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Research Article

Ethnic Disparities in Age-Stratified Prostate-Specific Antigen (PSA) Elevations: A Comparative Analysis Using Fixed and NICE-Adjusted Thresholds in the UK Population

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Abstract

Introduction: Prostate cancer disproportionately affects Black men, who experience higher incidence and mortality compared to White men. Prostate-Specific Antigen (PSA) testing remains central to screening, yet uniform thresholds may obscure risk in high-risk populations. Understanding ethnic differences in PSA elevation rates is critical to improving equity in early detection.

Methods: A database of healthy volunteers who had previously attended healthcare screening was analyzed. PSA levels were available for 234 participants; however, 37 individuals lacking date of birth information were excluded, to allow accurate age-related stratification. The final cohort comprised 197 participants (54 Black and 143 White), with demographic categories self-reported at screening. All data were anonymized prior to analysis. PSA levels were treated as continuous variables, and race/ethnicity was categorized for subgroup comparisons.

Results: The mean PSA concentration in the Black men was 6.373 ng/mL compared to the mean PSA concentration in the White men of 3.727 ng/m, showing a high level of statistical significance. Using the fixed PSA threshold, among Black men in the dataset, the likelihood of having a PSA concentration above 5 ng/ml increased steadily with age. In those younger than 40 years, only a small proportion showed elevated PSA. By the age of 40-49 years, about one in five had raised levels, and this proportion rose further in the 50-59 and 60-69 age groups, where roughly one quarter of men were affected. In contrast, White men showed a more stable pattern across age groups. Fewer than one in ten men aged 40-49 years had elevated PSA, and in the 50-59 age group the proportion was modestly higher. However, in the 60-69 and 70-79 age groups, the proportion remained around one in seven.

Applying NICE age-adjusted thresholds, Among Black men, elevated PSA values were seen increasingly with age. In those younger than 40 years, nearly one in five had a PSA above the 2.5 ng/ml threshold. In the 40-49 age group, just over one quarter were above the same threshold. By ages 50-59, more than one in three exceeded the 3.5 ng/ml cut-off, and in the 60-69 group, over two in five had PSA levels above 4.5 ng/ml. This demonstrates a progressive rise in PSA elevation with age, reaching over 40% in the oldest group assessed.

In White men, the pattern was different. In the 40-49 age group, fewer than one in five had PSA above 2.5 ng/ml. In the 50-59 group, one quarter exceeded the 3.5 ng/ml threshold. However, in the 60-69 group, only about one in seven had PSA above 4.5 ng/ml, and in the 70-79 group, the proportion fell further to around one in sixteen above the 6.5 ng/ml threshold.

Conclusion: These findings highlight consistently higher PSA levels among Black men across all age groups, with steeper age-related increases. The results reinforce the need for ethnicity- and age-sensitive screening strategies to improve risk stratification, referral, and equity in prostate cancer detection and outcomes.

Keywords: PSA, Prostate cancer, Ethnicity, Black men, NICE thresholds, Screening disparities

Introduction

Prostate cancer disproportionately affects Black men, with higher incidence and mortality rates. PSA testing remains a key screening tool, but uniform thresholds may obscure risk in high-risk populations. In the United States, Black men face roughly double the risk of being diagnosed with and dying from prostate cancer compared to white men [1]. In the United Kingdom, despite distinct ancestral backgrounds and healthcare systems from their American counterparts, Black British men still experience a lifetime risk two to three times greater of developing prostate cancer than white British men. Additionally, their mortality rate from the disease is twice as high as that of white British men [2]. A total of 730,515 men underwent PSA testing, with 88.9% identifying as White. Black men and those of mixed ethnicity exhibited higher PSA levels, particularly among individuals over 60 years old. Within a year of receiving an elevated PSA result (based on age-specific thresholds), prostate cancer incidence was highest among Black men at 24.7% (95% CI 23.3%, 26.2%), while Asian men had the lowest rate at 13.4% (12.2%, 14.7%). For White men, incidence was recorded at 19.8% (19.4%, 20.2%). Across all groups, the peak occurrence of prostate cancer was observed in men aged 70-79 [3].

Prostate cancer screening, typically through Prostate-Specific Antigen (PSA) testing, is a topic of considerable debate. According to Cancer Research UK (2020), Black men are 1.5 to 2 times more likely to develop prostate cancer than White men. The mortality rate also reflects this disparity, with Black men having a higher likelihood of dying from the disease. Factors contributing to this increased risk may include genetic predisposition, socioeconomic status, and access to healthcare services [4]. NICE does not recommend a national PSA screening programme in the UK. Instead, PSA testing is available to men who request it, with guidance focused on symptomatic referral (NG12) and asymptomatic counselling from the Prostate Cancer Risk Management Programme (PCRMP). Men over 50 can ask their GP for a PSA test, but they should first be counselled on the risks and benefits. [5,6]. This study looked at the PSA results of two community groups - black and white men [7] - in the UK who had PSA included in their health screen checks and looked to stratifying the men into age groups of <40 years, 40-49 years, 50-59 years, 60-69 years and 70-79 years.

Methods

Study Population

A database of healthy volunteers who had previously attended healthcare screening was utilized for this analysis. The database contained information on 234 participants, each of whom had Prostate-Specific Antigen (PSA) levels recorded as part of their screening profile.

Inclusion and Exclusion Criteria

Participants were included if they had complete demographic and laboratory data available. A total of 37 individuals did not have their date of birth recorded, and these cases were excluded from the analysis to ensure accurate age-related stratification. Following this exclusion, data from 197 participants remained eligible for analysis.

Demographic Characteristics

The final study cohort consisted of 54 Black participants and 143 White participants. These demographic categories were self-reported at the time of screening and were used to stratify the dataset for comparative analysis.

Data Handling

All data were retrieved from the screening database and anonymized prior to analysis. PSA levels were treated as continuous variables, while demographic information (race/ethnicity) was categorized for subgroup comparisons. Exclusion criteria were applied consistently across the dataset to minimize bias and ensure reproducibility.

PSA Sample Measurement

The sample used in this population was capillary blood. PSA measurements were obtained from participants using the Boditech iCHROMA™ PSA immunoassay, a point-of-care fluorescence lateral flow device. This study focused on the relationship between age and PSA levels.

The study population was evaluated using two different thresholds for elevated PSA levels: fixed threshold (> 5.0 ng/ml) and the NICE thresholds described below:

NICE PSA Thresholds

<40 years: Use clinical judgement (for this study we used 2.5 ng/mL); 40-49 years: PSA >2.5 ng/mL; 50-59 years: PSA >3.5 ng/mL; 60-69 years: PSA >4.5 ng/mL; 70-79 years: PSA >6.5 ng/mL; >80 years: Use clinical judgement (for this study we used 6.5 ng/mL).

The samples were measured using the Boditech iCHROMA™ POCT device. For data Integrity and comparability, all the PSA results, had been measured by the same device and method, thereby eliminating inter-assay variability and age-linked results allow contextual interpretation against age-specific reference ranges and risk thresholds. In addition, the Boditech iCHROMA™ platform provides quantitative PSA values very well validated and it is the only PSA point of care testing device in the UKNEQAS (Figure 1).

iCHROMATM

The Boditech iCHROMA™ PSA method is a well validated method. Our previous study determined the performance of the iCHROMA™ using the RIQAS and UKNEQAS quality control schemes with other PSA methods (Abbott Architect, Beckman Access standardised to WHO, Beckman DXI standardised to Hybritech, Ortho Vitros, Roche Modular E-170, Roche Elecsys, Siemens Advia Centaur, Siemens Immulite 1000, Roche Cobas, Abbott Axsym Monoclonal,

Abbott Axsym polyclonal, BioMerieux Vidas, Siemens Centaur XP/XPT/Classic, Siemens/Dade Dimension, Siemens Immulite 2000/2500, Siemens Immulite 1000, Siemens Immulite 2000 /2500 3rd generation, DiaSorin, Liaison, Monobind Inc. ELISA/ CLIA, Roche COBAS® 4000/e411, Beckman DXI standardised to WHO IRP96/670). It exhibited a bias in RIQAS that was in the order of -2.99ng/ml to +6.8ng/ml, with an average of +0.88ng/ml. The UKNQEAS, on the other hand, displayed bias between +0.53 and +2.58ng/ml, with an average of +1.46ng/ml (4). Over 50% of the RIQAS and UKNEQAS approaches revealed a positive bias greater than 1.0 ng/ml for all the methods used. Both studies showed positive bias, but this present study revealed lower positive bias, below 1.0ng/ml. In addition, the iCHROMA™ PSA method correlated very well with Roche PSA methods [8-10] (Figure 1).

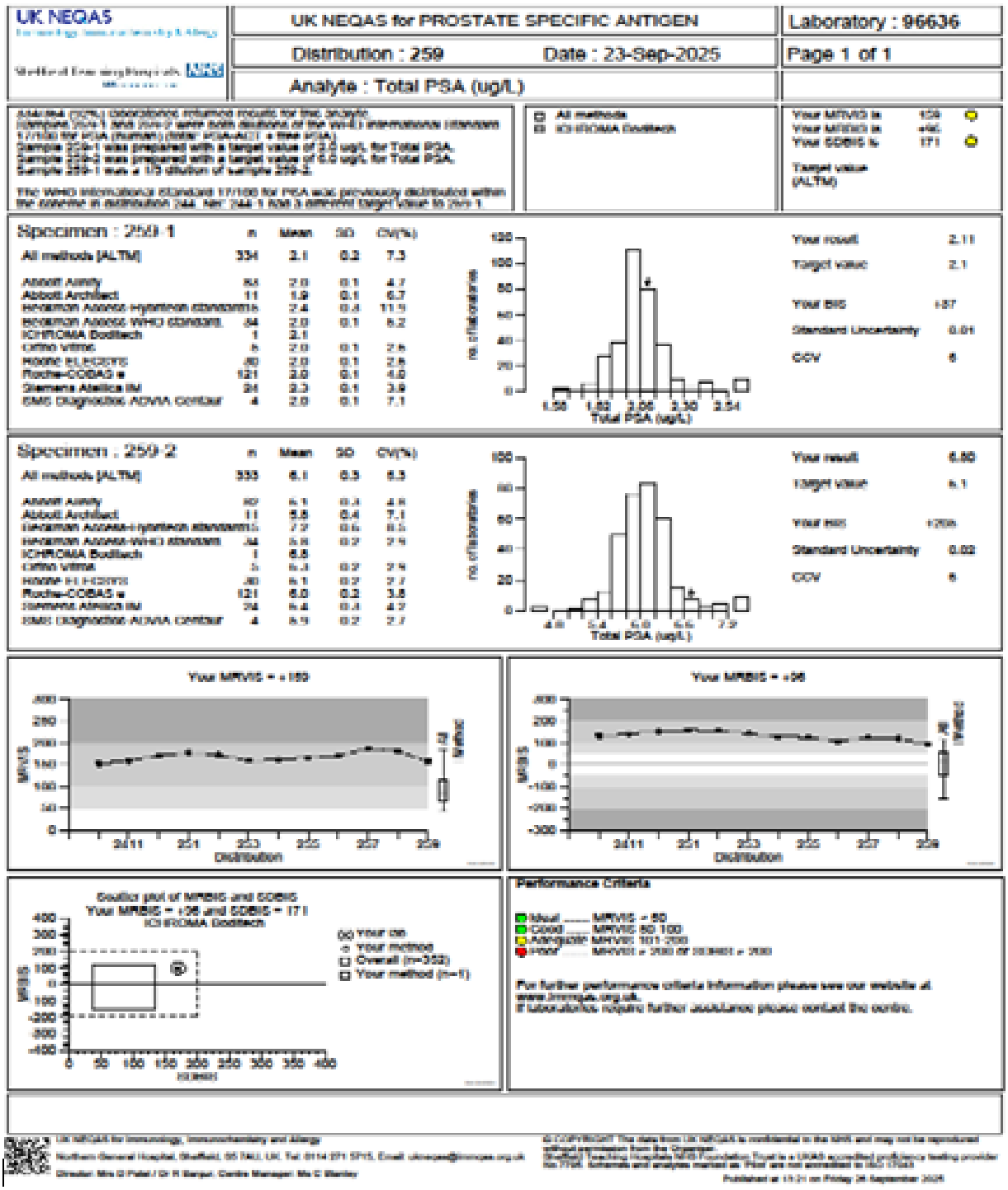

Figure 1: UK NEQAS for Prostate specific antigen report, showing Boditech iCHROMA™ result amongst other methods.

The iCHROMA™ POCT PSA method is a quantitative assay for measuring total PSA in serum, plasma or whole blood using fluorescence immunoassay technology to assess total PSA in serum, plasma, or whole blood. The technique uses the sandwich immunodetection principle, whereby the fluorescence-labelled detector antibody binds the target protein in the sample. The fluorescence-labelled antigen-antibody complex is then transferred to a test strip, where it is caught by a second antibody incorporated into the solid phase. The quantity of PSA present correlates with the recorded complex's fluorescence signal intensity, allowing the estimation of sample PSA concentration via a pre-programmed calibration process. The reader shows the test's outcome as nanograms per millilitre (ng/ml). In brief, 75µL of serum was mixed with a pre-measured volume of detection buffer containing fluorescence-labelled anti-PSA monoclonal antibodies and anti-rabbit IgG. A small volume, 75µL, of the mixture was then loaded into the sample well of the test strip, and the cartridge was incubated at room temperature for 15 mins. The intensity of the captured fluorescence-labelled PSA-antibody complexes was measured using the supplied meter, and the concentration of PSA in the sample was calculated.

Data Analysis

Data analysis was carried out using Statistical Package for Social Sciences (SPSS) version 21(IBM, Chicago, IL, USA). The Shapiro-Wilk test was used to assess the normality of data distribution. The data was analyzed using the student's t-test and One-Way Analysis of Variance (ANOVA) statistical tools. Significance was defined as $p < 0.05$, while $p < 0.01$ indicated a high level of statistical significance.

Results

There were no white males in the < 40 years age group and no black males in the 70-79-year age group. The mean PSA concentration in Black men was 6.373 ng/mL compared to the mean PSA concentration in White men of 3.727 ng/m, showing a high level of statistical significance.

Fixed Threshold

Among Black men in the dataset, the likelihood of having a PSA concentration above 5 ng/ml increased steadily with age. In those younger than 40 years, only a small proportion showed elevated PSA. By the age of 40-49 years, about one in five had raised levels, and this proportion rose further in the 50-59 and 60-69 age groups, where roughly one quarter of men were affected. This pattern suggests a clear age-related rise in PSA elevation among Black men.

In contrast, White men showed a more stable pattern across age groups. Fewer than one in ten men aged 40-49 years had elevated PSA, and in the 50-59 age group the proportion was modestly higher. However, in the 60-69 and 70-79 age groups, the proportion remained around one in seven, without the sharp increase seen in Black men.

Nice Age-Adjusted Thresholds

Using NICE age adjusted PSA thresholds, stratifying by age group in the subset of the data, (54 Black and 143 White men) where ages were available, in the black population for the age group below 40 years, 2 of the 11 subjects (18%) had a PSA concentration greater than 2.5 ng/ml. For the age group 40-49 years, 4 of the 15 subjects (27%) had a PSA concentration greater than 2.5 ng/ml. For the age group 50-59 years, 6 of the 16 subjects (37.5%) had a PSA concentration greater than 3.5 ng/ml. For the age group 60-69 years, 5 of the 12 subjects (42%) had a PSA concentration greater than 4.5 ng/ml. For the White Population: Ages 40-49 years, 2 of the 11 subjects (18%) had a PSA concentration greater than 2.5 ng/ml. Ages 50-59 years 4 of the 16 subjects (25%) had a PSA concentration greater than 3.5 ng/ml. Ages 60-69 years,10 of the 69 subjects (14%) had a PSA concentration greater than 4.5 ng/ml. Ages 70-79 years, 3 of the 47 subjects (6.3%) had a PSA concentration greater than 6.5 ng/ml (Figure 2) (Table 1,2).

Table 1: Fixed Threshold Comparison.

Age Group(yrs)	Black Men		White Men	
	No.	%	No.	%
< 40	1 out 9	9		
41 - 49	3 out 15	20	1 out 11	9
51 - 59	4 out 17	24	3 out 20	15
61 - 69	3 out 12	25	10 out of 73	14
> 70			5 out 39	13

Table 2: NICE Age Adjusted PSA Threshold Comparison.

Age Group(yrs)	NICE Age Adjusted PSA (ng/ml)	Black Men		White Men	
		No.	%	No.	%
< 40	> 2.5	2 out 11	18	-	-
41 - 49	> 2.5	4 out 15	27	2 out 11	18
51 - 59	> 3.5	6 out 16	37.50	4 out 16	25
61 - 69	> 4.5	5 out 12	42	10 out of 69	14.4
> 70	> 6.5	-	-	3 out 47	6.3

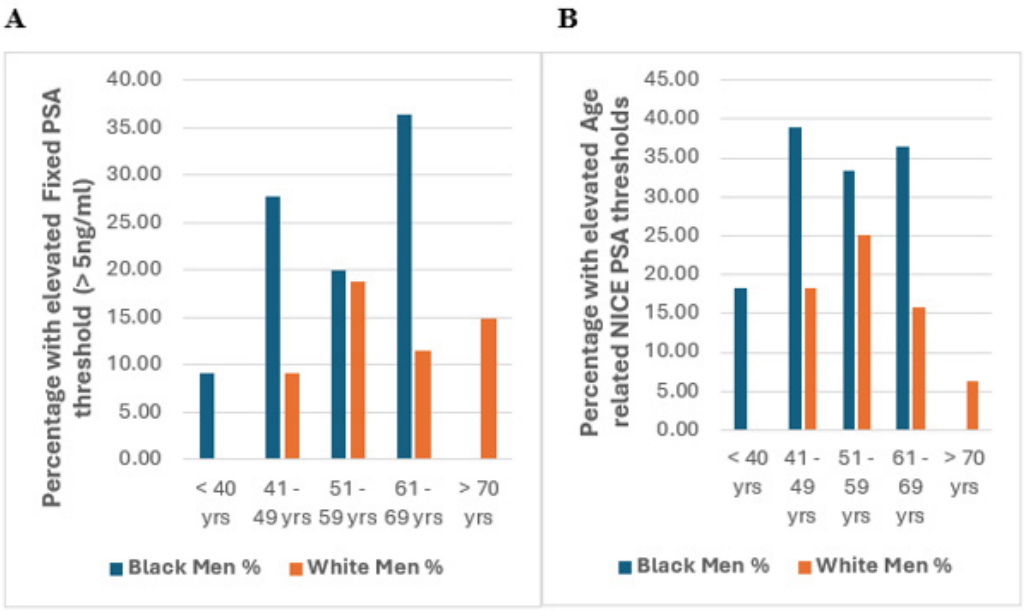

Figure 2: PSA Elevation by Age Group and Ethnicity (Fixed & NICE Age-related PSA Thresholds).

Discussion

From this study, we observe that the White population had a higher mean age (65.3 years) compared to the Black population (49.7 years) although there were no white males below 40 years of age who were volunteered for screening compared to the black males. This is consistent with what is expected in the UK, where the expected age to be screened is 50 years of age, apart from if you are Black or have a family history. The Black population had a higher mean PSA level (6.3 ng/mL) compared to the White population (3.7 ng/mL) which was statistically significant. Using a fixed PSA threshold of >5 ng/mL, elevated levels were assessed across age categories (<40, 41-49, 51-59, 61-69, and >70 years), the Black men consistently exhibited higher rates of PSA elevation compared to White men. The most marked disparity occurred in the 61-69 years group, where approximately 25% of Black men had elevated PSA levels versus 14% of White men. Using the age-specific PSA thresholds recommended by NICE, the proportion of Black and White men with elevated prostate-specific antigen (PSA) levels was assessed across five age categories: <40 years, 41-49 years, 51-59 years, 61-69 years, and >70 years. The Black men consistently exhibited higher rates of PSA elevation compared to White men. The most pronounced disparity was observed in the 61-69 years group, where approximately 42% of Black men had elevated PSA levels versus 14.4% of White men. This data complements the data described by Down et al, [3].

The disparities in age-adjusted PSA thresholds between Black and White men observed in this dataset are consistent with evidence from the United States. Large population-based studies, including analyses from the SEER (Surveillance, Epidemiology, and End Results) program, have consistently shown that African American men have the highest incidence of prostate cancer worldwide, with rates nearly 60-70% higher than White men, and mortality rates approximately two to three times greater [11]. Elevated PSA levels in Black men have been reported in multiple U.S. cohorts, including the Prostate Cancer Prevention Trial and PLCO (Prostate, Lung, Colorectal, and Ovarian Cancer Screening Trial), where baseline PSA values were significantly higher among African American participants compared to White participants, even after adjusting for age and clinical factors [12]. These findings have fuelled debate about whether uniform PSA thresholds are appropriate in racially diverse populations. Critics argue that standard cut-offs risk under-detecting clinically significant cancers in Black men, while simultaneously contributing to overdiagnosis in lower-risk groups. In response, U.S. guidelines, such as those from the American Urological Association (AUA), now emphasize the importance of shared decision-making and acknowledge that Black men represent a high-risk group who may benefit from earlier and more intensive screening. Taken together, both U.S. and UK data highlight the need for ethnicity-specific risk stratification in PSA interpretation to improve equity in prostate cancer detection and outcomes.

Conclusion

Age-adjusted PSA thresholds reveal significant ethnic disparities in elevation rates. Tailored screening strategies may improve early detection and reduce prostate cancer mortality in Black men.

Acknowledgements

None.

Conflict of Interest

None.

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