

Total PSA as a Predictor of Bone, Lymph Node, and Visceral Metastasis in Patients with Prostate Cancer: A Cameroonian Retrospective Study

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Abstract

Background: Metastatic prostate cancer is frequently diagnosed in resource-limited settings, where the cost and limited availability of staging investigations may delay appropriate management. This study assessed the ability of serum prostate-specific antigen (PSA) to predict metastasis among patients with prostate cancer treated at a urological center in Douala, Cameroon. **Methods:** We retrospectively reviewed the clinical records of 216 patients with prostate cancer from 2020 to 2025. Demographic, clinical, PSA, and metastatic-status data were analyzed using R version 4.5.1. Metastases were categorized into overall, bony, visceral, or ganglionic. Receiver operating characteristic (ROC) curve analyses were performed to estimate PSA thresholds for predicting overall, bony, and ganglionic metastases. Diagnostic performance was summarized using the area under the curve (AUC), sensitivity, specificity, positive predictive value, and negative predictive value. **Results:** The participants had a mean age of 65.76 ± 8.13 years. Metastases were present in 76 patients (35.19%), including 41, 3, and 68 with bony, visceral, and ganglionic metastases, respectively. The median PSA titer was significantly higher among patients with metastases, and the proportion of metastatic disease progressively increased with increasing PSA concentration. For overall metastasis, the AUC was 0.9600 (95% CI: 0.9287 - 0.9796), with an optimal threshold of 54.585 ng/mL, yielding sensitivity, specificity, positive predictive, and negative predictive values of

93.42%, 87.14%, 79.78%, and 96.06%, respectively. For bone metastasis, the AUC was 0.9438 (95% CI: 0.9008 - 0.9756), with a threshold of 150.70 ng/mL. For ganglionic metastasis, the AUC was 0.9317 (95% CI: 0.8943 - 0.9617), with a threshold value of 54.585 ng/mL. **Conclusion:** PSA demonstrated excellent discrimination for metastatic disease in this Cameroonian cohort. The identified thresholds may support risk-adapted prioritization of staging investigations in resource-constrained settings, but extra validation is needed before routine adoption.

Keywords

Prostatic Neoplasms, Prostate-Specific Antigen, Neoplasm Metastasis, Bone Neoplasms, Lymphatic Neoplasms, Resource-Limited Settings

1. Introduction

Prostate cancer is the second most common cancer in men worldwide [1]. It is a major public health problem whose burden keeps increasing worldwide, particularly among men of African ancestry. In sub-Saharan Africa, incidence rates are rising in several countries [2], while mortality remains high and survival is substantially poorer than in high-income settings [3]. These unfavorable outcomes are the result of multiple factors, including delayed diagnosis, limited access to specialist care, inadequate staging, and restricted treatment availability. Previous studies have demonstrated that the majority of patients with prostate cancer in resource-limited settings are diagnosed at an advanced stage [4], highlighting the dire need for timely identification of patients at risk of metastatic disease in such settings.

Metastatic spread is a critical determinant of prostate cancer prognosis and treatment selection. Although the disease may metastasize to lymph nodes, viscera, and other sites, the skeleton is the most clinically important metastatic compartment because osseous involvement causes pain, pathological fractures, spinal cord compression, and even anemia due to bone marrow invasion [5]. In addition to being associated with a dismal prognosis, the complications of metastasis significantly reduce the quality of life of patients with prostate cancer, which underscores the need for accurate staging. However, accurate staging requires imaging modalities such as bone scintigraphy (BS), computed tomography (CT), magnetic resonance imaging (MRI), or positron-emission tomography (PET). In resource-limited settings, not all patients in need can benefit from these facilities because of a combination of their limited availability, a paucity of trained experts, geographical inaccessibility, and economic barriers. In places like Douala, where many patients pay for healthcare out of pocket [6], the cumulative cost of imaging and laboratory investigations can lead to incomplete staging and delayed treatment decisions.

Serum prostate-specific antigen (PSA) is inexpensive, minimally invasive, and

widely employed in the diagnosis, risk stratification, and follow-up of prostate cancer. Several studies have demonstrated an association between increasing PSA concentrations and the probability of bone or distant metastases [7] [8]. Earlier investigations reported that bone metastases were uncommon among patients with PSA concentrations of <10 ng/mL, whereas PSA titers of exceeding 100 ng/mL were strongly predictive of osseous disease [8]. Another study of newly diagnosed patients found that the prevalence of metastatic findings increased progressively across PSA categories [9]. Many of these studies proposed clinically relevant thresholds for predicting metastasis; however, these thresholds vary according to many factors.

Importantly, PSA should not be regarded as a substitute for definitive staging workup in patients with prostate cancer, especially as evidence of its use to predict metastasis has been equivocal. A large population-based analysis showed that no PSA threshold, even when combined with tumor stage and grade group, could simultaneously identify most men with metastases and correctly classify most men without metastatic disease [10]. Therefore, PSA may be most useful as a risk-stratification tool: a locally derived threshold could help prioritize imaging for patients with a sufficiently high probability of metastatic disease while avoiding the inappropriate exclusion of those with lower PSA values. Since the relationship between PSA and metastatic disease may differ across populations and healthcare settings, thresholds derived predominantly from European, North American, or Asian cohorts may not be directly applicable to Cameroonian patients. Thus, it is important to investigate the association between serum PSA concentrations and the presence of metastasis, while estimating a threshold PSA that can reasonably discriminate between patients with and without metastatic disease in Cameroonian clinical settings. By providing locally generated evidence, this study aims to inform risk-adapted staging pathways and support more rational allocation of limited diagnostic resources. The proposed threshold is intended to complement, without replacing, adequate clinical assessment, digital rectal examination, histopathological grading, and appropriate imaging when feasible.

2. Materials and Methods

This retrospective cohort study was conducted from 2020 to 2025 at the Saint Cyr Endoscopy Urology Center in Douala, Cameroon. We included all patients diagnosed with prostate cancer from January 2020 to December 2025 and excluded those with incomplete clinical records. In total, 216 patients were included in the study. Digital rectal examination (DRE) and transrectal prostate ultrasound (TRUS) were performed in all patients, and blood samples were collected from all participants to measure total serum PSA (PSAT) levels. The data collected from the records of the patients included age, hemoglobin level, DRE findings (positive or negative), clinical stage, PSAT, prostate volume (from TRUS), PSA density (PSAT ÷ prostate volume), Gleason score, International Society of Urological Pathology (ISUP) classification, and the presence of metastasis (bone, visceral, or ganglionic

metastasis).

In each patient, prostate cancer was diagnosed via transrectal ultrasound-guided biopsy with histopathology. Metastases were generally identified during diagnosis, as the extension workup was performed once abnormal PSA titers were detected. PSA testing was performed before biopsy in all patients. The extension workup was performed within 14 days of prostate cancer diagnosis. Although bone scintigraphy is not available in Cameroon, all metastatic lesions were identified using chest and abdominal computed tomography. All 216 participants received the same assessment. To mitigate the risk of post-biopsy prostatitis, Monuril (3 g) was administered two hours before the biopsy in each patient. Twelve biopsy specimens were collected following the same method: two specimens were collected from the base, median zone, and apex in each of the two lobes. The extension workup was performed to search for metastases in each participant. This workup comprised chest and abdominal CT scans, since bone scintigraphy is currently unavailable in Cameroon.

The data were entered into Microsoft Excel 2016 and then exported to R version 4.5.1 for statistical analysis. Continuous data are presented as the mean value with its corresponding standard deviation when normally distributed, and as the median value with its corresponding interquartile range when not normally distributed. Comparisons between quantitative data were performed using the Mann-Whitney U test when not normally distributed or with Student's t-test when normally distributed. Categorical data are presented as frequencies with percentages, and comparisons between categorical variables were performed using Fisher's exact test or the Chi-square test where appropriate. $P < 0.05$ was considered statistically significant. The packages "tidyverse", "dplyr", "broom", and "pROC" were used to clean the data, perform the relevant analyses, draw receiver operating characteristic (ROC) curves, calculate the area under the curve (AUC), and estimate threshold values for PSAT that are predictive of metastasis. The ROC curve was obtained by plotting sensitivity against $1 - \text{specificity}$. The optimal thresholds for PSAT considered predictive of metastasis in this study were determined using the Youden Index, $J (J = \text{Sensitivity} + \text{Specificity} - 1)$. Internal validation with bootstrapping was performed using the "cutpointr" package, with boot_runs set to 2000. The package "CIfinder" was used to identify the 95% confidence intervals for the sensitivity, specificity, positive predictive value, and negative predictive value of the different PSAT cutoffs. This study was approved by the institutional review board of the Faculty of Medicine and Pharmaceutical Sciences (FMPS) of the University of Douala and by the ethical committee of Saint Cyr Endoscopy Urology Center, Douala, Cameroon. The requirement for patients' informed consent was waived due to the retrospective nature of the study.

3. Results

In this study, we included 216 men with prostate cancer, whose ages ranged from 41 years to 89 years, with a mean value of 65.76 ± 8.13 years. The 60 - 69-year age

group was the most represented (100, 46.30%). Digital rectal examination was positive in 114 (52.78%) of them. The clinical stage was T1 in 102 (47.22%) cases, T2 in 57 (26.39%) cases, T3 in 38 (17.59%) cases, and T4 in 19 (8.80%) cases. The clinical parameters of the study participants are presented in **Table 1**.

Table 1. Clinical parameters of the study participants.

Variable	Frequency	Percentage (%)
Age (years)		
<50	4	1.85
50 - 60]	53	24.54
60 - 70]	100	46.30
≥70	59	27.31
Digital rectal examination		
Positive	114	52.78
Negative	102	47.22
Clinical stage		
T1	102	52.78
T2	57	26.39
T3	38	17.59
T4	19	8.80

Regarding the paraclinical parameters of the participants, their hemoglobin levels ranged from 6.30 g/dL to 17.00 g/dL, with a median value of 13 [11.50 - 14.00] g/dL. The majority of participants (75.46%) had hemoglobin levels of 10 - 15 g/dL. Their PSA titers ranged from 4.28 ng/mL to 8832 ng/mL, with a median value of 38.41 [17.20 - 126.85] ng/mL. The PSA density (PSA titer ÷ Prostate volume) ranged from 0.01 ng/mL to 119.35 ng/mL, with a median value of 0.68 [0.30 - 2.03] ng/mL. Most participants (90, 41.67%) had a PSA density of <0.5 ng/mL. The prostate volume on ultrasound ranged from 17 mL to 216 mL, with a median value of 57 [43 - 77.25] mL. Regarding the Gleason score, most participants (91, 42.13%) had a Gleason score of 6 (3 + 3). The ISUP score was 1 in 92 (42.59%), 2 in 52 (24.07%), 3 in 18 (8.33%), 4 in 40 (18.52%), and 5 in 14 (6.48%). Metastasis had occurred in 76 (35.19%) participants but not in 140 (64.81%) of them. Among patients with metastasis, 41 had bony metastasis, 3 had visceral metastasis, and 68 had ganglionic metastasis. The paraclinical parameters of the study participants are presented in **Table 2**.

Generally, the median PSA titer of those with metastasis was significantly higher than that of patients without metastasis, as shown in **Table 3**.

The proportion of patients with metastases was classified according to PSA range to see how these parameters vary with each other. The proportion of patients with metastasis increased as the PSA titer increased. These findings are presented in **Table 4**.

Table 2. Paraclinical parameters of the study participants.

Variable	Frequency	Percentage (%)
Hemoglobin level (g/dL)		
<10	38	17.59
10 - 15	163	75.46
>15	15	6.94
PSA titer (ng/mL)		
<10	26	12.04
10 - 20]	36	16.67
20 - 50]	61	28.24
50 - 100]	33	15.28
100 - 200]	25	11.57
200 - 500]	19	8.80
500 - 1000]	9	4.17
≥1000	7	3.24
Prostate volume (mL)		
<50	90	41.66
50 - 100]	102	47.22
≥100	24	11.11
PSA density (ng/mL)		
<0.5	90	41.67
0.5 - 1]	35	16.20
1 - 2]	36	16.67
≥2	55	25.46
Gleason score		
6 (3 + 3)	91	42.13
6 (4 + 2)	1	0.46
7 (3 + 4)	53	24.54
7 (4 + 3)	17	7.87
8 (3 + 5)	18	8.33
8 (4 + 4)	16	7.41
8 (5 + 3)	6	2.78
9 (4 + 5)	6	2.78
9 (5 + 4)	8	3.70
ISUP score		
1	92	42.59
2	52	24.07
3	18	8.33
4	40	18.52
5	14	6.48

Continued

Metastasis		
Yes	76	35.19
No	140	64.81
Type of metastasis		
Bone	41	53.95
Visceral	3	3.95
Ganglionic	68	89.47

Table 3. Comparison of PSA titers between patients with and without metastasis.

	N	PSA titer				P-value
		Median	Q1	Q3	IQR value	
Metastasis						
No	140	24.2	12.1	38.1	26.1	<0.001
Yes	76	189	94.5	410	315	
Bone metastasis						
No	175	29.4	14.4	56.9	42.4	<0.001
Yes	41	300	182	657	475	
Visceral						
No	213	37.8	16.9	126	109	0.29
Yes	3	111	66.2	2555	2489	
Ganglionic						
No	148	25.3	12.8	41.9	29.1	<0.001
Yes	68	193	93.8	421	327	

Table 4. Variation of serum PSA titer with the proportion of patients with metastasis.

PSA range	N	No metastasis (%)	Metastasis (%)
<10	26	26 (100)	0 (0)
10 - 20]	36	35 (97.22)	1 (2.77)
20 - 50]	61	57 (93.44)	4 (6.56)
50 - 100]	33	18 (54.55)	15 (45.45)
100 - 200]	25	4 (16)	21 (84)
200 - 500]	19	0 (0)	19 (100)
500 - 1000]	9	0 (0)	9 (100)
≥1000	7	0 (0)	7 (100)

A receiver operating characteristic (ROC) curve was generated to determine the threshold PSA titer that can be considered predictive of overall metastasis in this study. The area under the ROC curve (AUC) was 0.96; 95% confidence interval: 0.9287 - 0.9796 (2000 stratified bootstrap replicates). The threshold PSA titer for predicting overall metastasis was 54.585 (95% CI: 46.2 - 88), with 93.42% sensitivity

(95% CI: 85.31% - 97.83%), 87.14% specificity (95% CI: 80.44% - 92.20%), a positive predictive value of 79.78% (95% CI: 69.93% - 87.55%), and a negative predictive value of 96.06% (95% CI: 91.05% - 98.71%). The ROC curve is shown in **Figure 1**.

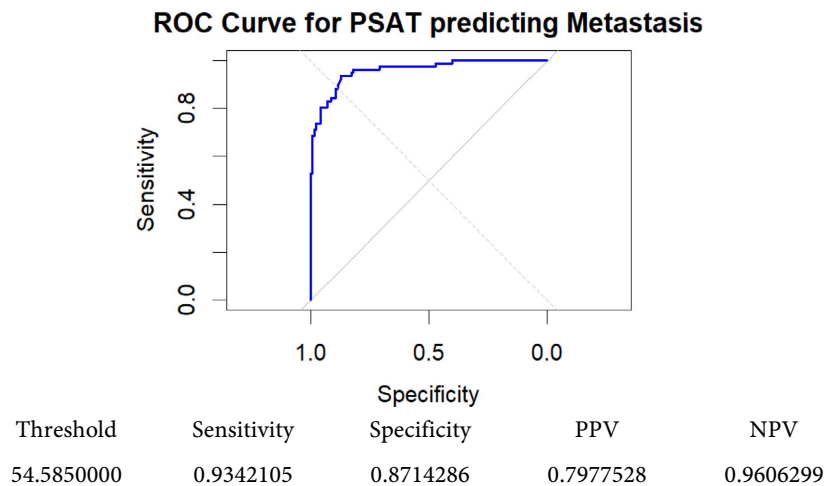


Figure 1. Receiver operating characteristic (ROC) curve for PSAT predicting overall metastasis.

A ROC curve was also generated to determine the threshold PSA titer that can be considered predictive of bone metastasis in this study. Its AUC was 0.9438; 95% CI: 0.9008 - 0.9756 (2000 stratified bootstrap replicates). The threshold PSA titer for predicting bone metastasis was 150.70, with 85.37% sensitivity (95% CI: 70.83% - 94.43%), 92.57% specificity (95% CI: 87.63% - 95.99%), a positive predictive value of 72.92% (95% CI: 58.15% - 84.72%), and a negative predictive value of 96.43% (95% CI: 92.39% - 98.68%).

The ROC curve for the prediction of bone metastasis is presented in **Figure 2**.

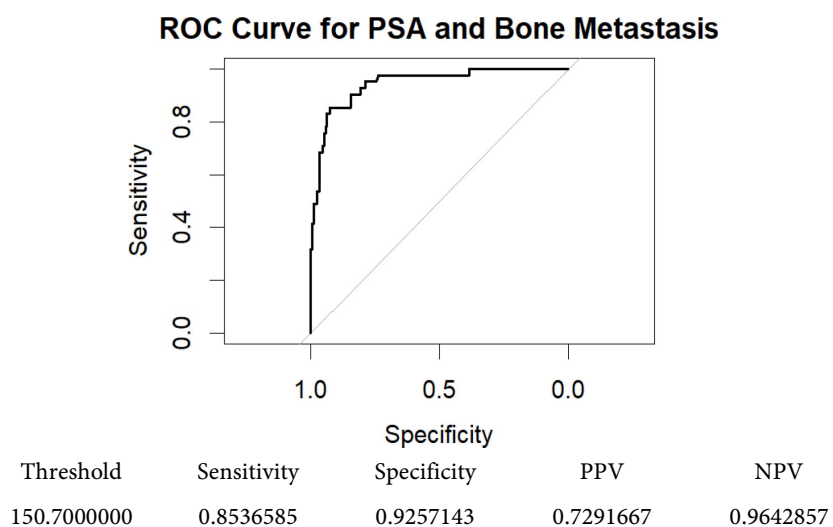
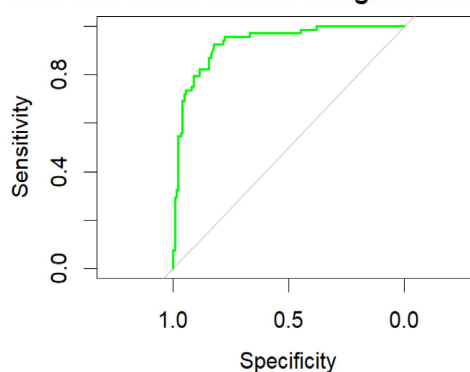


Figure 2. Receiver operating characteristic (ROC) curve for PSAT predicting bone metastasis.

A ROC curve was also generated to determine the threshold PSA titer that can be considered predictive of ganglionic metastasis in this study. Its AUC was 0.9317; 95% CI: 0.8943 - 0.9617 (2000 stratified bootstrap replicates). The threshold PSA titer for predicting lymph node metastasis was 54.585 (95% CI: 46.2 - 88), with 92.65% sensitivity (95% CI: 83.67% - 97.57%), 82.43% specificity (95% CI: 75.33% - 88.19%), a positive predictive value of 70.79% (95% CI: 60.19% - 79.95%), and a negative predictive value of 96.06% (95% CI: 91.05% - 98.71%).

The ROC curve for the prediction of ganglionic metastasis is presented in **Figure 3**.

ROC Curve for PSA and Ganglionic Metastasis



Threshold	Sensitivity	Specificity	PPV	NPV
54.5850000	0.9264706	0.8243243	0.7078652	0.9606299

Figure 3. Receiver operating characteristic (ROC) curve for PSAT predicting ganglionic metastasis.

Since there were only three participants with visceral metastasis in this study, similar analyses could not be performed for the latter.

To assess whether PSA adds classification value beyond clinical T stage and ISUP grade, we fitted multivariable logistic regression models for metastatic disease. Model 1 included the clinical T stage and ISUP grade; Model 2 included log₂-transformed PSA alone; Model 3 combined all three predictors. The combined model provided significantly better benefit than the clinical model alone. The comparisons are shown in **Table 5**.

Table 5. Comparison between models predictive of metastasis.

Comparison	Deviance difference	Degrees of freedom	P-value	Interpretation
Clinical model vs. combined model	36.257	1	1.73×10^{-9} (<0.001)	PSA significantly improves fit beyond T stage and ISUP
PSA-only model vs. combined model	6.1959	2	0.045	T stage and ISUP provide additional information beyond PSA

Adding log₂-transformed PSA adds substantial independent predictive value for metastasis beyond clinical T stage and ISUP grade. The AIC values for the clinical model, PSA-only model, and combined model were 140.9984, 108.9377, and 106.7417, respectively. The combined model has the lowest Akaike Information Criterion (AIC) value, indicating that it has the best overall model fit. Thus, although PSA makes a substantial contribution to predicting metastasis, it cannot, by itself, capture all relevant prognostic information. Clinical T stage and ISUP grade also provide additional, independent predictive value. The clinically appropriate model includes PSA, ISUP, and T stage.

4. Discussion

This study evaluated the relationship between serum PSA concentration and metastatic disease among 216 patients with prostate cancer managed at a urological reference center in Douala, Cameroon. The mean age of the participants was 65.76 ± 8.13 years, which is comparable to the age at which prostate cancer is commonly diagnosed in African and intercontinental cohorts [11]. In a population-based registry study covering sub-Saharan African countries, the average age distribution similarly reflected a predominantly older population, although many patients presented with advanced disease and incomplete staging [12].

Metastasis was identified in 35.19% of participants. Among the 76 metastatic cases, 41 had bone metastases, 3 had visceral metastases, and 68 had ganglionic metastases, but the three categories are not mutually exclusive. The relatively high metastatic burden observed in the present study is therefore consistent with the broader pattern of late-stage prostate cancer diagnosis in sub-Saharan Africa, where only a minority of patients undergo complete diagnostic work-up [13]. In a sub-Saharan African registry, 37.3% of patients with available tumor information had metastatic disease at diagnosis [12], a proportion that is similar to the 35.19% observed in this cohort. The observed predominance of ganglionic and osseous metastases is biologically and clinically plausible. Prostate cancer commonly spreads through lymphatic pathways to pelvic and retroperitoneal lymph nodes [14] [15], while bone is the most frequent site of hematogenous dissemination and an important cause of morbidity, mainly through pathological fractures, spinal cord compression, and anemia [5] [16] [17].

The median PSA concentration was significantly higher among patients with metastasis than among those without metastasis. In addition, the proportion of patients with metastasis increased progressively as the PSA concentration increased. These findings support the biological relationship between tumor burden, disease dissemination, and PSA secretion. PSA is produced by epithelial cells, and extensive or poorly differentiated tumor involvement may result in markedly elevated circulating concentrations. Previous studies have consistently reported higher PSA levels among patients with metastatic prostate cancer, particularly in those with skeletal involvement [18] [19]. In a West African cohort of 363 patients, Amoako *et al.* found associations among total PSA, Gleason score, and osseous

metastasis. Their AUC was 0.72, with a cutoff value of ≥ 20 predicting metastasis with 86.5% sensitivity and 41.2% specificity [20].

The ROC analysis for metastasis of any type demonstrated excellent discrimination in the present cohort. The AUC was 0.96 (95% confidence interval: 0.9287 - 0.9796), indicating that PSA had a very high ability to distinguish patients with metastasis from those without metastasis. The optimal threshold PSA titer was 54.585, with 93.42% sensitivity, 87.14% specificity, a positive predictive value of 79.78%, and a negative predictive value of 96.06%. These results indicate that a PSA concentration below 54.585 ng/mL was particularly useful for identifying patients unlikely to have metastatic disease, while a concentration of at least this level substantially increases the probability of metastasis among Cameroonian patients. This is particularly relevant in resource-limited settings where many patients cannot afford to foot the bills of a full extension work-up, as the PSA titer will provide a reliable clue. In such settings, the high negative predictive value (96.06%) is particularly important, as it indicates that most study participants with values below the proposed threshold did not have documented metastasis. Such a threshold could potentially assist in prioritizing advanced imaging for patients with higher PSA concentrations when universal staging is financially or logistically not feasible. Nevertheless, the threshold should not be interpreted as an absolute exclusion rule. A negative predictive value depends on disease prevalence, and the prevalence of metastasis in this cohort was relatively high. In addition, PSA alone cannot reliably identify every patient with metastatic disease. According to previous studies, no PSA cut-off simultaneously achieved high sensitivity and specificity to safely replace imaging for metastatic prostate cancer detection [21].

The analysis restricted to bone metastasis also showed excellent discriminatory performance, as the AUC was 0.9438 (95% CI: 0.9008 - 0.9756), and the optimal PSA threshold was 150.70 ng/mL. This threshold yielded a sensitivity of 85.37%, specificity of 92.57%, positive predictive value of 72.92%, and negative predictive value of 96.43%. The higher threshold for bone metastasis than for metastasis of any type is clinically plausible. Patients may develop ganglionic or limited visceral metastases at PSA concentrations below those typically associated with extensive skeletal dissemination [22]. The threshold value of 150.70 ng/mL also corresponds closely to the median PSA titer reported among patients with bone metastases in the study by Wolff *et al.* [8], who found that PSA values of >100 ng/mL were highly predictive of bone metastasis, whereas values below 10 ng/mL nearly excluded it. However, the relatively modest positive predictive value for bone metastasis indicates that a PSA titer above the threshold should be regarded as a strong indication for imaging rather than definitive evidence of bone disease. A retrospective study of 336 newly diagnosed prostate cancer patients found that those with bone metastases had significantly higher PSA titers than those without bone metastases [23], which is also in line with our findings. Other studies conducted on different continents have reported lower PSA thresholds for bone imaging. In an Indian cohort, bone metastases were absent among patients with PSA values of 0 - 10

ng/mL but occurred in 38.46% of those with PSA values of 10.1 - 20 ng/mL, 60.87% of those with values of 20.1 - 100 ng/mL, and all patients with PSA titers above 100 ng/mL [24]. Another study examining patients with low PSA despite bone metastases reported a PSA cut-off of 48 ng/mL, with 68.3% sensitivity and 86.1% specificity. These variations emphasize that PSA thresholds should be locally validated rather than transferred uncritically between settings.

The ROC analysis for ganglionic metastasis produced an AUC of 0.9317 (95% CI: 0.8943 - 0.9617), also indicating excellent discrimination. The reported threshold was 54.585, with 92.65% sensitivity, 82.43% specificity, and positive and negative predictive values of 70.79% and 96.06%, respectively. The high sensitivity and negative predictive value suggest that this threshold may be useful for identifying patients at low probability of ganglionic involvement, which will be of immense help in situations where clinicians need to select tests to be performed because the patient cannot afford a comprehensive work-up. The association between PSA and lymphadenopathy is supported by earlier studies, although PSA is not sufficient to establish nodal disease status. In a cohort of 569 patients undergoing staging lymphadenectomy, nodal metastasis increased from 4% among patients with PSA concentrations of ≤ 4 ng/mL to 67% among those with PSA concentrations of > 40 ng/mL; PSA, clinical stage, and tumor grade were independently associated with nodal disease. Nevertheless, the authors concluded that PSA added limited predictive accuracy beyond stage and grade, implying it could not replace definitive nodal assessment [25]. Therefore, no robust conclusions should be drawn based on PSA levels alone.

The clinical implications of these findings are considerable for Douala. A practical strategy could involve prioritizing bone imaging and cross-sectional staging for patients with PSA concentrations above 54.6 ng/mL, particularly when accompanied by digital rectal examination, high-grade histology, bone pain, weight loss, or neurological symptoms. Patients with PSA titers of > 150.7 ng/mL could be considered at high risk of osseous disease and should undergo urgent skeletal assessment whenever feasible. Conversely, patients with titers below the lower threshold may have a lower probability of metastasis, but imaging should still be performed when clinical findings raise suspicion.

Nevertheless, several limitations of this study should be acknowledged. First, this was a single-center study, and the sample may not represent all patients with prostate cancer in Cameroon. Referral to a specialized surgical center may have enriched the cohort for advanced or symptomatic disease. Second, the retrospective nature of the study may have introduced recall, selection, and information bias. Third, the number of patients with visceral metastases was small, preventing a reliable site-specific analysis. Finally, the thresholds were derived and evaluated in the same cohort, which may have produced optimistic estimates of discrimination and diagnostic performance. However, despite these drawbacks, this is the first known study conducted in the Cameroonian context to highlight the potential instrumentality of PSA as an indicator of prostate cancer metastasis in resource-

limited settings where logistic, human resource, and economic constraints get in the way of a comprehensive extension work-up.

5. Conclusion

In conclusion, this study demonstrates a strong association between PSA concentration and metastatic prostate cancer in a Cameroonian clinical population. PSA showed excellent discrimination for overall, bone, and ganglionic metastasis, with thresholds of 54.585 ng/mL for overall metastasis and ganglionic disease and 150.70 ng/mL for bone metastasis. These thresholds may support risk-adapted prioritization of staging investigations in settings where patients face substantial financial barriers. They should, however, complement rather than replace clinical evaluation, histopathological risk assessment, and imaging wherever possible. External validation in larger, multicenter Cameroonian cohorts is necessary before these thresholds can be formally adopted as staging criteria.

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Availability of Data and Materials

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

Ethics Statement

Ethics approval for this study was granted by the institutional review board of Saint Cyr Endoscopy Urology Center, Douala, Cameroon. All data were collected anonymously, and no identifying information was entered in the study database.

Informed Consent

The need for written informed consent was waived due to the retrospective nature of the study.

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Author Contributions

CK, DEE, and AKW conceived the study and guided data collection; MT, ZS, and HEMM wrote the first draft of the manuscript under the supervision of CK and DEE. AKW, ZS, DEE, and MT participated in data analysis and interpretation; CK, and AKW, and HEMM critically reviewed the manuscript for important intellectual content. All authors have read and approved the final manuscript.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

References

- [1] Raychaudhuri, R., Lin, D.W. and Montgomery, R.B. (2025) Prostate Cancer: A Review. *JAMA*, **333**, 1433-1446. <https://doi.org/10.1001/jama.2025.0228>
- [2] Seraphin, T.P., Joko-Fru, W.Y., Kamaté, B., Chokunonga, E., Wabinga, H., Somdya, N.I.M., *et al.* (2021) Rising Prostate Cancer Incidence in Sub-Saharan Africa: A Trend Analysis of Data from the African Cancer Registry Network. *Cancer Epidemiology, Biomarkers & Prevention*, **30**, 158-165. <https://doi.org/10.1158/1055-9965.epi-20-1005>
- [3] Seraphin, T.P., Joko-Fru, W.Y., Manraj, S.S., Chokunonga, E., Somdya, N.I.M., Korir, A., *et al.* (2021) Prostate Cancer Survival in Sub-Saharan Africa by Age, Stage at Diagnosis, and Human Development Index: A Population-Based Registry Study. *Cancer Causes & Control*, **32**, 1001-1019. <https://doi.org/10.1007/s10552-021-01453-x>
- [4] Bunani, N., Nakanwagi Kisakye, A., Ssenyonjo, A. and Nuwaha, F. (2024) Late Diagnosis among Patients with Prostate Cancer at the Uganda Cancer Institute: A Retrospective Cohort Study. *African Health Sciences*, **24**, 147-155. <https://doi.org/10.4314/ahs.v24i3.19>
- [5] Nieder, C., Haukland, E., Pawinski, A. and Dalhaug, A. (2010) Pathologic Fracture and Metastatic Spinal Cord Compression in Patients with Prostate Cancer and Bone Metastases. *BMC Urology*, **10**, Article No. 23. <https://doi.org/10.1186/1471-2490-10-23>
- [6] Makau-Barasa, L.K., Manirakiza, A., Carvalho, A.L. and Rebbeck, T.R. (2022) Prostate Cancer Screening, Diagnostic, Treatment Procedures and Costs in Sub-Saharan Africa: A Situational Analysis. *Cancer Control*, **29**, 1-15.
- [7] Lin, Y., Mao, Q., Chen, B., Wang, L., Liu, B., Zheng, X., *et al.* (2017) When to Perform Bone Scintigraphy in Patients with Newly Diagnosed Prostate Cancer? A Retrospective Study. *BMC Urology*, **17**, Article No. 41. <https://doi.org/10.1186/s12894-017-0229-z>
- [8] Wolff, J.M., Bares, R., Jung, P.K., Buell, U. and Jakse, G. (1996) Prostate-Specific Antigen as a Marker of Bone Metastasis in Patients with Prostate Cancer. *Urologia Internationalis*, **56**, 169-173. <https://doi.org/10.1159/000282834>
- [9] Luining, W.I., Hagens, M.J., Meijer, D., Ringia, J.B., de Weijer, T., Bektas, H.O., *et al.* (2023) The Probability of Metastases within Different Prostate-Specific Antigen Ranges Using Prostate-Specific Membrane Antigen Positron Emission Tomography in Patients with Newly Diagnosed Prostate Cancer. *European Urology Open Science*, **59**, 55-62. <https://doi.org/10.1016/j.euros.2023.12.001>
- [10] Thomsen, F.B., Westerberg, M., Garmo, H., Robinson, D., Holmberg, L., Ulmert, H.D., *et al.* (2020) Prediction of Metastatic Prostate Cancer by Prostate-Specific Antigen in Combination with T Stage and Gleason Grade: Nationwide, Population-Based Register Study. *PLOS ONE*, **15**, e0228447. <https://doi.org/10.1371/journal.pone.0228447>
- [11] Bechis, S.K., Carroll, P.R. and Cooperberg, M.R. (2011) Impact of Age at Diagnosis on Prostate Cancer Treatment and Survival. *Journal of Clinical Oncology*, **29**, 235-241. <https://doi.org/10.1200/jco.2010.30.2075>
- [12] Jalloh, M., Cassell, A., Niang, L. and Rebbeck, T. (2024) Global Viewpoints: Updates on Prostate Cancer in Sub-Saharan Africa. *BJU International*, **133**, 6-13. <https://doi.org/10.1111/bju.16178>
- [13] Seraphin, T.P., Joko-Fru, W.Y., Hämmerl, L., Griesel, M., Mezger, N.C.S., Feuchtner,

- J.C., *et al.* (2021) Presentation, Patterns of Care, and Outcomes of Patients with Prostate Cancer in Sub-Saharan Africa: A Population-Based Registry Study. *Cancer*, **127**, 4221-4232. <https://doi.org/10.1002/cncr.33818>
- [14] Briganti, A., Suardi, N., Capogrosso, P., Passoni, N., Freschi, M., di Trapani, E., *et al.* (2012) Lymphatic Spread of Nodal Metastases in High-Risk Prostate Cancer: The Ascending Pathway from the Pelvis to the Retroperitoneum. *The Prostate*, **72**, 186-192. <https://doi.org/10.1002/pros.21420>
- [15] Dattani, S.M.T., Yamada, M.L., Dhoot, N.M., Ghazala, G., Levene, A. and Somsundaram, R. (2022) Metastatic Prostate Cancer Presenting as Incidental Pelvic Lymphadenopathy—A Report of Three Cases with Literature Review. *Radiology Case Reports*, **17**, 2247-2252. <https://doi.org/10.1016/j.radcr.2022.03.053>
- [16] Rucci, N. and Angelucci, A. (2014) Prostate Cancer and Bone: The Elective Affinities. *BioMed Research International*, **2014**, Article ID: 167035. <https://doi.org/10.1155/2014/167035>
- [17] Lee, R.J., Saylor, P.J. and Smith, M.R. (2011) Treatment and Prevention of Bone Complications from Prostate Cancer. *Bone*, **48**, 88-95. <https://doi.org/10.1016/j.bone.2010.05.038>
- [18] Obeng, F., Yawson, A., Hammond, N., Boakye, S.A., Kpankyaano, B., Boadu, A.W., *et al.* (2025) Predicting Bone Metastasis in Prostate Cancer Patients Using Total Serum Prostate-Specific Antigen and Serum Alkaline Phosphatase: Model Development, Validation, and Deployment as a Digital Risk Estimator. *Cureus*, **17**, e87786. <https://doi.org/10.7759/cureus.87786>
- [19] Qureshi, A., Makhdomi, K. and Stones, W. (2017) Prostate-Specific Antigen as a Risk Factor for Skeletal Metastasis in Native Ethnic African Men with Prostate Cancer: A Case-Control Study. *World Journal of Nuclear Medicine*, **16**, 26-32. <https://doi.org/10.4103/1450-1147.181150>
- [20] Amoako, Y.A., Hammond, E.N.B., Assasie-Gyimah, A., Laryea, D.O., Ankrah, A. and Amoah, G. (2019) Prostate-Specific Antigen and Risk of Bone Metastases in West Africans with Prostate Cancer. *World Journal of Nuclear Medicine*, **18**, 143-148. https://doi.org/10.4103/wjnm.wjnm_38_18
- [21] Lojanapiwat, B., Anutrakulchai, W., Chongruksut, W. and Udomphot, C. (2014) Correlation and Diagnostic Performance of the Prostate-Specific Antigen Level with the Diagnosis, Aggressiveness, and Bone Metastasis of Prostate Cancer in Clinical Practice. *Prostate International*, **2**, 133-139. <https://doi.org/10.12954/pi.14054>
- [22] Xu, N., Wu, Y., Ke, Z., Liang, Y., Tao, X., Chen, S., *et al.* (2019) Risk Factors of Developing Visceral Metastases at Diagnosis in Prostate Cancer Patients. *Translational Cancer Research*, **8**, 928-938. <https://doi.org/10.21037/tcr.2019.05.31>
- [23] Chien, T.-M., Lu, Y.-M., Geng, J.-H., Huang, T.-Y., Ke, H.-L., Huang, C.-N., *et al.* (2016) Predictors of Positive Bone Metastasis in Newly Diagnosed Prostate Cancer Patients. *Asian Pacific Journal of Cancer Prevention*, **17**, 1187-1191. <https://doi.org/10.7314/apjcp.2016.17.3.1187>
- [24] Singh, O.P., Yogi, V., Redhu, P., Ghori, H.U., Pareek, A. and Lal, N. (2019) Role of Serum Prostate-Specific Antigen as Predictor for Bone Metastases in Newly Diagnosed Prostate Cancer. *Journal of Cancer Research and Therapeutics*, **15**, S39-S41. https://doi.org/10.4103/jcrt.jcrt_189_18
- [25] Elizabeth Sands, M., Zagars, G.K., Pollack, A. and Von Eschenbach, A. (1994) Serum Prostate-Specific Antigen, Clinical Stage, Pathologic Grade, and the Incidence of Nodal Metastases in Prostate Cancer. *Urology*, **44**, 215-220. [https://doi.org/10.1016/s0090-4295\(94\)80134-7](https://doi.org/10.1016/s0090-4295(94)80134-7)