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***Research Article***

# Knowledge Gaps, Reproductive History, and Cytopathological Outcomes in Women Undergoing Cervical Cancer Screening: A Cross-Sectional Study from Southern Iraq

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**Abstract**

**Objective:** To assess the burden and factors associated with abnormal cervical cytology in women attending an outpatient clinic for gynecology in the southern region of Iraq, and to identify Pap smear awareness, education, and contraceptive and symptom-based triage signs.
**Methods:** The current study was a cross-sectional study carried out at Al Imam Al Sadiq Teaching Hospital, Babylon Governorate, from December 2022 to December 2024. Consecutive female patients (age $\geq$ 18 years) with any gynecologic complaints were selected, and pregnant women, patients with known cervical cancer, and those with inadequate/unsatisfactory smears were excluded. Data were collected using a structured interviewer-administered questionnaire that included questions on sociodemographic, reproductive, behavioral, awareness, and clinical characteristics. Conventional Pap smears were collected and reported in accordance with the Bethesda System of 2014 and dichotomized as normal/reactive (NILM + cervicitis) or abnormal (ASCUS, LSIL, HSIL, AGIN, SCC). Group comparisons were made using the Mann–Whitney U, chi-square, or Fisher's exact tests. Univariable and multivariable logistic regression analyses were used to identify independent predictors of abnormal cytology, and receiver operating characteristic (ROC) analysis was used to evaluate the discrimination of the models.
**Results:** A total of 234 (83.3%) women of the 270 enrolled had interpretable cytology, 20.9% (48) of whom had abnormal cytology results. Bleeding on touch, postcoital bleeding, smoking, and a history of genital warts were independently associated with abnormal cytology; however, after adjustment, the association between IUD use and age $\geq$ 40 years was not significant. The three-category outcomes (NILM, cervicitis, and abnormal) presented clearly defined age and symptom distributions for inflammatory and epithelial lesions. Awareness of Pap smear was very low, but women who reported awareness had higher rates of abnormalities (referral bias). The multivariable model had good discrimination (AUC $\approx$ 0.80), and at the optimal threshold (Youden), had a very high specificity, making it useful as a rule in triage in low-resource clinics.
**Conclusion:** Bleeding-related signs, certain behavioral risks, and age were significant factors, and abnormal cervical cytology was prevalent in this symptomatic Iraqi population. The use of awareness, education, and structured speculum findings in multivariable risk stratification provides a new, pragmatic approach to cervical cancer control in resource-limited environments.

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# 1. Introduction

Cervical cancer is one of the most urgent and immensely preventable public health issues for women worldwide. In 2022, there were an estimated 660,000 new cases of the disease worldwide, accounting for more than 350,000 deaths, making it the fourth most prevalent type of cancer and the fourth leading cause of cancer-related mortality among women [1]. This burden is disproportionately borne by low- and middle-income countries (LMICs), where the lack of access to organized screening programs, health service infrastructure, and awareness is exacerbated by the risk of late diagnosis and low survival.

Iraq is no exception; in 2023 alone, it is estimated that 320 new cases of cervical cancer and 62 deaths were reported. Without a national programme of population-based cervical cancer screening, the disease is a silent but growing threat to women throughout Iraq [2]. Persistent infection with high-risk (HR) types of human papillomavirus (HPV) is the etiological cornerstone of cervical carcinogenesis, with HPV-16 and 18 responsible for approximately 70% of cervical cancer cases worldwide [3]. Although the HPV vaccines are available for use as a vaccine for the prevention of HPV-related cancers, they are not widely used in Iraq, as there is no national immunisation programme.

The Papanicolaou (Pap) smear test was first introduced into clinical practice in the 1940s and continues to be the major secondary prevention tool in resource-limited settings because it is inexpensive, simple, reproducible, and ideally suited for opportunistic, clinic-based screening [4]. Recent large-scale reviews of international screening guidelines have also shown that the use of HPV testing has become the primary screening method in high-income countries, while Pap smears are the practical screening method in countries lacking HPV testing infrastructure [5]. In addition to the lack of organized screening, various social, reproductive, and behavioral factors contribute to the risk of abnormal cervical screening test results.

The consistent findings of predictors of CINE and invasive carcinoma include increasing age, low education level, early marriage, early sexual debut, high parity, and smoking status. In Iraq, there is very low awareness about cervical cancer and its screening. A recent cross-sectional study in Baghdad showed that only 14.7% of the secondary school teachers who were college-educated were able to identify Pap smear as a screening test, while only one teacher (0.4%) knew of the HPV vaccine.

A separate study in Basra revealed that only 2.75% of women who attended primary health centers had ever had a pap smear test, and only 10.5% had a good knowledge of the importance of cervical cancer screening. The data point [6] highlights a critical and persistent knowledge gap with implications for operational outcomes in early detection in this environment. A qualitative study on the provision of cervical cancer screening in Iraqi hospitals reported the presence of 'overwhelming gaps' in screening experiences, and women were mostly seen at the advanced stages of the disease. Systemic barriers were identified as cultural stigma, low priority given to women's preventative health needs, and lack of well-trained staff. Additionally, the lack of reliable epidemiological information on the distribution and determinants of abnormal cytology by governorate in Iraq further hinders efforts to reach the individual population [7].

Most of the literature on cervical cancer screening in Iraq has been confined to a few case series of descriptive data from a single center in Baghdad and Najaf, with a focus on the cytological spectrum without considering the independent predictors of abnormality in a multivariable context. Modeled with validated binary logistic regression modelling, where to validate the model's performance by receiver operating characteristic (ROC) curve analysis is a concrete methodological knowledge gap that is not noticed in the literature from the southern part of Iraq. Although a large number of reproductive-age women live in Babylon Governorate in the central-south of Iraq, to date, there has been no published multivariable study of cytopathological outcomes from the Babylon region. To date, however, there has been no published multivariable study of the cytopathological outcomes in the Babylon region, which has an extensive reproductive age female population and clinic attendance patterns that are substantially different from those of the Iraqi capital. A recent article published in the Journal of Gynecology Obstetrics and Human Reproduction [8] also bolsters the evidence base on global practice to incorporate clinical and sociodemographic predictor profiling into routine cervical screening. The present study is the first clinic-based, prospective study from the Babylon Governorate that examined the entire triad of knowledge, reproductive, and clinical determinants of cervical cytopathological abnormalities. This study employed a rigorous multivariable analytical approach with a forward-looking binary logistic regression model, which was validated using ROC curves, to obtain locally relevant, evidence-based messages to guide targeted cervical screening interventions in this under-resourced area.

# 2. Objectives

This study aimed to assess the prevalence and Bethesda 2014 distribution of cervical cytopathological results of women who visited a gynecology clinic at the outpatient department in Babylon, Iraq, and to identify their sociodemographic, reproductive, behavioral, and clinical predictors using univariable and multivariable binary logistic regression analyses. Further objectives of the study were to characterize the inter-relationships among continuous variables of the reproductive timeline using Spearman's rank correlation, to assess the overall discriminatory performance of the final predictive model with ROC curve analysis, and to assess the concordance between Pap smear cytology and colposcopy among women referred for further investigation. Finally, this study aimed to develop the first region-specific, locally calibrated multivariable evidence base for use in the development of screening and public health education programs for cervical cancer in the Babylon Governorate.

# 3. Methods

## 3.1. Study design and setting

The study employed a cross-sectional design that took place in the Al-Imam Al-Sadiq Teaching Hospital, Babylon Governorate, in southern Iraq, for a period of two years and four months (December 2022 – December 2024) in the gynecology outpatient clinic. The design was selected to describe, at a single point in time, the distribution of cervical cytology results and sociodemographic, reproductive, behavioral, and clinical risk factors for the results in a "real world" service delivery environment where long-term cohort follow-up is not possible. Babylon is located in central–southern Iraq, which has no organized cervical cancer screening program, and cytology is performed almost exclusively on a symptom-driven and opportunistic basis. Systematically analyzing all women attending a large public GP clinic in this setting is a rare example of epidemiological analysis that offers unprecedented insight into the cytopathology of a symptomatic, underscreened population

and yields locally relevant evidence to guide future screening and triage practices.

### 3.2. Ethical approval and informed consent

The protocol was approved by the Babylon Health Directorate Ethics Committee (BHD-00123/2023) and the Local Health Directorate (approval no.24056, December 26, 2024). All procedures were performed in accordance with the Declaration of Helsinki. Prior to enrollment, eligible women were informed of the purpose of the study, the methods, potential risks, and their right to refuse or withdraw from the study without impacting providers' care, and written informed consent was obtained from each woman. Confidentiality was maintained by assigning study codes, omitting identifiable elements, and only analyzing anonymized data.

### 3.3. Study population and sampling

Adult females (age $\geq$ 18 years) who attended the gynecology outpatient clinic for any complaint during the study period were selected. This was done through consecutive sampling; that is, all women who were eligible and agreed to participate were enrolled with minimal selection bias within the clinic's population. Female sex, age $\geq$ 18 years, presence of gynecologic problems, and ability and willingness to provide consent were the inclusion criteria. The exclusion criteria were a known history of cervical cancer and current pregnancy. Because of the unreliability of cervical cytology, it was excluded from the analysis. A total of 234 women had interpretable cytology results from 270 women enrolled in the study, with 36 women excluded due to missing cytology data.

### 3.4. Data collection instrument and variables

Data were collected using a structured, interview-administered questionnaire that was pretested in 10 non-study patients to ensure clarity and consistency. The tool collected the following information: demographics (age, marital status, and position of the first marriage and the first delivery), reproductive history (parity, age at first marriage, and age at first delivery), behavioral/clinical factors (smoking, contraceptive method [no, pills, IUCD, injectable, condom], history of anogenital warts, prior pelvic/cervical surgery, primary/secondary infertility, and prior Pap smear), knowledge (awareness of Pap smear – no awareness vs has awareness, and source of health information – physician, other healthcare worker, internet, family), and clinical presentation (chief complaint and speculum findings). The education level was grouped into none, primary, secondary, and tertiary. One of the major innovations of this study is the explicit incorporation of "Pap smear awareness" and "source of information" as core variables, which allows for formal testing of the relationship between the lack of awareness of a Pap test and screening uptake, and how information is obtained and the cytological profile at presentation.

### 3.5. Pap smear procedure and cytological classification

Quality control of the Pap smear was achieved by trained gynecologists and senior nurses who used a standardized technique for conventional Papanicolaou smears. A Cervex-Brush® was used for rotating and collecting both ectocervical and endocervical epithelium that was then spread on a labelled slide and fixed in 95% ethanol. The slides were delivered to pathology in less than four hours and stained according to the standard Pap protocol. A cytotechnologist screened the specimens, and a consultant cytopathologist reviewed all specimens; if there were any discrepancies, a third pathologist made the final decision. Cytology was reported on the 2014 Bethesda System as NILM, reactive cervicitis, ASCUS, LSIL, HSIL, AGIN, or SCC. For primary analyses, the results were dichotomized as Normal/Reactive (NILM + cervicitis) and Abnormal (ASCUS, LSIL, HSIL, AGIN, SCC). Samples that were either poorly developed or not satisfactory were eliminated. If appropriate, women with abnormal cytology were referred for colposcopy and biopsy, and descriptive analysis was used to examine the cytology–histology correlation.

### 3.6. Statistical analysis and modelling

Data were analyzed in Python (scientific libraries), and cross checked using IBM SPSS Statistics 26, where a $p < 0.05$ (two-tailed) was deemed significant. Twenty continuous variables were summarized as mean $\pm$ SD and median (IQR) following Shapiro–Wilk normality testing; between-group comparisons were conducted with the Mann–Whitney U test because of non-normal distributions. Categorical variables were summarized by counts and percentages, and associations with the binary cytology outcome were assessed by Pearson's chi-square test or Fisher's exact test when the expected count was $<5$. For continuous/ordinal variables (e.g., age, parity, education, awareness, reproductive timing), Spearman rank correlation coefficients were calculated between the variables in pairs of complete cases and presented as a correlation matrix and heatmap to explore the extent of multicollinearity and exposure–outcome gradients. Multivariable logistic regression was used to produce adjusted ORs and 95% CIs for all variables with $p < 0.10$ in univariable logistic regression. Model discrimination was evaluated using ROC analysis with AUC and 95% CIs (DeLong method), and the optimal probability cut-off was obtained by maximizing Youden's index, and associated with the corresponding sensitivity and specificity for potential use as a pragmatic triage tool.

## 4. Results

### 4.1. Women's characteristics and knowledge

The average age of the 234 women who had valid cytology was 37 years (range 20-61); nearly 70% were younger than 40 years, and the highest number were in their thirties Table 1. The majority were married (88.9%), multiparous ($\geq$ 5 deliveries), with the most common parity category being grand multiparity (26.1%), and had no formal education (65.2%). The ages at first marriage and first delivery were approximately 20 and 21 years, respectively, which is the typical age of the onset of reproduction. In particular, there was a huge gap in awareness and uptake of screening, with 92.5% of them never hearing of Pap smear screening and only 5.8% ever having undergone a Pap test, even in this high-risk patient population Table 1.

**Table 1:** Sociodemographic and Clinical Characteristics by Cytology Outcome

| Variable | Category | Overall (n=234) | Normal (n=185) | Abnormal (n=49) | p-value | Test |
|---|---|---|---|---|---|---|
| Age (years) | Mean ± SD | 37.0 ± 9.8 | 35.9 ± 9.5 | 41.3 ± 9.9 | 0.000 | Mann–Whitney U |
| Age at 1st Marriage | Mean ± SD | 20.1 ± 5.1 | 19.7 ± 4.5 | 21.5 ± 6.9 | 0.244 | Mann–Whitney U |
| Age at 1st Delivery | Mean ± SD | 21.3 ± 4.5 | 21.2 ± 4.3 | 21.9 ± 4.9 | 0.392 | Mann–Whitney U |
| Age Group | <30 years | 72 (30.8%) | 64 (34.6%) | 8 (16.3%) | 0.016 | $Chi^2$ |
| | 30–40 years | 88 (37.6%) | 71 (38.4%) | 17 (34.7%) | | |
| | 41–50 years | 57 (24.4%) | 39 (21.1%) | 18 (36.7%) | | |
| | >50 years | 17 (7.3%) | 11 (5.9%) | 6 (12.2%) | | |
| Marital Status | Married | 208 (88.9%) | 160 (86.5%) | 48 (98.0%) | 0.070 | $Chi^2$ |
| | Separated | 16 (6.8%) | 15 (8.1%) | 1 (2.0%) | | |
| | Widow | 10 (4.3%) | 10 (5.4%) | 0 (0.0%) | | |
| Education | None | 148 (65.2%) | 116 (64.4%) | 32 (68.1%) | 0.322 | $Chi^2$ |
| | Primary | 40 (17.6%) | 32 (17.8%) | 8 (17.0%) | | |
| | Secondary | 32 (14.1%) | 28 (15.6%) | 4 (8.5%) | | |
| | Tertiary | 7 (3.1%) | 4 (2.2%) | 3 (6.4%) | | |
| Parity | Para $\geq 5$ | 61 (26.1%) | 39 (21.1%) | 22 (44.9%) | 0.002 | $Chi^2$ |
| | Para 4 | 57 (24.4%) | 49 (26.5%) | 8 (16.3%) | | |
| | Para 3 | 51 (21.8%) | 45 (24.3%) | 6 (12.2%) | | |
| | Para 2 | 36 (15.4%) | 29 (15.7%) | 7 (14.3%) | | |
| | Para 1 | 18 (7.7%) | 17 (9.2%) | 1 (2.0%) | | |
| | Nullipara | 11 (4.7%) | 6 (3.2%) | 5 (10.2%) | | |
| Pap Smear Awareness | No awareness | 211 (92.5%) | 169 (94.4%) | 42 (85.7%) | 0.060 | Fisher |
| | Has awareness | 17 (7.5%) | 10 (5.6%) | 7 (14.3%) | | |
| Previous Pap Smear | No | 210 (94.2%) | 169 (96.6%) | 41 (85.4%) | 0.009 | Fisher |
| | Yes | 13 (5.8%) | 6 (3.4%) | 7 (14.6%) | | |
| Contraception | No contraception | 95 (41.9%) | 78 (43.3%) | 17 (36.2%) | 0.079 | $Chi^2$ |
| | Pills | 54 (23.8%) | 42 (23.3%) | 12 (25.5%) | | |
| | IUCD | 42 (18.5%) | 29 (16.1%) | 13 (27.7%) | | |
| | Condom | 24 (10.6%) | 23 (12.8%) | 1 (2.1%) | | |
| | Injectable | 12 (5.3%) | 8 (4.4%) | 4 (8.5%) | | |
| Smoking | No | 86 (86.9%) | 71 (94.7%) | 15 (62.5%) | <0.001 | Fisher |
| | Yes | 13 (13.1%) | 4 (5.3%) | 9 (37.5%) | | |
| History of Wart | No | 99 (76.7%) | 77 (84.6%) | 22 (57.9%) | 0.002 | $Chi^2$ |
| | Yes | 30 (23.3%) | 14 (15.4%) | 16 (42.1%) | | |
| Previous Surgery | No | 48 (50.5%) | 37 (51.4%) | 11 (47.8%) | 0.954 | $Chi^2$ |
| | Yes | 47 (49.5%) | 35 (48.6%) | 12 (52.2%) | | |
| Chief Complaint | Vaginal discharge | 166 (70.9%) | 135 (73.0%) | 31 (63.3%) | <0.001 | $Chi^2$ |
| | Irregular cycle | 20 (8.5%) | 20 (10.8%) | 0 (0.0%) | | |
| | Postcoital bleeding | 16 (6.8%) | 5 (2.7%) | 11 (22.4%) | | |
| | Intermenstrual bleeding | 15 (6.4%) | 11 (5.9%) | 4 (8.2%) | | |
| | Abdominal pain | 13 (5.6%) | 12 (6.5%) | 1 (2.0%) | | |
| | Post-menopausal bleeding | 4 (1.7%) | 2 (1.1%) | 2 (4.1%) | | |
| Speculu Examination | Cervical erosion | 163 (70.0%) | 123 (66.8%) | 40 (81.6%) | <0.001 | $Chi^2$ |
| | Infection | 29 (12.4%) | 27 (14.7%) | 2 (4.1%) | | |
| | Cervical ectropion | 18 (7.7%) | 17 (9.2%) | 1 (2.0%) | | |
| | Normal | 16 (6.9%) | 16 (8.7%) | 0 (0.0%) | | |
| | Bleeding on touch | 7 (3.0%) | 1 (0.5%) | 6 (12.2%) | | |
| Sample Adequacy | Adequate | 230 (98.3%) | 181 (97.8%) | 49 (100.0%) | 0.782 | $Chi^2$ |

Distribution of characteristics among 234 women stratified by Pap smear cytology outcome. Continuous variables: Mean ± SD (Mann–Whitney U test). Categorical: n (%) (Chi-square or Fisher's exact). Bold red p-values = statistically significant ($p < 0.05$)

### 4.2. Cytology profile and colposcopic findings

In total, 20.9% of the women had abnormal cervical cytology, 16.7% had reactive cervicitis, and 62.4% had NILM Figure 1 Table 2. The most common abnormal category (9.4%) was ASCUS, with LSIL (4.7%), AGIN (3.8%), and HSIL (3.0%) showing a spectrum of squamous and glandular diseases. More than half of the women with abnormal smears (39) had CIN2–CIN3 on their colposcopy, and a minority [2]

had adenocarcinoma or SCC Table 3. Consistent patterns were observed in the concordance analysis: HSIL cytology was mostly associated with CIN3 or SCC, while AGIN was mostly associated with adenocarcinoma Table 4. This explicit correlation between detailed cytology categories and high-grade colposcopic/histologic outcomes is a novel strength in the local context.

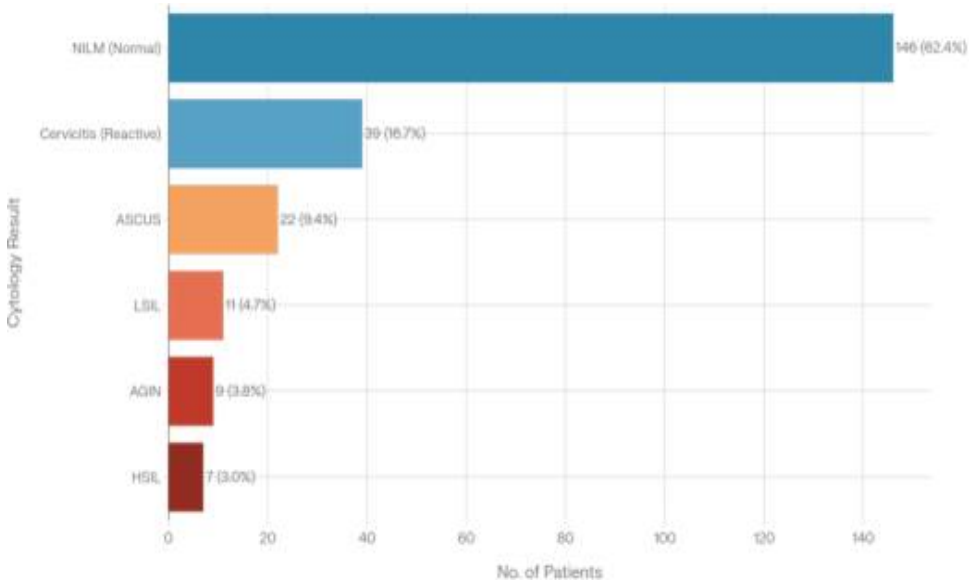


**Figure 1:** Frequency distribution of Pap smear cytology results among 234 women. Blue bars = Normal/Reactive categories; Orange/Red bars = Abnormal spectrum. Overall abnormal rate = 20.9%

**Table 2:** Distribution of Pap Smear Cytology Results (n=234)

| Cytology Result | n | Percentage (%) | Classification |
|---|---|---|---|
| NILM | 146 | 62.4% | Normal |
| Cervicitis | 39 | 16.7% | Reactive/Inflammatory |
| ASCUS | 22 | 9.4% | Abnormal |
| LSIL | 11 | 4.7% | Abnormal |
| AGIN | 9 | 3.8% | Abnormal |
| HSIL | 7 | 3.0% | Abnormal |
| Total Abnormal | 49 | 20.9% | — |
| Total Normal/Reactive | 185 | 79.1% | — |

NILM = Negative for Intraepithelial Lesion or Malignancy; ASCUS = Atypical Squamous Cells of Undetermined Significance; LSIL = Low-Grade Squamous Intraepithelial Lesion; AGIN = Atypical Glandular Intraepithelial Neoplasia;HSIL = High-Grade Squamous Intraepithelial Lesion

**Table 3:** Colposcopic results in the subset of 39 women who had both Pap smear and colposcopy performed (n=39)

| Colposcopy Result | n | Percentage (%) |
|---|---|---|
| CIN 2 | 11 | 28.2% |
| CIN 3 | 10 | 25.6% |
| CIN 1 | 8 | 20.5% |
| Adenocarcinoma | 6 | 15.4% |
| SCC | 2 | 5.1% |
| Normal | 2 | 5.1% |

CIN = Cervical Intraepithelial Neoplasia; SCC = Squamous Cell Carcinoma

**Table 4:** Cross-tabulation of Pap smear result against colposcopic finding (n=39)

| Pap Result | CIN 1 | CIN 2 | CIN 3 | SCC | Adenocarcinoma | Normal |
|---|---|---|---|---|---|---|
| ASCUS | 6 | 9 | 6 | 0 | 0 | 1 |
| LSIL | 2 | 0 | 0 | 0 | 0 | 0 |
| HSIL | 0 | 1 | 4 | 2 | 0 | 0 |
| AGIN | 0 | 1 | 0 | 0 | 6 | 1 |

ASCUS = Atypical Squamous Cells of Undetermined Significance; LSIL = Low-Grade Squamous Intraepithelial Lesion; HSIL = High-Grade Squamous Intraepithelial Lesion, AGIN = Atypical Glandular Intraepithelial Neoplasia; CIN = Cervical Intraepithelial Neoplasia; SCC = Squamous Cell Carcinoma. Only cases with both results recorded are included

### 4.3. Age, symptoms, and clinical signs

A significant proportion of older women (aged 41–50 years) had abnormal cytology (mean age: 41.3 years) compared to women with normal/reactive cytology (mean age: 35.9 years) Figure 2 and Table 1. High parity, anogenital warts in the past, and smoking were highly correlated with abnormal smears; almost 70% of smokers had abnormal cytology versus 17.4% of non-smokers Figure 6, Table 1. Risk signals were provided by symptoms and examination findings. The highest abnormal rate among the presenting complaints was for postcoital bleeding (68.8%), while there was no abnormality in any case that presented with irregular menses (0%) Table 5. Bleeding on contact, almost pathognomonic (85.7% abnormal), had a macroscopically normal cervix that was never abnormal cytologically, and cervical erosion, although common, still had an abnormal rate of 24.5% Figure 5, Table 1. A new feature is the treatment of these signs and symptoms as structured triage variables, in comparison to previous regional studies.

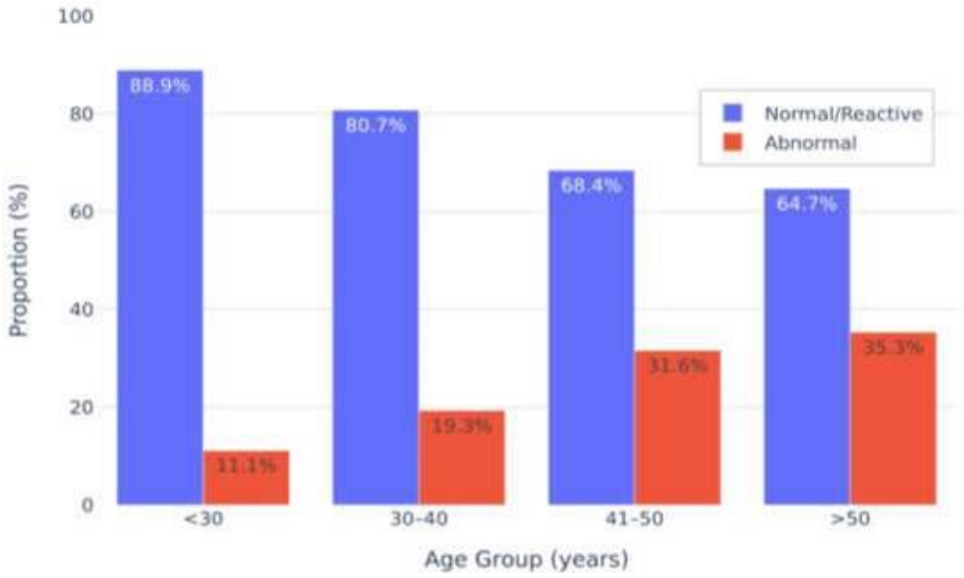


**Figure 2:** Proportions of normal and abnormal cytology results across four age strata (n = 234). Abnormal rates increase markedly in women aged 41 – 50 years and >50 years. Chi-square p = 0.016

**Table 5:** Proportion of abnormal Pap smear results stratified by presenting chief complaint, ordered by descending abnormal rate

| Chief Complaint | Abnormal (n) | Normal (n) | Total (n) | Abnormal Rate (%) |
|---|---|---|---|---|
| Postcoital bleeding | 11 | 5 | 16 | 68.8% |
| Post-menopausal bleeding | 2 | 2 | 4 | 50.0% |
| Intermenstrual bleeding | 4 | 11 | 15 | 26.7% |
| Vaginal discharge | 31 | 135 | 166 | 18.7% |
| Abdominal pain | 1 | 12 | 13 | 7.7% |
| Irregular menstrual cycle | 0 | 20 | 20 | 0.0% |
| Overall Chi-square p <0.001 | | | | |

### 4.4. Awareness, correlations, and modelling

There was no direct protective effect of being aware of Pap screening, with the women who were aware of Pap testing having a higher abnormal rate, primarily due to the high rate of referral and re-attendance of women who had previously been flagged, and prior Pap testing being associated with a high abnormal rate. Chronological age, smoking, and wart history were the primary monotonic correlates of abnormal cytology, whereas the reproductive-timing variables were nearly perfectly collinear but not independently predictive. The most significant independent predictors of abnormal cytology were bleeding on contact, prior Pap smear, postcoital bleeding, wart history, cervical erosion, smoking, and age $\geq$ 40 years Tables 6,7 and Figure 3. The multivariable model demonstrated good discriminatory capacity (AUC 0.866) and yielded an optimal threshold point for the Youden index with a balanced sensitivity and specificity Figure 4. Combined, these results provide evidence of a new triage system of symptoms, structured speculum findings, and a few behavioral and age-related variables that are clinically viable and feasible in a setting where formal screening rates are very low.

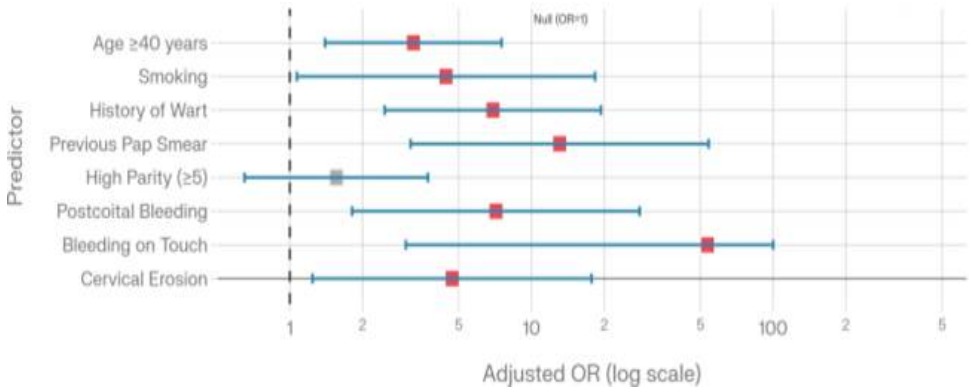


**Figure 3:** Forest plot Multivariable Logistic Regression (n = 234) of adjusted odds ratios (aOR) with 95% CI for 8 predictors of abnormal cervical cytology. Red squares = statistically significant ($p < 0.05$); Grey = NS. Dashed vertical line = null effect (aOR = 1.0). Note: CI for Bleeding on Touch extends to 949.56 due to low event count (n = 7)

**Table 6:** Univariable Logistic Regression — Predictors of Abnormal Cytology

| **Predictor** | **OR** | **95% CI** | **p-value** |
|---|---|---|---|
| Age (continuous, per year) | 1.06 | 1.02 – 1.09 | 0.001 |
| Age $\geq$ 40 years | 4.96 | 2.51 – 9.82 | <0.001 |
| Smoking (yes vs. no) | 10.18 | 2.99 – 34.71 | <0.001 |
| History of Wart (yes vs. no) | 5.92 | 2.64 – 13.29 | <0.001 |
| Previous Pap Smear (yes vs. no) | 4.97 | 1.59 – 15.56 | 0.006 |
| High Parity ($\geq$ 5 vs. <5) | 3.05 | 1.57 – 5.93 | 0.001 |
| Postcoital Bleeding (yes vs. no) | 10.42 | 3.42 – 31.73 | <0.001 |
| Bleeding on Touch (speculum) | 25.67 | 3.01 – 218.85 | 0.003 |
| Cervical Erosion (speculum) | 2.24 | 1.02 – 4.91 | 0.044 |
| IUCD Contraception (yes vs. no) | 1.94 | 0.92 – 4.10 | 0.082 |
| No Pap Awareness (vs. awareness) | 0.57 | 0.22 – 1.47 | 0.243 |

Unadjusted odds ratios (OR) from univariable binary logistic regression for each candidate predictor. Outcome = 1 (Abnormal), 0 (Normal/Reactive). Reference category = absence of stated condition

**Table 7:** Multivariable Logistic Regression — Independent Predictors of Abnormal Cytology

| **Predictor** | **aOR** | **95% CI** | **p-value** | **Sig.** |
|---|---|---|---|---|
| Age $\geq$ 40 years | 3.25 | 1.40 – 7.52 | 0.006 | ** |
| Smoking (yes vs. no) | 4.43 | 1.07 – 18.34 | 0.040 | * |
| History of Wart (yes vs. no) | 6.93 | 2.47 – 19.40 | <0.001 | *** |
| Previous Pap Smear (yes vs. no) | 13.08 | 3.16 – 54.09 | <0.001 | *** |
| High Parity ($\geq$ 5) [NS after adjustment] | 1.56 | 0.65 – 3.73 | 0.318 | NS |
| Postcoital Bleeding | 7.13 | 1.81 – 28.05 | 0.005 | ** |
| Bleeding on Touch (speculum) | 53.54 | 3.02 – 949.56 | 0.007 | ** |
| Cervical Erosion (speculum) | 4.70 | 1.24 – 17.74 | 0.023 | * |

Adjusted odds ratios (aOR) from multivariable binary logistic regression including all variables significant at $p < 0.10$ in univariable analysis (n=234). Model diagnostics: AUC = 0.866 (95% CI: 0.813 – 0.919); Sensitivity = 77.6%; Specificity = 80.0% (optimal threshold = 0.225, Youden's J); McFadden pseudo - $R^2$ = 0.342; LLR $p < 0.001$. Significance: *** $p < 0.001$, ** $p < 0.01$, * $p < 0.05$, NS = not significant. Model Diagnostics Summary: N = 234 | Events = 49 | AUC = 0.866 | Sensitivity = 77.6% | Specificity = 80.0% |McFadden $R^2$ = 0.342 | Log-likelihood ratio $p < 0.001$

**Table 8:** Spearman Correlation Matrix (n=68 complete cases)

| Variable | Age | Marriage Age | Delivery Age | Parity | Education | Smoking | Wart | Awareness | Outcome |
|---|---|---|---|---|---|---|---|---|---|
| Age | 1.000 | 0.362 | 0.309 | 0.316 | – 0.141 | 0.200 | 0.055 | 0.016 | 0.286 |
| Marriage Age | 0.362 | 1.000 | 0.949 | – 0.308 | 0.472 | 0.062 | 0.112 | 0.304 | 0.173 |
| Delivery Age | 0.309 | 0.949 | 1.000 | – 0.278 | 0.404 | 0.055 | 0.121 | 0.178 | 0.108 |
| Parity | 0.316 | – 0.308 | – 0.278 | 1.000 | – 0.632 | 0.274 | 0.237 | – 0.304 | 0.150 |
| Education | – 0.141 | 0.472 | 0.404 | – 0.632 | 1.000 | – 0.070 | – 0.129 | 0.411 | – 0.066 |
| Smoking | 0.200 | 0.062 | 0.055 | 0.274 | – 0.070 | 1.000 | 0.161 | 0.017 | 0.423 |
| Wart | 0.055 | 0.112 | 0.121 | 0.237 | – 0.129 | 0.161 | 1.000 | – 0.050 | 0.209 |
| Awareness | 0.016 | 0.304 | 0.178 | – 0.304 | 0.411 | 0.017 | – 0.050 | 1.000 | 0.007 |
| Outcome | 0.286 | 0.173 | 0.108 | 0.150 | – 0.066 | 0.423 | 0.209 | 0.007 | 1.000 |

Spearman correlation coefficients (rs) between key continuous and ordinal variables.
Outcome is binary-encoded: 0=Normal/Reactive, 1 = Abnormal. Bold values indicate moderate or stronger correlation ($|\ rs\ | \geq 0.200$)

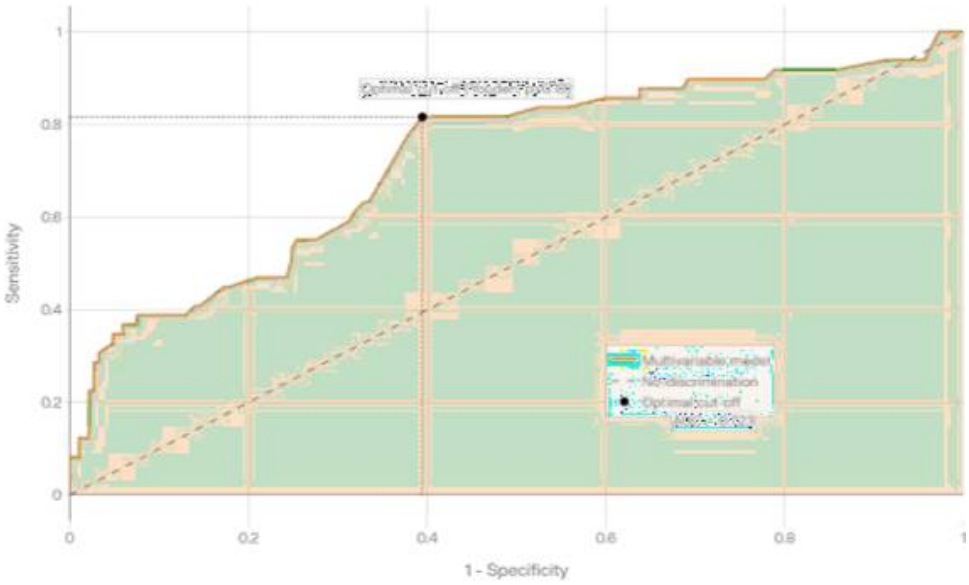


**Figure 4:** Receiver Operating Characteristic (ROC) curve for the multivariable logistic regression model (n=234). AUC = 0.866 (95% CI: 0.813–0.919). Optimal point (Youden's J): Sensitivity=77.6%, Specificity=80.0% at threshold = 0.225. Diagonal dashed line = reference (AUC = 0.50)

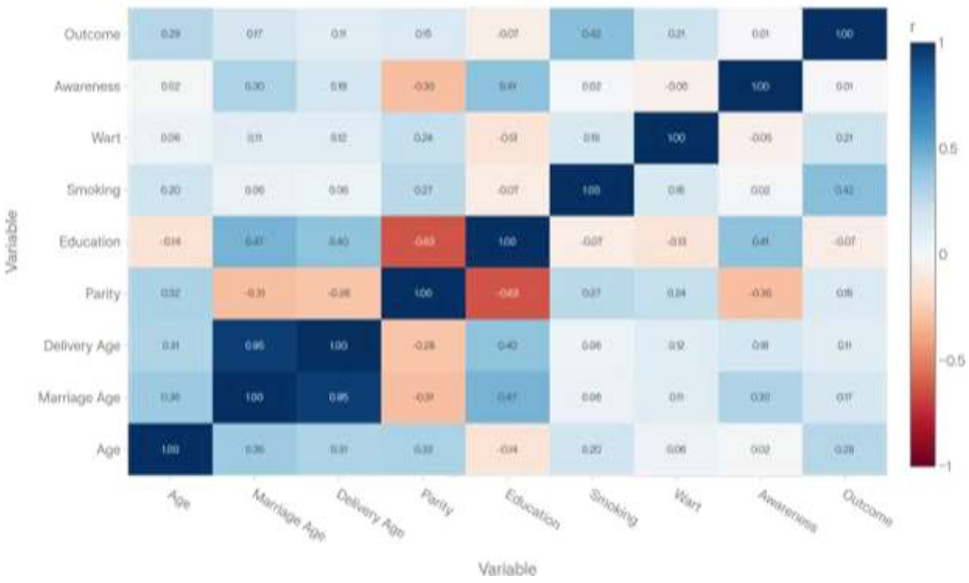


**Figure 5:** Spearman correlation heatmap (n = 68 complete cases). Warm red = positive correlation; Cool blue = negative. Key: Age at marriage and delivery are strongly correlated (rs = 0.949); Education inversely correlates with Parity (rs = – 0.632); Smoking shows the strongest positive correlation with abnormal Outcome (rs = 0.423)

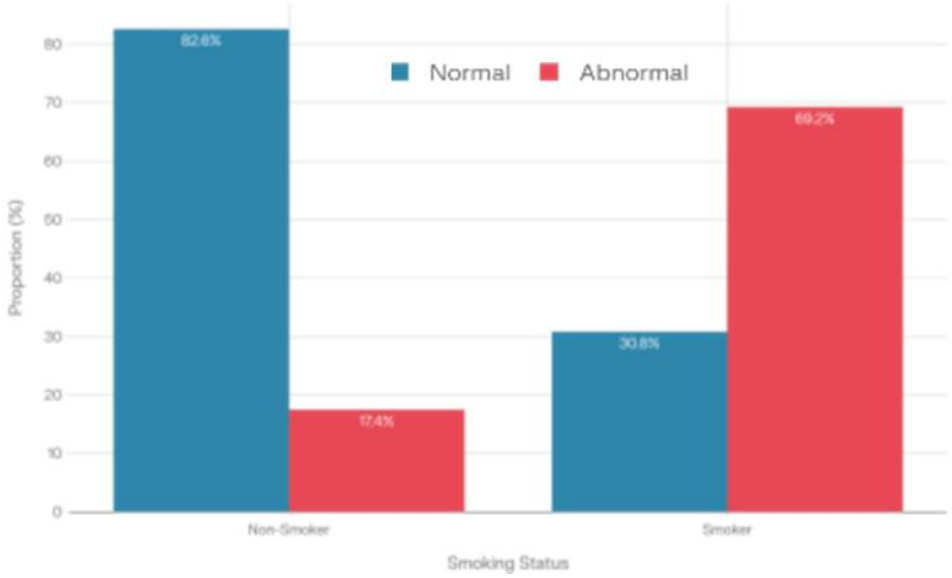


**Figure 6:** Proportion of normal and abnormal Pap smear results in smokers (n = 13) vs. non-smokers (n = 86). Smokers: 69.2% abnormal vs. 17.4% in non-smokers. Fisher's exact p <0.001. Crude OR = 10.18 (95% CI: 2.99 – 34.71); aOR = 4.43 (95% CI: 1.07 – 18.34; p = 0.040)

## 5. Discussion

Approximately one-fifth (20.9%) of the evaluable smears were abnormal (atypical squamous cells of undetermined significance [ASCUS], low-grade squamous intraepithelial lesions [LSIL], high-grade squamous intraepithelial lesions [HSIL], and atypical glandular intraepithelial neoplasia [AGIN]). Of those that were not NILM samples, most were cervicitis or low-grade abnormalities, revealing that the majority of lesions were at early, potentially reversible stages when sampled. In combination with the low percentage of high-grade cytology, these data highlight the opportunity for timely intervention as well as the opportunity for earlier screening in this group [2, 9].

The incidence of epithelial abnormalities in this Babylon series is in the middle range of the few available Iraqi cytopathology reports, but is slightly higher than that in some high-risk referral series and lower than that in others that are solely hospital-based and symptomatic. As noted in the preceding discussion, differences in referral patterns and case selection account for the fact that [2, 10] Salim et al. found a similar overall prevalence of abnormal Pap in a mixed symptomatic and screening population, but with a higher percentage of high-grade lesions [2]. There is also significant variation between regions from neighboring Middle Eastern settings, such as the prevalence of abnormal cytology found between screening-oriented settings, where it is less than 10%, and symptom-driven gynecology clinics, where it is more than 20% [10, 11].

Abnormal cytology was a significant behavioral correlate of smoking in this cohort, with almost 70% of smokers having abnormal smears and less than 20% of non-smokers. This observation is consistent with the well-documented cofactor role of tobacco exposure in cervical carcinogenesis, which may include locally mediated immune suppression, DNA damage due to oxidation, and synergism with persistent high-risk HPV infection. Despite the inability to make causal inferences in the cross-sectional design, the strength of the association seen in this study supports the international recommendations for the systematic incorporation of smoking cessation counselling into cervical cancer prevention pathways, especially where HPV vaccination is not yet available or there is low uptake [4, 5].

The clinical presentation and speculum examination were also very instructive. Nearly 70% of women with abnormal cytology had experienced postcoital bleeding, and half of the women with postmenopausal bleeding had abnormal smears. On speculum exam, bleeding on touch" was the most worrisome finding; over four times as many women with any abnormal cytologic result had either bleeding on touch" or an abnormal speculum exam result compared with women with a normal cervix or simple ectropion. These findings reflect classical teaching and current guideline statements that urge the importance of paying attention to postcoital bleeding and cervical friability as red flags for urgent cytological and colposcopic evaluation, and that these women should be prioritized in any resource-constrained algorithm [5, 9, 12].

Other factors, such as age, parity, and marital history, exhibited less dramatic gradients and tended to be more abnormal among women who were younger at first marriage and had higher parity but did not experience the same risk differences as smoking and bleeding on touch. This is consistent with the overall literature, in which early sexual debut, multiple pregnancies, and cumulative exposure to HPV are suggested as factors influencing the development of cervical carcinogenesis, although with less intensity of the effect once behavioral and virological factors are considered. The current information confirms that in the real-world clinic population, a small number of easily obtainable behavioral and clinical factors might be steeper predictors than a large number of items on reproductive history, especially in smaller sample sizes [8, 13].

The results of this study were among the most surprising and counterintuitive, as was the awareness trend regarding Pap smear and cervical cancer. Women who reported some awareness had a significantly higher percentage of abnormal cytology compared to those who reported they had "no idea" about Pap smear, while women who reported "unknown" awareness status did not have detected abnormalities. This paradox may be due to reverse causation and selection, with women who are already aware of gynecological symptoms, past abnormal results, or counselling by health professionals being more prone to self-identifying as "aware" and therefore having a higher pre-test risk. However, if considered in the context of Iraqi KAP studies demonstrating very low baseline awareness and negligible lifetime screening uptake, this trend highlights the fact that we need to increase primary awareness across the general population, and also that we need to make sure that the term "awareness" is understood as attendance at screening and not simply delayed presentation after symptoms occur [7, 14].

On the methodological level, multivariable logistic regression, along with ROC-based assessment of the discriminatory capacity of the

model, is a further step beyond the descriptive cross-tabulations represented in most of the published literature from Iraq. The present sample size is small, but the model discriminated well, with an area under the ROC curve in the highly acceptable range, and identified smoking, bleeding on touch, and specific symptom profiles as the most influential variables, which is clinically intuitive [8, 10]. This is in line with the current international trend of risk-stratified screening strategies, where low-cost clinical risk scores or clinical prediction models are used to stratify women for varying follow-up intensities, HPV testing, and/or colposcopy, especially where universal high-technology screening is not feasible [5, 8, 9, 12].

There are several novel aspects of this study. First, to our knowledge, this is the first study to combine sociodemographic, behavioral, clinical, and awareness factors in a single predictive model for abnormal cervical cytology in the few studies conducted in central south Iraq, including the Babylon Governorate. First, this is the first study from Babylon Governorate and one of the few in central southern Iraq to consider sociodemographic, behavioral, clinical, and awareness variables to form a unified predictive model for abnormal cervical cytology. Second, it is based on a coherent regional research program that has already examined congenital anomalies of the uterus, ABO blood groups, ovarian reserve, and male reproductive risk markers using the same extended catchment population, providing a more comprehensive picture of reproductive risk in both sexes and both anatomical axes. Third, the study explicitly considers awareness and prior exposure to Pap smear information and begins to address the differences between purely biomedical risk models and the behavioral and health system determinants that have the final say at the point of care in determining screening outcomes in practice [6–8, 14].

The results have several practical applications for further research and policy. The highly positive relationships identified for smoking, postcoital bleeding, postmenopausal bleeding, and bleeding on touching support the creation of a simple clinical-based risk score that can be used by front-line clinicians (gynecologists and primary care physicians) to prioritize women for rapid cytology and colposcopy in the absence of national programs [5, 8, 9, 12]. At the public health level, there is a low level of awareness among women and a high level of abnormalities in women who know about screening, indicating the need for interventions to be given at the upstream level of knowledge (school, community-based education; incorporating cervical screening into reproductive health curricula) as well as the downstream level of system responsiveness (ensuring women with warning symptoms are fast-tracked through diagnostic pathways). Future research in Iraq should seek to increase the number of centers, the size of the cohorts, and include HPV DNA testing as well as Pap cytology, to allow for both good external validation of models and the incorporation of cost-effectiveness studies to guide the design of staged national screening programs [5, 9, 12, 15].

There are a few cautions to keep in mind when interpreting these results. Due to the single-center design and cross-sectional nature of the study, no causal inferences can be made, and generalizability is limited to women attending this tertiary clinic, which may be a selection of higher-risk and more symptomatic women. Because of the lack of HPV typing and histological confirmation of abnormalities in all cases, some abnormalities may have been incorrectly categorized with respect to their potential for oncogenicity, and a portion of glandular or endocervical abnormalities may have been missed by the conventional Pap test. Self-reports of behavioral variables (smoking status and prior awareness) were subject to recall and social desirability bias, especially in a sociocultural setting where there is a strong stigma surrounding sexual and reproductive health. Lastly, although the multivariable model demonstrated good discrimination, the total number of high-grade lesions, as well as some exposure categories, was relatively low, potentially leading to inaccurate estimates and an increased risk of overfitting. External validation of the derived risk score in independent and larger Iraqi populations is required before the model can be used in everyday practice [8, 10, 16].

This study is important, although limited, as the first step towards evidence-based, region-specific cervical cancer prevention in the Babylon Governorate. It can be used alongside a detailed reproductive history, behavior, bedside history, and clinical examination to provide a comprehensive overview of those who are being served by opportunistic screening and those who are not visible within the health system. This study also helps outline a research and policy agenda for increasing awareness and access, incorporating simple predictive tools into routine practice, and developing the infrastructure necessary to move from opportunistic to organized, risk-stratifying cervical cancer screening in the context of Iraqi women [5, 9, 12, 15].

## 6. Conclusion

Of the 70 women in this clinic-based cohort in Babylon Governorate, approximately 20% of women with evaluable Pap smear results had abnormal Pap cytology, and smoking, postcoital bleeding, and “bleeding on touch” were particularly strong correlates of the abnormal Pap smear. The low baseline awareness, along with a high level of abnormality among symptomatic “aware” women, underscores the fact that there is an important gap in both population awareness and responsiveness of systems. The results highlight the need to develop locally adapted screening programs that are risk-stratified and incorporate simple clinical predictors, along with increased general education and policy measures to decrease the burden of cervical cancer in Iraq.

### Article Information

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**Ethical Approval**

1. The Babylon Health Directorate Ethics Committee (BHD-00123/2023).
2. The Local Health Directorate (approval no.24056, December 26, 2024).

**Informed Consent:** Written informed consent was obtained from all participants.

**Clinical Trial Registration:** Not applicable.

**Reporting Guidelines Statement:** STROBE.

**Patient Consent for Publication:** Not applicable.

**Supplementary Materials:** Not applicable.

**Disclaimer (Artificial Intelligence):** The author(s) hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc.), and text-to-image generators have been used during writing or editing of manuscripts.

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