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Association Between Prostate-Specific Antigen Levels, Age, and Gleason Score Among Patients with Prostate Cancer: A Cross-Sectional Study

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Abstract: Background: *Prostate cancer continues to be a leading source of cancer-related morbidity and mortality, and it is one of the most common cancers among men globally. The diagnosis, prognosis, and treatment of prostate cancer depend heavily on Gleason grading and prostate-specific antigen (PSA) testing.* ***Objective:*** *To evaluate the relationship between serum PSA levels, age, and Gleason score among patients diagnosed with prostate cancer.* ***Methods:*** *A descriptive cross-sectional study was conducted among 100 prostate cancer patients attending National Cancer Institute at wad Madani, Gezira state, Sudan during the period between 2023 – 2024. Data were analyzed using the Statistical Package for Social Sciences (SPSS). Variables included age groups, PSA levels, and Gleason scores. Descriptive statistics, analysis of variance (ANOVA), and Pearson correlation analysis were used to assess associations between variables.* ***Results:*** *The majority of patients were aged 61–70 years (47%), followed by 71–80 years (32%) and 50–60 years (21%). PSA categories revealed that 20% of patients had PSA levels within the grey zone (4–10 ng/mL), 38% had PSA levels suggestive of probable prostate cancer (11–20 ng/mL), and 42% had PSA levels suggestive of metastatic tumor (>20 ng/mL). Gleason score distribution demonstrated that Gleason score three was the most common (42%), followed by score five (19%), score two (18%), score four (16%), and score one (5%). Mean PSA levels increased slightly with age but the difference was not statistically significant (P = 0.589). Similarly, PSA levels across Gleason score groups showed no statistically significant variation (P = 0.281). Pearson correlation analysis demonstrated a weak positive correlation between age and PSA (r = 0.124, P = 0.219), a very weak positive correlation between age and Gleason score (r = 0.040, P = 0.696), and a statistically significant weak negative correlation between PSA and Gleason score (r = −0.213, P = 0.033).* ***Conclusion:*** *The results show that patients with prostate cancer frequently have increased PSA values, especially those in older age groups. A strong negative connection was seen between PSA and Gleason score, however neither age nor Gleason score categories were substantially correlated with PSA levels. PSA testing is still a crucial clinical indicator for assessing and tracking prostate cancer.*

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Keywords:
Prostate cancer, PSA, Gleason score, prostate-specific antigen, age, prostate carcinoma.

Introduction:

Prostate cancer is one of the most prevalent malignancies affecting men worldwide and represents a major public health issue. The incidence of this condition rises noticeably with age, and it primarily affects older men. Despite recent improvements in diagnostic and treatment methods, prostate cancer continues to be a leading cause of cancer-related mortality globally [1,2]. The prostate gland's epithelial cells produce the glycoprotein enzyme known as prostate-specific antigen (PSA). PSA testing is one of the most common laboratory tests for prostate cancer screening, diagnosis, monitoring, and prognosis. Elevated blood PSA levels may indicate prostate cancer, although benign prostatic hyperplasia and prostatitis can also cause elevated PSA. Even with its limited specificity, PSA remains a valuable biomarker in clinical settings [3,4]. The foundation for the histological assessment of prostate cancer is the Gleason grading system. It evaluates glandular architectural patterns and provides crucial prognostic information regarding tumor aggressiveness and clinical outcomes. Poorly differentiated tumors, advanced disease, and a higher likelihood of metastasis are generally associated with higher Gleason scores [5,6]. Numerous studies have investigated the relationship between PSA levels and Gleason score; however, results remain inconsistent. While some research has demonstrated positive associations between higher Gleason scores and rising PSA levels, other studies have found weak or nonexistent correlations. Understanding the relationship among these variables could enhance diagnostic accuracy and patient management [7,8]. Therefore, the purpose of this study was to assess serum PSA levels in patients with prostate cancer and determine how they relate to Gleason score and age [9,10].

Materials and Methods:

Study Design: A descriptive cross-sectional study was conducted to evaluate the association between PSA levels, age, and Gleason score among prostate cancer patients.

Study area and duration: Study was conducted at National Cancer Institute at wad Madani, Gezira state, Sudan during the period between 2023 – 2024.

Study Population: The study included 100 patients diagnosed with prostate cancer. Participants were categorized according to age groups, PSA levels, and Gleason scores.

Data Collection: Data were collected from patient laboratory and pathological records. **Variables included:**

- Age groups
- Serum PSA levels
- Gleason scores

PSA levels were categorized as follows:

- 4–10 ng/mL: Grey zone
- 11–20 ng/mL: Probability of prostate cancer
- 20 ng/mL: Probability of metastatic tumor

Statistical Analysis: Data were analyzed using SPSS software. Descriptive statistics including frequencies, percentages, means, and standard deviations were calculated. Analysis of variance (ANOVA) was used to compare mean PSA levels among age groups and Gleason score categories. Pearson correlation analysis was used to determine relationships between variables. Statistical significance was considered at $P < 0.05$.

Results:

Distribution of Study Population According to Age:

Among the 100 prostate cancer patients included in the study, the majority belonged to the 61–70 years' age group representing 47% of participants. Patients aged 71–80 years accounted for 32%, while those aged 50–60 years represented 21%.

Table 1: Distribution of Participants According to Age

Age Group	Frequency	Percentage
50–60 years	21	21.0%
61–70 years	47	47.0%
71–80 years	32	32.0%
Total	100	100.0%

Distribution of PSA Categories

PSA category analysis demonstrated that 42% of patients had PSA levels greater than 20 ng/mL, suggesting possible metastatic disease. Patients with PSA levels between 11–20 ng/mL represented 38%, while 20% were within the grey zone (4–10 ng/mL).

Table 2: Distribution of PSA Categories

PSA Category	Frequency	Percentage
4–10 ng/mL (Grey zone)	20	20.0%
11–20 ng/mL (Probability of PCa)	38	38.0%
>20 ng/mL (Probability of metastatic tumor)	42	42.0%
Total	100	100.0%

Distribution of Gleason Scores

Gleason score three was the predominant category accounting for 42% of cases. Gleason score five represented 19%, score two represented 18%, score four represented 16%, and score one represented 5%.

Table 3: Distribution of Gleason Scores

Gleason Score	Frequency	Percentage
One	5	5.0%
Two	18	18.0%

Three	42	42.0%
Four	16	16.0%
Five	19	19.0%
Total	100	100.0%

Relationship Between Age and PSA Levels

Mean PSA levels increased gradually with age. Patients aged 50–60 years had a mean PSA level of 18.00 ± 9.545 ng/mL, while patients aged 61–70 years had a mean PSA of 20.45 ± 10.782 ng/mL. The highest mean PSA level was observed among patients aged 71–80 years (20.78 ± 10.015 ng/mL). However, the association was not statistically significant (P = 0.589).

Table 4: PSA Levels According to Age Groups

Age Group	N	Mean PSA	Standard Deviation	P-value
50–60 years	21	18.00	9.545	0.589
61–70 years	47	20.45	10.782	
71–80 years	32	20.78	10.015	
Total	100	20.04	10.245	

Relationship Between Gleason Score and PSA Levels

Patients with Gleason score one had the highest mean PSA level (22.80 ± 11.904 ng/mL), followed by Gleason score two (22.78 ± 10.752 ng/mL). Lower mean PSA levels were observed among Gleason score five patients (15.74 ± 7.694 ng/mL). Statistical analysis demonstrated no significant association between PSA levels and Gleason score categories (P = 0.281).

Table 5: PSA Levels According to Gleason Score

Gleason Score	N	Mean PSA	Standard Deviation	P-value
One	5	22.80	11.904	0.281
Two	18	22.78	10.752	
Three	42	20.50	11.046	
Four	16	20.00	9.158	
Five	19	15.74	7.694	
Total	100	20.04	10.245	

Correlation Analysis

Pearson correlation analysis demonstrated a weak positive correlation between age and PSA levels (r = 0.124), which was not statistically significant (P = 0.219). A very weak positive correlation was observed between age and Gleason score (r = 0.040, P = 0.696). Interestingly, a statistically significant weak negative correlation was found between PSA levels and Gleason score (r = −0.213, P = 0.033).

Table 6: Correlation Between Age, PSA, and Gleason Score

Variable	Correlation Coefficient (r)	P-value
Age vs PSA	0.124	0.219
Age vs Gleason score	0.040	0.696
PSA vs Gleason score	-0.213	0.033*

*Statistically significant at P < 0.05.

Discussion:

Among older men worldwide, prostate cancer continues to be one of the most common cancers. According to the established epidemiological distribution of prostate cancer, the majority of patients in this study were between the ages of 61 and 70 years. This finding aligns with earlier research indicating that increasing age is one of the most significant risk factors for the development of prostate cancer [11,12]. The current results demonstrated that a substantial percentage of patients had markedly elevated PSA levels, with 42% exhibiting PSA concentrations higher than 20 ng/mL. Advanced disease and a higher tumor burden are frequently associated with elevated PSA levels. For patients with prostate cancer, PSA remains a crucial biomarker for early detection, diagnosis, monitoring, and treatment assessment [13,14]. Mean PSA concentrations gradually increased with age according to the analysis of PSA levels by age group. However, this correlation was not statistically significant. This result may suggest that PSA elevation in prostate cancer patients is influenced by multiple factors, including tumor biology, inflammation, prostate volume, and disease stage [15,16]. Regarding Gleason score distribution, the majority of patients had a Gleason score of three. The Gleason grading system is an essential histological tool for determining tumor aggressiveness and guiding treatment decisions. Higher Gleason scores are typically linked to increased metastatic potential and a poorer prognosis [17,18]. No statistically significant correlation was observed in this investigation between Gleason score categories and PSA levels. However, correlation analysis revealed a statistically significant weak negative relationship between PSA and Gleason score. This finding contrasts with several studies that reported a positive correlation between PSA levels and tumor aggressiveness. The disparity may be explained by variations in sample size, patient characteristics, tumor heterogeneity, or the presence of advanced disease in certain patient subgroups [19,20]. Because PSA production may increase with age due to changes in prostate tissue architecture and the increased prevalence of prostate pathology among older individuals, the study's weak positive correlation between age and PSA levels is biologically plausible [21,22]. Overall, the current study emphasizes the clinical significance of both Gleason grading and PSA measurement in the assessment of prostate cancer. Combining histopathological evaluation with serum biomarker testing may enhance patient care and disease stratification [23,24].

Conclusion:

The current study showed that older men, especially those between the ages of 61 and 70, are more likely to get prostate cancer. Participants in the study frequently had elevated PSA readings, with a significant percentage exhibiting PSA values indicating of advanced illness. A statistically significant weak negative link was found between PSA and Gleason score, but no statistically significant correlations were found between PSA levels and age groups or Gleason score categories. PSA testing is still a useful indicator for the detection and tracking of prostate cancer. Important prognostic information is provided by the integration of PSA assessment with Gleason grading, which may help physicians make treatment decisions and control diseases.

Recommendations:

1. Routine PSA screening should be encouraged among elderly men and high-risk populations for early detection of prostate cancer.
2. Combined evaluation of PSA levels and Gleason score should be used for improved prognostic assessment.
3. Larger multicenter studies are recommended to further investigate the relationship between PSA and Gleason score.
4. Additional biomarkers should be explored to improve diagnostic specificity and prognostic accuracy.

Limitations of the Study:

- The study included a relatively small sample size.
- The cross-sectional design limited causal interpretation.
- Clinical staging and treatment history were not included.
- Other potential prognostic biomarkers were not evaluated.

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