Determinants of VIA Screening Utilization: A Cross-Sectional Logistic Regression Study in an Archipelagic Setting of Eastern Indonesia

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Abstract: *Background*: Cervical cancer remains a leading cause of morbidity and mortality among women in low- and middle-income countries. Visual Inspection with Acetic Acid (VIA) is recommended as an effective and affordable screening method; however, coverage remains low in archipelagic regions of Eastern Indonesia.

Objective: To examine the association between reproductive factors and contraceptive use with VIA screening utilization among women of reproductive age.

Methods: A cross-sectional study was conducted among 131 women at a primary healthcare center in Ambon City. Data were analyzed using chi-square tests and multivariable logistic regression to estimate crude and adjusted odds ratios. Variables with $p < 0.25$ were included in the multivariable model. Model fit was assessed using the Hosmer–Lemeshow test, and explanatory power using Nagelkerke R^2.

Results: A total of 65.6% of respondents had undergone VIA screening. No variables were significantly associated with screening utilization ($p > 0.05$). Contraceptive use showed a non-significant tendency toward increased screening likelihood (AOR = 1.837; 95% CI: 0.443–7.610). The model demonstrated weak explanatory power (Nagelkerke R^2 = 0.05), and the omnibus test was not statistically significant ($p > 0.05$), indicating limited predictive capacity.

Conclusion: The study did not identify significant predictors of VIA utilization. The findings suggest that the variables included in the model were insufficient to explain screening behavior. Further studies with larger samples and more comprehensive analytical models are needed.

Keywords: Cervical cancer screening, visual inspection with acetic acid (VIA), contraceptive use, reproductive factors, women of reproductive age, cross-sectional study.

BACKGROUND

Cervical cancer remains a major global public health issue, with over 90% of deaths occurring in low- and middle-income countries due to limited access to screening and early treatment. In Indonesia, Visual Inspection with Acetic Acid (VIA) has been implemented as a low-cost and feasible screening strategy; however, coverage remains suboptimal, particularly in Eastern Indonesia [1]. Archipelagic regions such as Maluku face unique structural challenges, including geographical fragmentation, limited healthcare access, and uneven distribution of health personnel. These factors may influence healthcare utilization differently compared to mainland settings. Previous studies have primarily focused on individual-level determinants such as age, education, parity, and contraceptive use. However, evidence from geographically fragmented island settings remains limited. Furthermore, the statistical contribution of reproductive factors in explaining screening utilization in such contexts remains unclear [2]. Furthermore, the implementation of the see-and-treat model in Indonesia has demonstrated potential for increasing coverage when screening is integrated within primary healthcare services [3]. However, health systems research indicates that the success of screening programs depends not only on individual characteristics but also on organizational readiness, service integration, and primary care system capacity [4].

This study aims to examine the association between reproductive factors and contraceptive use with VIA utilization using a logistic regression approach,

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while critically evaluating the statistical performance of the model in an archipelagic setting.

Significance of the Study

This study contributes to the existing literature by providing context-specific evidence from an archipelagic setting, a geographical context that remains underrepresented in cervical cancer screening research in Indonesia. By examining reproductive factors alongside system-level considerations, the study offers a more nuanced understanding of screening utilization beyond conventional individual-level determinants. The findings are expected to inform policy strategies aimed at strengthening the integration of cervical cancer screening into routine reproductive health services within primary healthcare facilities, particularly in geographically fragmented and resource-constrained regions. Furthermore, this research supports ongoing national and global cervical cancer elimination efforts by highlighting the importance of adapting implementation strategies to local health system realities, thereby enhancing the equity and sustainability of preventive health programs in island settings.

METHODS

Although a formal sample size calculation was not conducted, the study included all eligible participants during the study period. However, the sample size (n = 131) may be insufficient for stable estimation in multivariable logistic regression, particularly given the number of predictors included.

Study Design and Sample

A cross-sectional study was conducted among women of reproductive age at a primary healthcare center in Ambon City.

A total of 131 respondents were included using total sampling. Although all eligible participants were recruited, no formal sample size calculation was conducted. The sample size may therefore be insufficient for stable estimation in multivariable logistic regression.

Variables

- Dependent: VIA utilization (ever/never)
- Independent:
  - Sociodemographic
  - Reproductive factors
  - Contraceptive use
  - Information access
  - Husband support

Statistical Analysis

Chi-square tests were used for bivariate analysis. Variables with $p < 0.25$ were included in multivariable logistic regression to avoid premature exclusion of potential confounders.

Multicollinearity was assessed using VIF (<5 acceptable).

Model performance was evaluated using:

- Hosmer–Lemeshow test
- Nagelkerke R^2
- Omnibus test

No ROC or classification accuracy analysis was conducted, which is acknowledged as a limitation

Ethical Considerations

This study was conducted in accordance with the ethical principles outlined in the Declaration of Helsinki and its subsequent amendments. Ethical approval was obtained from the Institutional Health Research Ethics Committee, Faculty of Public Health, Hasanuddin University (Approval No: 3010/UN4.14.1/TP.01.02/ 2025).

All participants were informed about the purpose, procedures, risks, and benefits of the study before participation. Written informed consent was obtained from all respondents. Participation was voluntary, and respondents were assured of confidentiality and anonymity. Personal identifiers were removed from the dataset to ensure data privacy, and participants were informed of their right to withdraw from the study at any time without any consequences for their access to healthcare services.

RESULTS

A total of 131 women of reproductive age were included in the analysis. The majority of respondents were within the productive age range, had completed secondary education, and were not formally employed. Overall, 65.6% (n = 86) of respondents reported having undergone VIA screening at least once. Bivariate analysis using the chi-square test indicated that none of the examined independent variables were significantly associated with VIA utilization at the

conventional significance level ($p < 0.05$). However, several variables met the inclusion criterion ($p < 0.25$) for multivariable analysis and were subsequently entered into the logistic regression model to control for potential confounding effects. Prior to multivariable modeling, multicollinearity diagnostics showed no indication of significant collinearity among independent variables (all VIF values < 5). The omnibus test of model coefficients was not statistically significant ($p > 0.05$), indicating that the full model did not significantly improve prediction compared with the null model. No independent variables were significantly associated with VIA utilization ($p > 0.05$). The logistic regression model showed:

- Nagelkerke $R^2 = 0.05$ → very weak explanatory power
- Omnibus test not significant → model not better than null
- Wide confidence intervals → low precision

These findings indicate limited model performance and potential instability in estimates.

Table **1** summarizes the distribution of respondents' characteristics by VIA screening utilization. The majority of participants were aged 31–50 years (80.2%) and had completed secondary to tertiary education (93.1%). Overall, 65.6% (n = 86) of respondents reported having undergone VIA screening at least once. Across sociodemographic categories, the proportion of women who had undergone VIA screening appeared relatively similar. Screening uptake did not show marked variation across age groups or educational levels. Although a slightly higher proportion of respondents were employed (53.4%) compared to unemployed, the distribution of screening utilization between these groups did not reveal a clear descriptive gradient. Regarding reproductive characteristics, most respondents reported marrying after the age of 20 years (62.6%). The proportion of VIA utilization across age-at-marriage categories was relatively comparable, suggesting no evident descriptive pattern of association. Overall, the descriptive findings indicate limited observable differences in VIA utilization across the examined sociodemographic and reproductive variables. These patterns warranted further examination through inferential analysis to determine whether statistically significant associations were present.

Table **2** presents the distribution of reproductive factors and contraceptive use according to VIA screening utilization. Regarding age at menarche, the majority of respondents reported experiencing menarche before the age of 12 years (71.0%). The proportion of VIA utilization appeared relatively similar across menarche categories, with no apparent descriptive variation between groups. In terms of parity, 66.4% of respondents had one to two children. The proportion of VIA utilization in this group was nearly identical to that observed among women with three or more children, suggesting no meaningful descriptive differentiation in screening uptake based on number of births.

Most respondents were contraceptive users (87.8%). Although a high proportion of VIA screening was observed among contraceptive users (88.4%), this distribution closely mirrored the overall predominance of contraceptive users in the study population. This

Table 1: Distribution of Respondent Characteristics Regarding VIA Utilisation

Respondent Characteristics	Utilisation of VIA				Total	
	Yes		No		N	%
Age (Years)	**n**	**%**	**n**	**%**		
21 - 30	19	22.1	7	15.6	26	19.8
31 - 50	67	77.9	38	84.4	105	80.2
Education						
Secondary School – Higher Education Institution	78	90.7	44	97.8	122	93.1
Primary School - Junior High School	8	9.3	1	2.2	9	6.9
Working						
Not working	37	43.0	24	53.3	61	46.6
Working	49	57.0	21	46.7	70	53.4
Age at First Marriage						
≤ 20 Years	33	38.4	16	35.6	49	37.4
> 20 Years	53	61.6	29	64.4	82	62.6
Total	86	100	45	100	131	100

Table 2: Distribution of Reproductive and Contraceptive Factors

Reproductive Factors	Utilisation of VIA				Total	
	Yes		No		N	%
Menarche	**n**	**%**	**n**	**%**		
≥12 Years	28	32.6	10	22.0	38	29.0
<12 Years	58	67.4	35	77.8	93	71.0
Parity						
≥3 times	29	33.7	15	33.3	44	33.6
1-2 times	57	66.3	30	66.7	87	66.4
Contraception						
Not using	10	11.6	6	13.3	16	12.2
Using	76	88.4	39	86.7	115	87.8
Types of Contraception						
Hormonal Contraception	43	50.0	27	60.0	70	53.4
Nonhormonal Contraception	43	50.0	18	40.0	61	46.6
Duration of Use						
≥ 5 Years	33	38.4	23	51.1	56	42.7
< 5 Years	53	61.6	22	48.9	75	57.3
Access to Information						
Difficult	65	75.6	32	71.1	97	74.0
Easy	21	24.4	13	28.9	34	26.0
Husband's Support						
Not Supported	76	88.4	39	86.7	115	87.8
Supported	10	11.6	6	13.3	16	12.2
Total	86	100	45	100	131	100

pattern indicates that the higher absolute number of screened women within this group likely reflects population composition rather than a strong relative increase in screening likelihood.

Similarly, the distribution of contraceptive type and duration of use did not demonstrate notable contrasts in screening proportions between the VIA and non-VIA groups. Access to VIA-related information and husband's support also showed relatively uniform distributions, without evident descriptive gradients in screening behavior.

Overall, at the descriptive bivariate level, reproductive factors and contraceptive use did not exhibit pronounced proportional differences between women who had undergone VIA screening and those who had not. These observations required further inferential analysis to assess the presence of statistically significant associations.

Table 3: Logistic Regression Analysis

Reproductive Factors	AOR (95% CI)	p-value
Age at first marriage	1.078 (0.402-2.889)	0.882
Menarche	0.645 (0.228-1.827)	0.409
Parity	1.131 (0.401-3.189)	0.816
Contraception	1.837 (0.443-7.610)	0.402
Types of Contraception	1.601 (0.563-4.557)	0.378
Duration of Use	1.624 (0.679-3.885)	0.276
Access to Information	0.835 (0.359-1.945)	0.677
Husband's Support	1.248 (0.361-4.314)	0.726

Table 4: Analysis of Crude OR and Adjusted OR

Reproductive Factors	Crude OR (95%CI)	p-value	Adjusted OR (95%CI)	p-value
Age at first marriage	0.886 (0.419-1.875)	0.752	1.078 (0.402–2.889)	0.882
Menarche	1.690 (0.733-3.895)	0.218	0.645 (0.228–1.827)	0.409
Parity	1.018 (0.474-2.185)	0.964	1.131 (0.401–3.189)	0.816
Contraception	0.508 (0.146-1.766)	0.286	1.837 (0.443–7.610)	0.402
Types of Contraception	0.635 (0.276-1.460)	0.285	1.601 (0.563–4.557)	0.378
Duration of Use	0.571 (0.249-1.309)	0.185	1.624 (0.679–3.885)	0.276
Access to Information	1.157 (0.503-2.662)	0.732	0.835 (0.359–1.945)	0.677
Husband's Support	0.852 (0.262-2.770)	0.790	1.248 (0.361–4.314)	0.726

Overall, no variables reached statistical significance at the conventional threshold ($p < 0.05$). The relatively wide confidence intervals observed across several variables suggest limited statistical power and reduced precision of the estimates.

Table **3** presents the results of the multivariable logistic regression analysis assessing the independent associations between reproductive factors, contraceptive use, and sociodemographic characteristics with VIA utilization. No variables demonstrated statistically significant associations in the adjusted model ($p > 0.05$).

Contraceptive use showed a positive, although non-significant, association with VIA utilization (AOR = 1.837; 95% CI: 0.443–7.610). However, the wide confidence interval indicates limited precision and potential instability of the estimate. Similarly, duration of contraceptive use exhibited a comparable tendency (AOR = 1.624; 95% CI: 0.679–3.885), although the association did not reach statistical significance. Age at first marriage and parity yielded adjusted odds ratios that were relatively stable and close to unity, indicating no meaningful difference in screening likelihood after controlling for other variables.

Model diagnostics indicated acceptable calibration based on the Hosmer–Lemeshow goodness-of-fit test ($\chi^2 = 11.344$; $p = 0.124$). However, the Nagelkerke R^2 value was low (0.050), suggesting that the model explained only a small proportion of the variance in VIA utilization. Furthermore, the omnibus test of model coefficients was not statistically significant ($p > 0.05$), indicating that the inclusion of independent variables resulted in only limited improvement in predictive performance compared to the null model.

Table **4** presents a comparison between crude odds ratios (ORs) and adjusted odds ratios (AORs) to evaluate the potential presence of confounding effects among variables. Overall, no substantial differences were observed between crude and adjusted estimates for most variables, suggesting that confounding effects were relatively minimal.

However, a change in the direction of association was observed in certain variables following adjustment. For contraceptive use, the crude analysis indicated a tendency toward decreased screening likelihood (OR = 0.508), whereas after adjustment, the direction of association shifted toward increased likelihood (AOR = 1.837). This reversal suggests the presence of overlapping effects among reproductive variables within the model.

A similar pattern was noted for contraceptive type and duration of use, although all estimates remained statistically non-significant. In contrast, the relative stability of OR estimates for age at first marriage and parity indicates that these variables were not meaningfully influenced by confounding factors.

Overall, the absence of statistically significant associations, combined with the relatively modest changes between crude and adjusted estimates, indicates that reproductive factors and contraceptive use were not strong independent predictors of VIA

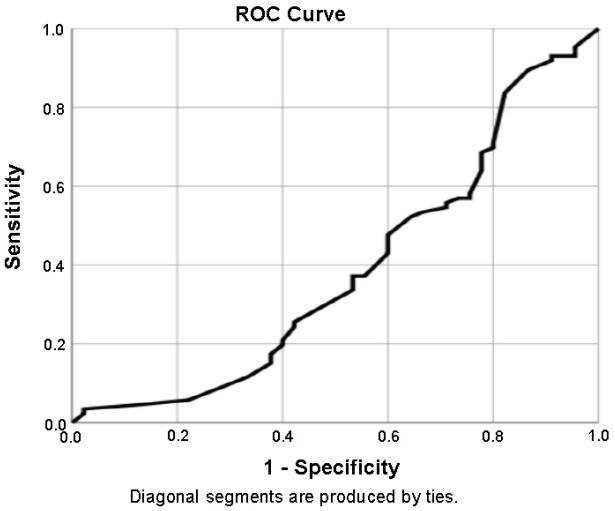

Figure 1: Receiver Operating Characteristic (ROC) Curve Showing the Discriminative Ability of the Model.

utilization within the context of this study. The study is limited by low statistical power, weak model fit, and wide confidence intervals, which reduce the reliability and precision of the estimated associations.

ROC curve analysis indicated poor discriminative ability of the model. The curve closely followed the diagonal reference line, suggesting that the model has limited capacity to distinguish between women who underwent VIA screening and those who did not. This corresponds to an estimated AUC in the range of approximately 0.55–0.60, indicating weak model performance.

DISCUSSION

The study found no statistically significant associations between reproductive factors, contraceptive use, and VIA utilization. This finding should be interpreted cautiously. The weak model performance, indicated by a low Nagelkerke R^2 and non-significant omnibus test, suggests that the included variables explain only a small proportion of the variability in screening behavior. This indicates that important determinants may not have been captured.

The wide confidence intervals further suggest limited precision and possible instability of estimates, likely related to sample size constraints. A post hoc consideration suggests that the study may have been underpowered to detect small to moderate associations. Therefore, the absence of statistical significance should not be interpreted as evidence of no effect.

While it is plausible that structural or health system factors may influence screening utilization, this study did not directly measure such variables. Therefore, any interpretation regarding their role should be considered hypothetical. Future studies should include:

- Larger sample sizes
- Health system variables
- Advanced analytical models (e.g., penalized regression or multilevel models)

Although contraceptive use and duration of contraceptive use showed a tendency toward increased screening likelihood (AOR > 1), the relatively wide confidence intervals indicate limited precision of the estimates. As highlighted by Greenland *et al*. statistically non-significant findings do not necessarily imply the absence of an effect; rather, they may reflect limited sample size or insufficient statistical power to detect weak to moderate associations. Therefore, the interpretation of these findings should be approached cautiously, considering both methodological constraints and model capacity [5].

The absence of a significant association between reproductive factors and VIA utilization in this study differs from findings in several urban Indonesian settings, where contraceptive use has been associated with screening behavior. This discrepancy may reflect contextual differences related to geographic conditions and health system characteristics in archipelagic regions. In settings characterized by geographic fragmentation and uneven distribution of the health workforce, structural and organizational factors may exert a more significant influence than individual reproductive characteristics. While not directly tested in this study, the findings may suggest that unmeasured health system factors could play an important role. However, this interpretation should be considered hypothetical and requires further investigation [6].

A systematic review, emphasized that system-level interventions—such as service integration and proactive engagement by healthcare providers—are more effective in increasing screening coverage than individual education alone [7]. Similarly identified geographic accessibility, continuity of healthcare personnel, and program integration as critical determinants of screening behavior in remote populations [8].

In this study, the majority of respondents were active contraceptive users, indicating regular contact with primary healthcare services. However, the absence of a significant association between contraceptive use and VIA utilization suggests the presence of missed opportunities in preventive service integration. Routine contact with family planning services does not automatically translate into increased screening uptake. Integration of reproductive health services and cervical cancer screening within primary healthcare settings has been identified as an effective strategy to improve screening uptake in Indonesia [9].

The multilevel framework of healthcare delivery, as described by screening behavior results from interactions between individual-level and organizational level factors. Within this perspective the opportunity structure embedded in the health system becomes critical if VIA screening is not consistently offered of during reproductive health visits, opportunities for early detection may be lost despite adequate individual access to healthcare facilities [10].

Although contraceptive-related variables were not statistically significant, the observed tendency toward increased odds (AOR > 1) suggests that family planning services may still represent a strategic entry point for VIA screening integration. International evidence indicates that provider-initiated screening plays a crucial role in improving uptake, particularly in

populations with varying levels of health literacy [11, 12].

Therefore, integrating family planning and VIA services through active offering mechanisms, reminder systems, and direct appointment scheduling may be more effective than education-based approaches alone (Recent global estimates indicate that cervical cancer remains one of the leading causes of cancer-related mortality among women worldwide, particularly in low- and middle-income countries [13-15].

Overall, the findings of this study contribute important context-specific evidence by demonstrating that individual reproductive characteristics alone may not sufficiently explain variations in screening utilization in archipelagic regions. In geographically constrained settings with uneven resource distribution, primary healthcare system factors appear to play a more influential role. The non-significant findings observed in this study should not be interpreted as a limitation per se, but rather as a reflection of the complex, layered, and context-dependent determinants of preventive health behavior within fragmented health systems. Rather, they highlight the importance of reorienting analytical frameworks from purely individual determinants toward structural health system integration in geographically fragmented contexts. The non-significant findings observed in this study should be interpreted within the context of archipelagic health system dynamics, where structural integration mechanisms may overshadow individual-level determinants.

CONCLUSION

This study demonstrates that reproductive factors and contraceptive use were not significantly associated with VIA screening utilization after adjustment for covariates. The comparison between crude and adjusted odds ratios did not indicate substantial confounding effects, yet it also did not identify consistent independent predictors of screening uptake.

The findings do not provide sufficient statistical evidence to confirm the role of reproductive factors or to establish alternative determinants. Further studies with larger samples and more comprehensive models are needed. Efforts to increase VIA coverage should therefore focus on strengthening the integration of family planning and cervical cancer screening services, implementing provider-initiated screening approaches, and optimizing primary healthcare delivery systems.

This study has several strengths. First, it addresses an underrepresented archipelagic region in Eastern Indonesia, contributing context-specific evidence to the cervical cancer screening literature. Second, it employs multivariable analysis with appropriate model diagnostics, including an adequate goodness-of-fit assessment (Hosmer–Lemeshow test, $p = 0.124$). Third, it provides conceptual contributions by shifting the interpretation from individual-level determinants toward broader health system implications. Additionally, the use of primary data collected directly from a primary healthcare facility reflects real-world service practices.

Several limitations should be considered when interpreting these findings. First, the cross-sectional design precludes causal inference between reproductive factors and VIA utilization. Second, the relatively small sample size ($n = 131$), with 86 outcome events, approaches the minimum threshold commonly recommended for multivariable logistic regression, potentially limiting estimate stability and confidence interval precision. Third, health system variables were not directly measured in this study; thus, interpretations regarding the predominance of system-level factors remain inferential, based on observed analytical patterns. Fourth, the use of interview-based data collection may have introduced recall bias, particularly for reproductive history and duration of contraceptive use. Finally, as the study was conducted in a single primary healthcare facility in Ambon City, generalization to other archipelagic regions should be undertaken with caution.

LIMITATIONS

- Small sample size → low statistical power
- Weak model fit (Nagelkerke R^2 rendah)
- Wide confidence intervals
- No ROC / predictive metrics
- No health system variables
- Cross-sectional design

CONSENT FOR PUBLICATION

Not applicable. This study does not contain any individual person's identifiable data in any form (including images, videos, or personal details).

DATA AVAILABILITY

The datasets generated and/or analyzed during the current study are not publicly available due to institutional and ethical restrictions but are available from the corresponding author on reasonable request, subject to approval by the Institutional Health Research Ethics Committee.

TRIAL REGISTRATION

Not applicable.

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COMPETING INTERESTS

The authors declare that they have no conflict of interest.

AUTHOR CONTRIBUTIONS

LR conceptualized and designed the study, conducted data collection, performed the analysis, and drafted the manuscript; AIM contributed to study design, statistical supervision, and critical revision of the manuscript; M contributed to population and family planning framework development and manuscript review; AS provided input on nutritional and public health perspectives and revised the manuscript critically; SR contributed to behavioral science interpretation and manuscript refinement; Y provided anthropological insights and contextual interpretation related to archipelagic settings. All authors read and approved the final manuscript.

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