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Research Article

Comprehensive analysis of pancreatic fine needle aspiration cyto-histopathological correlation

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ABSTRACT

Objective: Pancreatic cancer is a major global health challenge with high mortality rates and limited therapeutic options. Fine-needle aspiration (FNA) cytology is a key diagnostic tool, but discrepancies between cytological and histological diagnoses can impact patient management. This study aims to evaluate the diagnostic accuracy of pancreatic FNA using the World Health Organization (WHO) reporting system to assess the risk of malignancy (ROM) across different diagnostic categories.

Material and Methods: The WHO reporting system was employed to reclassify 122 FNAs, with 37 cases undergoing subsequent histological correlation to evaluate the ROM. The sensitivity, specificity, positive and negative predictive values, and accuracy of ROM using the WHO system were determined through statistical analyses.

Results: The discrepancy rate between cytology and histology diagnoses was 16.2%. Category 6 (malignant) showed consistent ROM values (89%), confirming its reliability in predicting malignancy. However, Categories 1, 2, and 3 had higher ROM values than previously reported, while Category 4 had a lower ROM. Factors such as small lesion size, poor cellularity, and sampling limitations contributed to diagnostic discrepancies.

Conclusion: The study offers significant insights into the cyto-histopathological correlation in pancreatic FNA, highlighting the effectiveness of the WHO reporting system in ROM assessment. Future research with larger samples is necessary to enhance the accuracy of pancreatic FNA cytology for improved patient outcomes.

Keywords: Diagnostic accuracy, Fine-needle aspiration, Pancreatic neoplasms, Risk assessment, World Health Organization

INTRODUCTION

Pancreatic cancer is a significant global health burden, with high mortality rates and limited treatment options.[1] It ranks as the tenth most common cancer in men and eighth in women worldwide.[2] In the United States, pancreatic cancer is the fourth leading cause of cancer-related deaths, with an estimated 64,050 new cases expected in 2023.[3] The overall 5-year survival rate for pancreatic cancer is only 12%, the lowest among major cancers.[1] In Saudi Arabia, the incidence of pancreatic cancer is lower than the global average, but it remains a significant cause of cancer-related mortality.[4,5]

Fine-needle aspiration (FNA) cytology is a critical diagnostic tool for pancreatic lesions, offering a minimally invasive method to assess the risk of malignancy (ROM). However, discrepancies between cytological and histological diagnoses can lead to challenges in patient management.[6] The World Health Organization (WHO) has developed a standardized

reporting system for pancreaticobiliary cytopathology to improve diagnostic accuracy and risk stratification. This system categorizes pancreatic FNAs into seven tiers, each with an associated ROM and management recommendations.[7]

The primary objective of this study is to evaluate the diagnostic accuracy of pancreatic FNA using the WHO reporting system and to assess the ROM across different diagnostic categories. By analyzing the correlation between cytological and histological diagnoses, we aim to identify factors contributing to diagnostic discrepancies and propose strategies to improve the accuracy of pancreatic FNA cytology. This research provides valuable insights into the utility of the WHO reporting system in clinical practice to guide future improvements in diagnostic techniques for pancreatic cancer.

MATERIAL AND METHODS

Study design and ethical approval

This retrospective study was conducted at a tertiary educational hospital, following approval from the institutional ethics review board. The study adhered to the ethical principles outlined in the latest edition of the Declaration of Helsinki (2024),[8] and informed consent was obtained from all patients before their inclusion.

Case selection and inclusion criteria

A total of 122 pancreatic FNA cases performed between 2008 and 2024 were included in the analysis. Inclusion criteria consisted of the availability of cytological material for diagnosis, clinical and radiological correlation, and histological follow-up for cases requiring further confirmation. Cases were excluded if there was no clinical or radiological correlation.

Cytological staining and preparation

The cytological smears were stained using Diff-Quik (DQ) stain and Papanicolaou (PAP) stain. The DQ stain, a rapid Romanowsky-type stain, was employed for immediate on-site evaluation of cellular adequacy and preliminary diagnosis. The staining process involved several steps: first, air-dried smears were fixed in methanol for 10-15 s to preserve cellular morphology. Following fixation, the smears were immersed in Staining Solution I (Eosin Y, Catalog Number HT110116, manufactured by Sigma-Aldrich United States) for 5-10 s, staining cytoplasmic components and extracellular material pink to red. After a brief rinse in water, the smears were immersed in Staining Solution II (Methylene Blue, Catalog Number M9140, manufactured by Sigma-Aldrich United States) for another 5-10 s, which stained nuclear chromatin and basophilic cytoplasmic components blue to purple. The smears were then rinsed gently in water, air-dried, and mounted with a coverslip using a suitable mounting medium for microscopic examination.

The DQ stain provided excellent visualization of cytoplasmic details, nuclear morphology, and background material, making it particularly useful for assessing pancreatic FNA samples and for rapid on-site evaluation during the procedure. The PAP stain was utilized for definitive diagnosis, with the cytological diagnoses being reclassified according to the WHO reporting system for pancreaticobiliary cytopathology, which categorizes findings into seven diagnostic tiers: "insufficient/inadequate/non-diagnostic," "benign/negative for malignancy," "atypical," "(pancreaticobiliary neoplasm-low risk/low grade [PaN-Low])," "(pancreaticobiliary neoplasm-high risk/high grade [PaN-High])," "suspicious for malignancy," and "positive for malignancy."[9] The WHO reporting system is detailed in the WHO *Classification of Tumors* editorial board publication, which provides comprehensive guidelines for the classification and reporting of pancreaticobiliary cytopathology.[10]

Histological correlation and ROM calculation

For cases with subsequent histological correlation (n = 37), the histological diagnoses were the gold standard to assess the accuracy of the cytological findings. The ROM for each WHO diagnostic category was calculated based on the histological outcomes, defined as the proportion of cases within each category that were confirmed as malignant on histology.

Statistical analysis

Statistical analyses were performed using IBM Statistical Package for the Social Sciences Statistics version 27 (IBM Corporation, Armonk, NY, USA) to determine the diagnostic performance metrics, including sensitivity, specificity, positive predictive value (PPV), negative predictive value (NPV), and overall accuracy. These metrics were calculated to evaluate the diagnostic performance of the WHO system. Receiver operating characteristic (ROC) curve analysis was conducted to assess the overall diagnostic performance of the WHO system, with the area under the curve (AUC) used as a measure of accuracy. Figures were created using GraphPad Prism version 9.5.1 (GraphPad Software, San Diego, CA, USA) and Microsoft Excel version 2308 (Microsoft Corporation, Redmond, WA, USA). GraphPad Prism was used for generating the bar chart, ROC curve, and pie chart, while Excel assisted in data organization and preliminary visualizations. A $P < 0.05$ was considered statistically significant.

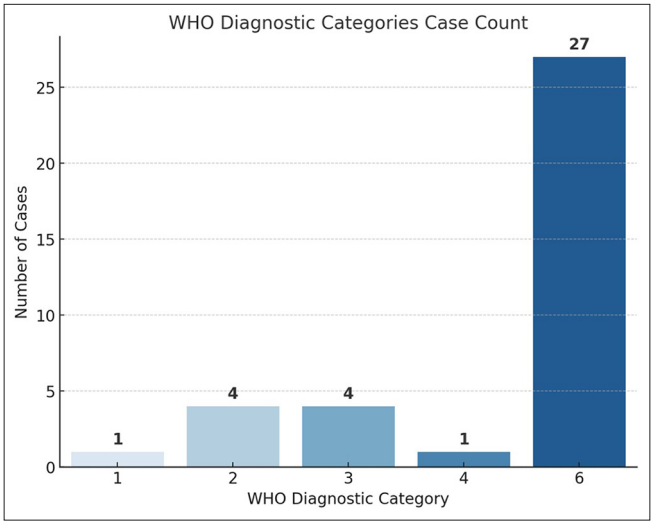

Figure 1: Distribution of cases by the World Health Organization (WHO) categories. Figure 1 is a bar chart showing the distribution of all 122 fine-needle aspiration cases across the WHO diagnostic categories. The chart highlights the prevalence of each category, with Category 6 (malignant) being the most common (24/27 cases). Notably, no cases were identified in Category 5. This figure provides a clear overview of the case distribution and underscores the importance of refining diagnostic criteria for categories with higher risk of malignancy values, such as Categories 1, 2, and 3.

RESULTS

Case distribution and diagnostic categories

A total of 122 pancreatic FNAs were performed at the tertiary educational hospital between 2008 and 2024, of which 37 cases (30.3%) had subsequent histology correlation and were categorized under the WHO reporting system to assess the ROM. The distribution of cases across the WHO diagnostic categories is illustrated in Figure 1. Category 6 (malignant) was the most common, with 24 out of 27 cases confirmed as malignant on histology. No cases were identified in Category 5. The atypia rate was observed at 6.6% (8/122), and discrepancies between cytology and histology diagnoses were recorded in six cases (16.2%).

ROM across WHO categories

The calculated ROM for each WHO category was Category 1 (1/2): 50%; Category 2 (3/3): 100%; Category 3 (4/4): 100%; Category 4 (0/1): 0%; and Category 6 (24/27): 89%. In concordance with the results of other studies, Category 6 exhibited consistent ROM values, confirming its utility for malignancy prediction. However, Categories 1, 2, and 3 demonstrated higher ROM values, while Category 4 had a lower ROM than previously reported. These variations may be influenced by sample size, regional differences, or procedural limitations.

Diagnostic performance of the WHO system

The diagnostic performance metrics for the WHO system were sensitivity 90.63%, specificity 40%, PPV 90.63%, NPV 40%, and overall accuracy 83.78%. Advanced statistical analyses, including ROC curve evaluations, indicated an AUC of 0.79, demonstrating the moderate diagnostic performance of the WHO system [Figure 2]. The ROC curve highlights the trade-off between sensitivity and specificity, underscoring the system's ability to correctly identify malignant cases while showing room for improvement in reducing false positives.

Microscopic findings

The cytological images [Figure 3] provide illustrative examples of the cellular features observed in pancreatic FNA samples, particularly in Category 6 (malignant) cases. The DQ stain was useful for highlighting cytoplasmic details, nuclear morphology, and background material. For example, in Image A, the DQ stain clearly demonstrated the "drunken honeycomb" pattern of ductal adenocarcinoma, with disorganized clusters of neoplastic cells showing nuclear crowding, overlapping, and loss of polarity. Image B, also stained with DQ, highlighted the pleomorphic nature of ductal adenocarcinoma, with irregular nuclear contours, prominent nucleoli, and a high nuclear-to-cytoplasmic (N/C) ratio. The granular cytoplasm and vacuolization characteristic of acinar cell carcinoma were vividly depicted in Image D using DQ stain. These findings underscore the utility of DQ stain in providing rapid and reliable cytological evaluation, particularly for on-site adequacy assessment and preliminary diagnosis.

Factors contributing to diagnostic discrepancies

Detailed analysis of the 16.2% discrepancy rate between cytology and histology diagnoses revealed that small lesion size (< 5 cm), poor cellularity, and sampling technique limitations were primary contributors [Figure 4]. For example, cases with insufficient cytological adequacy frequently resulted in false-negative results. These factors highlight the challenges in diagnosing small or poorly sampled lesions and underscore the need for improved sampling techniques and cytological adequacy assessment.

This study underscores the WHO system's utility in stratifying malignancy risk while also identifying areas requiring improved cytological adequacy and sampling precision. These findings offer significant implications for refining diagnostic strategies and enhancing patient outcomes.

DISCUSSION

Over the past 10 years, there has been significant progress in the development of standardized reporting systems for

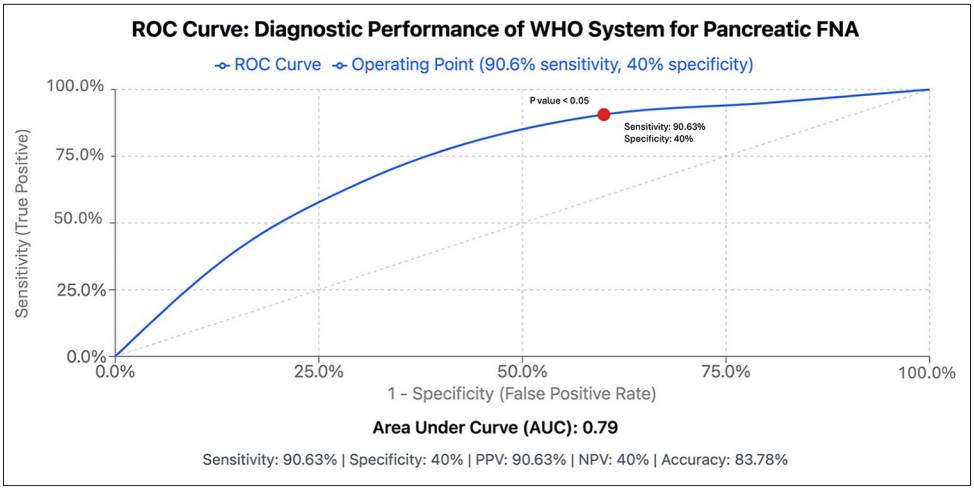

Figure 2: Receiver operating characteristic (ROC) curve. Figure 2 presents the ROC curve, which illustrates the diagnostic performance of the World Health Organization (WHO) classification system in assessing the risk of malignancy in pancreatic fine-needle aspiration (FNA). The red points on the curve indicate threshold values at which sensitivity and specificity were calculated, highlighting clinically significant decision points. The area under the curve (AUC) is 0.79, indicating moderate diagnostic accuracy. The *P*-value for the ROC curve analysis is <0.05, indicating statistical significance. The ROC curve demonstrates the trade-off between sensitivity (90.63%) and specificity (40%), highlighting the system's ability to correctly identify malignant cases while also showing room for improvement in reducing false positives. Unlike ROC curves with a sharp inflection point, this curve appears smooth due to the continuous nature of the data, the absence of a clear optimal cutoff, and the interpolation methods used to generate the curve. Relevant values, including sensitivity, specificity, and AUC, are annotated on the figure for clarity. This visual representation supports the utility of the WHO system in clinical practice but underscores the need for further refinement to enhance diagnostic precision. PPV: Positive predictive value, NPV: Negative predictive value.

cytopathology across various organ systems, including the pancreaticobiliary system. The initial reporting system for pancreaticobiliary cytology was introduced by the PAP Society of Cytopathology (PSC) in 2014.[9]

More recently, the WHO, the International Academy of Cytology, and the International Agency for Research on Cancer have collaborated to present an updated and standardized reporting system for pancreaticobiliary cytopathology. This new system, which follows a seven-tiered approach, offers evidence-based terminology with associated ROM and diagnostic management recommendations for each diagnostic category. It is part of a comprehensive series of reporting systems for various anatomical sites, aligning with the WHO Classification of Tumors series.[7] By aligning with the WHO Classification of Tumors series, the reporting system adopts similar principles and terminology, facilitating better communication and comparability of data among pathologists, clinicians, and researchers. This alignment also allows for the integration of pancreaticobiliary cytopathology findings within the broader context of tumor classification and enhances collaboration across different specialties and institutions. The *WHO Reporting System for Pancreaticobiliary Cytopathology* replaces the previous six-tiered PSC system and introduces the following classifications: "insufficient/inadequate/nondiagnostic," "benign/negative for malignancy," "atypical," "PaN-Low," "PaN-High," "suspicious for malignancy," and "positive for malignancy."[10]

Significant differences in the way neoplasms are classified between the two systems. In the PSC system, neoplasms are categorized into two groups: "other," which encompasses intraductal papillary mucinous neoplasms IPMNs of any grade, mucinous cystic neoplasms of any grade, pancreatic neuroendocrine tumors (PanNETs), and solid pseudopapillary neoplasms (SPNs) and "benign," which includes lymphangiomas and serous cystadenomas. The WHO system classifies these neoplasms into four distinct groups: PaN-Low, PaN-High, and positive for malignancy (PanNETs and SPNs). The category of "benign/negative for malignancy" in the WHO system encompasses severe cystadenomas and lymphangiomas. In addition, in the WHO system, pancreatic FNAs previously classified as "atypical" in the PSC system but displaying results suspicious for a well-differentiated PanNET or SPN are reclassified as "suspicious for malignancy." These revisions in the neoplasia classification highlight the divergences between the PSC and WHO systems and their implications for diagnostic interpretation and subsequent management decisions.[11]

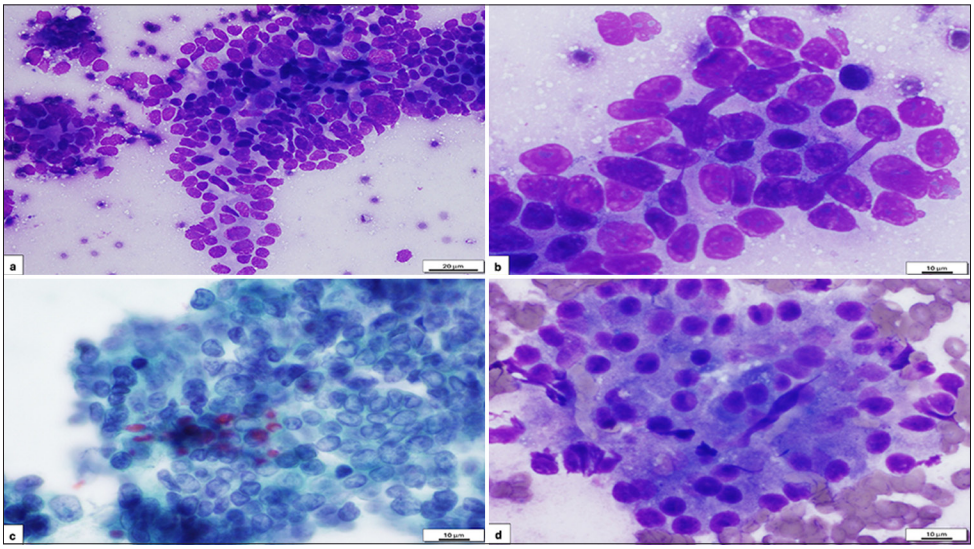

Figure 3: (a) The image shows clusters of neoplastic ductal cells arranged in a disorganized, "drunken honeycomb" pattern, characteristic of ductal adenocarcinoma. The cells exhibit nuclear crowding, overlapping, and loss of polarity. The nuclei are hyperchromatic with irregular nuclear membranes and occasional prominent nucleoli. The cytoplasm is scant, and the nuclear-to-cytoplasmic (N/C) ratio is markedly increased (Diff-Quik [DQ] stain, ×20, scale bar: 20 μm). (b) This high-power view demonstrates marked cellular pleomorphism, with irregularly shaped nuclei and prominent nucleoli. The nuclear membranes are irregular. The cells exhibit a high N/C ratio, with scant cytoplasm and nuclear overlapping (DQ stain, ×60, scale bar: 10 μm). (c) The image reveals pleomorphic ductal cells with irregular nuclear contours and prominent nucleoli. The nuclear membranes are thickened and irregular, and the cells display a high N/C ratio. These features are diagnostic of ductal adenocarcinoma (Papanicolaou stain, ×60, scale bar: 10 μm). (d) This image shows clusters of acinar cell carcinoma cells with abundant granular cytoplasm and occasional vacuolization. The nuclei are round to oval. The cytoplasm exhibits a granular appearance, characteristic of acinar cell carcinoma (DQ stain, ×60, scale bar: 10 μm).

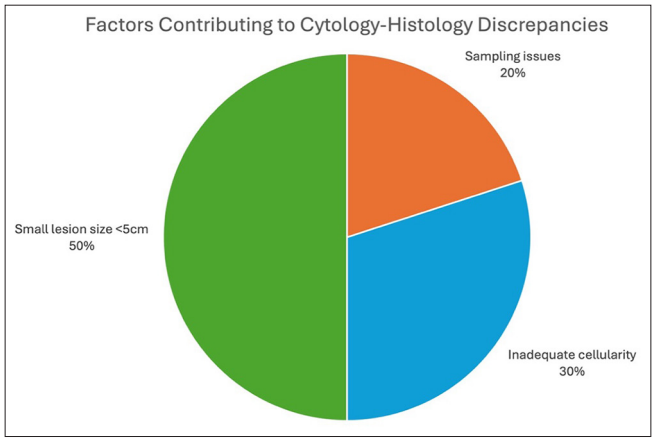

Figure 4: Diagnostic discrepancies. Figure 4 is a pie chart that breaks down the reasons behind the 16.2% discrepancy rate between cytology and histology diagnoses. The primary contributors to these discrepancies include small lesion size (<5 cm), poor cellularity, and limitations in sampling techniques. For example, cases with insufficient cytological adequacy often resulted in false-negative results. This figure visually emphasizes the key challenges in pancreatic fine-needle aspiration cytology and provides a clear representation of the factors that need to be addressed to improve diagnostic accuracy.

The WHO revised the seven-tiered system for reporting pancreaticobiliary cytopathology offers numerous benefits over the previous PSC six-tiered approach. The additional tier enables more nuanced categorization of cytological interpretations, leading to enhanced diagnostic precision. Introducing categories such as PaN-Low and PaN-High facilitates improved risk stratification, aiding clinicians in treatment planning. The system also provides standardized terminology for each diagnostic category, enhancing communication among healthcare professionals and researchers while enabling data comparability. It offers diagnostic management recommendations for each category, guiding clinical decision-making. Last, the alignment with the WHO Classification of Tumors series ensures global consistency, promoting collaboration and data integration across various anatomical sites and tumor types. These improvements contribute to more accurate diagnoses, better patient management, and increased reporting uniformity, ultimately enhancing patient care quality for those with pancreaticobiliary cytological findings.[12,13]

Research has been conducted to assess the efficacy of the WHO International System for Reporting *Pancreaticobiliary*

Cytopathology in determining ROM from pancreatic FNA samples. Hoda *et al*. examined 334 pancreatic aspirates, finding ROM ranges from 1.0% for benign cases to 100% for malignant cases. Their study demonstrated that the WHO system offered superior risk stratification compared to the PSC system.[14]

Gocun *et al*. reclassified 420 FNA specimens, revealing ROM percentages across various categories, with the highest risk (100%) observed in the "PaN-High" and "malignant" categories. Their findings indicated that the WHO system exhibited slightly improved sensitivity, specificity, and NPV compared to the PSC system. The study also noted that the "nondiagnostic" category had a ROM consistent with previous literature.[15]

Kundu *et al*. focused on comparing the WHO and PSC systems for pancreaticobiliary cytology reporting.[16] Their analysis of 230 pancreatic cytology samples revealed that the WHO system provided enhanced sensitivity, resulting in improved risk stratification and patient management, which is a conclusion also supported by Ali *et al*. The high specificity and moderate sensitivity of the WHO system highlighted the value of FNA in evaluating pancreatic lesions.[17] The studies suggest that the WHO International System for Reporting Pancreaticobiliary Cytopathology enhances the classification accuracy of pancreatic FNA samples, resulting in improved risk assessment and potentially better patient care for suspected pancreatic cancer cases.

Aligned with the WHO *Classification of Tumors* series, the WHO *Reporting System for Pancreaticobiliary Cytopathology* offers an evidence-based nomenclature system with accompanying reference guides, facilitating effective patient management by clinical teams. The current literature primarily documents the ROM performance indicator based on the PSC system. Future research should focus on validating and refining performance indicators in accordance with the current WHO system to ensure their precision and relevance in clinical settings.

In assessing the WHO system's performance for pancreatic FNA cytology, our data's calculated ROM was compared to existing literature. Our findings, in line with previous studies, showed high ROM in Categories 1, 3, and 6, suggesting a high probability of malignancy. However, we noted a discrepancy in Categories 2 and 4, where our calculated ROM was lower than the reported values.

The observed 16.2% discrepancy between cytological findings and histological diagnoses may be attributed to various factors. Masses smaller than 5 cm can hinder the collection of adequate cytology samples, reducing sensitivity and potentially underestimating ROM. Cases lacking cytology adequacy, characterized by hypocellular smears or insufficient cellularity, can lead to inconclusive or false-negative cytology results. These factors, including small lesion size, poor cellularity, and limitations in sampling techniques, contribute to the observed discrepancies between FNA and histology diagnoses.

Addressing these challenges is crucial for improving diagnostic accuracy. Future research should focus on optimizing sampling techniques, such as using guided imaging or larger needles, to enhance cytological adequacy. In addition, integrating molecular diagnostics and standardized protocols for assessing sample adequacy could help resolve ambiguous cases and reduce diagnostic errors. Training programs for pathologists and larger prospective studies are also needed to validate these findings and refine the diagnostic process, ultimately leading to better patient outcomes.

Pancreatic cancer in Saudi Arabia ranks fifteenth in prevalence, which is lower than the global average.[2] This lower ranking may be attributed to several factors, including differences in risk factors such as smoking rates, genetic predispositions, and dietary habits. Underdiagnosis due to limited access to advanced diagnostic tools and challenges in cytological sampling, as highlighted in our study, could contribute to the lower reported prevalence. Our findings suggest that improving diagnostic accuracy through better sampling techniques and the use of the WHO reporting system could lead to more accurate prevalence data and better patient outcomes.

It is crucial to recognize the limitations of our study. The retrospective approach and relatively small sample size may introduce bias and restrict the generalizability of the findings. Additional studies with larger sample sizes and prospective designs are necessary to confirm our results and provide more substantial evidence.

SUMMARY

This study analyzes the cyto-histopathological correlation in pancreatic FNA using the WHO reporting system. Our findings demonstrate the utility of the WHO system in assessing the ROM across different diagnostic categories, with Category 6 (malignant) showing consistent ROM values (89%), reaffirming its reliability in predicting malignancy. However, higher-than-expected ROM values in Categories 1, 2, and 3, as well as a lower ROM in Category 4, highlight potential variations influenced by sample size, regional differences, or procedural limitations. The observed 16.2% discrepancy rate between cytology and histology diagnoses underscores the challenges posed by small lesion size, poor cellularity, and sampling technique limitations, which can lead to false-negative or inconclusive results.

The moderate diagnostic performance of the WHO system, as evidenced by an AUC of 0.79, supports its clinical utility

but also indicates room for improvement. Addressing these diagnostic challenges through enhanced sampling techniques, improved cytological adequacy, and integrated molecular diagnostics could significantly improve the accuracy of pancreatic FNA cytology. Standardized protocols and training for pathologists may help reduce variability in diagnostic interpretation and improve patient outcomes.

Future studies with larger sample sizes and prospective designs are necessary to confirm our results and refine the diagnostic accuracy of pancreatic FNA cytology.[16] By addressing the limitations identified in this study, such as improving sampling techniques and cytological adequacy, we can enhance the reliability of FNA as a diagnostic tool and improve patient care. This study not only reinforces the value of the WHO reporting system in pancreaticobiliary cytopathology but also provides a foundation for future advancements in the diagnosis and management of pancreatic cancer.

AVAILABILITY OF DATA AND MATERIALS

The datasets used and/or analyzed during the current study are available from the corresponding author upon reasonable request.

ABBREVIATIONS

AUC: Area under the curve
FNA: Fine-needle aspiration
IPMN: Intraductal papillary mucinous neoplasm
MCN: Mucinous cystic neoplasm
PaN-High: Pancreaticobiliary neoplasm-high risk/high grade
PaN-Low: Pancreaticobiliary neoplasm-low risk/low grade
PanNET: Pancreatic neuroendocrine tumor
PSC: Papanicolaou society of cytopathology
ROC: Receiver operating characteristic
ROM: Risk of malignancy
SPN: Solid pseudopapillary neoplasm
WHO: World Health Organization

AUTHOR CONTRIBUTIONS

SS: Contributed significantly to the conception, design, data collection, analysis, and interpretation of the study. The author meets ICMJE authorship requirements.

ETHICS APPROVAL AND CONSENT TO PARTICIPATE

This study was conducted in accordance with the ethical principles outlined in the Declaration of Helsinki (2024). Ethical approval was obtained from the Unit of Biomedical Ethics at "King Abdulaziz University, Jeddah, Saudi Arabia." (Reference No: 461-23). Informed consent was obtained from all participants before their inclusion in the study.

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Not applicable.

CONFLICT OF INTEREST

The authors declare no conflict of interest.

EDITORIAL/PEER REVIEW

To ensure the integrity and highest quality of CytoJournal publications, the review process of this manuscript was conducted under a **double-blind model** (authors are blinded for reviewers and vice versa) through an automatic online system.

REFERENCES

1. Siegel RL, Miller KD, Wagle NS, Jemal A. Cancer statistics, 2023. CA Cancer J Clin 2023;73:17-48.
2. Sung H, Ferlay J, Siegel RL, Laversanne M, Soerjomataram I, Jemal A, *et al*. Global cancer statistics 2020: GLOBOCAN estimates of incidence and mortality worldwide for 36 cancers in 185 countries. CA Cancer J Clin 2021;71:209-49.
3. Surveillance, epidemiology, and end results (SEER) program. SEER stat database: Incidence - SEER research data, Surveillance research program; 2023. Available from: https://www.seer.cancer.gov [Last accessed on 2024 Oct 16].
4. Saudi cancer registry: Cancer incidence report; 2020. Available from: https://shc.gov.sa/arabic/ncc/activities/annualreports/cancer%20incidence%20report%202020.pdf [Last accessed on 2024 Oct 16].
5. Alghamdi IG, Almadi M, Alsohaibani F, Mosli M, De Vol EB, Abaalkhail F, *et al*. Epidemiology of pancreatic cancer in Saudi Arabia: A retrospective analysis of pancreatic cancer diagnosed in Saudi Arabia between 2004 and 2015. Clin Exp Gastroenterol 2021;10:45-57.
6. Khalaf N, El-Serag HB, Abrams HR, Thrift AP. Burden of pancreatic cancer: From epidemiology to practice. Clin Gastroenterol Hepatol 2021;19:876-84.
7. Pitman MB, Centeno BA, Reid MD, Siddiqui MT, Layfield LJ, Perez-Machado M, *et al*. The world health organization reporting system for pancreaticobiliary cytopathology. Acta Cytol 2023;67:304-20.
8. World Medical Association. WMA declaration of Helsinki - ethical principles for medical research involving human subjects; 2024. Available from: https://www.wma.net/policies/post/wma/declaration/of/helsinki/ethical/principles/for/medical-research-involving-human-subjects [Last accessed on 2024 Oct 16].
9. Pitman MB, Centeno BA, Ali SZ, Genevay M, Stelow E, Mino-Kenudson M, *et al*. Standardized terminology and nomenclature for pancreatobiliary cytology: The papanicolaou

society of cytopathology guidelines. Cytojournal 2014;11:3.
10. Nagtegaal ID, Odze RD, Klimstra D, Paradis V, Rugge M, Schirmacher P, *et al*. The 2019 WHO classification of tumours of the digestive system. Histopathology 2020;76:182-8.
11. Pitman MB, Centeno BA, Reid MD, Saeig M, Siddiqui MT, Layfield LJ, *et al*. A brief review of the WHO reporting system for pancreaticobiliary cytopathology. J Am Soc Cytopathol 2023;12:243-50.
12. Field AS, Pitman M, Cree IA, Canberk S, Bubendorf L, Mahrotra R, *et al*. The rationale for the development and publication of the world health organization reporting systems for cytopathology and a brief overview of the first editions of the lung and pancreaticobiliary systems. Cancer Cytopathol 2023;131:751-61.
13. Pitman MB. The world health organization reporting system for pancreaticobiliary cytopathology: Review and comparison to the papanicolaou society of cytopathology system. Arch Pathol Lab Med 2025;149:e39-46.
14. Hoda RS, Arpin RN 3rd, Rosenbaum MW, Pitman MB. Risk of malignancy associated with diagnostic categories of the proposed world health organization international system for reporting pancreaticobiliary cytopathology. Cancer Cytopathol 2022;130:195-201.
15. Gocun PU, Simsek B, Ekinci O, Ekmen N, Arhan M, Karakan T, *et al*. Risk of malignancy using the diagnostic categories proposed by the world health organization international system for reporting pancreaticobiliary cytopathology. Acta Cytol 2022;66:475-85.
16. Kundu R, Kollabathula A, Gupta N, Rohilla M, Rana SS, Nada R, *et al*. The WHO system versus the papanicolaou society of cytopathology system for reporting pancreaticobiliary cytology for risk stratification-which is better? Diagn Cytopathol 2024;52:145-55.
17. Ali A, Chukwudebe O, Ahmed N, Chau K, Ziemba Y, Soundararajan S, *et al*. Risk stratification of pancreatic lesions using world health organization international system for reporting pancreaticobiliary cytopathology: ROM based on a single institutional data from a large cohort of cases. J Am Soc Cytopathol 2023;12:S30.

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