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ORIGINAL RESEARCH

Unmasking Elevated PSA: Prevalence and Modifiable Risk Factors in Men Aged ≥ 40 Years Attending Kabutare District Hospital in Rwanda

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Objective: The objective of the study was to determine the prevalence of elevated PSA levels (> 4.0 ng/mL) and examine sociodemographic and modifiable lifestyle risk factors associated with PSA elevation among asymptomatic Rwandan men aged ≥ 40 years.

Material and Methods: A cross-sectional study was conducted at Kabutare District Hospital in Rwanda between March and April 2025, enrolling 136 asymptomatic male participants aged ≥ 40 years. Lifestyle and anthropometric data were collected via structured interviews. Serum total PSA was measured using the enzyme linked immunosorbent assay (Fortress BXE0851A kit). Elevated PSA was defined as > 4.0 ng/mL. Statistical analyses included descriptive statistics and Chi-square/Fisher's exact tests for bivariate associations.

Results: Elevated PSA was observed in 14% of participants. Chi-square analysis revealed significant associations between elevated PSA and BMI category ($p < 0.001$), smoking status ($p < 0.001$), alcohol use ($p < 0.001$), sexual activity frequency ($p = 0.018$), and occupation ($p < 0.001$).

Conclusion: Elevated PSA prevalence among asymptomatic Rwandan men mirrors global patterns observed in Black populations. Associations with underweight status, occupational exposure, and alcohol use suggest multifactorial influences. These findings highlight the need for targeted screening strategies and community-level interventions to promote early prostate cancer detection in Rwanda.

Keywords: prostate cancer, PSA, modifiable risk factors, Rwanda, screening, occupational exposure, ELISA

Introduction

Prostate cancer (PCa) continues to be a global public health problem, ranking as the second most common malignancy among men following lung cancer.[1] The rising burden is especially pronounced in developing countries, with suggested projections of approximately 50% increase in coming years.[1] While developed nations start to experience stabilization or even decline in PCa cases, in sub-Saharan Africa (SSA) the incidence rates are rapidly rising.[2] Several factors likely drive this disparity, including heightened public awareness, enhanced healthcare infrastructure, and increased prostate specific antigen (PSA) testing, ultimately boosting diagnosis rates.[3] Understanding PSA as a biomarker for PCa enables timely diagnosis and informed management.[4] This underscores the value of PSA screening, typically using a threshold of around 4.0 ng/mL, to guide further diagnostic procedures like biopsy.[4]

In Rwanda, PCa tops the list of male cancers, according to GLOBOCAN 2022.[5] Late diagnosis is a major challenge, as symptoms often emerge in advanced stages, complicating treatment and yielding poor outcomes.[6] While digital rectal examination (DRE) and PSA testing enable early detection, limited accessibility to these services – predominantly in urban

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hospital settings – creates a significant barrier.[2,6] Compounding this issue are shortages of specialized healthcare professionals and inadequate infrastructure, further hindering timely diagnosis and effective management of PCa nationwide.[2,7] Lifestyle and modifiable factors significantly impact PSA levels and prostate cancer risk. Heavy alcohol use and smoking are associated with increased PCa risk likely through epigenetic changes and carcinogen metabolism.[8] Obesity, however, tends to lower PSA levels due to haemodilution.[9] Diets rich in fruits and vegetables may offer protective benefits.[8] Yet, evidence is often conflicting, and most PSA data comes from high-screening populations in developed countries.[10]

Prostate cancer is among the leading causes of cancer-related morbidity and mortality in men worldwide, with an increasing burden in SSA.[11–13] Despite this trend, early detection through PSA screening remains limited in many African countries, including Rwanda, where data on PSA prevalence and associated risk factors are virtually absent.[1,2,14] This gap hampers the development of evidence-based screening strategies and preventive interventions tailored to local populations. Understanding the prevalence of elevated PSA and its modifiable determinants is critical for informing public health policies and reducing late-stage diagnoses in resource-constrained settings.[2,14]

Sub-Saharan Africa, including Rwanda, lacks comprehensive data on systematic PSA screenings and associated risk factors in asymptomatic men.[10] For comparison, a Taiwanese study reported that 4% of men aged > 40 years had PSA ≥ 4 ng/mL, whereas a Nigerian cohort reported approximately 10%.[10,15] In Rwanda, recent data on PSA patterns and modifiable risk factors in asymptomatic men is notably absent.

Therefore, this study aimed to determine the prevalence of elevated PSA levels (> 4.0 ng/mL) and identify socio-demographic and lifestyle factors associated with PSA elevation among asymptomatic men aged ≥ 40 years attending Kabutare District Hospital in Rwanda. By bridging this knowledge gap, we seek to provide context-specific evidence to guide targeted screening strategies and public health interventions, ultimately enhancing prostate cancer detection and prevention in Sub-Saharan Africa.

Methods

Study Design and Population

This cross-sectional study was conducted at Kabutare District Hospital between March and April 2025 and enrolled adult men aged 40 years and older who attended the outpatient department during the study period. Participants were eligible if they were asymptomatic for urinary or prostate-related symptoms, as the study aimed to assess PSA levels and associated risk factors in men without clinical suspicion of prostate disease. Men with urinary symptoms were excluded to avoid confounding from conditions such as prostatitis or benign prostatic hyperplasia, which can independently elevate PSA levels. Additional exclusion criteria included a prior diagnosis of PCA recent sexual intercourse within three days, DRE within the preceding week, or any other recent prostate-related diagnosis or treatment, as these factors could influence serum PSA measurements.

Sampling Strategy and Enrollment

A consecutive sampling strategy was employed, whereby all eligible men who volunteered to participate and met the aforementioned criteria were enrolled. A total of 136 asymptomatic male participants were enrolled after providing informed consent.

Data Collection

This study gathered data through confidential, researcher-administered questionnaires, delving into participants' lifestyles and habits to understand their impact on prostate health. Participants were asked about their dietary habits, including how often they ate fruits, vegetables, and protein-rich foods. We also explored their alcohol consumption, smoking status (current, former or never), and physical activity levels, ranging from daily exercise to complete inactivity. Additionally, we inquired about the frequency of sexual activity and environmental exposures, such as pesticides or insecticides. High exposure was defined as handling pesticides or herbicides ≥ 3 days per week for ≥ 6 months cumulatively; low exposure as occasional use (< 3 days per week) or indirect contact only (eg, staying in fields during spraying). By gathering this comprehensive information, we were able to create a detailed profile of each participant's lifestyle and risk factors, providing valuable insights into potential influences on prostate health outcomes.

Anthropometric Measurements

Body weight and height were measured for each participant, and the Body Mass Index (BMI) was calculated as weight (kg) divided by height squared (m^2). BMI was categorized according to World Health Organization (WHO) criteria into underweight (< 18.5 kg/m^2), normal weight (18.5–24.9 kg/m^2), overweight (25.0–29.9 kg/m^2), and obese (≥ 30.0 kg/m^2).

Laboratory Procedures

Venous blood samples were collected from each participant via venipuncture at the antecubital fossa and placed in plain red-top blood collection tubes. The samples were then transported to the laboratory within two hours, centrifuged to harvest serum, and stored at −20°C until the time for PSA testing. Serum total PSA levels were determined using the sandwich Enzyme-Linked Immunosorbent Assay (ELISA) method, specifically utilizing the Fortress BXE0851A diagnostic kit (Antrim, United Kingdom). PSA values ≥ 4.0 ng/mL were considered elevated, serving as the clinical cutoff for defining prevalence. For statistical analytical purposes, PSA values were further stratified into specific ranges: 0–2.5 ng/mL, 2.6–4.0 ng/mL, 4.1–10.0 ng/mL, and > 10 ng/mL. PSA was also dichotomized into "Normal" (≤ 4.0 ng/mL) and "High" (> 4.0 ng/mL) for bivariate and multivariable analyses.

Statistical Analysis

Participant characteristics were summarised using descriptive statistics. Due to non-normal distribution, PSA values were described using median and interquartile range (IQR). Categorical variables were presented as frequencies and percentages. Bivariate associations between categorical characteristics and elevated PSA levels were assessed using Chi-square or Fisher's exact tests, as appropriate. Statistical analyses were performed using STATA 13 (StataCorp, College Station, TX, USA) with significance set at $p < 0.05$.

Results

Overview of Study Participants and Data Structure

A total of 136 male participants were enrolled in this study. The results are presented in four thematic sections aligned with the study objectives: (1) lifestyle and demographic characteristics, (2) PSA distribution and prevalence of elevated PSA, (3) bivariate associations between participant characteristics and PSA levels, and (4) multivariable analysis of independent correlates of elevated PSA. A summary of the lifestyle characteristics of the study participants is presented in Table 1.

Table 1 Lifestyle Characteristics of Study Participants

Variables	n	Percent
Marital Status		
Divorced	12	9%
Married	119	87%
Single	5	4%
Occupation		
Farmer	72	53%
Formal employment	18	13%
Labourer	3	2%
Self employed	17	13%
Unemployed	26	19%

(*Continued*)

Table 1 (Continued).

Variables	n	Percent
Frequency of Physical Exercise		
Daily	19	14%
Monthly	19	14%
Never	73	54%
Weekly	25	18%
Smoking Status		
Current	24	18%
Former	32	23%
Never	80	59%
Alcohol Consumption		
Daily	32	23%
Monthly	12	9%
Never	43	32%
Weekly	49	36%
Pesticide/Insecticide Exposure		
High Exposure	52	38%
Low Exposure	2	2%
No Exposure	82	60%
Frequency of Sexual Activity		
Daily	13	10%
Monthly	49	29%
Rarely	27	20%
Weekly	56	41%
Vegetable and Fruit Consumption		
Occasional	49	36%
Rarely	46	34%
Regularly	41	30%
Fat Rich or fried Food Consumption		
Occasional	30	22%
Rarely	67	49%
Regularly	39	29%

(*Continued*)

Table 1 (Continued).

Variables	n	Percent
Protein Rich Foods Consumption		
Occasional	20	15%
Rarely	104	76%
Regularly	12	9%
Energy Rich Foods Consumption		
Occasional	14	10%
Rarely	11	8%
Regularly	111	82%

Lifestyle and Demographic Characteristics of Study Participants

The median age of participants was 53 years (IQR: 46.5–63), with most aged between 40–59 years (67%). Participants exhibited diverse lifestyle behaviours. The majority were married (87%), and farmers constituted the largest occupational group (53%), followed by the unemployed (19%) and self-employed (13%). In terms of physical activity, over half of the respondents (54%) reported never exercising, while only 14% exercised daily. Smoking was prevalent, with 18% being current smokers and 24% being former smokers. Regarding alcohol use, 24% consumed alcohol daily, while 36% drank weekly, and 32% reported complete abstention. Sexual activity patterns varied, with 41% engaging in intercourse weekly and 29% monthly. Diet quality showed substantial variation: only 30% reported regular consumption of vegetables and fruits, and 29% regularly consumed fat-rich or fried foods. Intake of protein-rich foods was low, with just 9% reporting regular consumption. Conversely, energy-rich food consumption was high, with 82% consuming such foods regularly. Lastly, 38% reported high exposure to pesticides or insecticides, indicative of significant environmental exposure, possibly occupational. The mean BMI was 22.2 ± 4.6 kg/m^2, with nearly 25% being underweight, 20% overweight, and 7% obese. The lifestyle and clinicodemographic characteristics of the study participants are presented in Tables 1 and 2 respectively.

Table 2 Clinicodemographic Characteristics of Study Participants

Variables	n (%)/Mean (SD)/Median (IQR)
Total PSA ng/mL	
Median (IQR)	2.11 (1.0–3.31)
PSA Category n (%)	
Normal ≤ 4.0 ng/mL	117 (86)
High > 4.0 ng/mL	19 (14)
PSA Category ng/mL	
0–2.5	81 (60)
2.6–4.0	36 (26)
4.1–10	7 (5)
> 10	12 (9)

(*Continued*)

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Table 2 (Continued).

Variables	n (%)/Mean (SD)/Median (IQR)
Age (years)	
Median (IQR)	53 (46.5–63)
Age Category n (%)	
40–49	51 (37.5)
50–59	40 (29.4)
60–69	36 (26.5)
≥ 70 years	9 (6.6)
BMI (kg/m^2)	
Mean (SD)	22.2 ± 4.6
BMI Category n (%)	
Normal	65 (48)
Obese	10 (7)
Overweight	27 (20)
Underweight	34 (25)

Abbreviations: PSA, Prostate Specific Antigen; BMI, Body Mass Index; IQR, Interquartile Range; SD, Standard Deviation.

PSA Distribution and Prevalence of Elevated Levels

PSA distribution revealed that 14% (n =19) of the study population had elevated serum PSA levels (> 4.0 ng/mL). The median serum PSA was 2.11 ng/mL (IQR: 1.0–3.31). Stratified PSA levels showed 60% had PSA levels between 0–2.5 ng/mL, 27% between 2.6–4.0 ng/mL, 5% between 4.1–10.0 ng/mL, and 9% had levels exceeding 10 ng/mL. The serum PSA was stratified into "Normal" and "High" based on a PSA cut off point of 4.0 ng/mL. The correlates of elevated PSA were then determined using the Chi-square test or Fisher's exact test. The results are presented in Table 2.

Correlates of Elevated Serum PSA Levels

The analysis revealed several characteristics that were significantly associated with elevated PSA levels (Table 3). Notably, BMI category showed a strong association, with elevated PSA being most prevalent among underweight participants (74%) and least common among those with a normal BMI (16%), a difference that was statistically significant ($p < 0.001$). Smoking status also demonstrated a significant relationship with elevated PSA levels, with current smokers (18%) and former smokers (32%) being more likely to have elevated PSA compared to those who never smoked (21%), $p < 0.001$. Furthermore, alcohol use was strongly associated with elevated PSA, particularly among daily drinkers (68%), $p < 0.001$. Physical activity frequency was another factor that showed a notable association, with a higher proportion of individuals with elevated PSA (74%) reporting that they never exercised. Additionally, sexual activity frequency was linked to PSA levels, with those who had infrequent sexual activity (monthly or rarely) showing higher PSA levels compared to those who were sexually active on a weekly basis (32% vs 11%), $p = 0.018$. Demographic factors such as marital status, age category, pesticide exposure, and dietary habits did not reach statistical significance. However, in multivariable models men within 60–69 age range were independently associated with elevated PSA [cOR: 4.3 (CI 1.1–17.6), p value = 0.041, aOR: 1071 (CI 1.87–611,056.3), p value = 0.031] compared to men aged 40–49 years. Regression results are presented in Supplementary Table S1. Some adjusted odds ratios are large with wide confidence intervals, reflecting sparse data and potential model instability; this should be interpreted with caution.

Table 3 Correlates of Serum PSA Levels

Variables	Serum PSA Categories n (%)		*P*-value
	Normal ≤ 4.0 ng/mL (n = 117)	High > 4.0 ng/mL (n = 19)	
Age Category (Years)			
40–49	48 (41)	3 (16)	0.152
50–59	33 (28)	7 (37)	
60–69	28 (28)	8 (42)	
≥ 70	8 (7)	1 (5)	
BMI Category			
Normal	62 (53)	3 (16)	< 0.001*
Obese	9 (8)	1 (5)	
Overweight	26 (22)	1 (5)	
Underweight	20 (17)	14 (74)	
Sexual Intercourse Frequency			
> 3 times a week	9 (8)	4 (21)	0.018*
Monthly	33 (28)	7 (37)	
Rarely	21 (18)	6 (32)	
Once weekly	54 (46)	2 (10)	
Tobacco Smoking Status			
Current	15 (13)	9 (47)	< 0.001*
Former	26 (22)	6 (32)	
Never	76 (65)	4 (21)	
Alcohol Consumption			
Daily	19 (16)	13 (68)	< 0.001*
Monthly	11 (9)	1 (5)	
Never	41 (35)	2 (11)	
Weekly	46 (39)	3 (16)	
Pesticide/Insecticide Exposure			
Highly Exposed	45 (39)	7 (37)	0.833
Low Exposure	2 (2)	0 (0)	
Not Exposed	70 (60)	12 (63)	
Marital Status			
Not in Union	16 (14)	1 (5)	0.304
Married	101 (86)	18 (95)	

(*Continued*)

Table 3 (Continued).

Variables	Serum PSA Categories n (%)		*P*-value
	Normal ≤ 4.0 ng/mL (n = 117)	**High > 4.0 ng/mL (n = 19)**	
Occupational Status			
Farmer	66 (56)	6 (32)	< 0.001*
Formally employed	17 (15)	1 (5)	
Labourer	1 (1)	2 (11)	
Self-employed	16 (14)	1 (5)	
Unemployed	17 (15)	9 (47)	
Frequency of Physical Exercises			
Daily	18 (15)	1 (5.3)	0.287
Monthly	17 (15)	2 (10.5)	
Never	59 (50)	14 (73.7)	
Weekly	23 (20)	2 (10.5	
Frequency of Fatty or Fried Food Consumption			
Occasionally	25 (21)	5 (26)	0.226
Rarely	61 (52)	6 (32)	
Regularly	31 (27)	8 (42)	
Frequency of Protein Rich Foods Consumption			
Occasionally	18 (15)	2 (11)	0.914
Rarely	88 (75)	16 (84)	
Regularly	11 (9)	1 (5)	
Frequency of Energy Rich Foods Consumption			
Occasionally	13 (11)	1 (5)	0.892
Rarely	10 (9)	1 (5)	
Regularly	94 (80)	17 (90)	

Notes: *Significance was set at 0.05.
Abbreviations: BMI, Body Mass Index; PSA, Prostate Specific Antigen.

Discussion

Our study sought to determine the prevalence and correlates of elevated serum total PSA levels (> 4.0 ng/mL) in asymptomatic men. The median age of participants in this study was 53 years, which may appear relatively young compared to global prostate cancer screening cohorts.[16–18] This finding likely reflects the demographic characteristics of men attending outpatient services and the low uptake of preventive screening among older men in Rwanda. Previous studies have shown that older men in SSA often seek healthcare only when symptomatic, influenced by cultural norms, socioeconomic barriers, and limited awareness of preventive health services.[19–21] These factors may explain the under-representation of older men in our sample and highlight the need for targeted awareness campaigns to improve screening uptake among high-risk age groups.

Although most of the study cohort had PSA levels within the normal range, a considerable 14% displayed levels greater than 4 ng/mL. Our results further demonstrated notable relationships between PSA levels and several key factors. Body mass index category, frequency of sexual activities, smoking status, alcohol consumption and occupation were strongly linked to elevated PSA levels. These individuals with elevated PSA levels warrant further evaluation, as such readings may suggest underlying conditions like prostate cancer or benign prostatic hyperplasia.[3]

The proportion of patients with high PSA levels in this study, is similar to another study that reported the percentage of black men with a PSA > 4.0ng/mL as 14% although that study focused on men aged 65+.[4] This finding from the present study is also comparable to results of study in a rural community of Edo State, Nigeria that reported a 16% prevalence rate of PSA > 4 ng/mL among men 50 years and older.[5] Another US-based study found that approximately 6% of men aged > 40 years had a PSA level of > 4.0 ng/mL.[6] Given the age-related increase in PSA levels and prostate size, our findings indicate that further investigation is warranted to determine the underlying cause of elevated PSA levels, which could be indicative of prostate cancer or benign prostatic hyperplasia.[6,22] Therefore, promoting PSA screening within the general population for prostate cancer detection is advisable, and prostate biopsies should be considered for individuals exhibiting elevated PSA levels.[7]

The significant association between elevated serum PSA levels and advancing age is a well-established fact in both urology and oncology.[3] In the present study, men within 60–69 age range were independently associated with elevated PSA compared to men aged 40–49 years. This corroborates the findings of previous studies.[7,8] Surprisingly, PSA levels appeared to be significantly higher in underweight individuals compared to other BMI categories in the present study. This is contrasts with the widely recognized inverse relationship between obesity and PSA.[9,10] However, physiological conditions associated with lower body mass like dehydration and poor nutritional status are believed to cause haemo-concentration that may result in perceived elevated PSA levels.[15,23] Furthermore, pre-existing conditions often seen in individuals with lower body weight, such as chronic inflammatory states, endocrine disorders, and cancer cachexia, can independently contribute to high PSA levels.[24,25] This suggests that in these cases, the elevated PSA may not be solely due to body weight changes but rather a symptom of these underlying health issues.

Men who engaged in sexual intercourse at least once a week had lower PSA compared to those who engaged in sexual intercourse monthly or after longer durations (11% vs 32% elevated). This may reflect mechanical clearance of prostatic fluid or differential androgen milieu, but warrants confirmation in longitudinal studies.[26,27] Occupation revealed a strong association with elevated PSA levels with unemployed participants and farmers being the most affected categories. These findings suggest that unemployed men may face financial barriers to accessing routine medical check-ups, including PSA screenings.[22] Consequently, they might only seek medical attention once symptoms become noticeable, potentially leading to the detection of elevated PSA levels at a more advanced stage.[22] On the other hand, farmers may be exposed to insecticides/pesticides, chemical fertilizers, organic dusts, solvents, diesel exhaust fumes, and mycotoxins from crops.[28] These substances can cause hormonal dysfunction disrupting the normal function of prostate or may cause direct damage to prostatic cells leading to a high level of serum PSA.[29–31] Besides pesticide exposure, farmers in our cohort reported chronic lifting of heavy farm produce packages and prolonged sitting on hard tractor seats-mechanical factors that can induce chronic prostatic inflammation and raise PSA independently of chemical exposure.[32,33] Furthermore, lifestyle choices like smoking habit and alcohol consumption were significantly associated with high serum PSA levels. Available data suggest that smoking affects different hormones in the body[34] which in turn may increase the levels of serum PSA.[35,36] Another contributing factor to the observed serum PSA levels might be differences in healthcare-seeking behaviour between smokers and non-smokers. It is plausible that non-smokers are more inclined to seek regular medical check-ups, including PSA screenings, compared to smokers.[37] This could lead to earlier detection of prostate conditions and, consequently, earlier intervention or corrective measures for non-smokers. Conversely, if smokers are less likely to undergo PSA check-ups, any underlying prostate issues might go undiagnosed or unmanaged for longer periods, potentially leading to higher PSA levels when they eventually do get tested. On the other hand, alcohol intake has always been associated with low PSA levels.[38,39] The perceived high levels in this study may reflect the long-term, chronic effects of alcohol on prostate health in this specific cohort.[40] It is believed that the combined biological effects of alcohol such as inducing oxidative stress, impairing immune surveillance and disrupting hormonal balance which are all linked to prostate pathologies might be the reason of elevated PSA levels in this

particular population.[41] Furthermore, unmeasured confounders or unique genetic and environmental factors within our study population in Rwanda could contribute to this observed relationship.

This study is the first in Rwanda to report the prevalence of elevated serum PSA levels among asymptomatic men and to explore associations with modifiable lifestyle factors. These findings are particularly important in a context where PCa incidence is rising,[2,13] yet systematic screening programs remain absent and awareness low.[42,43] Establishing baseline PSA patterns and identifying risk factors provide critical evidence for policymakers and clinicians to design targeted screening strategies and preventive interventions tailored to Rwanda's population. Furthermore, this work contributes to the broader understanding of PCa risk in SSA, where late-stage diagnosis[44–46] and limited diagnostic infrastructure are major challenges.[44,47] Although clinical follow-up to confirm prostate pathology, was not included in this manuscript, the study lays a foundation for future longitudinal research and informs health education initiatives aimed at improving early detection and reducing prostate cancer burden in Rwanda.

This study has several limitations that should be considered when interpreting the findings. First, the cross-sectional design precludes establishing causal relationships between lifestyle factors and PSA elevation. Second, the sample size was relatively small (n = 136), primarily due to resource constraints and the limited pool of eligible participants during the study period, which restricts generalizability. Third, reliance on self-reported lifestyle data introduces potential recall and social desirability bias, which may affect the accuracy of reported behaviors. Importantly, PSA was measured only once, and no clinical follow-up or biopsy confirmation was included in this manuscript. Fourth, as this was a single-centre survey, the sample may not adequately represent the national population, which limits external validity. Multi-site studies are needed to confirm the generalisability of these findings. While participants with elevated PSA were notified and referred for further evaluation, these follow-up results will be reported in future work. The rationale for publishing this initial analysis is to provide foundational data on PSA prevalence and associated risk factors in Rwanda, where such information is scarce. These findings can inform public health strategies and guide the design of larger, longitudinal studies that incorporate confirmatory diagnostics and repeated PSA measurements.

Conclusion

Our study underscores the multifactorial nature of elevated PSA levels, highlighting the interplay of demographic, physiological, occupational, and lifestyle factors. The significant proportion of individuals with elevated PSA, particularly in older age groups, underweight individuals, the unemployed, and farmers, necessitates targeted public health interventions. Promoting PSA screening in the general population, especially for those at higher risk, and considering prostate biopsies for individuals with elevated levels are crucial steps for early detection and management of prostate-related conditions. Further research is warranted to elucidate the precise mechanisms underlying the observed associations, particularly regarding BMI, occupation, and the nuanced impact of lifestyle choices on PSA levels.

Abbreviations

BMI, Body Mass Index; DRE, Digital rectal examination; ELISA, Enzyme-Linked Immunosorbent Assay; IQR, Interquartile Range; PCa, Prostate cancer; PSA, Prostate Specific Antigen; SD, Standard Deviation.

Data Sharing Statement

All data generated in this study are included in this manuscript. However, the dataset will be made available by the corresponding author (nzitakera@gmail.com) upon reasonable request.

Ethics Approval and Consent to Participate

All study procedures were conducted in accordance with the ethical principles outlined in the Declaration of Helsinki. Ethical approval was obtained from the University of Rwanda Institutional Review Board (Reference No. CMHS/IRB/044/2025). Additionally, authorization for data collection at the study site was granted by the Education and Research Committee of Kabutare District Hospital (Reference No. 70-A/02/Hop.Kab/2025).

All participants provided written informed consent after receiving comprehensive information about the study's objectives, procedures, potential risks, and anticipated benefits. To maintain confidentiality, each participant was assigned a unique study identification code unrelated to personal identifiers. Physical records were securely stored in locked cabinets accessible only to authorized personnel, while electronic data were encrypted, password-protected, and accessible solely to the principal investigators.

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Author Contributions

All authors made a significant contribution to the work reported, whether that is in the conception, study design, execution, acquisition of data, analysis and interpretation, or in all these areas; took part in drafting, revising or critically reviewing the article; gave final approval of the version to be published; have agreed on the journal to which the article has been submitted; and agree to be accountable for all aspects of the work.

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