doi.org/10.1093/qjmed/hcaa068.004

32. Akgor U, Ozgul N, Gunes AC, Turkyılmaz M, Gultekin M. Evaluation of Endocervical Curettage in Colposcopy in the Turkish Cervical Cancer Screening Program. J Clin Med. 2024;13(15):4417. https://doi.org/10.3390/jcm13154417

33. Atla B, Prasad U, Botta VSK, Namballa U, Pujari L, Lalam N. Comparative study of conventional Pap smear and liquid based cytology as a screening method for cervical cancer. Int J Res Med Sci. 2021;9(8):2439-43. https://-doi.org/10.18203/2320-6012.ijrms20213096

34. Okunade KS, Adejimi AA, John-Olabode SO, Oshodi YA, Oluwole AA. An Overview of HPV Screening Tests to Improve Access to Cervical Cancer Screening Amongst Underserved Populations: From Development to Implementation. Risk Manag Healthc Policy. 2022;15:1823-30. https://doi.org/10.2147/RMHP.S296914

35. Cubie HA, Seagar AL, McGoogan E, Whitehead J, Brass A, Arends MJ, et al. Rapid real-time PCR to distinguish between high risk human papillomavirus types 16 and 18. Mol Pathol. 2001;54(1):24-9. https://doi.org/10.1136/mp.54.1.24

36. Ouyang Y, Abuduxikuer G, Abulimiti T, Abudurexiti G, Zhuo Q, Li W, et al. Clinical performance of the SureX PCR HPV test versus hybrid capture assays (DH2/careHPV) in primary cervical cancer screening. Tumour Virus Res. 2025;19:200319. https://doi.org/10.1016/j.tvr.2025.200319

37. Baena A, Mesher D, Salgado Y, Martínez S, Villalba GR, Amarilla ML, et al. Performance of visual inspection of the cervix with acetic acid (VIA) for triage of HPV screen-positive women: Results from the ESTAMPA study. Int J Cancer. 2023;152(8):1581-92. https://doi.org/10.1002/ijc.34384

38. Bogale AL, Teklehaymanot T, Kassie GM, Medhin G, Ali JH, Belay NB. Performance of visual inspection with acetic acid for cervical cancer screening as compared to human papillomavirus deoxyribonucleic acid testing among women with HIV in Ethiopia: A comparative cross-sectional study. Cancer Control. 2022;29:10732748221114980. https://-

doi.org/10.1177/10732748221114980

39. Fentie AM, Tadesse TB, Gebretekle GB. Factors affecting cervical cancer screening uptake, visual inspection with acetic acid positivity and its predictors among women attending cervical cancer screening service in Addis Ababa, Ethiopia. BMC Womens Health. 2020;20(1):147. https://doi.org/10.1186/s12905-020-01008-3

40. Vedantham H, Silver MI, Kalpana B, Rekha C, Karuna BP, Vidyadhari K, et al. Determinants of VIA (visual inspection of the cervix after acetic acid application) positivity in cervical cancer screening of women in a peri-urban area in Andhra Pradesh, India. Cancer Epidemiol Biomarkers Prev. 2010;19(5):1373-80. https://doi.org/10.1158/1055-9965.EPI-09-1282