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RESEARCH ARTICLE

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The influence of prostate volume on clinical parameters in prostate cancer screening

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Abstract

Purpose: The purpose of the study was to evaluate the diagnostic significance of two new and a few clinical markers for prostate cancer (PCa) at various prostate volumes (PV).

Methods: The study subjects were divided into two groups. Among them, there were 70 cases in the PV ≤30 ml group (benign prostatic hyperplasia [BPH]: 32 cases, PCa: 38 cases) and 372 cases in the PV > 30 ml group (BPH: 277 cases, PCa: 95 cases). SPSS 26.0 and GraphPad Prism 8.0 were used to construct their receiver operating characteristic (ROC) curves for diagnosing PCa and calculating their area under the ROC curve (AUC).

Results: In the PV ≤30 ml group, the diagnostic parameters based on prostate-specific antigen (PSA) had a decreased diagnostic significance for PCa. In the PV > 30 ml group, PSAD (AUC = 0.709), AVR (AVR = Age/PV, AUC = 0.742), and A-PSAD (A-PSAD = Age×PSA/PV, AUC = 0.736) exhibited moderate diagnostic significance for PCa, which was better than PSA-AV (AUC = 0.672), free PSA (FPSA, AUC = 0.509), total PSA (TPSA, AUC = 0.563), (F/T) PSA (AUC = 0.540), and (F/T)/PSAD (AUC = 0.663). Compared with AVR, A-PSAD exhibited similar diagnostic significance for PCa, but higher than PSA density (PSAD).

Conclusions: Choosing appropriate indicators for different PVs could contribute to the early screening and diagnosis of PCa. The difference in the diagnostic value of two new indicators (A-PSAD and AVR), and PSAD for PCa may require further validation by increasing the sample size.

KEYWORDS
clinical indicator, prostate biopsy, prostate cancer, prostate volume, screening

Jiahao Shan, Xinyu Geng and Youlu Lu contributed the same value in this study.

1 | INTRODUCTION

Prostate cancer (PCa) is one of the most common cancers affecting men, especially in the western world.[1] The morbidity and fatality rates associated with prostate cancer are much lower in China than in western nations.[2] However, in China, due to the recent popularization of screening for prostate-specific antigen (PSA), the incidence of PCa has seen a noticeable upward trend.

Currently, PSA screening is the primary approach for early detection and making a definitive diagnosis of PCa by performing a prostate biopsy. PSA is the first biomarker approved by the U.S. Food and Drug Administration (FDA) for the early screening of PCa and because of its feasibility, ease, and rapid detection, this method has been extensively applied in many countries for the early detection of PCa. In China, with the development of screening for PCa, a few studies have revealed that the median PSA level of Chinese patients who have recently been diagnosed with PCa is much higher compared with the patients of western countries.[3] Furthermore, in China, the application of PSA>4 ng/ml as the standard method for the early screening of PCa remains controversial.[4,5] Therefore, improving the positive rate of prostate biopsy by combining other relevant parameters before puncture is the current challenge for urologists.

Age and prostatic volume (PV) were found to be significant in the development of PCa.[6,7] In the previous study, we had proposed two new indicators; AVR[8] (AVR: ratio of patients' age to prostate volume) and A-PSAD[9] (A-PSAD: age multiplied by PSA and divided by prostate volume), for the early screening of PCa by combining the age, PV, and PSA of patients. Given the influence of age on PSA and PCa, we also researched the influence of PSA-based clinical indicators on PCa screening in different age groups[10] and obtained a good clinical outcome. Given the influence of PV in PCa screening, this study aimed to use a PV of 30 ml as the limit to examine the screening efficacy of a variety of clinical markers for PCa at distinct PVs.

2 | MATERIALS AND METHODS

2.1 | Research object

Patients who came to the General Hospital of Ningxia Medical University from December 2015 to April 2022 and met with at least one of the indications for puncture recommended by the Chinese Urological Association (CUA) were included in the study. The CUA guidelines included the following points: (1) Patients having prostatic nodules as revealed on digital rectal examination; (2) patients with abnormal prostate images as revealed on B-scan ultrasonography, magnetic resonance imaging (MRI), or computed tomography (CT); (3) patients with PSA > 10 ng/ml; (4) patients with a PSA value between 4 and 10ng/ml, an abnormal (F/T) PSA value, or an aberrant PSAD value. The medical data of individuals who underwent a B-ultrasound-guided transrectal biopsy for the first time was collected. The following criteria were used for exclusion: (1) Patients with the infection or obstruction of the urinary tract; (2) patients who underwent cystoscopy, prostatic massage, digital rectal examination, and other operations 2 weeks before PSA testing; (3) patients who had undergone a prostatic biopsy in the past.

2.2 | Prostate biopsy

The operation was carried out by an experienced urologist, but the prostate biopsy was not performed by the same urologist. During the surgery, the patient was posited in the left lateral position, the surgical area was draped and disinfected as usual, and lidocaine glue was used as a topical anesthetic. Then, the probe was inserted from the anus along with the puncture cannula. Subsequently, the prostate volume was measured and after that, the standard prostate puncture (10 needle punctures) was performed using the puncture gun inserted from the cannula.

2.3 | Research variables

Study variables included were as follows: Age, PSAD, (F/T) PSA, FPSA, PSA-AV,[11] TPSA, AVR, (F/T)/PSAD,[12] A-PSAD, and prostate biopsy pathology results. The measurement of FPSA and TPSA was done with the help of an electrochemiluminescence assay kit (Roche Diagnostic GmbH, Germany). Prostate volume (PV) was determined with the aid of a transrectal color Doppler ultrasound (Pro Focus 2202 Ultra View, BK Medical, Herlev, Denmark). PV = 0.52 × (anteroposterior diameter) × (left and right diameter) × (upper and lower diameter).

2.4 | Statistical analyses

The SPSS 26.0 statistical software was used to execute the analyses of statistical data. The measured data without a normal distribution were subjected to a comparison utilizing the Mann–Whitney U test and the median (quartile) was used to express the data [M (P25 ± P75)]. Count data were compared using the χ^2 test. The GraphPad Prism 8.0 software was utilized to generate ROC of AVR, (F/T)/PSAD, PSA-AV, PSAD, (F/T) PSA, FPSA, TPSA, and A-PSAD. Furthermore, after computing the area under the ROC curve (AUC), the Medcalc program was utilized to analyze the variations in the area under the ROC curve generated by each index. $p < 0.05$ was set as the criterion for a significant difference.

3 | RESULT

The fundamental data of the diagnostic characteristics of the cases of PCa and BPH are presented in Table 1 wherein each non-normally distributed diagnostic parameter is expressed as the median

TABLE 1 Basic data of each diagnostic parameter

		TPSA (ng/ml) Median (IQR)	FPSA (ng/ml) Median (IQR)	(F/T) PSA Median (IQR)	PSAD (ng/ml/ml) Median (IQR)	PSA-AV Median (IQR)	AVR Median (IQR)	(F/T)/PSAD Median (IQR)	A-PSAD Median (IQR)
PV ≤ 30 ml (BPH:32, PCa:38)	BPH	9.07 (7.20–12.90)	0.86 (0.55–1.11)	0.10 (0.06–0.16)	0.42 (0.31–0.59)	153.19 (102.11–217.14)	2.58 (2.29–2.90)	0.22 (0.14–0.36)	29.09 (17.97–36.94)
	PCa	12.58 (8.70–16.22)	1.19 (0.76–2.12)	0.12 (0.08–0.16)	0.57 (0.39–0.84)	118.40 (91.85–173.90)	2.90 (2.49–3.80)	0.19 (0.10–0.35)	36.52 (24.68–55.63)
	p	0.024	0.007	0.202	0.028	0.134	0.024	0.054	0.011
PV > 30 ml (BPH:277, PCa:95)	BPH	10.06 (7.59–14.59)	1.67 (1.13–2.50)	0.16 (0.12–0.21)	0.15 (0.10–0.22)	435.42 (288.92–667.08	0.96 (0.67–1.38)	1.01 (0.57–1.89)	10.12 (6.84–14.30)
	PCa	11.91 (8.61–16.44)	1.61 (1.12–2.48)	0.15 (0.11–0.20)	0.25 (0.17–0.35)	287.68 (212.53–419.77)	1.57 (1.11–1.86)	0.61 (0.35–1.04)	18.02 (11.34–25.06)
	p	0.066	0.783	0.242	*p* < 0.001	*p* < 0.001	*p* < 0.001	*p* < 0.001	*p* < 0.001

Abbreviations: (F/T) PSA, FPSA/TPSA; (F/T)/PSAD, (F/T) PSA/PSAD; A-PSAD, age multiplied by PSA and divided by PV; AVR, ratio of patients' age to prostate volume; BPH, benign prostatic hyperplasia; FPSA, free prostate- specific antigen; PCa, prostate cancer; PSA-AV, age multiplied by previous gland volume divided by total prostate- specific antigen; PSAD, prostate -specific antigen density; PV, prostate volume; TPSA, total prostate- specific antigen.

(quartile). The differences between these parameters were evaluated using the Z test. As depicted in Table 1, in the PV ≤30 ml group, considerable variations were observed in TPSA, FPSA, PSAD, AVR, and A-PSAD between the BPH and PCa cases ($p < 0.05$). However, no remarkable variations were observed in (F/T)/PSAD, PSA-AV, and (F/T) PSA between the two case groups. On the contrary, significant variations were observed between the BPH and PCa cases in the PV > 30 ml group in terms of A-PSAD, (F/T)/PSAD, AVR, PSA-AV, and PSAD ($p < 0.05$), while the differences in TPSA, FPSA, and (F/T) PSA were not statistically significant.

The ROC curves for diagnosing PCa were drafted for (F/T)/PSAD, AVR, PSA-AV, PSAD, (F/T) PSA, TPSA, FPSA, and A-PSAD in the PV ≤30 ml and PV > 30 ml groups (Figures 1 and 2) and their AUC, standard error (SE) and 95% confidence interval (CI) (Table 2) were computed. As presented in Table 2, the AUC values of FPSA, (F/T) PSA, TPSA, PSAD, AVR, PSA-AV, (F/T)/PSAD, and A-PSAD for diagnosing PCa were 0.657, 0.689, 0.653, 0.589, 0.653, 0.604, 0.657, 0.542, and 0.678, respectively, thus implying that when PV≤30 ml, each diagnostic parameter had a lower diagnostic value for PCa. Correspondingly, the AUC values in the PV ≤30 ml group and were 0.563, 0.509, 0.540, 0.709, 0.672, 0.742, 0.663, and 0.736, respectively, in the PV > 30 ml group, PSAD, AVR, and A-PSAD have moderate diagnostic values for PCa.

To further evaluate the significance of each diagnostic parameter for PCa, the AUC of each diagnostic parameter for PCa diagnosis was compared (Tables 3 and 4). As presented in Table 3, when PV ≤30 ml, a noticeable difference was seen in the AUC of TPSA for diagnosing PCa as compared to that of (F/T)/PSAD. Additionally, a noticeable difference was seen in the AUC of PSAD for diagnosing PCa as compared to that of (F/T)/PSAD. Moreover, (F/T)/PSAD and PSA-AV had statistically significant differences in the AUC of PCa diagnosis as compared to A-PSAD. A significant difference in the AUC of PCa diagnosis was not observed in the pair-wise comparison of other diagnostic parameters.

As presented in Table 4, when PV > 30 ml, the AUC of PSAD for diagnosing PCa varied significantly from that of A-PSAD, PSA-AV, and (F/T)/PSAD ($p < 0.05$). The AUC of PSA-AV for diagnosing PCa varied significantly from that of AVR and A-PSAD ($p < 0.05$). However, no remarkable variation was observed between PSA-AV and (F/T)/PSAD. The AUC of AVR for diagnosing PCa varied substantially from that of (F/T)/PSAD ($p < 0.05$), but no remarkable variation was found between AVR and A-PSAD. Furthermore, the AUC of (F/T)/PSAD for diagnosing PCa varied considerably from that of A-PSAD ($p < 0.05$). This implied that when PV > 30 ml, A-PSAD, AVR, and A-PSAD might have higher diagnostic values for PCa than other indicators. Additionally, the variations in the sensitivity and specificity among A-PSAD, AVR, and PSAD were compared. In Table 5, it is seen that the sensitivity of A-PSAD for diagnosing of PCa was higher than that of PSAD (70.53% vs. 54.74%), and the difference was statistically significant ($p < 0.001$). Moreover, the specificity of A-PSAD for diagnosing PCa was lower than that of PSAD (71.84% vs. 80.87%), and the difference was statistically significant ($p < 0.001$). Though the

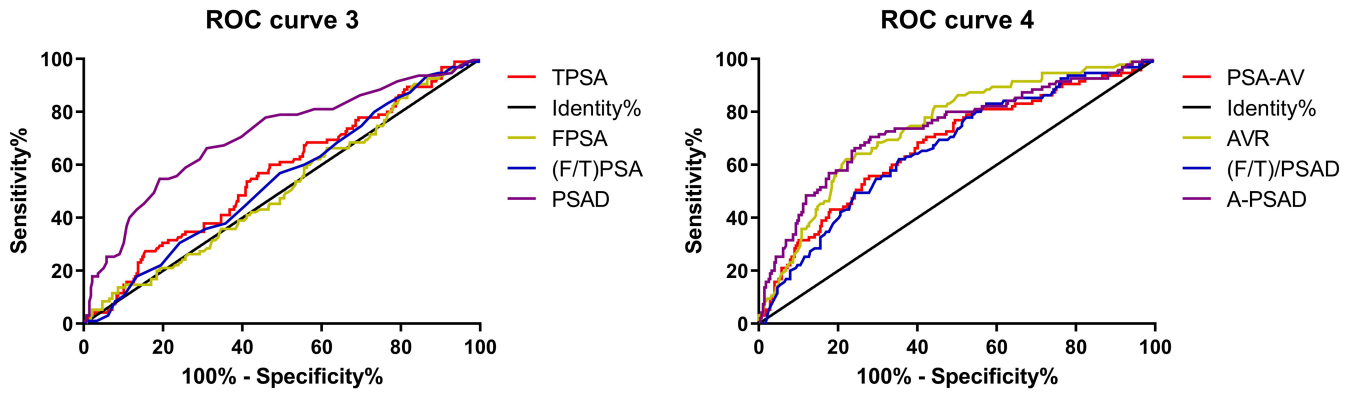

FIGURE 1 ROC curve 1, 2:In the PV ≤30 ml group, the ROC curve of (F/T)/PSAD, AVR, PSA-AV, PSAD, (F/T) PSA, FPSA, TPSA, and A-PSAD for diagnosing PCa.

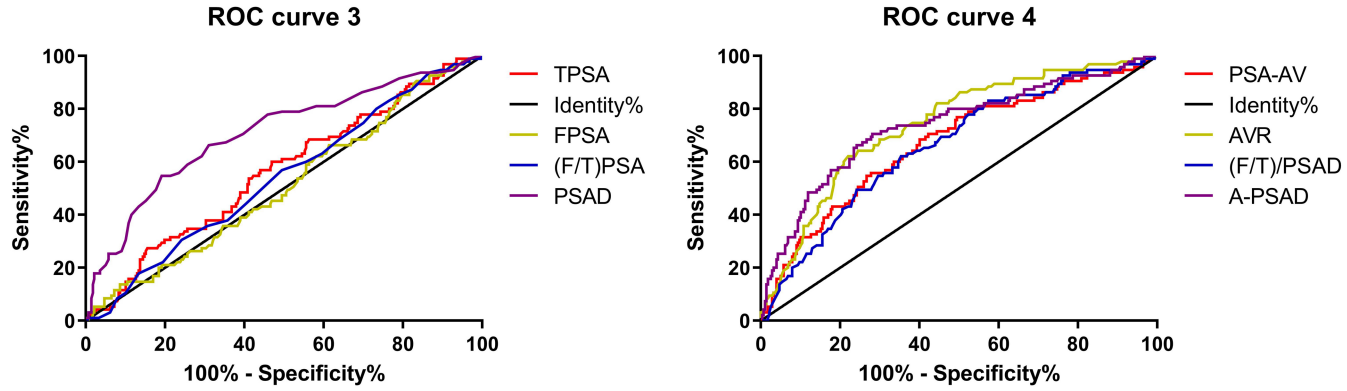

FIGURE 2 ROC curve 3, 4:In the PV >30 ml group ROC curve of (F/T)/PSAD, AVR, PSA-AV, PSAD, (F/T) PSA, FPSA, TPSA, and A-PSAD for diagnosing PCa.

AVR was sensitive for diagnosing PCa as compared to PSAD, no significant statistical difference was noted in the sensitivity and specificity ($P_{\text{sensitivity}} = 0.230$, $P_{\text{specificity}} = 0.777$).

4 | DISCUSSION

Prostate-specific antigen is widely used as a biomarker for the early screening of PCa; nonetheless, it is nonspecific to PCa and is susceptible to influence from a variety of variables.[13,14] Therefore, PSA alone might not be able to distinguish between benign and malignant prostatic diseases. Previous studies have revealed that the increase in PV led to an increase in the serum PSA level.[15] Hence, for every 1 g increase of prostate tissue, the serum PSA level increased substantially in patients with PCa compared to patients with BPH.[16] This further increased the difficulty of distinguishing between BPH and PCa, especially, in the PSA gray area. To further exclude the effect of PV on serum PSA levels, a few scholars introduced PSAD for the identification of BPH and PCa.[17] Additionally, several research reports have postulated indicators, including PSA-AV and (F/T)/PSAD, for the early screening of PCa. However, a few studies have demonstrated that even if the relevant parameters are introduced in the PSA grey area, the positive rate of puncture is still low.[18,19] Furthermore, a few scholars do not recommend the usage of PSA alone in the early screening of PCa.[20,21] Therefore, the identification and selection of suitable indicators for early PCa screening has become a sought-after direction for further research.

The latest European Association of Urology (EAU) guidelines have updated the PSA threshold for PCa screening.[22] However, because PSA is affected by several factors, like race and region; the threshold for PSA is inconsistent at home and abroad. Presently, in China, large-scale research data on the screening for PCa is still lacking. The results of a meta-analysis involving 6425 cases of screening for PCa in the Chinese population revealed that on the usage of 4.0 ng/ml of PSA, a satisfactory clinical outcome would be obtained.[23] The latest Chinese guidelines for the screening and early detection of PCa (2022, Beijing) has recommended the usage of 4.0 ng/ml of PSA as the screening positive cutoff value.[24] The standard approach most widely recognized for diagnosing PCa is by performing a prostate biopsy. Studies have revealed that the detection rate of PCa for prostatic biopsy is inversely proportional to PV.[25,26] Matalga et al.[27] speculated that increasing the number of needles for prostate biopsy could improve the positive rate of PCa biopsy. However, on increasing the number of puncture points, the incidence of complications, such as bleeding, infection, and urinary

TABLE 2 AUC, SE, and 95% CI of each diagnostic parameter

		TPSA	FPSA	(F/T) PSA	PSAD	PSA-AV	AVR	(F/T)/PSAD	A-PSAD
PV ≤ 30 ml	AUC	0.657	0.689	0.589	0.653	0.604	0.657	0.542	0.678
	SE	0.066	0.064	0.069	0.066	0.068	0.066	0.070	0.064
	95% CI	0.534–0.766	0.567–0.794	0.465–0.705	0.530–0.763	0.480–0.719	0.534–0.767	0.419–0.662	0.555–0.784
PV > 30 ml	AUC	0.563	0.509	0.540	0.709	0.672	0.742	0.663	0.736
	SE	0.034	0.034	0.033	0.033	0.033	0.029	0.032	0.032
	95% CI	0.511–0.614	0.457–0.561	0.488–0.592	0.660–0.754	0.622–0.720	0.694–0.785	0.612–0.711	0.689–0.781

Abbreviations: (F/T) PSA, FPSA/TPSA; (F/T)/PSAD, (F/T) PSA/PSAD; A-PSAD, age multiplied by PSA and divided by prostate volume; AUC, area under the curve; AVR, ratio of patients' age to prostate volume; CI, confidence interval; FPSA, free prostate -specific antigen; PSA-AV, age multiplied by previous gland volume divided by total prostate- specific antigen; PSAD, prostate- specific antigen density; SE, standard error of mean; TPSA, total prostate -specific antigen.

retention, also increased significantly.[28] Currently, various researchers have hypothesized that different puncture plans should be made according to PV. However, determining the optimal PV limit remains controversial.[27,29] Chinese scholars usually refer to PV ≤30 ml as small PV.[30,31] Therefore, given the impact of PV on serum PSA level and prostatic biopsy detection rate, the diagnostic values of (F/T)/PSAD, AVR, PSAD, PSA-AV, (F/T) PSA, FPSA, TPSA, and A-PSAD for PCa at different PV values were examined by using a PV of 30 ml as the limit.

Tables 2 and 3 demonstrate that when PV ≤30 ml, the diagnostic parameters based on PSA exhibited an impaired diagnostic value for PCa. However, TPSA (AUC = 0.657), PSAD (AUC = 0.653), and A-PSAD (AUC = 0.678) for PCa were higher than (F/T)/PSAD (AUC = 0.542). Moreover, the A-PSAD test had a greater diagnostic value for PCa compared with the PSA-AV (AUC = 0.604). However, due to the small sample size of this study, the results obtained might have some deviation from the actual results. Therefore, further verification needs to be done by using a bigger sample size.

When PV > 30 ml, PSAD (AUC = 0.709), AVR (AUC = 0.742), and A-PSAD (AUC = 0.736) revealed moderate diagnostic values for PCa, which were better compared with that of PSA-AV (AUC = 0.672), (F/T) PSA (AUC = 0.540), FPSA (AUC = 0.509), TPSA (AUC = 0.563), and (F/T)/PSAD (AUC = 0.663). Though the A-PSAD diagnostic value (AUC = 0.736) for PCa was lower compared with that of AVR (AUC = 0.742), no significant statistical difference was observed between the two ($p = 0.831$). This implied that A-PSAD and AVR had comparable diagnostic significance for PCa. The A-PSAD diagnostic value (AUC = 0.736) was higher compared with that of PSAD (AUC = 0.709), with a statistically significant difference ($p < 0.001$). This implied that A-PSAD had a greater diagnostic significance for PCa compared with PSAD. Concurrently, the sensitivity and specificity of the two were compared. From Table 5, it can be observed that the sensitivity of A-PSAD for the screening and diagnosis of PCa is higher than PSAD, but the specificity is lower than PSAD. For the early screening of PCa, high-sensitivity indicators might be more conducive to improving the positive screening rate. Hence, A-PSAD might be better suitable for early screening of PCa. The diagnostic value of AVR (AUC = 0.742) for PCa was greater compared with that of PSAD (AUC = 0.709), but their difference was statistically insignificant ($p = 0.176$), This implied that the two had comparable diagnostic values for PCa. Therefore, when PV > 30 ml, A-PSAD, AVR, and PSAD should be preferentially selected for the screening of PCa to further improve the detection rate of PCa. A study of 2355 patients revealed that the PSA-AV score also had some diagnostic value in the early screening of PCa in the Chinese population,[32] In this study, the PSA-AV score had a lower diagnostic value in both the PV ≤30 ml and PV > 30 ml groups. This difference could be associated with the small sample size of this study. A-PSAD[9] and AVR[8] are two new indicators that have been proposed by us. Their diagnostic value for PCa in the range of PSA 4-20 ng/ml was already confirmed in our previous study conducted by us. In this study, it has a moderate diagnostic value for

TABLE 3 *p*-values for AUC comparisons between diagnostic parameters (PV ≤ 30 ml)

	TPSA	FPSA	(F/T) PSA	PSAD	PSA-AV	AVR	(F/T)/PSAD	A-PSAD
TPSA	*N*	*N*	*N*	*N*	*N*	*N*	*N*	*N*
FPSA	0.658	*N*	*N*	*N*	*N*	*N*	*N*	*N*
(F/T) PSA	0.533	0.081	*N*	*N*	*N*	*N*	*N*	*N*
PSAD	0.921	0.646	0.558	*N*	*N*	*N*	*N*	*N*
PSA-AV	0.266	0.315	0.891	0.009	*N*	*N*	*N*	*N*
AVR	0.997	0.729	0.479	0.948	0.495	*N*	*N*	*N*
(F/T)/PSAD	0.043	0.173	0.727	0.023	0.192	0.172	*N*	*N*
A-PSAD	0.630	0.884	0.407	0.185	0.036	0.749	0.010	*N*

Abbreviations: (F/T) PSA, FPSA/TPSA; (F/T)/PSAD, (F/T) PSA/PSAD; A-PSAD, age multiplied by PSA and divided by prostate volume; AVR, ratio of patients'' age to prostate volume; FPSA, free prostate -specific antigen; PSA-AV, age multiplied by previous gland volume divided by total prostate-specific antigen; PSAD, prostate- specific antigen density; TPSA, total prostate -specific antigen.

TABLE 4 *p*-values for AUC comparisons between diagnostic parameters (PV > 30 ml)

	TPSA	FPSA	(F/T) PSA	PSAD	PSA-AV	AVR	(F/T)/PSAD	A-PSAD
TPSA	*N*	*N*	*N*	*N*	*N*	*N*	*N*	*N*
FPSA	0.058	*N*	*N*	*N*	*N*	*N*	*N*	*N*
(F/T) PSA	0.615	0.618	*N*	*N*	*N*	*N*	*N*	*N*
PSAD	$p < 0.001$	$p < 0.001$	$p < 0.001$	*N*	*N*	*N*	*N*	*N*
PSA-AV	$p < 0.001$	$p < 0.001$	$p < 0.001$	$p < 0.001$	*N*	*N*	*N*	*N*
AVR	$p < 0.001$	$p < 0.001$	$p < 0.001$	0.176	0.007	*N*	*N*	*N*
(F/T)/PSAD	0.003	0.002	$p < 0.001$	0.010	0.578	0.002	*N*	*N*
A-PSAD	$p < 0.001$	$p < 0.001$	$p < 0.001$	$p < 0.001$	$p < 0.001$	0.831	$p < 0.001$	*N*

Abbreviations: (F/T) PSA, FPSA/TPSA; (F/T)/PSAD, (F/T)PSA/PSAD; A-PSAD, age multiplied by PSA and divided by prostate volume; AVR, ratio of patients'' age to prostate volume; FPSA, free prostate -specific antigen; PSA-AV, age multiplied by previous gland volume divided by total prostate-specific antigen; PSAD, prostate -specific antigen density; TPSA, total prostate- specific antigen.

TABLE 5 Variations in the sensitivity and specificity among A-PSAD, AVR, and PSAD

	Sensitivity	χ^2	*p*	Specificity	χ^2	*p*
A-PSAD	70.53%	13.07	<0.001	71.84%	16.41	<0.001
PSAD	54.74%			80.87%		
AVR	62.11%	1.44	0.230	77.98%	0.08	0.777
PSAD	54.74%			80.87%		

Abbreviations: A-PSAD, age multiplied by PSA and divided by prostate volume; AVR, ratio of patients'' age to prostate volume; PSAD, prostate- specific antigen density; TPSA, total prostate-specific antigen.

PCa when the PV > 30 ml, which may further support the role of the two in PCa screening.

Considering that the PSA levels in serum could be affected by a variety of factors, their influence should be fully evaluated in the early screening of PCa to reduce unnecessary prostate biopsies. In the previous studies conducted on evaluating the diagnostic significance of clinical markers for PCa, the primary focus was on the grey area of PSA (PSA in 4–10 ng/ml) or PSA ranging between 4 and 20 ng/ml. Moreover, extremely few studies have explored the diagnostic significance of clinical markers for PCa based on the PV limit. In this study, it was discovered that in different PVs, the diagnostic value of each clinical index for PCa screening was different. Although the study sample for this study was small, our study could provide an opportunity for PCa screening in the future by using novel ideas and selecting appropriate indicators according to the different PVs of patients.

This study has the following limitations: (1) It is retrospective research with a limited number of participants. Hence, there is a possibility of selection bias; (2) the data collection in this research is done primarily from single-centric studies. Hence, the results of this study need to be further evaluated by using multi-centric data with large sample sizes; (3) additionally, due to the small sample size, the cutoff value, sensitivity, and specificity of relevant parameters, and other related indicators need further analysis.

5 | CONCLUSION

When screening for early stages of PCa at varying volumes, various clinical markers ought to be considered. When PV ≤30 ml, PSA-based clinical markers have a low diagnostic value for PCa, and when PV > 30 ml, A-PSAD, AVR, and PSAD may be preferred for the early PCa screening. The AUC and sensitivity of A-PSAD for the diagnosis of PCa are higher than those of PSAD, but the specificity is lower than that of PSAD. As this study is a single-center study with a small sample size; therefore, the difference in the screening and diagnostic value of PCa between the two may require multi-center and large sample data to further explore.

AUTHOR CONTRIBUTIONS

SHB provided ideas, technical routes, and revised the article for this study; SJH, GXY, and LYL participated in collating data, statistical analysis and drafting the article; LZY, ZHY, ZRR, ZZY, GXH, and ZDB participated in data collection and summary data. All authors read and approved the final article.

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CONFLICT OF INTEREST

All authors in this study have no competing interests requiring special clarification.

DATA AVAILABILITY STATEMENT

The data that support the findings of this study are available on request from the corresponding author. The data are not publicly available due to privacy or ethical restrictions.

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