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# Community-Based Pre-Cancerous Cervical Screening Using Visual Inspection with Acetic Acid (VIA) in Urban of Hodeidah , Yemen

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**ABSTRACT**

**Background**: Cervical cancer remains a major public health concern in low-resource settings, where screening coverage is often inadequate. Visual inspection with acetic acid (VIA) offers a low-cost, accessible method for early detection of precancerous lesions, particularly in underserved urban populations.

**Objective**: This study aimed to determine the prevalence of precancerous cervical lesions and associated risk factors among women in Hodeidah, Yemen using VIA test .

**Methodology** : A retrospective study design was conducted among 143 women who underwent VIA screening in Hodeidah, Yemen. Data on demographic characteristics, socioeconomic status, behavioral exposures, reproductive history, clinical findings, and preventive measures were collected using structured questionnaires. VIA-positive women were referred for histopathological confirmation. Diagnostic indices—including sensitivity, specificity, predictive values, likelihood ratios, and accuracy—were calculated to assess VIA performance.

**Results**: The overall VIA positivity rate was 12.6% (18/143), pre-cancerous lesions were identified in 12 women (8.3%) through VIA, and histopathology confirmed 13 cervical cancer cases (9.1%). VIA demonstrated high diagnostic accuracy, with a sensitivity of 92.31%, specificity of 95.38%, and overall accuracy of 95.10%. VIA-positive women were more frequently aged 31–40 years (38.9%) and belonged to low-income groups (77.8%). Behavioral exposures such as smoking, qat chewing, and shamma use showed no clear association with VIA positivity. Moderate parity (1–4 births) was common among VIA-positive women (88.9%). Clinical symptoms, particularly post-coital bleeding (61.1% vs. 21.0%) and cervical ulcers (27.8% vs. 14.0%), showed strong associations with VIA positivity. Preventive measures were very limited, with only 2.8% vaccinated for HPV and 4.2% previously screened.

**Conclusion**: VIA proved to be a reliable, sensitive, and cost-effective method for detecting cervical pre-cancerous lesions, demonstrating strong diagnostic value in low-resource settings. Clinical symptoms—particularly post-coital bleeding and cervical ulceration—were more predictive of VIA positivity than behavioral or reproductive factors. Strengthening HPV vaccination and cervical cancer screening programs remains essential to improving early detection and reducing disease burden.

**Keywords:** *Cervical cancer, Community-based study, VIA, Screening, Precancerous lesions , Yemen*

## 1. INTRODUCTION

Cervical cancer is a preventable disease and a clear indicator of global health inequity. It ranks as the fourth most common cancer among women worldwide, with a disproportionate burden in low- and middle-income countries (LMICs), where access to systematic screening and human papillomavirus (HPV) vaccination remains limited In 2020, there were an estimated 604,000 new cases and 342,000 deaths globally, the majority occurring in settings with weak health infrastructure [1, 2] . Effective screening options include HPV DNA testing, cytology (Pap smear), and visual inspection with acetic acid (VIA). While these approaches differ in accuracy and programmatic requirements, all are widely applied across global programs [1, 3]. The World

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Health Organization (WHO) recommends HPV DNA testing as the preferred primary method where feasible, but acknowledges that cytology and VIA continue to play important roles in resource-constrained environments [4]. Economic analyses show Pap cytology can be cost-effective, though HPV testing becomes increasingly favorable as costs decline, allowing longer screening intervals and more efficient programs [3, 5, 6].

Primary prevention has been revolutionized by prophylactic HPV vaccines, which provide near-complete protection against the most oncogenic HPV strains when given before exposure [1, 2]. Successful implementation requires careful program design to ensure appropriate targeting, test selection, and strong quality assurance [5, 7].In low-resource settings, VIA remains a pragmatic option. Evidence from community-based studies demonstrates its utility for case-finding, with one health-camp survey reporting a 14.3% prevalence of precancerous lesions—approximately twice the rate observed in facility-based studies and concentrated within certain age groups [2, 8]. In Yemen, the burden of cervical cancer is real but likely underestimated due to limited surveillance and service disruptions. GLOBOCAN reported about 212 new cases and 153 deaths in 2022 (~1.3% of national cancer incidence), while ICO/IARC figures are similar (~225 cases and 153 deaths annually). Ongoing humanitarian challenges and fragmented health services further constrain prevention and early detection [4].

At present, there is no organized national screening program; cytology is largely opportunistic and concentrated in the private sector. Although HPV-based strategies represent the global standard, VIA remains a practical interim approach where budgets, logistics, or workforce limitations hinder laboratory expansion. VIA is inexpensive, can be delivered by trained mid-level providers, and allows for same-day “screen-and-treat” when ablative therapy is available [1, 4, 5]. However, because its accuracy depends heavily on provider skill, sustained training, supervision, and verification are essential [6, 9]. Studies of Yemeni women abroad highlight additional sociocultural and access barriers that suppress screening uptake [10]. In fragile urban settings like Hodeidah, community-based VIA delivered through primary care and outreach provides a feasible entry point for early detection. Experiences from other LMICs suggest that many precancerous cases remain undetected within facility-based services alone [10, 11]. This study aimed to generate Yemen-specific implementation evidence for detection of precancerous cervical lesions based on the validated VIA and describe the sociodemographic, risk factors, behavioral, reproductive, clinical factors, and outcomes**.**

## 2. METHDOLOGY

### *2.1. Study area*

The study was conducted in the urban area of Hodeidah governorate, Yemen. Screening activities took place in community health outreach sites and primary care facilities serving women in the city and nearby urban neighborhoods. The study was conducted under the supervision of the Center of Tropical Medicine and Epidemiology Studies — Hodeidah University (CTMES–HU).

### *2.2. Study setting*

Community-based screening sessions were organized at local primary health centers and temporary outreach clinics. Trained nurses and clinicians performed visual inspection with VIA and collected cervical biopsy specimens (when indicated) for histopathology at a regional laboratory. Health education and referral pathways to tertiary care for confirmed cases were provided. The study was carried out in 2016 – 2017 in collaboration with Cancer Treatment Center and Gynecology and Obstetrics Department – Authority of Public Al Thawara Hospital in Hodeidah, Yemen .

### *2.3. Study design*

A retrospective study design. Women attending outreach clinics during the study period were screened once using VIA; VIA positives were referred for confirmatory diagnostic based on standard procedure .

### *2.4. Sample size*

The sample size used: 143 women (final enrolled and screened). Sampling approach: consecutive (convenience) sampling of eligible women who attended the outreach screening sessions and met the inclusion criteria. Inclusion criteria (example text you can adapt): women aged ≥ 21 years (or local program age-range), sexually active, not currently pregnant, no prior hysterectomy, able and willing to give informed consent. The exclusion criteria included active heavy vaginal bleeding preventing adequate visualization, known cervical cancer under treatment, or other contra-indication to the speculum exam.

### *2.5. Variable size*

The dependent variables included VIA result (positive/negative) and final histopathological diagnosis (confirmed cancer / pre-malignant lesion / no cancer), and the independent variables (candidate

predictors/covariates). Demographics: age (categorical: ≤30, 31–40, 41–50, >50), socioeconomic status (low/middle). ; Behavioral: tobacco smoking (current/non), qat chewing (yes/no), Shamma use (yes/no); Reproductive history: gravidity, parity, number of live births, number of spouses; Clinical symptoms/signs: post-coital bleeding, vaginal discharge, dyspareunia, cervical ulcer, genital warts, history of cauterization, previous cervical screening, HPV vaccination status.

### *2.6. VIA procedure*

a) Pre-test counselling and informed consent: explain test purpose, process, possible outcomes, and management/referral for positives.
b) Positioning and speculum exam: woman in lithotomy position; adequate lighting; sterile speculum inserted to visualize cervix.
c) Visual inspection baseline: inspect cervix for gross lesions, ulcers, warts, bleeding. Record clinical findings (discharge, ulcer, etc.).
d) Application of 5% acetic acid: apply acetic acid to the cervix (using soaked gauze or spray), wait ~1 minute.
e) Interpretation: observe for acetowhite changes on the squamocolumnar junction or new white epithelium within transformation zone. Classify as:
    - VIA positive: well-defined acetowhite area near squamocolumnar junction or suspicious lesion.
    - VIA negative: no acetowhite changes or only faint/transient whiteness unrelated to transformation zone (TZ).
    - Inadequate: cervix not visible or bleeding prevents interpretation.
f) Immediate management: depending on program algorithm — cryotherapy or thermal ablation for eligible small lesions ("see and treat") or referral for colposcopy/biopsy if lesion not eligible for ablative therapy. Provide counselling and schedule further investigation for positives.
g) Documentation: capture result, photograph if program allows, record symptoms and risk factors [4].

### *2.7. Cancer confirmation*

- All VIA-positive women were referred for diagnostic confirmation. Confirmation was based on Pap smear and histopathological examination of cervical biopsy specimens.
- Laboratory processing: formalin fixation, paraffin embedding, hematoxylin & eosin staining, and read by a pathologist. Final diagnosis categories: invasive cervical cancer, high-grade lesion (CIN2+), low-grade lesion (CIN1), or benign/no neoplasia.

### 2.8. Data management

Data were analyzed using SPSS with verification to minimize errors. Descriptive statistics summarized participant characteristics, while the diagnostic accuracy of VIA was assessed against histopathology, including sensitivity, specificity, predictive values, accuracy, likelihood ratios, and disease prevalence. Analyses followed WHO guidelines and were supported by the MedCalc Diagnostic Test Evaluation Calculator [12,13]

### *2.9. Ethical considerations*

Obtain ethics approval from the local institutional review board (e.g., CTMES–HU). Obtain written informed consent from all participants, ensure confidentiality, and provide referral and treatment for positive cases.

## 3. RESULTS

### *3.1. Prevalence of cervical pre-cancerous*

Among all 143 participants, the majority were ≤30 years old (59.4%), followed by those aged 31–40 years (25.9%). Smaller proportions were in the 41–50 years (11.2%) and >50 years (3.5%) groups. Among the 18 VIA-positive women, the age pattern shifts slightly: 31–40 years constituted the largest proportion (38.9%). Women ≤30 years accounted for 33.3%, notably lower than their proportion in the overall sample. Those aged 41–50 years and >50 years represented 16.7% and 11.1%, respectively, both higher than in the full sample. (Table 1 and Figure 1).

**Table 1.** Demographic data of participants (N: 143)

| Characteristic | Category | All Participants N=143 (%) | VIA-Positive n=18 (%) |
|---|---|---|---|
| **DEMOGRAPHIC CHARACTERISTICS** | | | |
| Age group (years) | ≤30 | 85 (59.4) | 6 (33.3) |
| | 31-40 | 37 (25.9) | 7 (38.9) |
| | 41-50 | 16 (11.2) | 3 (16.7) |
| | >50 | 5 (3.5) | 2 (11.1) |
| Income level | Low | 105 (73.4) | 14 (77.8) |
| | Middle | 38 (26.6) | 4 (22.2) |

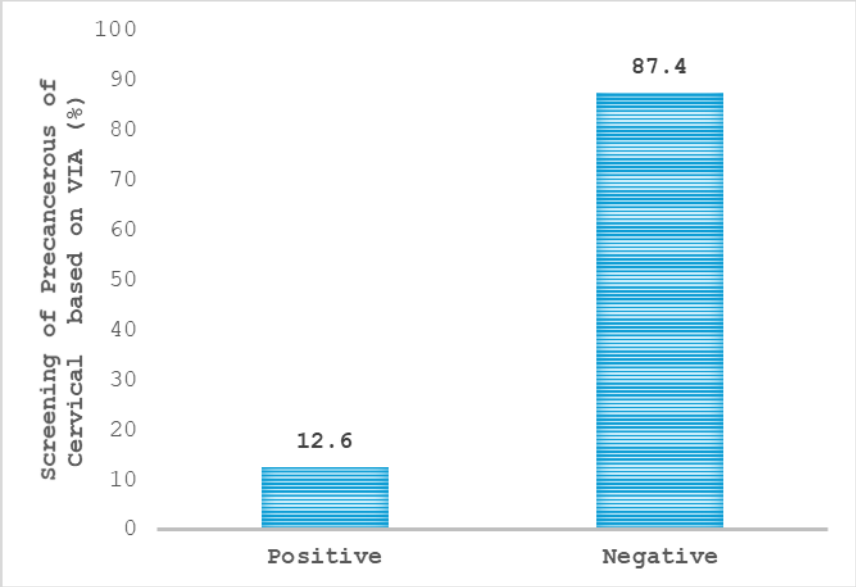


**Figure 1.** Screening of pre-cancerous lesions of the cervix based on VIA (%)

### *3.2. Socioeconomic status*

Overall, 73.4% of participants were from low-income households, while 26.6% belonged to the middle-income category. Among VIA-positive women: 77.8% were from low-income households. 22.2% were from middle-income households. (Table 1).

### *3.3. Behavioral exposures*

Among the behavioral exposures assessed, current smoking was reported by 57.3% of all participants, whereas non-smokers accounted for 42.7%; however, among VIA-positive women, smoking and non-smoking were equally distributed (50% each), indicating no apparent relationship between smoking and VIA positivity. Similarly, qat chewing was highly prevalent in the total sample (71.3%), yet only half (50%) of the VIA-positive women reported chewing qat, suggesting that qat use may not be a major contributing factor to VIA outcomes. Shamma use was reported by 27.3% of all participants and 22.2% of VIA-positive women, reflecting a slightly lower prevalence in the VIA-positive group. Overall, these findings show that smoking, qat chewing, and shamma use were less common among VIA-positive women than in the general participant pool, suggesting that the behavioral exposures examined did not demonstrate a strong association with VIA positivity in this study. (Figure 2 and Table 2).

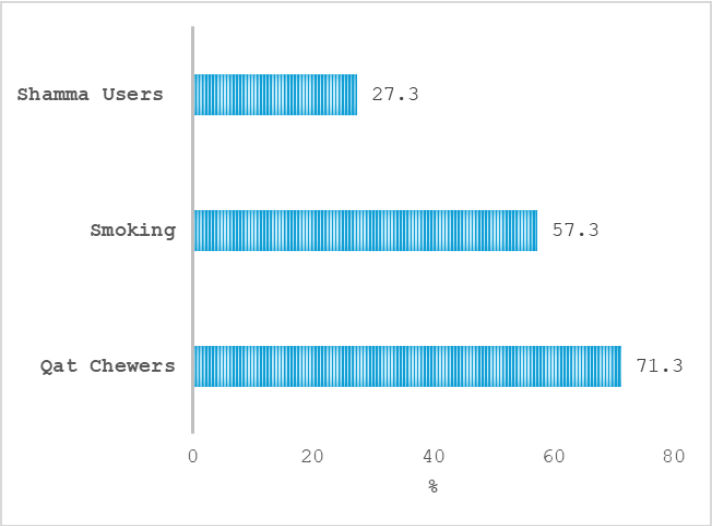


**Figure 2.** Behavioral exposures (%)

**Table 2.** Behavior factors

| Characteristic | Category | All Participants N=143 (%) | VIA-Positive n=18 (%) |
|---|---|---|---|
| **BEHAVIORAL EXPOSURES** | | | |
| Smoking status | Current smoker | 82 (57.3) | 9 (50.0) |
| | Non-smoker | 61 (42.7) | 9 (50.0) |
| Qat chewers | Yes | 102 (71.3) | 9 (50.0) |
| | No | 41 (28.7) | 9 (50.0) |
| Shamma users | Yes | 39 (27.3) | 4 (22.2) |
| | No | 104 (72.7) | 14 (77.8) |

### *3.4. Reproductive history*

Among the reproductive characteristics, gravidity patterns were similar between the overall sample and VIA-positive women, with approximately half of both groups reporting ≤2 pregnancies, while higher gravidity (≥5 pregnancies) accounted for 30.1% of all participants and 27.8% of VIA-positive cases. Parity showed a more notable pattern: while 9.1% of the total sample were nulliparous, none of the VIA-positive women had no prior births. Most VIA-positive women (88.9%) had 1–4 live births, and only 11.1% had ≥5 births, suggesting that higher parity, particularly moderate parity (1–4 births), may be more common among VIA-positive cases. Nearly all VIA-positive women (88.9%) reported having one spouse, with 11.1% reporting two or more.. (Table 3).

**Table 3.** Reproductive History

| Characteristic | Category | All Participants N=143 (%) | VIA-Positive n=18 (%) |
|---|---|---|---|
| **REPRODUCTIVE HISTORY** | | | |
| Gravidity | ≤2 pregnancies | 72 (50.3) | 9 (50.0) |
| | 3-4 pregnancies | 28 (19.6) | 4 (22.2) |
| | ≥5 pregnancies | 43 (30.1) | 5 (27.8) |
| Parity | Nulliparous (0) | 13 (9.1) | 0 (0.0) |
| | 1-4 live births | 105 (73.4) | 16 (88.9) |
| | ≥5 live births | 25 (17.5) | 2 (11.1) |
| Spouses | 1 | - | 16 (88.9) |
| | ≥2 | - | 2 (11.1) |

### *3.5. Clinical finding*

Clinical findings revealed clearer associations: post-coital bleeding was reported by 21% of all participants but was markedly higher among VIA-positive women (61.1%), indicating a strong clinical correlate of positive VIA outcomes. Vaginal discharge and dyspareunia were highly prevalent in the entire cohort (88.8% and 89.5%, respectively) and remained common among VIA-positive women (83.3% for both). Cervical ulcers were observed in 14% of all participants but in 27.8% of VIA-positive women, while genital warts remained rare in both groups (3.5% vs. 5.6%). Cauterization history was more frequent among VIA-positive women (27.8%) compared with the full sample (16.8%), and the presence of other diseases was also slightly higher (11.1% vs. 5.6%). Surgical history showed minimal differences between groups. Medical history factors showed limited associations: family history of cancer was uncommon in both groups, and no participants reported allergies or immunosuppressive medication use. However, steroid use was identified in 5.6% of VIA-positive women only, and among contraceptive users, 33.3% of VIA-positive women used oral contraceptive pills while 22.2% used other methods. Overall, the findings suggest that clinical symptoms—particularly post-coital bleeding and cervical ulceration—show stronger associations with VIA positivity than reproductive or general medical history variables (Table 4 and 5 and Figure 3).

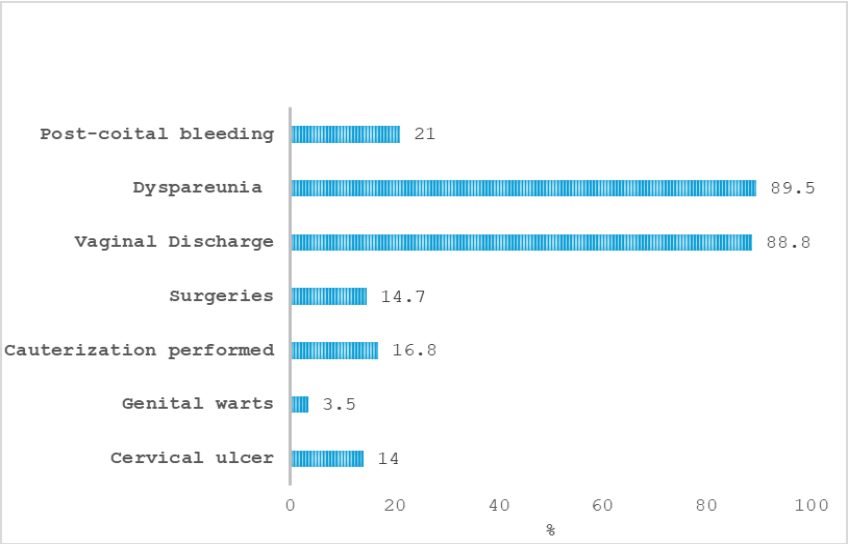


**Figure 3.** Clinical finding

**Table 4.** Clinical History

| Characteristic | Category | All Participants N=143 (%) | VIA-Positive n=18 (%) |
|---|---|---|---|
| **CLINICAL FINDINGS** | | | |
| Post-coital bleeding | Yes | 30 (21.0) | 11 (61.1) |
| | No | 113 (79.0) | 7 (38.9) |
| Vaginal discharge | Yes | 127 (88.8) | 15 (83.3) |
| | No | 16 (11.2) | 3 (16.7) |
| Dyspareunia (painful intercourse) | Yes | 128 (89.5) | 15 (83.3) |
| | No | 15 (10.5) | 3 (16.7) |
| Cervical ulcer | Present | 20 (14.0) | 5 (27.8) |
| | Absent | 123 (86.0) | 13 (72.2) |
| Genital warts | Present | 5 (3.5) | 1 (5.6) |
| | Absent | 138 (96.5) | 17 (94.4) |
| Cauterization performed | Yes | 24 (16.8) | 5 (27.8) |
| | No | 119 (83.2) | 13 (72.2) |
| Other diseases | Present | 8 (5.6) | 2 (11.1) |
| | Absent | 135 (94.4) | 16 (88.9) |
| Surgeries | Yes | 21 (14.7) | 2 (11.1) |
| | No | 122 (85.3) | 16 (88.9) |

**Table 5.** Clinical History

| Characteristic | Category | All Participants N=143 (%) | VIA-Positive n=18 (%) |
|---|---|---|---|
| **CLINICAL FINDINGS** | | | |
| **MEDICAL HISTORY** | | | |
| Family cancer history | Yes | 11 (7.7) | 1 (5.6) |
| | No | 132 (92.3) | 17 (94.4) |
| Allergies | Present | 0 (0.0) | 0 (0.0) |
| Immunosuppressive medications | Yes | 0 (0.0) | 0 (0.0) |
| Steroid use | Yes | - | 1 (5.6) |
| Contraceptive use | Oral pills | - | 6 (33.3) |
| | Other methods | - | 4 (22.2) |

### *3.6. Preventive measures*

Only 2.8% were HPV vaccinated, and 4.2% had ever been screened for cervical cancer. Among VIA-positive cases, 94.4% were unvaccinated and unscreened previously (Table 6).

**Table 6.** Preventive measures (**N: 143 ; n: 18)**

| Characteristic | Category | All Participants N=143 (%) | VIA-Positive n=18 (%) |
|---|---|---|---|
| **PREVENTIVE MEASURES** | | | |
| HPV vaccination status | Vaccinated | 4 (2.8) | 1 (5.6) |
| | Unvaccinated | 139 (97.2) | 17 (94.4) |
| Cervical smear history | Previously screened | 6 (4.2) | 1 (5.6) |
| | Never screened | 137 (95.8) | 17 (94.4) |
| | None | - | 8 (44.4) |

### *3.7. Screening outcomes*

Histological confirmation identified 13 cases of cervical cancer (9.1%). VIA detected 12 of these cases (8.3%), corresponding to a sensitivity of 92.3% in this study (Table 7).

**Table 7:** Diagnostic performance of VIA compared with histopathology (N = 143; VIA-positive = 18)

| Characteristic | Category | All Participants N=143 (%) | VIA-Positive n=18 (%) |
|---|---|---|---|
| **SCREENING OUTCOMES** | | | |
| VIA examination result | Positive | 18 (12.6) | 18 (100.0) |
| | Negative | 125 (87.4) | 0 (0.0) |
| Final cancer diagnosis | Confirmed cancer | 13 (9.1) | 12 (66.7) |
| | No cancer | 130 (90.9) | 6 (33.3) |

### *3.8. Sensitivity and specificity of VIA*

VIA showed excellent performance in detecting cervical precancerous lesions, with high sensitivity (92.31%), specificity (95.38%), and overall accuracy (95.10%). The strong positive likelihood ratio (20.00) and very low negative likelihood ratio (0.08) confirm its reliability as a diagnostic tool. VIA achieved a positive predictive value of 66.67% and an outstanding negative predictive value of 99.20%, ensuring that very few cases were missed. These results highlight VIA as a low-cost, practical, and effective screening method, especially suitable for low-resource settings (Table 8).

**Table 8.** Diagnostic accuracy of VIA compared with histopathology (N = 143)

| parameters | Value (%) | CI 95% |
|---|---|---|
| Sensitivity | 92.31% | 63.97% – 99.81% |
| Specificity | 95.38% | 90.22% – 98.29% |
| Positive likelihood ratio | 20.00 | 9.01 – 44.38 |
| Negative likelihood ratio | 0.08 | 0.01 – 0.53 |
| Positive predictive value (Precision) | 66.67% | 47.40% – 81.61% |
| Negative predictive ratio | 99.20% | 94.96% – 99.88% |
| Accuracy | 95.10% | 90.17% – 98.01% |

## 1. DISCUSSION

VIA is a sensitive, specific, and practical method for cervical cancer screening in weak health systems, according to this community-based study conducted in Hodeidah, Yemen. 92.31% of sensitivity and 95.38 % of specificity, our results show excellent diagnostic accuracy. The precsion was 66.67% that indicates that more than two-thirds of VIA-positive women truly had precancerous lesions, while the negative predictive value was 99.20 % that highlights VIA's reliability in excluding disease. With an overall accuracy of 95.10 %, VIA proves to be a robust and practical screening method in primary health care and low-resource contexts. These findings are particularly important in Yemen, where there is no national screening program and preventive coverage remains limited.

The observed VIA positivity rate of 12.6% is comparable to the 11.9% pooled prevalence reported in African meta-analyses [14] and closely aligns with results from Tanzania, where sensitivity and specificity exceeded 90% [15]. In contrast, global meta-analyses have reported lower sensitivities (67–79%) and specificities (49–86%), underscoring the strong performance observed in our setting [16-19]. Studies from India (88%/78%) and Ethiopia (76.7%;85.5%) also demonstrated lower accuracy [20, 21], while our results were more consistent with the Tanzanian experience [15].

Our findings are in line with global pooled evidence showing VIA sensitivity around 79–80% and specificity near 81–85% [16, 17]. Similarly, the ESTAMPA (EStudio multicéntrico de TAMizaje y triaje de cáncer de cuello uterino con pruebas del virus del PApiloma humano; Spanish acronym) multicountry trial confirmed high sensitivity (~84.5%) but noted variable specificity, highlighting the importance of training and quality assurance in program implementation [22].

Beyond accuracy, contextual barriers remain critical. Studies in Tanzania and Kenya highlighted that sociocultural acceptance, HIV status, and provider experience influence VIA performance [23,24]. In Yemen, ongoing war , fragile health infrastructure, and limited awareness contribute to underdiagnosis and delayed presentation [10,25]. From a programmatic perspective, VIA is advantageous because of its low cost, immediacy, and adaptability to outreach services. However, the WHO recommends HPV DNA testing as the gold standard for primary screening, with VIA serving as a triage tool or interim method in resource-constrained settings [26,27]. Integrating HPV testing with same-visit VIA triage and treatment reduces loss to follow-up and improves program effectiveness [28]. Recent innovations such as portable thermal ablation provide effective treatment options with outcomes comparable to cryotherapy and excision, strengthening the feasibility of screen-and-treat models in low- and middle-income countries [29]. Taken together, our findings support the integration of community-based VIA screening into primary health care in Yemen, alongside the progressive introduction of HPV testing, scale-up of HPV vaccination, and structured provider training. Such a multi-component strategy can enhance early detection, reduce the cervical cancer burden, and bridge equity gaps in fragile health systems.

## 2. CONCLUSION

This community-based screening in Hodeidah, Yemen, found a high prevalence of cervical abnormalities, with 12.6% VIA-positive cases and 9.1% histologically confirmed cervical cancer. Older age, post-coital bleeding, cervical ulcers, and prior cauterization were associated with higher detection rates. Preventive coverage was very limited, with HPV vaccination and prior screening. VIA demonstrated high diagnostic accuracy for cervical precancerous detection, with excellent sensitivity, specificity, and predictive values. Its strong likelihood ratios confirm reliability, and its low cost makes it a practical, effective screening option for

low-resource settings. Scaling up VIA screening, expanding HPV vaccination, raising awareness, and integrating screening into primary health services are strongly recommended.

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**Conflicts of Interest**
The authors declare that they have no conflicts of interest.

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