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Diagnostic Performance of the Prostate Imaging Reporting and Data System and Diffusion Coefficient in Predicting Prostate Cancer Aggressiveness

PI-RADS and ADC in Prostate Cancer Grading

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ABSTRACT: Biparametric magnetic resonance imaging (bpMRI) interpreted with the Prostate Imaging Reporting and Data System version 2.1 (PI-RADS v2.1) is increasingly used for pre-biopsy risk stratification of prostate cancer, but evidence correlating PI-RADS score and apparent diffusion coefficient (ADC) with histopathological grade in Indonesian patients remains limited. This retrospective diagnostic accuracy study evaluated the performance of PI-RADS score and ADC for predicting tumour aggressiveness in 50 men with biopsy-confirmed prostate adenocarcinoma who underwent bpMRI followed by prostate biopsy at RSUP Dr. Wahidin Sudirohusodo and RSP Universitas Hasanuddin, Makassar, between May and November 2025. PI-RADS v2.1 scores and ADC values were correlated with the International Society of Urological Pathology (ISUP) grade group using Spearman correlation, receiver operating characteristic (ROC) analysis, and multivariable logistic regression. The mean age was 71.2 years, the mean prostate-specific antigen (PSA) level was 242.1 ng/mL, and high-grade disease (ISUP grade group 4–5) was present in 64% of patients. PI-RADS score showed a strong positive correlation with ISUP grade group ($\varrho = 0.84$, $p < 0.001$), whereas ADC demonstrated a weak, non-significant inverse correlation ($\varrho = -0.18$, $p = 0.20$). ADC showed modest discrimination for high-grade cancer (area under the curve [AUC] 0.65, 95% confidence interval [CI] 0.49–0.80), while PI-RADS ≥4 achieved a sensitivity of 94% and a specificity of 94%. In multivariable analysis, PI-RADS score remained strongly associated with high-grade cancer, whereas ADC and PSA were not independent predictors (all $p > 0.05$). In this Indonesian cohort, PI-RADS v2.1 was the primary predictor of histopathological grade, whereas ADC provided no significant incremental value beyond PI-RADS. PI-RADS ≥4 may support pre-biopsy risk stratification, although larger prospective multicentre studies are required to validate the additional role of ADC.

1. INTRODUCTION

Prostate cancer is the second most common malignancy and a leading cause of cancer death in men worldwide, with an estimated global incidence of 30.7 per 100 000 men and mortality of 7.7 per 100 000 men; both figures continue to rise in many Asian countries, including Indonesia, where population-based epidemiological data remain limited [1]. Because clinical presentation overlaps substantially with benign prostatic disease, imaging-based risk stratification before biopsy has become central to contemporary diagnostic pathways.

Multiparametric magnetic resonance imaging (mpMRI), interpreted using the Prostate Imaging Reporting and Data System version 2.1 (PI-RADS v2.1), is now recommended by international guidelines to triage men with suspected prostate cancer before biopsy [2]. However, the dynamic contrast-enhanced sequence required for a full multiparametric protocol adds cost, scan time, and gadolinium exposure, motivating growing interest in biparametric MRI (bpMRI), which relies solely on T2-weighted and diffusion-weighted imaging. Meta-analyses indicate that bpMRI achieves diagnostic accuracy comparable with that of mpMRI for detecting clinically significant prostate cancer, making it an attractive and more accessible alternative in resource-limited settings such as regional referral hospitals in Indonesia.

Despite the wide adoption of PI-RADS v2.1, the system remains a semi-quantitative, reader-dependent score, and pooled diagnostic performance data show that specificity is only moderate even at higher PI-RADS thresholds, which can result in unnecessary biopsies [3,4]. The apparent diffusion coefficient (ADC), derived quantitatively from diffusion-weighted imaging, has been proposed as a complementary, more objective biomarker that inversely reflects tumour cellularity and, by extension, Gleason grade. Recent series have confirmed a consistent inverse relationship between ADC and both Gleason score and ISUP grade group, with ADC providing high discriminative accuracy for high-grade disease [5]. Nonetheless, the combined incremental value of qualitative PI-RADS scoring and quantitative ADC measurement for grade prediction has not been well characterised in Southeast Asian populations, where patients frequently present later, with markedly elevated prostate-specific antigen (PSA) and advanced histopathological grade at diagnosis.

This gap is clinically important. In many Indonesian referral centres, patients present with very high PSA values and bulky disease, a pattern that differs from the lower-risk, screening-detected populations described in most published PI-RADS and ADC validation cohorts. Whether the diagnostic thresholds and correlations established in these predominantly Western and East Asian cohorts translate to a population with a high baseline burden of high-grade disease has not been established, and this evidence gap limits confident local application of bpMRI-based risk stratification.

This retrospective study therefore aimed to evaluate, in a real-world Indonesian cohort with biopsy-confirmed prostate adenocarcinoma identified through review of medical records, (i) the distribution of PI-RADS v2.1 categories and ADC values, (ii) the correlation between PI-RADS score and ISUP grade group and between ADC and ISUP grade group, (iii) the diagnostic performance of ADC for predicting high-grade cancer, and (iv) the independent predictors of high-grade disease among PI-RADS score, ADC, and PSA using multivariable analysis.

2. MATERIALS AND METHODS

2.1 Study Design

This was a retrospective, two-centre diagnostic accuracy study evaluating prostatic lesions assessed by biparametric MRI (bpMRI) using the PI-RADS v2.1 system, correlated with histopathological findings obtained by prostate biopsy performed as part of routine clinical care. Data were extracted from medical records at two participating centres; no patients were prospectively recruited or followed forward in time for the purposes of this study.

2.2 Study Setting

The study was conducted at RSUP Dr. Wahidin Sudirohusodo Makassar and RSP Universitas Hasanuddin, Makassar, Indonesia. Medical records of patients who underwent bpMRI and prostate biopsy between May and November 2025 were reviewed; data extraction and analysis were performed between December 2025 and March 2026.

2.3 Study Population and Sampling

Consecutive medical records of men who underwent bpMRI of the prostate for clinically suspected prostate cancer, on the basis of elevated PSA, at the two participating centres between May and November 2025 were reviewed (consecutive sampling).

Using a minimum-correlation sample-size formula ($r = 0.50$, $\alpha = 0.05$, $\beta = 0.10$), a minimum of 33 participants was required. Fifty men with complete PI-RADS, ADC, and histopathological (ISUP grade group) data recorded, and with histopathologically confirmed prostate adenocarcinoma on biopsy, were identified and constituted the analytic cohort. All patients underwent prostate biopsy as part of routine clinical management irrespective of PI-RADS category, on the basis of elevated PSA and clinical judgement; no biopsy-negative cases were identified among the medical records reviewed for this cohort (Figure 1).

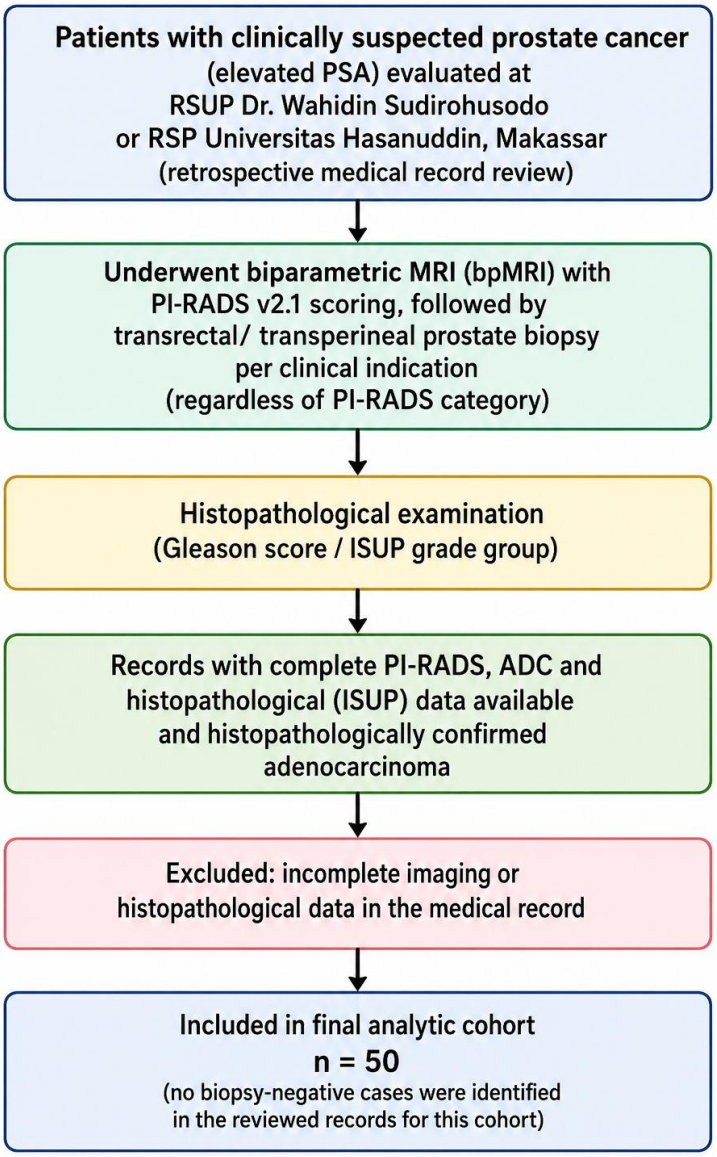


Figure 1. STARD-style flowchart of patient identification and selection (retrospective medical-record review).

2.4 Eligibility Criteria

Inclusion criteria were: men with clinically suspected prostate cancer on the basis of elevated PSA, classified according to the European Association of Urology (EAU) 2025 risk categories (4–10 ng/mL, low risk; >10–20 ng/mL, intermediate risk; >20 ng/mL, high/very-high risk); who underwent bpMRI followed by prostate biopsy at one of the two participating centres within the study period; and with complete PI-RADS, ADC, and histopathological data available in the medical record. Exclusion criteria were contraindication to MRI, prior pelvic radiotherapy, prior chemotherapy, prior prostatectomy, biopsy not

performed within two weeks of MRI, incomplete PI-RADS, ADC, or histopathological data in the record, or a history of urinary-tract calculi or other urinary-tract tumours. Histopathological grade (Gleason score/ISUP grade group) was an outcome variable determined after biopsy and was not used as an eligibility criterion (see Section 2.8).

2.5 MRI Protocol

Biparametric MRI was performed using a 3-T scanner at RSUP Dr. Wahidin Sudirohusodo and a 1.5-T scanner at RSP Universitas Hasanuddin, with an endorectal and/or pelvic surface coil as appropriate. The protocol comprised axial, sagittal, and coronal T2-weighted imaging and diffusion-weighted imaging (DWI) with a maximum b-value of at least 2000 s/mm², from which the ADC map was calculated.

2.6 PI-RADS Assessment

Each detected lesion was scored using PI-RADS v2.1 (score 1–5) by the radiologist performing the study, and findings were validated by one of two consultant radiologists at the two participating centres.

2.7 Histopathological Examination and Reference Standard

Transrectal or transperineal prostate biopsy was performed within two weeks of MRI as part of routine clinical care. Histopathological reporting included the ISUP grade group (1–5). Histopathological data (ISUP grade group) were obtained retrospectively from pathology reports issued by the Department of Anatomical Pathology at both participating hospitals. Gleason score and ISUP grade group were recorded in the source dataset as a single, unified histopathological classification (ISUP grade group); results are therefore reported using ISUP grade group only, rather than as two separately tabulated grading systems.

2.8 Study Variables and Outcome Definitions

The independent variables were PI-RADS v2.1 score and ADC value. The dependent (outcome) variable was histopathological grade, classified according to the ISUP grade group (1–5), determined only after biopsy. Age and PSA were considered potential confounders. High-grade cancer was defined a priori as ISUP grade group ≥4.

2.9 Statistical Analysis

Data were analysed using IBM SPSS Statistics version 26.0 (IBM Corp., Armonk, NY, USA) and Python 3 (SciPy, scikit-learn, statsmodels). Normality was assessed with the Mann–Whitney test. Numerical variables are presented as mean ± standard deviation (SD) or median with interquartile range (IQR), as appropriate; categorical variables are presented as frequencies and percentages. Diagnostic accuracy (sensitivity, specificity, positive and negative predictive values) of PI-RADS score for predicting high-grade cancer (ISUP ≥4) was calculated at cut-offs of ≥3, ≥4, and 5, using the histopathological ISUP grade group as the reference standard. Associations between PI-RADS score and ISUP grade group, and between ADC and ISUP grade group, were assessed using the chi-square test and Spearman's rank correlation coefficient (ρ). Receiver operating characteristic (ROC) curve analysis was used to evaluate the discriminative performance of ADC for high-grade cancer (ISUP ≥4), with the optimal cut-off determined by the Youden index; the 95% confidence interval (CI) for the area under the curve (AUC) was estimated using bootstrap resampling (2000 replicates). Multivariable logistic regression, including PI-RADS score, ADC, and PSA, was performed to identify independent predictors of high-grade cancer; odds ratios (OR) with 95% CIs are reported. Because the strong association between PI-RADS category and histopathological grade produced quasi-complete separation in this model (a subset of observations was perfectly classified by PI-RADS alone), the resulting estimates for PI-RADS have wide confidence intervals and are interpreted with caution; results are reported alongside the univariable associations for transparency. A two-tailed $p < 0.05$ was considered statistically significant.

2.10 Ethical Approval and Consent

This study was approved by the Health Research Ethics Committee, Faculty of Medicine, Universitas Hasanuddin (Komite Etik Penelitian Universitas Hasanuddin), reference number 5/UN4.6.4.5.31/PP36/2025, protocol UH25121159; final approval documentation is dated 6 January 2026. As this was a retrospective review of medical records collected between May and November 2025, formal ethics approval documentation was completed following the period of data collection, consistent with the retrospective design of the study. Patient data were de-identified prior to analysis, and confidentiality was maintained throughout.

3. RESULTS AND DISCUSSION

3.1 Baseline Characteristics

Fifty men with histopathologically confirmed prostate adenocarcinoma, identified through retrospective review of medical records, were included. Mean age was 71.2 years (range 46–97 years). Mean PSA was 242.1 ng/mL (range 10.2–7271.8 ng/mL); 32% of patients had PSA <20 ng/mL, 64% had PSA 20–1000 ng/mL, and 4% had PSA >1000 ng/mL. Mean ADC was 0.85 × 10^{-3} mm^2/s (range 0.50–1.10 × 10^{-3} mm^2/s); 40% of patients had ADC in the low range (0.5–0.8 × 10^{-3} mm^2/s) and 60% in the higher range (0.9–1.2 × 10^{-3} mm^2/s) (Table 1) (Figure 1).

Table 1. Baseline characteristics of the study cohort (n = 50).

Variable	Value
Age, years, mean (range)	71.2 (46–97)
PSA, ng/mL, mean (range)	242.1 (10.2–7271.8)
PSA <20 ng/mL, n (%)	16 (32%)
PSA 20–1000 ng/mL, n (%)	32 (64%)
PSA >1000 ng/mL, n (%)	2 (4%)
ADC (×10^{-3} mm^2/s), mean (range)	0.85 (0.50–1.10)
ADC 0.5–0.8 × 10^{-3} mm^2/s, n (%)	20 (40%)
ADC 0.9–1.2 × 10^{-3} mm^2/s, n (%)	30 (60%)

PSA: prostate-specific antigen; ADC: apparent diffusion coefficient.

3.2 Distribution of PI-RADS Scores

The distribution of PI-RADS v2.1 categories is shown in Table 2. Overall, 72% of patients had PI-RADS ≥3, and 60% had a high-suspicion score (PI-RADS 4–5), reflecting a cohort weighted towards imaging findings highly suspicious for malignancy.

Table 2. Distribution of PI-RADS score (n = 50).

PI-RADS category	n	%
1	4	8%
2	10	20%
3	6	12%
4	18	36%
5	12	24%
Total	50	100%

3.3 Apparent Diffusion Coefficient Findings

Mean ADC across the cohort was 0.85 ± 0.19 × 10^{-3} mm^2/s; median ADC was 0.90 × 10^{-3} mm^2/s (IQR 0.70–1.00), with a range of 0.50–1.10 × 10^{-3} mm^2/s (Table 3), consistent with the predominance of high-grade disease in this population.

Table 3. Descriptive values of apparent diffusion coefficient (×10^{-3} mm^2/s).

Parameter	Value
Mean ± SD	0.85 ± 0.19
Median (IQR)	0.90 (0.70–1.00)
Range	0.50–1.10

3.4 Distribution of Histopathological Grade

According to ISUP grade group, 8% of patients were grade 1, 18% grade 2, 10% grade 3, 16% grade 4, and 48% grade 5; overall, 74% of patients had ISUP grade 3–5, of whom 64% of the total cohort had ISUP ≥4 (Table 4). Because Gleason score and ISUP grade group were recorded in the source dataset as a single, unified classification (see Section 2.7), only ISUP grade group is reported.

Table 4. Distribution of histopathological grade (ISUP grade group, n = 50).

ISUP grade group	n	%
1	4	8%
2	9	18%
3	5	10%
4	8	16%
5	24	48%

ISUP: International Society of Urological Pathology.

3.5 Relationship Between PI-RADS and ISUP Grade Group

A cross-tabulation of PI-RADS score against ISUP grade group for the full cohort (n = 50) showed a clear trend toward higher-grade disease with increasing PI-RADS score (Table 5, Figure 3); the association was statistically significant by chi-square test ($p < 0.001$), although several cells had expected counts <5, so this result should be interpreted alongside the Spearman correlation. Spearman correlation confirmed a strong, statistically significant positive relationship between PI-RADS score and ISUP grade group ($\varrho = 0.84$, $p < 0.001$).

Table 5. Correlation between PI-RADS score and ISUP grade group (N = 36).

PI-RADS score	ISUP 1	ISUP 2	ISUP 3	ISUP 4	ISUP 5	Total
1	3	1	0	0	0	4
2	1	7	2	0	0	10
3	0	1	2	1	1	5
4	0	0	1	6	11	18
5	0	0	0	1	12	13
Total	4	9	5	8	24	50

Chi-square $p < 0.001$; Spearman correlation $\varrho = 0.84$, $p < 0.001$. the PI-RADS 3 and PI-RADS 5 row totals (5 and 13) differ from Table 2 (6 and 12).

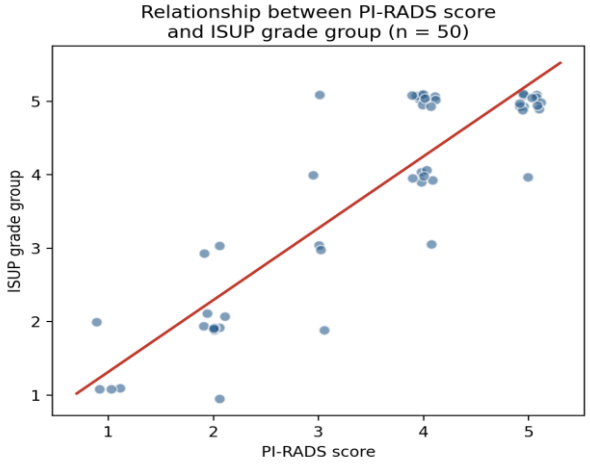


Figure 3. Scatter plot illustrating the relationship between PI-RADS score and ISUP grade group (n = 50).

3.6 Relationship Between ADC and ISUP Grade Group

Mean ADC did not show a consistent decreasing trend across ISUP grade groups (Table 6): 0.83 ± 0.22 × 10^{-3} mm^2/s in grade 1, 0.97 ± 0.12 in grade 2, 0.90 ± 0.23 in grade 3, 0.80 ± 0.19 in grade 4, and 0.82 ± 0.21 in grade 5. Spearman correlation between ADC and ISUP grade group was weak and not statistically significant ($\varrho = -0.18$, $p = 0.20$).

Table 6. Apparent diffusion coefficient (×10^{-3} mm^2/s) according to ISUP grade group.

ISUP grade group	ADC, mean ± SD	ADC, median (IQR)
1	0.83 ± 0.22	0.90 (0.80–0.93)
2	0.97 ± 0.12	1.00 (0.90–1.10)
3	0.90 ± 0.23	1.00 (0.90–1.00)
4	0.80 ± 0.19	0.85 (0.68–0.90)
5	0.82 ± 0.21	0.85 (0.60–1.00)

Spearman correlation $\varrho = -0.18$, $p = 0.20$ (not statistically significant).

3.7 Diagnostic Performance of PI-RADS for High-Grade Cancer

Because all patients in this cohort underwent biopsy irrespective of PI-RADS category (see Section 2.3), diagnostic performance was assessed against high-grade cancer (ISUP ≥4) rather than against cancer presence or absence. At a cut-off of PI-RADS ≥3, sensitivity for high-grade cancer was 100% and specificity 78% (positive predictive value [PPV] 89%, negative predictive value [NPV] 100%). At PI-RADS ≥4, sensitivity was 94% and specificity 94% (PPV 97%, NPV 89%). At PI-RADS 5 alone, sensitivity fell to 41% with a specificity of 100% (PPV 100%, NPV 49%) (Table 7). Notably, no patient with PI-RADS 1–2 in this cohort had high-grade (ISUP ≥4) disease, which supports the negative predictive value of low PI-RADS categories even though, in this retrospective cohort, biopsy was performed in these patients regardless of PI-RADS category because of elevated PSA.

Table 7. Diagnostic performance of PI-RADS score for predicting high-grade prostate cancer (ISUP ≥4).

PI-RADS cut-off	Sensitivity	Specificity	PPV	NPV
≥3	100%	78%	89%	100%
≥4	94%	94%	97%	89%
= 5	41%	100%	100%	49%

PPV: positive predictive value; NPV: negative predictive value.

3.8 ROC Analysis of ADC

ROC curve analysis of ADC for predicting high-grade cancer (ISUP ≥4) demonstrated only modest discrimination, with an area under the curve (AUC) of 0.65 (95% CI 0.49–0.80). The optimal ADC cut-off by the Youden index was ≤0.80 × 10^{-3} mm^2/s, yielding a sensitivity of 50% and a specificity of 78% (Youden index 0.28) (Table 8, Figure 2).

Table 8. Diagnostic performance of apparent diffusion coefficient for predicting high-grade prostate cancer (ISUP ≥4).

Parameter	Value
AUC (95% CI)	0.65 (0.49–0.80)
Optimal ADC cut-off	≤0.80 × 10^{-3} mm^2/s
Sensitivity	50%
Specificity	78%
Youden index	0.28

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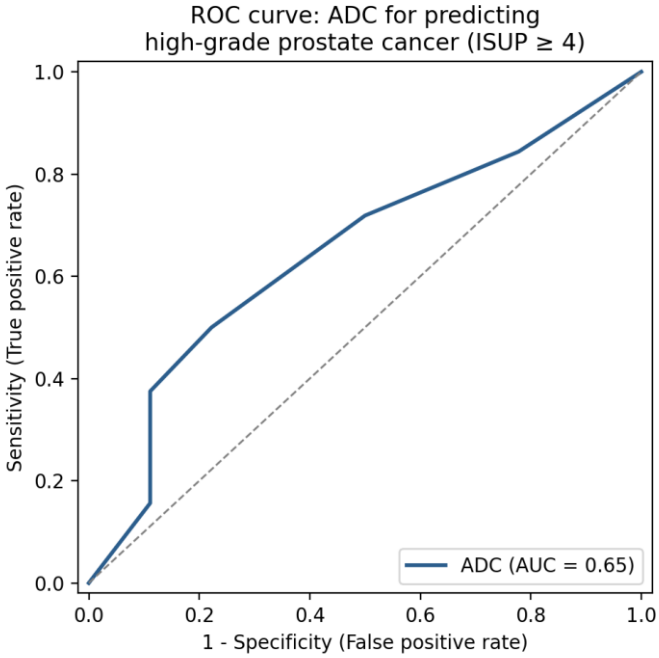


Figure 2. Receiver operating characteristic curve of the apparent diffusion coefficient for predicting high-grade prostate cancer (ISUP ≥4).

3.9 Multivariable Logistic Regression Analysis

On multivariable logistic regression including PI-RADS score, ADC, and PSA, PI-RADS score showed a very strong association with high-grade cancer; however, because a subset of patients with high PI-RADS scores were perfectly classified as high-grade, the model exhibited quasi-complete separation, and the resulting odds ratio for PI-RADS (OR 69.4, 95% CI 3.2–1481.7, p = 0.007) has an unstable, very wide confidence interval and should be interpreted with caution rather than as a precise effect estimate. ADC (OR 1.68 per 0.1 × 10^{-3} mm²/s decrease, 95% CI 0.86–3.31, p = 0.087) and PSA (OR 1.00, 95% CI 1.00–1.00, p = 0.97) were not independent predictors of high-grade cancer in this model (Table 9).

Table 9. Multivariable logistic regression analysis of predictors of high-grade prostate cancer (ISUP ≥4).

Predictor	OR	95% CI	p-value
PI-RADS score (per point)*	69.4	3.2–1481.7	0.007
ADC (per 0.1 × 10^{-3} mm²/s decrease)	1.68	0.86–3.31	0.087
PSA (ng/mL)	1.00	1.00–1.00	0.97

*OR: odds ratio; CI: confidence interval. *Estimate affected by quasi-complete separation; interpret with caution (see Section 2.9 and the limitations in Section 3.10).*

3.10 Discussion

In this retrospective cohort of 50 men with biopsy-confirmed prostate adenocarcinoma, PI-RADS v2.1 score rather than ADC was the dominant correlate and discriminator of histopathological grade. PI-RADS score correlated strongly with ISUP grade group (ρ = 0.84, p < 0.001) and, at a cut-off of ≥4, showed excellent sensitivity and specificity (94% each) for high-grade disease. By contrast, ADC showed only a weak, statistically non-significant inverse correlation with grade (ρ = −0.18, p = 0.20) and modest discrimination on ROC analysis (AUC 0.65, 95% CI 0.49–0.80). These findings differ from our original hypothesis and from some previously published series, and are discussed below.

The strong positive correlation observed between PI-RADS score and ISUP grade group is consistent with the established rationale of PI-RADS as a risk-stratification tool rather than a purely binary detection test, and is corroborated by the high sensitivity and specificity of PI-RADS ≥4 for high-grade disease in this cohort. Contemporary meta-analyses of PI-RADS v2.1 report cancer detection rates that rise steeply across categories, broadly consistent with the grade gradient identified in our

cohort [5,6]. Direct comparison of diagnostic accuracy with these pooled analyses is limited, however, because our cohort, unlike most published series, consisted exclusively of biopsy-positive patients drawn from a single pair of referral centres [7,8].

The absence of a significant inverse relationship between ADC and histopathological grade in this cohort contrasts with several previously published series reporting strong inverse correlations and AUC values in the 0.91–0.94 range for ADC-based discrimination of grade [9,10]. Several features of the present retrospective dataset may explain this discrepancy. First, ADC values were derived from single-reader measurements without formal inter-reader reliability testing, and MRI was performed on two scanners of different field strength (3-T and 1.5-T) without harmonisation of acquisition or region-of-interest (ROI) placement protocols, both recognised sources of ADC measurement variability [11,20]. Second, the retrospective design did not allow verification of measurement conditions, and some ADC values may reflect heterogeneous ROI sampling across readers and time. Third, the wide and right-skewed PSA distribution in this cohort (range 10.2–7271.8 ng/mL), reflecting a population presenting with markedly advanced disease, may have introduced non-linearities or floor/ceiling effects in the ADC–grade relationship that were not present in the more homogeneous cohorts underlying previously reported correlations. Finally, the modest sample size, and in particular the small number of patients with intermediate ISUP grades, limits precision for correlation and ROC analyses.

The principal clinically relevant finding of this study is therefore that PI-RADS score alone provided strong, consistent discrimination of high-grade disease in this real-world retrospective cohort, while the incremental value of ADC beyond PI-RADS could not be demonstrated. This is compatible with the broader literature on PI-RADS variability, which has documented substantial inter-reader variation in category assignment and correspondingly variable incremental value of quantitative ADC across studies and centres [12,13]. Rather than assuming that ADC will add independent value in every setting, our findings suggest that the incremental benefit of ADC over PI-RADS should be locally validated before quantitative ADC thresholds are adopted into routine reporting.

From a clinical standpoint, these findings support continued reliance on the PI-RADS v2.1 category, particularly a cut-off of ≥4, for pre-biopsy risk stratification of high-grade disease in this population, while quantitative ADC thresholds should be considered adjunctive and hypothesis-generating rather than confirmatory until validated locally with standardised, multi-reader protocols. In this cohort, patients with PI-RADS 1–2 nonetheless underwent biopsy because of elevated PSA and clinical judgement, consistent with recommended practice when clinical suspicion remains high despite low-risk imaging; reassuringly, no patient with PI-RADS 1–2 in this cohort had high-grade disease, supporting the negative predictive value of low PI-RADS categories in this setting even where biopsy was not withheld on the basis of imaging alone [14–16].

This study has several strengths, including the use of a standardised PI-RADS v2.1 protocol across two collaborating centres and histopathological confirmation in all participants, which minimises verification bias for the correlative analyses. Nonetheless, several limitations warrant consideration. First, the retrospective design is subject to selection and information bias inherent to medical-record review, and did not allow prospective standardisation of image acquisition, ADC measurement, or follow-up. Second, the sample size, while adequate for the pre-specified correlation analysis, is modest for subgroup and multivariable estimates; the strong association between PI-RADS category and grade produced quasi-complete separation in the multivariable model, so the reported PI-RADS odds ratio should be interpreted as indicative rather than precise. Third, ADC values were derived from single-reader measurements without formal inter-reader reliability testing, and MRI was performed on two scanners of different field strength, which could introduce measurement variability that may partly explain the weaker-than-expected ADC–grade association. Fourth, dynamic contrast-enhanced imaging was not performed, precluding direct within-study comparison between biparametric and multiparametric protocols. Finally, Gleason score and ISUP grade group were recorded in the source dataset as a single classification rather than independently, so the two systems could not be cross-validated against each other in this cohort [17,18].

Future prospective, multicentre studies with standardised ADC acquisition, blinded multi-reader assessment, and larger, more heterogeneous PSA distributions are needed to determine whether ADC provides consistent incremental value over PI-RADS v2.1 for grade prediction, and whether incorporating ADC into structured reporting alongside PI-RADS meaningfully changes biopsy decisions or reduces unnecessary procedures in Indonesian and other Southeast Asian populations [19,20].

4. CONCLUSION

In this retrospective Indonesian cohort with a high burden of advanced prostate cancer at diagnosis, PI-RADS v2.1 score rather than ADC was the dominant correlate and discriminator of histopathological grade, with excellent sensitivity and specificity at a cut-off of ≥4. ADC showed only a weak, non-significant association with grade and did not provide demonstrable incremental predictive value beyond PI-RADS in this sample. These findings support continued reliance on the PI-RADS v2.1 category for pre-biopsy risk stratification in this setting, while highlighting the need for prospective, standardised, multicentre validation before quantitative ADC thresholds are adopted into routine local practice.

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AUTHOR CONTRIBUTIONS

Natasya Uzu Barsela: Conceptualization, Data Collection, Data Analysis, Writing—Original Draft.

Bachtiar Murtala: Methodology, Critical Revision.

Nur Amelia Bachtiar: Supervision, Critical Revision.

Muhammad Asykar A. Palinrungi: Supervision, Critical Revision.

Muhammad Arfan: Supervision, Critical Revision.

CONFLICT OF INTEREST

The authors declare that they have no conflicts of interest relevant to this work.

ETHICS STATEMENT

This study was approved by the Health Research Ethics Committee, Faculty of Medicine, Universitas Hasanuddin, reference number 5/UN4.6.4.5.31/PP36/2025 (protocol UH25121159; final approval documentation dated 6 January 2026). As a retrospective review of de-identified medical records, Consent for publication: not applicable.

DATA AVAILABILITY STATEMENT

The datasets analysed during the current study are available from the corresponding author on reasonable request.

FUNDING

No funding was received for this study.

DECLARATION OF GENERATIVE AI AND AI-ASSISTED TECHNOLOGIES IN THE WRITING PROCESS

During the preparation of this manuscript, the authors used an AI-based language tool to assist with drafting and formatting the text according to journal style. All scientific content, data, and conclusions were reviewed and verified by the authors, who take full responsibility for the content of this publication.

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