

Serum Prostate-Specific Antigen, Testosterone, and Creatinine Levels in Nigerian Men with Prostate Carcinoma versus Benign Prostatic Hyperplasia: A Comparative Cross-Sectional Study

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Abstract

Prostate carcinoma frequently presents at advanced stages in Nigeria and sub-Saharan Africa, where screening remains limited. The limited specificity of prostate-specific antigen (PSA) highlights the need to investigate complementary biomarkers. This study compared serum PSA, testosterone, and creatinine levels between men with histologically confirmed prostate carcinoma and those with benign prostatic hyperplasia (BPH) at a Nigerian tertiary hospital. A hospital-based analytical cross-sectional study enrolled 81 male patients over two years. Serum PSA and testosterone were measured using sandwich and competitive enzyme-linked immunosorbent assays, respectively, while creatinine was measured using the Jaffe kinetic method. Group comparisons employed independent-samples t-tests and one-way analysis of variance. Patients with carcinoma were significantly older than those with BPH (73.05 ± 7.68 vs. 65.63 ± 6.37 years; $p < 0.001$). The carcinoma group had higher mean serum PSA (40.43 ± 32.57 vs. 18.75 ± 6.75 ng/mL; $p < 0.001$) and creatinine (1.62 ± 0.86 vs. 1.09 ± 0.28 mg/dL; $p < 0.001$), but lower testosterone (2.77 ± 1.70 vs. 3.53 ± 1.26 nmol/L; $p = 0.024$). Prostate size did not differ significantly between groups ($p = 0.401$). These findings demonstrate differences in serum biochemical profiles between prostate carcinoma and BPH and support further investigation of a

combined biomarker approach. Studies accounting for age differences and evaluating diagnostic performance are needed to establish whether testosterone and creatinine provide additional diagnostic value beyond PSA.

Keywords: Prostate Carcinoma; Benign Prostatic Hyperplasia; Prostate-Specific Antigen; Testosterone; Creatinine

INTRODUCTION

Prostate cancer ranks as the second most frequently diagnosed malignancy and the fifth leading cause of cancer-related mortality in men globally. According to GLOBOCAN 2020 data, over 1.4 million new cases and approximately 375,000 deaths were recorded worldwide, reflecting a substantial and growing disease burden.^{1,2} The incidence exhibits considerable geographical variation, with sub-Saharan Africa recording some of the highest rates, particularly in West African nations including Nigeria.^{3,4}

In Nigeria, prostate cancer is the most commonly diagnosed malignancy among men, contributing between 10% and 20% of all male cancers, with regional variations across urban and rural settings.^{5,6} The disease predominantly affects men above 60 years, though delayed diagnosis often results in presentation at advanced stages, limiting therapeutic options and worsening survival outcomes.^{3,7,8}

Serum prostate-specific antigen (PSA), a kallikrein family glycoprotein produced by prostatic epithelial cells, remains the most widely deployed biomarker for prostate cancer screening, diagnosis, and treatment monitoring.^{9,10} However, PSA elevations are not exclusive to malignancy, as BPH, prostatitis, and urinary tract infections also raise serum concentrations, limiting its diagnostic specificity.^{11,12,13}

Testosterone, the principal male androgen, plays a complex and paradoxical role in prostate oncology. While chronic androgenic stimulation promotes prostate epithelial proliferation, lower circulating testosterone levels have been associated with more aggressive tumor phenotypes and poorer clinical outcomes.^{14,15,16} Creatinine, a byproduct of skeletal muscle creatine phosphate catabolism excreted through glomerular filtration, serves as a standard indicator of renal function. In advanced prostate carcinoma, obstructive uropathy secondary to tumor compression may impair renal clearance, elevating serum creatinine concentrations.^{17,18}

Despite the established individual utility of these biomarkers, few studies from the West African sub-region have concurrently evaluated all three parameters in the same patient cohort. This study therefore sought to determine and compare serum PSA, testosterone, and creatinine levels between Nigerian men with histologically confirmed prostate carcinoma and those with BPH, providing a foundational biochemical profile for future integrated diagnostic strategies.^{19,20}

MATERIALS AND METHODS

A hospital-based analytical cross-sectional study was conducted between 2021 and 2023 at the Division of Urology, Edo State University Teaching Hospital (EDSUTH), Auchi, Edo State, Nigeria — a tertiary referral centre for urological and oncological care in the region.

Eighty-one adult male patients aged 40 years and above presenting with clinical and histological evidence of prostate disease were consecutively enrolled. Group I (benign cohort, $n = 36$) comprised patients with BPH confirmed by histology showing nodular hyperplasia and normal or marginally elevated PSA. Group II (malignant cohort, $n = 45$) comprised patients with histologically confirmed adenocarcinoma of the prostate. Sample size was estimated using the Cochran formula adjusted for an anticipated 80% completion rate.²¹

Included were male patients aged ≥ 40 years with histologically confirmed prostate carcinoma or BPH who provided written informed consent. Excluded were patients with acute prostatitis, urinary tract infections, pre-existing chronic kidney disease unrelated to prostate pathology, those on androgen deprivation therapy prior to sample collection, and those who declined participation.

Five millilitres of venous blood were aseptically collected from the antecubital fossa, allowed to clot at room temperature, and centrifuged at 3,000 rpm for 10 minutes. The separated serum was stored at -20°C until analysis. Serum PSA was quantified using a sandwich enzyme-linked immunosorbent assay (ELISA; Monobind Inc., USA) and expressed in ng/mL. Serum testosterone was determined by competitive ELISA with concentrations expressed in nmol/L. Serum creatinine was measured by the kinetic alkaline picrate (Jaffe) reaction using an automated spectrophotometer (Mindray BS-240, China) and expressed in mg/dL.

All patients with elevated PSA underwent digitally guided transrectal needle biopsy of the prostate (TNBP) using an 18G trucut needle mounted on a spring-loaded Magnum gun. Six-core biopsies were obtained from the apex, mid-portion, and base of each lateral lobe under local anaesthesia with 2% lidocaine gel. Specimens were fixed in 10% buffered formalin and processed at the EDSUTH Histopathology Laboratory. Antibiotic prophylaxis with ciprofloxacin and metronidazole was administered.

Data were analyzed using IBM SPSS version 25.0. Descriptive statistics were expressed as mean $\pm$ standard deviation. Independent samples t-tests compared biochemical parameters between groups, and one-way ANOVA was used for multigroup comparisons. A p-value < 0.05 was considered statistically significant.

Ethical approval was obtained from the Ethics and Research Committee of Ambrose Alli University, Ekpoma. All participants provided written informed consent. The study was conducted in accordance with the Declaration of Helsinki (2013).

RESULTS

A total of 81 male participants were studied: 45 with malignant prostate carcinoma and 36 with BPH. The majority of participants (40.7%) were aged 70–79 years, followed by 39.5% aged 60–69 years. Those aged 80 years and above represented 12.4%, while the youngest group (50–59 years) accounted for 7.4%. Nearly half (43.2%) had primary-level education, 29.6% had secondary education, 18.5% attained tertiary education, and 8.7% had no formal education. Full sociodemographic data are presented in Table 1.

Table 1. Sociodemographic Characteristics of Study Participants

Variable	Category	Frequency (n)	Percentage (%)
Age Group (years)	50–59	6	7.4
	60–69	32	39.5
	70–79	33	40.7
	≥ 80	10	12.4
Level of Education	None	7	8.7
	Primary	35	43.2
	Secondary	24	29.6
	Tertiary	15	18.5
Total		81	100

The mean age of participants with carcinoma of the prostate (73.05 ± 7.68 years) was significantly higher than that of the benign group (65.63 ± 6.37 years; $t = 4.591$, $p < 0.001$). Duration of lower urinary tract symptoms (LUTS), haematuria, and low back pain did not differ significantly between groups (Table 2). Paraplegia was observed exclusively in the malignant cohort.

Table 2. Comparison of Clinical Characteristics Between Malignant and Benign Cohorts

Variable	Malignant (n=45)	Benign (n=36)	t-value	p-value
Age (years)	73.05 ± 7.68	65.63 ± 6.37	4.591	$< 0.001^{***}$
Duration of LUTS (months)	12.10 ± 4.07	12.42 ± 6.37	-0.136	0.894
Duration of Haematuria (months)	1.88 ± 0.89	3.40 ± 3.75	-1.577	0.128
Duration of Low Back Pain (months)	3.50 ± 2.52	2.00	0.533	0.631

$*p < 0.05$; $**p < 0.01$; $***p < 0.001$; LUTS = Lower Urinary Tract Symptoms

Serum PSA was significantly elevated in the malignant cohort (40.43 ± 32.57 ng/mL) compared with BPH patients (18.75 ± 6.75 ng/mL; $t = 4.35$, $p < 0.001$). Serum testosterone was significantly lower among men with carcinoma (2.77 ± 1.70 nmol/L vs. 3.53 ± 1.26 nmol/L; $t = -2.30$, $p = 0.024$). Serum creatinine was significantly higher in the malignant group (1.62 ± 0.86 mg/dL vs. 1.09 ± 0.28 mg/dL; $t = 3.85$, $p < 0.001$). Prostate size did not differ significantly between groups (70.43 ± 25.52 g vs. 77.40 ± 43.17 g; $p = 0.401$). Full details are presented in Table 3.

Table 3. Comparison of Biochemical Parameters Between Malignant and Benign Cohorts

Parameter	Malignant (Mean $\pm$ SD)	Benign (Mean $\pm$ SD)	t-value	p-value
Prostate size (g)	70.43 ± 25.52	77.40 ± 43.17	-0.85	0.401
Serum PSA (ng/mL)	40.43 ± 32.57	18.75 ± 6.75	4.35	$< 0.001^{***}$
Serum Testosterone (nmol/L)	2.77 ± 1.70	3.53 ± 1.26	-2.30	0.024*
Serum Creatinine (mg/dL)	1.62 ± 0.86	1.09 ± 0.28	3.85	$< 0.001^{***}$

$*p < 0.05$; $***p < 0.001$; PSA = Prostate-Specific Antigen; SD = Standard Deviation

One-way ANOVA confirmed statistically significant differences between cohorts for PSA ($F = 15.382$, $p < 0.001$), testosterone ($F = 4.969$, $p = 0.029$), and creatinine

($F = 12.615$, $p = 0.001$), consistent with independent t-test findings. Prostate size remained non-significant ($F = 0.811$, $p = 0.371$), as shown in Table 4.

Table 4. ANOVA Comparison of Biochemical Parameters Between Cohorts

Parameter	Malignant (Mean $\pm$ SD)	Benign (Mean $\pm$ SD)	F-value	p-value
Prostate size (g)	70.43 $\pm$ 25.52	77.40 $\pm$ 43.17	0.811	0.371
PSA (ng/mL)	40.43 $\pm$ 32.57	18.75 $\pm$ 6.75	15.382	< 0.001***
Testosterone (nmol/L)	2.77 $\pm$ 1.70	3.53 $\pm$ 1.26	4.969	0.029*
Creatinine (mg/dL)	1.62 $\pm$ 0.86	1.09 $\pm$ 0.28	12.615	0.001**

* $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$

DISCUSSION

This study provides a comprehensive biochemical comparison between Nigerian men with histologically confirmed prostate carcinoma and those with BPH, evaluating three clinically significant serum parameters: PSA, testosterone, and creatinine. The findings demonstrate distinct biochemical signatures that differentiate malignant from benign prostatic disease and support the use of a multi-marker approach in clinical evaluation.²²

The significantly higher mean age of malignant patients (73.05 years) compared with benign patients (65.63 years) is consistent with the established epidemiological pattern of prostate carcinoma as a predominantly geriatric disease. This age disparity has been documented across Nigerian tertiary hospitals and aligns with global cancer registry data indicating a sharp rise in prostate cancer incidence after age 60.^{23,24,25} The absence of significant differences in LUTS duration, haematuria, and low back pain between groups reinforces the well-known clinical overlap between malignant and benign prostate conditions, underscoring the limitations of symptom-based diagnosis.^{26,27}

The markedly elevated PSA in the carcinoma group (40.43 $\pm$ 32.57 ng/mL) reflects the disruption of glandular architecture that characterizes malignant transformation, permitting increased PSA leakage into the systemic circulation.^{9,28} This pattern of high PSA at presentation is consistent with findings from Nigerian and other sub-Saharan African cohorts, where late-stage disease is common at diagnosis.^{5,7,29} Conversely, the BPH group's

mean PSA of 18.75 ng/mL is within ranges reported for benign hyperplastic disease in African populations, reflecting glandular enlargement without malignant transformation.^{30,13}

The significantly lower testosterone in the malignant cohort (2.77 ± 1.70 nmol/L) is consistent with the paradox of declining androgen levels in advanced prostate cancer. Muller et al.¹⁴ and Keto et al.¹⁵ have proposed that lower testosterone reflects tumor-driven suppression of the hypothalamic-pituitary-gonadal axis, adaptation of tumor cells to androgen-depleted environments through androgen-receptor hypersensitivity and intratumoral androgen synthesis, and systemic effects of cancer-related cachexia on gonadotropin secretion. Akinloye et al.⁵ and Ajani et al.³¹ similarly documented lower testosterone in Nigerian prostate cancer patients, supporting a region-specific pattern of hormonal disruption that may also have a genetic basis.^{19,16}

Elevated serum creatinine in the malignant group (1.62 ± 0.86 mg/dL) likely reflects obstructive uropathy secondary to bladder outlet obstruction or ureteric compression by locally advanced tumors, as well as systemic metabolic disturbances associated with advanced malignancy.^{17,18,7} This finding has important clinical implications, as renal impairment influences treatment eligibility, chemotherapy dosing, and overall prognosis. Early detection of renal compromise through creatinine measurement is therefore essential in managing advanced prostate carcinoma.³²

Prostate size did not differ significantly between groups, a finding that highlights the inability of gland volume alone to differentiate malignant from benign disease. This supports the necessity of biochemical and histopathological evaluation rather than size-based assessment in clinical decision-making.

CONCLUSION

Nigerian men with prostate carcinoma show markedly elevated PSA and creatinine alongside suppressed testosterone, a biochemical triad that sharply distinguishes malignant from benign disease. Together, these markers capture the converging forces of malignant transformation, hormonal disruption, and obstructive uropathy driving advanced prostate cancer. Clinicians in resource-limited settings should move beyond single-marker reliance: a three-marker panel offers stronger diagnostic leverage.

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