Analysis of False-Positive and False-Negative Rates in Cervical Cytopathology in Laboratories Evaluated by External Quality Monitoring at INCA

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Análise dos Índices de Falso-Positivos e Falso-Negativos na Citopatologia Cervical em Laboratórios Avaliados pelo Monitoramento Externo da Qualidade do INCA

Análisis de los Índices de Falsos Positivos y Falsos Negativos en Citopatología Cervical en Laboratorios Evaluados por el Monitoreo Externo de la Calidad del INCA

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ABSTRACT

Introduction: Ensuring the quality of cervical cancer screening tests is a global concern, and External Quality Monitoring (EQM) is essential for the continuous improvement of cytopathology. **Objective:** To analyze false-negative and false-positive indicators of laboratories evaluated by the EQM of the Integrated Cytopathology Technology Sector (Sitec) at the National Cancer Institute (INCA). **Method:** Observational, retrospective study with a quantitative approach, based on secondary data from EQM/Sitec/INCA reports. A total of 43 batches from three laboratories of the Brazilian public health system, in the state of Rio de Janeiro, were analyzed between 2013 and 2024. The sample included all positive and unsatisfactory tests, and a fraction of negative tests selected by information systems. False-negative and false-positive proportions and weighted Kappa coefficients were calculated. **Results:** False-negative rates were: LAB A (1.72%), LAB B (1.63%), and LAB C (2.34%); false-positive rates were: LAB A (12.11%), LAB B (26.98%), and LAB C (6.82%), with significant differences among laboratories ($p < 0.01$). Atypical squamous cells were the most frequent category among false-negative and false-positive results, while atypical glandular cells stood out among false positives. Kappa coefficients indicated almost perfect agreement for laboratories A (0.84) and C (0.87), and substantial agreement for laboratory B (0.73). **Conclusion:** Substantial to almost perfect diagnostic agreement was observed, with differences in indicators, especially in borderline categories. EQM proved essential for identifying weaknesses and supporting improvements in diagnostic quality.

Key words: Uterine Cervical Neoplasms/diagnosis; Cytodiagnosis; Quality Control; False Positive Reactions; Cytological Techniques.

RESUMO

Introdução: Garantir a qualidade dos exames para o rastreamento do câncer do colo do útero é uma preocupação mundial, sendo o Monitoramento Externo da Qualidade (MEQ) fundamental para a melhoria contínua da citopatologia. **Objetivo:** Analisar os indicadores de falso-negativo e falso-positivo dos laboratórios avaliados pelo MEQ do Setor Integrado de Tecnologia em Citopatologia (Sitec) do Instituto Nacional de Câncer (INCA). **Método:** Estudo observacional, retrospectivo, com abordagem quantitativa, baseado em dados secundários dos relatórios do MEQ/Sitec/INCA. Foram analisadas 43 remessas de 3 laboratórios do Sistema Único de Saúde, no Estado do Rio de Janeiro, entre 2013 e 2024. A amostra incluiu todos os exames positivos, todos os insatisfatórios e fração dos negativos selecionados por sistemas de informação. Foram calculadas as proporções de falso-negativo e falso-positivo, além do coeficiente Kappa ponderado. **Resultados:** As proporções de falso-negativo foram: LAB A (1,72%), LAB B (1,63%) e LAB C (2,34%); e de falso-positivo: LAB A (12,11%), LAB B (26,98%) e LAB C (6,82%), com diferença significativa entre os laboratórios (p<0,01). A categoria células escamosas atípicas foi a mais prevalente entre falso-negativos e falso-positivos, e atipias glandulares destacaram-se entre falso-positivos. Os coeficientes Kappa indicaram concordância quase perfeita para os laboratórios A (0,84) e C (0,87) e substancial para o laboratório B (0,73). **Conclusão:** Observou-se concordância diagnóstica substancial quase perfeita, com diferenças nos indicadores, especialmente em categorias limítrofes. O MEQ mostrou-se essencial para identificar fragilidades e subsidiar melhorias na qualidade diagnóstica.

Palavras-chave: Neoplasias do Colo do Útero/diagnóstico; Citodiagnóstico; Controle de Qualidade; Reações Falso-Positivas; Técnicas Citológicas.

RESUMEN

Introducción: Garantizar la calidad de las pruebas de tamizaje del cáncer de cuello uterino es una preocupación mundial, siendo el Monitoreo Externo de la Calidad (MEC) fundamental para la mejora continua de la citopatología. **Objetivo:** Analizar los indicadores de falsos negativos y falsos positivos de los laboratorios evaluados por el MEC del Sector Integrado de Tecnología en Citopatología (Sitec) del Instituto Nacional del Cáncer (INCA). **Método:** Estudio observacional, retrospectivo, con enfoque cuantitativo, basado en datos secundarios de los informes del MEC/Sitec/INCA. Se analizaron 43 remesas de tres laboratorios del sistema público de salud, en el estado de Río de Janeiro, entre 2013 y 2024. La muestra incluyó todos los exámenes positivos, todos los insatisfactorios y una fracción de los negativos seleccionados por sistemas de información. Se calcularon las proporciones de falsos negativos y falsos positivos, además del coeficiente Kappa ponderado. **Resultados:** Las proporciones de falsos negativos fueron: LAB A (1,72%), LAB B (1,63%) y LAB C (2,34%); y de falsos positivos: LAB A (12,11%), LAB B (26,98%) y LAB C (6,82%), con diferencias significativas entre los laboratorios (p < 0,01). Las células escamosas atípicas fueron la categoría más frecuente entre falsos negativos y positivos, mientras que las atipias glandulares destacaron entre los falsos positivos. Los coeficientes Kappa indicaron concordancia casi perfecta para los laboratorios A (0,84) y C (0,87), y sustancial para el laboratorio B (0,73). **Conclusión:** Se observó concordancia diagnóstica sustancial casi perfecta, con diferencias en los indicadores, especialmente en categorías limítrofes. El MEC se mostró esencial para identificar debilidades y apoyar mejoras en la calidad diagnóstica.

Palabras clave: Neoplasias del Cuello Uterino/diagnóstico; Citodiagnóstico; Control de Calidad; Reacciones Falso Positivas; Técnicas Citológicas.

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INTRODUCTION

Cancer of the cervix, or cervical cancer, ranks fourth among the most frequent types of cancer in women worldwide. In the Brazilian context, it stands out as the third most frequent cancer type in the female population, being the fifth most common in the Southeast Region of the country, according to estimations for the 2026-2028 period[1].

In Brazil, the guidelines for screening cervical cancer have been redefined, proposing an organized screening model based on molecular tests to detect oncogenic human papillomavirus (HPV) DNA, indicating a progressive substitution of the Pap smear test[2]. However, in most Brazilian States, the traditional Pap smear strategy remains, screening women aged 25 to 64 years, with a triennial interval after two consecutive negative annual results[3].

In this context, the initial scrutiny of cervical scrapings can be conducted by cytotechnicians (technicians in cytopathology), when available, or by duly licensed higher education professionals, depending on the organization of the healthcare services. This step involves distinguishing between normal cases and those suggestive of being atypical. It is an activity that requires high diagnostic accuracy, subject to errors throughout the process. Such errors may occur in the pre-analytical phase — related to sample collection, identification, and storage — or in the analytical phase, associated with microscopic interpretation and report emission[4]. It is noteworthy that non-conformities identified in the pre-analytical phase must be duly recorded and communicated to those responsible for the collection, aiming at continuous improvement of the quality of the exam.

In the analytical phase, mistaken cytomorphological interpretation is one of the main causes of false-negative results, which highlights the need for investment in continuous professional training and instruction in order to improve the quality of cytopathological screening and reduce diagnostic inconsistencies[5].

Due to the different types of errors, in addition to other variables that may directly influence the quality of results, quality monitoring programs began to stand out. Therefore, the relevance of the Federal Ordinance N. 3,388, of December 30th, 2013, which redefined the National Qualification in Cytopathology (QualiCito) in cervical cancer prevention within the context of Health Care Networks for People with Chronic Illnesses[6].

The reformulation instituted by QualiCito establishes new parameters to assess the quality of cytopathological exams of the cervix, following the performance of public and private laboratories that provide services to the National Health System (SUS). For that end, it was instituted a Quality Control Program composed of two complementary actions: the Internal Quality Monitoring (IQM), which is done within the laboratories and seeks to assess and improve internal processes, ensuring greater standardization and precision in the analyses conducted by the teams, and the External Quality Monitoring (EQM), conducted by external assessment institutions, which enabled to identify discrepancies, guide adjustments, and promote the harmonization of diagnostic criteria among the different services. Both are aimed at ensuring greater reliability and standardization of results[6].

According to the QualiCito guidelines, the laboratories involved in this process are divided into two groups: Type I, which encompasses public or private laboratories responsible for executing cytopathological tests for SUS, and Type II, composed of public laboratories designed to review the production of Type I laboratories, working as evaluation instances[6].

Regarding the definition of diagnostic errors, the Quality Management Manual provides specific criteria to classify results as false negatives or false positives. False negatives are those results in which scrapings were classified as normal on scrutiny but, upon reassessment using internal quality methods, demonstrated cellular alterations ranging from undetermined significance atypias to more severe lesions. This reclassification is done by a trained professional through a detailed analysis of the material. False positives correspond to scrapings that were initially interpreted as containing atypical cells or more severe alterations, but which, upon detailed review, are redefined as negative or considered unsatisfactory[7]. This distinction allows for a more precise understanding of the origin of diagnostic errors and guides continuous improvements in laboratory procedures.

In Brazil, health information systems play a fundamental role in monitoring cervical cancer screening actions. It is noteworthy that, from 2013 onwards, there was a transition from the Cervical cancer Information System[8] (Siscolo) to the Cancer Information System[9] (Siscan), with structural changes in how data is recorded and managed. This process can cause challenges related to information comparability and completeness over time, which must be considered when interpreting studies that use historical series based on these systems.

Ensuring the quality of exams for cervical cancer screening is nowadays a global concern, and EQM represents an essential strategy to ensure care safety and reliability of cytopathological results[7]. According to the International Organization for Standardization (ISO), there are many benefits to implementing a quality management system in organizations, as it is one of the

fundamental pillars for success, regardless of its size or field of work (ISO 9001-2015)[10].

This article has the objective of surveying the performance of quality indicators, false-negative and false-positive, of laboratories evaluated by the EQM of the Integrated Cytopathology Technology Sector (Sitec) at the Type II laboratory of the National Cancer Institute (INCA).

METHOD

Observational, analytical, cross-sectional, retrospective quantitative approach study that evaluated the diagnostic performance of EQM/Sitec/INCA participating laboratories. The sampling method was a convenience census, including data from Siscolo[8] and, in the context of the transition initiated in 2013, records from Siscan[9]. All the exams available in both systems from 2013 to 2024 that met the eligibility criteria were included. Given the system migration process throughout the analyzed period, care was taken to consolidate and interpret data, accounting for potential operational and recording differences between the databases.

False-negative and false-positive indices referring to 43 monthly batches (competencies) were analyzed, corresponding to 39,266 exams distributed, out of 42,288 selected exams. Data refers to three laboratories that conducted cytopathological exams for SUS in the State of Rio de Janeiro, identified here as LAB A, LAB B, and LAB C.

The description of the EQM/Sitec/INCA functioning was summarized in this section, with its detailing available in Supplementary Material 1. The dependent variables were the false negative and false positive indices. The evaluated laboratories and cytopathological diagnostic categories were considered as independent variables. The sample size was not calculated, as this is a study done with secondary data, including the totality of exams available in the analyzed period.

The analyzed performance indicators included the false positive and false negative rates, calculated based on the comparison between results issued by the laboratories and the review conducted in the scope of EQM. The cases classified as altered by the origin laboratory but reclassified as negative upon review were considered false positives. In turn, the cases initially classified as negative but identified as altered upon review were considered false negatives. The rates were calculated by the ratio between the number of cases classified as false positives or false negatives and the total exams reevaluated within the period, multiplied by 100. These indicators follow the same calculation logic used in IQM.

Laboratories that included at least three monthly batches evaluated in the studied period were included. Those that did not present enough data for statistical analysis were excluded.

Of the six laboratories initially evaluated by the EQM/Sitec/INCA, three met the eligibility criteria and were included in the study (LAB A, LAB B, and LAB C). The September 2015 batch from LAB C was excluded as it was returned to the original laboratory due to the presence of non-conformities.

Impartiality and confidentiality were ensured in the identification of the evaluated laboratories.

The comparison of false negative and false positive rates between laboratories was done using Pearson's chi-square association test[11], without Yates' correction, adopting a significance level of 5%. For the qualitative variables, absolute and relative frequencies are presented.

Trend curves for false negative and false positive percentages over time were evaluated using the LOESS (Locally Estimated Scatterplot Smoothing)[12] method with respective confidence intervals of 95%, and the statistical significance of the trends was assessed using the linear model with minimum generalized squares, assuming a first-order autoregressive (AR(1)) distribution for the model residuals.

The agreement between the diagnoses of evaluated laboratories (Type I) and the reviewer lab (Type II – EQM/Sitec/INCA) was estimated using the Kappa coefficient weighted by Cohen, appropriate to assess agreement considering different weights for diagnostic discordance.

The interpretation of Kappa values followed the classification proposed by Landis and Koch: values lower than 0 indicate poor agreement; from 0.00 to 0.20, slight; from 0.21 to 0.40, fair; from 0.41 to 0.60, moderate; from 0.61 to 0.80, substantial; and from 0.81 to 1.00, almost perfect. Values of $\kappa w \geq 0.60$ were considered indicative of acceptable agreement for clinical applications[13].

The analyses were conducted using Microsoft Excel (Office 365, Windows version) and statistical R software (version 4.4.1)[14].

This study has been approved by the INCA Research Ethics Committee, report number 6057934 (CAAE (submission for ethical review): 32632314.6.0000.5274) in conformity with the current sanitary legislation, including Law N. 9,782/1999 and Anvisa Resolution N. 978/2025, which provides guidelines for quality control and analytical performance in healthcare services[15,16].

RESULTS

The data was obtained from the EQM/Sitec/INCA reports in the period of December 2013 through March

2024, totaling 43 monthly batches (competencies) from three laboratories — LAB A, LAB B, and LAB C —, with 9, 6, and 28 batches, respectively. A total of 42,288 exams were selected using the cancer information systems, of which 40,012 were received. After excluding 746 non-conformities (which correspond to 1.86%), 39,266 exams were distributed to microscopic and statistical analysis. The distribution of monthly batches over the analyzed period did not occur uniformly across laboratories, with temporal variations that reflect the local health management's sample referral dynamic.

Of the total exams distributed for analysis, 27,232 were received as negative, 11,314 as positive, and 720 as unsatisfactory. A total of 596 false negatives and 1,014 false positive exams were identified. The detailed distribution of data per laboratory is presented in Table 1.

The false negative percentages were 1.72% in LAB A, 1.63% in LAB B, and 2.34% in LAB C. For false positive, the values were 12.11% in LAB A, 26.98% in LAB B, and 6.82% in LAB C. LAB C presented a higher rate of false negatives, while LAB B presented a higher rate of false positives. The differences between laboratories were statistically significant for both indicators (p<0.01).

Figure 1 presents the distribution of false negative exams per diagnostic category. There was a predominance of categories related to atypical squamous cells, especially undetermined significance (ASC-US) and atypical squamous cells, and it was not possible to exclude high-grade intraepithelial lesion (ASC-H), in all laboratories. In a lower proportion, cases classified as squamous intraepithelial lesions (LSIL – low-grade squamous intraepithelial lesion and HSIL – high-grade squamous intraepithelial lesion) were identified, indicating a higher frequency of false negatives in borderline cytological categories.

Figure 2 presents the distribution of false positive exams per diagnostic category. There was a higher frequency of diagnoses initially classified within the atypical cells' categories, with a highlight to atypical squamous cells of undetermined significance (ASC-US) and atypia in glandular cells (AGC), indicating a higher concentration of false positives in borderline cytological categories.

The temporal evolution of false negatives and false positives from 2013 to 2024 is presented in Figure 3. It is possible to observe that there is no trend in the proportion of false negatives (Figure 3 (a)) over the period. Although distinct trends can be observed for each laboratory, they were not considered significantly different. A slight general upward trend in the percentage of false positives is observed, though without statistical evidence of an association (p=0.063) (Figure 3 (b)). Regarding the false positives rate, an increase in variability over time is observed; furthermore, when each laboratory's trend is analyzed individually, it also shows an upward trend, though it was not considered significantly different from one another.

Table 2 presents Kappa agreement coefficients weighted between the evaluated laboratories and EQM/Sitec/INCA. Almost perfect agreement was observed for laboratories A (0.84) and C (0.87), and substantial agreement for laboratory B (0.73).

Despite the high levels of agreement observed, a variation was verified between laboratories, indicating differences in diagnostic performance regarding the reproducibility of cytopathological reports.

DISCUSSION

The literature describes that inter-observer variability in the diagnoses conducted using the Pap smear method mainly arises from the subjective nature of the interpretation of the diagnostic criteria defined for each category[17].

In the present study, the weighted Kappa coefficient presented substantial and almost perfect agreement between the diagnoses provided by the different laboratories (Type I – LAB A, LAB B, and LAB C; Type

Table 1. Distribution of cytopathological exams, according to laboratory and EQM/Sitec/INCA, processing steps, 2013-2024

LAB	Batch	Selected exam	Received	Non-conformities n (%)	Distributed	Negative	Positive	Unsatisfactory	False negative	False positive
LAB A	9	8,445	8,421	114 (1.35)	8,307	5,167	2,906	234	89	352
LAB B	6	1,948	1,944	49 (2.52)	1,895	1,413	441	41	23	119
LAB C	28	31,895	29,647	583 (1.97)	29,064	20,652	7,967	445	484	543
Total	43	42,288	40,012	746 (1.86)	39,266	27,232	11,314	720	596	1,014

Captions: LAB: Laboratories evaluated by the EQM/Sitec/INCA. Batch: corresponds to the competencies evaluated in each laboratory (each competence equals one monthly batch defined by the Municipal Health Secretariat). Selected exam: number of exams selected by the cancer information systems. Received: exams that were effectively received by EQM/Sitec/INCA. Non-conformities: exams with non-conformities, excluded from analysis. Non-conformities total (%): percentage of exams with non-conformities in relation to the total received (non-conformities ÷ received) x 100. Distributed: exams sent for microscopic and statistical analysis. Negative/Positive/Unsatisfactory: initial cytopathological classification. False negative/False positive: according to the definition from EQM/Sitec/INCA.

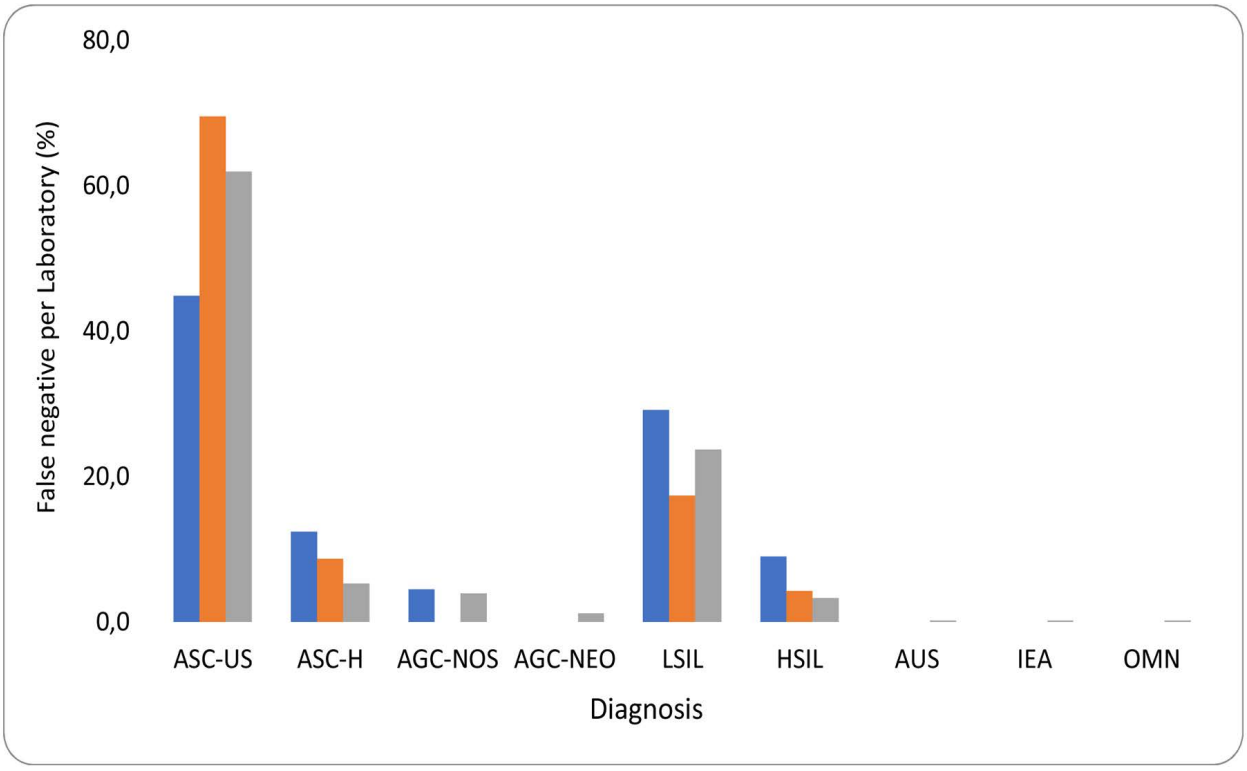

Figure 1. Percentage of false negative exams per diagnostic category in the laboratories evaluated by the EQM/Sitec/INCA (2013-2024)
Captions: ASC-US: atypical squamous cells of undetermined significance; ASC-H: atypical squamous cells, not possible to exclude high-grade intraepithelial lesion; AGC-NOS: atypia in glandular cells, not otherwise specified; AGC-NEO: atypia in glandular cells, suggestive of neoplasms; LSIL: low-grade squamous intraepithelial lesion; HSIL: high-grade squamous intraepithelial lesion; AUS: atypias of undetermined significance, suggestive of neoplasms; IEA: invasive endometrial adenocarcinoma; and OMN: other malignant neoplasms.

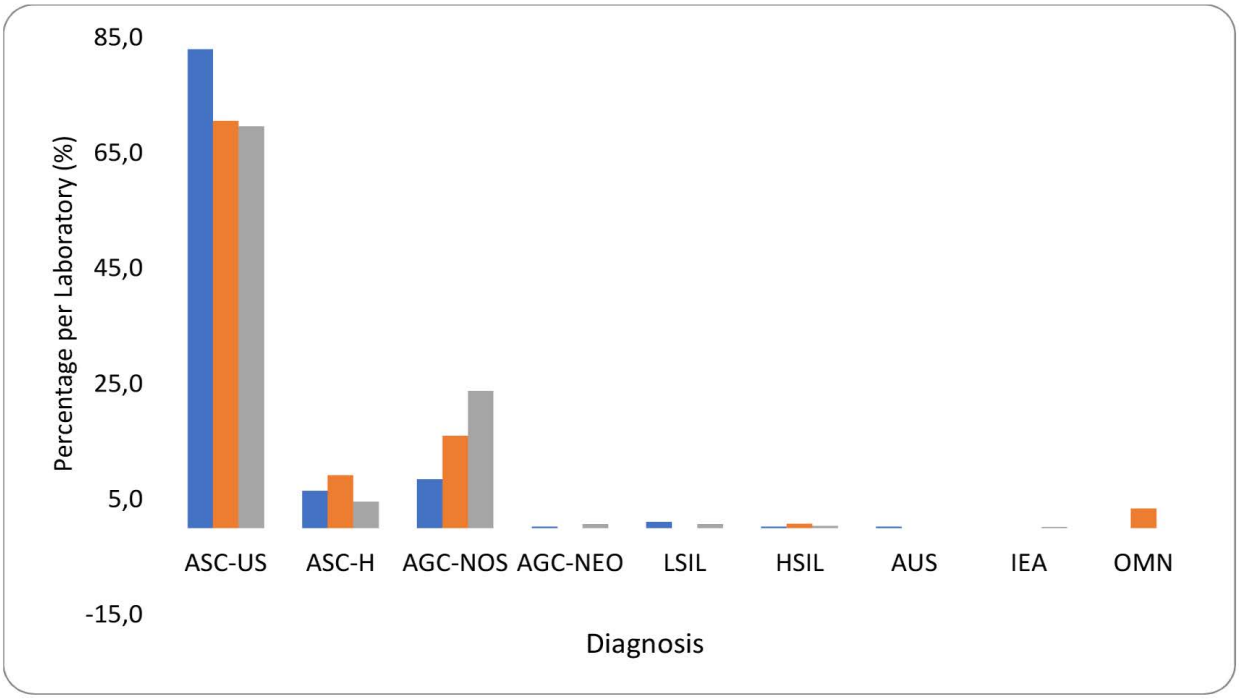

Figure 2. Percentage of false positive exams per diagnostic category in the laboratories evaluated by the EQM/Sitec/INCA (2013-2024)
Captions: ASC-US: atypical squamous cells of undetermined significance; ASC-H: atypical squamous cells, not possible to exclude high-grade intraepithelial lesion; AGC-NOS: atypia in glandular cells, not otherwise specified; AGC-NEO: atypia in glandular cells, suggestive of neoplasms; LSIL: low-grade squamous intraepithelial lesion; HSIL: high-grade squamous intraepithelial lesion; AUS: atypias of undetermined significance, suggestive of neoplasms; IEA: invasive endometrial adenocarcinoma; and OMN: other malignant neoplasms.

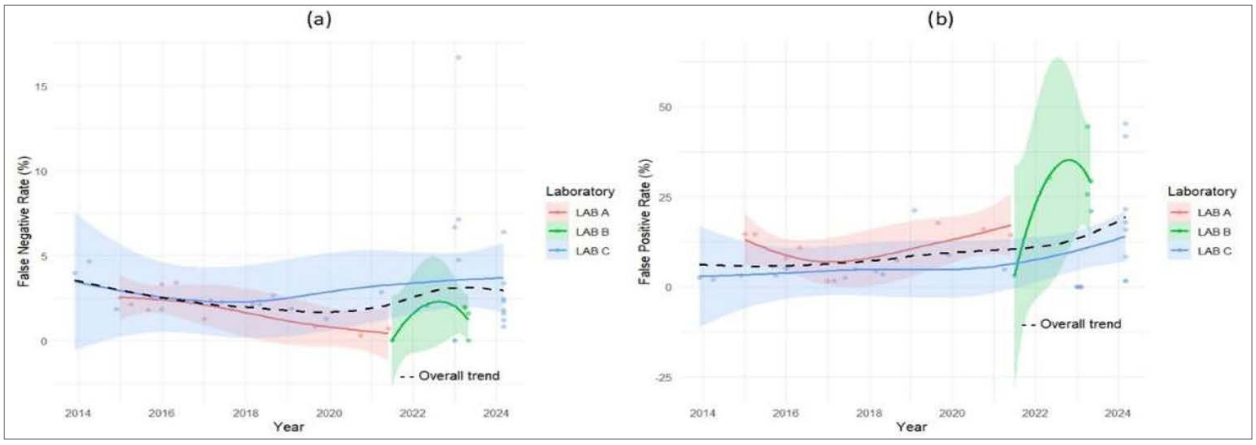

Figure 3 (a– b). Overall and laboratory-specific temporal evolution of false negative (a) and false positive (b) percentages in the laboratories evaluated by the EQM/Sitec/INCA between 2013 and 2024

Table 2. Interpretation of weighted Kappa results from each laboratory audited by EQM/SITEC/INCA between 2013 and 2024

Laboratory	Observed percentage of agreement	Kappa	Interpretation
LAB A	91.78%	0.84	Almost perfect agreement
LAB B	89.18%	0.73	Substantial agreement
LAB C	94.34%	0.87	Almost perfect agreement

II – EQM/Sitec/INCA review). LAB A (0.84) and LAB C (0.87) presented almost perfect agreement, while LAB B (0.73) presented substantial agreement. These results indicate that, despite the variability inherent to cytopathology, the evaluated laboratories maintain consistent patterns for diagnostic interpretation.

In addition to the agreement observed by Kappa, the false positive and false negative indices showed important differences between laboratories. The false positive rate across the three evaluated laboratories was 11.51%, with LAB B showing a higher proportion. This finding could be associated with a higher frequency of interpretation in borderline categories and must be monitored in light of the recommended quality parameters.

The proportion of false negatives was 2.04% between the three evaluated laboratories, which was considered adequate when compared to the values described in the Quality Management Manual, which ranges from 2% to 13%, including errors related to collection, scrutiny, and interpretation[7].

In a study conducted by INCA in the IQM scope from January 2008 to December 2018, a proportion of 1.4% (confidence interval — CI 95%: 1.38%–1.48%) of false negatives was observed[4]. Although both contexts use random sample review, differences inherent to the nature of monitoring — especially regarding independence from EQM evaluation — can influence the detection of false negatives, and reflect differences inherent to the evaluation process in the context of external monitoring. This means that such comparisons should be interpreted with caution.

The distribution of false negative exams per diagnostic category showed a predominance of ASC-US and ASC-H categories, followed by LSIL and HSIL. Whereas false positive exams concentrate on ASC-US and atypia in glandular cells, not otherwise specified (AGC-NOS). This pattern suggests that borderline or difficult-to-interpret cytological alterations are associated with a higher probability of underdiagnosis or overinterpretation, configuring critical points in the process of screening and cytopathological reading. Observations from international studies confirm that agreement on borderline categories such as ASC-US and ASC-H tends to be lower than for LSIL or HSIL, while glandular lesions present a greater interpretative challenge[18,19].

The term "atypia" describes cellular alterations that range from benign reactive modifications to potentially malignant manifestations. The interpretation of atypical cells, especially glandular cells (AGC-NOS), is highly subject, reinforcing the need for standardized diagnostic criteria, continuous training, and quality external and internal monitoring[20,21].

The ASC (Atypical Squamous Cells) category represents the most frequent atypia among the altered reports. For laboratory control, it is recommended that the frequency does not exceed 5% of the total exams and does not exceed twice to three times the number of LSIL[22]. Higher values suggest a possible overestimation of the category, while lower values can indicate underestimation. In this context, the analysis of this ratio in the evaluated laboratories could additionally contribute to identifying possible interpretive deviations.

From the care point of view, the communication of diagnoses classified as "atypical" can cause anxiety

and insecurity in patients, in addition to impairing clinical decision-making, as it does not always allow for distinguishing between cases requiring more intensive monitoring and those demanding only routine surveillance. Consequently, complementary exams can be requested, impacting on the costs and quality of care[23].

The participation of multiple professionals in the interpretation of exams, associated with continued education, contributes to reducing false positive and false negative results[24]. Systematic promotion of training and technical updates helps decrease non-conformities, positively impacting diagnostic accuracy and promoting the standardization of cytomorphological criteria.

The present study records quality indicators in force in the pre-implementation of oncogenic HPV DNA testing era, providing a reference landscape for future comparisons. The data presented might support the assessment of new quality indicators to be established in consonance with the most recent guidelines for cervical cancer screening in Brazil.

This study presents limitations that should be considered when interpreting the results. We highlight the use of data from two different information systems — Siscolo[8] and Siscan[9] — in the context of the transition initiated in 2013, which may have implicated differences in recording standards, completeness, and quality of information, potentially affecting the temporal comparability of data. Moreover, the long analysis period (2013–2024) and inclusion of only three laboratories that met the eligibility criteria might limit the generalization of the findings.

In this context, the temporal distribution of monthly batches varied among laboratories, reflecting the sample referral dynamic followed by the local healthcare management. This heterogeneity in the frequency of batches may have influenced the variability observed between laboratories, even after data aggregation by period. It is possible to observe that there is no trend in the proportion of false negatives over time. Although distinct trends can be observed for each laboratory, they were not considered significantly different. A slight general upward trend in the percentage of false positives is observed, though with no statistical evidence of an association (p=0.063). Regarding the false positives rate, an increase in variability over time is observed; furthermore, when each laboratory's trend is analyzed individually, it also shows an upward trend, though it was not considered significantly different from one another.

Furthermore, the use of consolidated secondary data from EQM prevents the calculation of classic diagnostic accuracy measures, such as sensitivity, specificity, predictive values, likelihood, relative risk, and odds ratio, since it was not possible to rebuild the full contingency table due to the team not having access to the evaluation of unsatisfactory exams. The reconstruction of the contingency table would only be possible in case results classified as unsatisfactory by the EQM/Sitec/INCA were disregarded. Therefore, the sensitivity and specificity estimations would be overestimated, which would also impact other classical measures for diagnostic accuracy. Consequently, the laboratories' performance evaluation was restricted to operational indicators, such as false-positive and false-negative rates, which, despite being relevant in the context of quality control, do not fully capture global diagnostic accuracy. This limitation also restricts broader comparisons with other studies and prevents association and economic impact analyses. Thus, the findings from this study must be interpreted considering these methodological restrictions.

To summarize, the results show that although EQM contributes to consistent patterns, differences remain among laboratories, especially in borderline cytological categories. It is recommended to continue with external monitoring, associated with technical training and standardization of diagnostic criteria, as strategies to improve diagnostic quality and accuracy in cytopathology.

CONCLUSION

The results demonstrate that laboratories evaluated by EQM/Sitec/INCA present substantial to almost perfect diagnostic agreement, indicating consistency in cytopathological interpretation. However, differences in false positive and false negative indicators persist, especially in borderline cytological categories, like ASC, which is still the main zone of diagnostic uncertainty. These findings reinforce the role of EQM as an essential tool for identifying weaknesses, following up with laboratory performance, and leading to improvements in diagnostic practice. Moreover, the study draws a baseline for indicators in the pre-implementation phase of oncogenic HPV DNA screening in Brazil, contributing to future evaluations for improvement of quality control strategies in cytopathology.

CONTRIBUTIONS

All the authors have substantially contributed to the study design, data acquisition, analysis, interpretation, wording, and critical review. They approved the final version for publication.

DECLARATION OF CONFLICT OF INTERESTS

There is no conflict of interest to declare.

DATA AVAILABILITY STATEMENT

All the contents associated with the article are included in the manuscript.

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None.

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