Population-based screening for prostate cancer by measuring free and total serum prostate-specific antigen in Iran

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Purpose: To evaluate the natural background of prostate cancer in Iran a large population-based study of screening using total prostate-specific antigen (tPSA) and per cent free PSA (fPSA) as the initial test was performed.

Materials and methods: For 9 years (1996 to 2004) in Tehran, Iran, 3670 Iranian men older than 40 years were mass checked by PSA-based screening. They were invited to have a digital rectal examination (DRE), serum PSA assay and transrectal ultrasonography (TRUS)-guided sextant prostate biopsy to see if the DRE was clinically suspicious of malignancy, the serum PSA was $\geq 2.1$ ng/ml or free-to-total PSA (f/tPSA) ratio $\leq 15\%$.

Results: In 433 (11.8\%) of screened males, tPSA levels exceeded the cut-off value of $\geq 2.1$ ng/ml and 128 prostate cancers were diagnosed (positive predictive value (PPV) 29.6\%) corresponding to an overall detection rate of 3.5\%. Altogether 138 cancers were detected (detection rate 3.8\%); none were stage M1, three were stage N+ and 4 stage T3. A threshold tPSA of $\geq 2.1$ ng/ml would have detected 128 cancers in 447 biopsied men (PPV 29\%). There were 109 of 138 (79\%) men with cancer who had an f/tPSA of $\leq 15\%$, while 152 of 305 (49.8\%) with benign biopsies had a f/tPSA of $\leq 15\%$, which corresponds to a PPV of 30.8\%.

Conclusion: PSA-based screening with low PSA cut-off values increase the detection rate of clinically significant, organ confined and potentially curable prostate cancer. Further studies are warranted in order to determine the incidence and prevalence of prostate cancer in different ethnic groups.

Key words: prostate cancer, epidemiology, prostatic specific antigen, screening

introduction

Epidemiology has been defined as the study of the distribution and determinants of disease frequency in man [1]. The distribution of cancers varies significantly from country to country all over the world. The latest estimates of global cancer incidence show that prostate cancer is the sixth most common cancer in the world (in the number of new cases), the third most common cancer in men, the most common cancer in men in Europe, North America, and some parts of Africa with half a million new cases each year, almost 10\% of all cancers in men [2–4]. Prostate cancer incidence is characterized by a very large geographical variability. Asian countries have much lower rates of occurrence of the disease than North American, and north and western European countries, with southern European and South American countries displaying an intermediate incidence rate [5]. The incidence of clinical prostate cancer in black men is greater than in any other ethnic group. Japanese and Chinese men are less likely to develop prostate cancer [6]. In Italy and Spain, prostate cancer incidence, according to estimates in 2000, was ranked third (approximately 10\% of all new diagnosed cancers), while in France it was the most common male cancer (approximately 19\%) [7]. Such differences seem to be linked to ethnic characteristics.

The incidence of prostate cancer is considerably low in Orientals. It was reported in Los Angeles County, United States, that the incidence rate was highest in African Americans (116/100 000 person-years) and lowest among Asians (Japanese, 39/100 000 person-years) and Chinese (28/100 000 person-years) [8]. Cancer registries are available in many countries, but it is important to note that the degree of accuracy may vary. In many countries cancer registries have only recently been established and/or may not cover the whole country, this may explain the low rates of cancer in some reports [9].

Prostate cancer screening using PSA testing is peculiar among screening interventions, because it is widely adopted in Western countries. PSA is a valid screening test for prostate cancer, which compares favorably with mammography for breast cancer [10].

Several studies have confirmed that PSA-based screening is the most effective screening method; however, most of these studies were done in men referred to urological care settings because of signs and symptoms [11–13].
Test sensitivity achieved with serum PSA in prostate cancer screening appears excellent in the context of a population based effectiveness trial [14]. Also, worldwide, the impact of PSA screening and the role of increasing detection of the rising incidence of prostate cancer have been approved [15–17].

Measuring the percentage of free PSA (fPSA) in relation to that of complexed PSA (cPSA) or tPSA (i.e. tPSA = fPSA + cPSA), as first shown by Stenman et al. [18] and Christensson et al. [19], can more efficiently distinguish subjects with benign prostatic hyperplasia (BPH) from those with cancer than can tPSA levels alone [20].

Epidemiological data represents an invaluable tool for the development of strategies and the allocation of adequate resources necessary for providing assistance for populations. Because Iranian men are ethnically and racially different from most of Asian countries’ men (e.g. Japanese, Chinese, and Arabic men) the biomedical parameters of prostate cancer should be different. To study this issue, we ruled out a mass screening for prostate cancer using serum PSA determination as a first-line screening method in Iranian men. To our knowledge, this is the first report of mass screening for prostate cancer in Iran.

materials and methods

For 9 years (1996 to 2004) in Tehran, Iran, 3670 volunteer Iranian men older than 40 years who agreed by informed consent were mass checked by PSA based screening and DRE as the initial tests. This geographical situation as well as the willingness of the general population to participate in preventive medical programs caused us to launch a state-wide mass screening program. None of them had a history of prostate cancer and males with a history of prostatitis and of prostatorectitis or other conditions that interfered with voiding, were excluded from the study.

Free and total PSA levels were determined with the DELFIA PSA dual label free/total PSA kit (Wallac Oy Turku, Finland). This kit uses monoclonal capture antibody (mAb) H117 for PSA and tPSA, samarium-labeled mAb H50 as a tracer antibody for fPSA, and europium-labeled mAb 5A10 as tracer antibody for tPSA and allows for simultaneous measurement of free PSA and α-1-antichymotrypsin-complexed PSA [21, 22]. mAb H117 and H50 afford equimolar detection of free and complexed forms of PSA with a correlation of r = 0.97 with the Tandem-R PSA assay (Hybritech Inc., San Diego, CA) [21, 23]. mAb 5A10 detects cPSA with 0.2% cross-reaction from α-1-antichymotrypsin-complexed PSA [24, 25]. The detection limit for cPSA is 0.05 ng/ml (5% coefficient of variation at 2.3 ng/ml) and 0.04 ng/ml for fPSA (5.9% at 0.25 ng/ml).

If the DRE was clinically suspicious of malignancy, the serum PSA was ≥2.1 ng/ml, or free-to-total PSA ratio was ≥15% the patient was referred for TRUS-guided sextant prostate biopsy. Following systematic sextant biopsy, all patients underwent two additional biopsies from the transitional zone (TZ). These biopsies were obtained from both the right and the left portion of the TZ. Any palpable nodule, induration, or asymmetry of the prostate gland was considered a reason for biopsy, DRE was performed by the same urologist, TRUS was ruled out by the same radiologist. Hypoechoic lesions were biopsied separately.

DRE and TRUS were performed with the subject lying on his left side. Palpable abnormalities were characterized according to UICC 1992 [26].

For the prostate biopsy, with informed consent provided, TRUS was performed using General Electric Logic 500. TRUS-guided, systematic, sextant, six-core biopsies with two additional biopsies from the transitional zone (TZ) were done using a biopsy gun (Promag 1, MD Tech) with an 18-gauge biopsy needle (2.2 Biopsy Needle, MD Tech).

Patients with clinically organ-confined disease and no medical contraindication to major surgery were subjected to radical prostatectomy. The histological criteria for prostate cancer used were those of the World Health Organization [27]. All histopathologic diagnoses of the biopsied specimens were reconfirmed by another expert pathologist. The clinical stage was evaluated according to the TNM classification [28] Union International Contra la Cancer (UICC) and the American Joint Committee on Cancer (AJCC). Cancers were graded according to the Gleason system [29].

For comparison of PSA levels, the free-to-total PSA ratio and PSA between the age groups, significance was tested using Mann–Whitney mean rank non-parametric analysis. Differences in incidence between groups were assessed using the chi-square and Fisher exact tests. Statistical analysis was performed using the computer statistical package SPSS/10.0 (SPSS, Chicago, IL) and SAS/6.4 (SAS Institute Cary, NC).

results

A total of 3670 subjects were enrolled in the screening study. The mean age of these men was 61 years ranging from 40 to 82 years old. Of these, 954 (26%) were between 40 and 49, 1101 (30%) were between 50 and 59, 918 (25%) were between 60 and 69, and 697 (19%) were ≥70 years of age. The DRE was recorded as clinically suspicious of malignancy in 44 (1.2%) overall. Among the screened men, 433 (11.8%) had a serum PSA concentration ≥2.1 ng/ml and 128 prostate cancers were diagnosed (PPV 29.6%) at screening, corresponding to an overall detection rate of 3.5%. The number of males with PSA levels above cut-off value, were 43 (10%), 95 (22%), 130 (30%), and 165 (38%) in 40–49, 50–59, 60–69, and ≥70 age groups respectively (Table 1). Additionally, 10 cancers were detected among 14 with PSA of <2.1 ng/ml who had a doubtful DRE finding. Therefore, the overall detection rate was 3.8%. Of 58 men with abnormal DRE, 45 (77.6%) had prostate cancers. We found foci of high-grade prostatic intra-epithelial neoplasia (PIN) concurrently with prostate cancer in seven patients (5%). Among the patients biopsied for the first time 12 (2.7%) had high-grade PIN without having prostate cancer. All of them had a second biopsy and prostate cancer was found in five (41.7%) of them.

Of 128 males with prostate carcinoma, DRE or TRUS showed abnormal finding in 45 (35.2%) and 50 (39.1%), respectively. The proportion of males with PSA levels above the cut-off value increased with age. The numbers of cancers detected for age groups 40–49, 50–59, 60–69, and ≥70 years of age were 13 (9.4%), 26 (18.8%), 44 (31.9%), and 55 (39.9%) respectively (Table 2).

Table 1. Serum prostate-specific antigen as a function of age

<table>
<thead>
<tr>
<th>Age group (years)</th>
<th>No. of volunteers n (%)</th>
<th>PSA (ng/ml) mean (range)</th>
<th>No. of volunteers with PSA ≥2.1 ng/ml n (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>40–49</td>
<td>954 (26)</td>
<td>1.2 (0.2–11.0)</td>
<td>43 (10)</td>
</tr>
<tr>
<td>50–59</td>
<td>1101 (30)</td>
<td>1.3 (0.2–27.5)</td>
<td>95 (22)</td>
</tr>
<tr>
<td>60–69</td>
<td>918 (25)</td>
<td>1.8 (0.3–31.8)</td>
<td>130 (30)</td>
</tr>
<tr>
<td>≥70</td>
<td>697 (19)</td>
<td>2.1 (0.5–37.7)</td>
<td>165 (38)</td>
</tr>
<tr>
<td>Totals</td>
<td>3670 (100)</td>
<td></td>
<td>433 (100)</td>
</tr>
</tbody>
</table>

PSA, prostate-specific antigen.
The mean PSA value (range) in all men without prostate cancer was 1.4 ng/ml (0.1–11.8) and in those with cancer 9.7 ng/ml (1.6–100) ($P < 0.001$). PSA values increased with age. In those aged 40–49, 50–59, 60–69, and ≥70 years, the mean PSA value (range) were 1.2 (0.2–1.0), 1.3 (0.2–2.7), 1.8 (0.3–31.8) and 2.1 (0.5–37.7) ng/ml, respectively. The resultant values for patients with prostate cancer were 5.2 (1.9–32.5), 7.8 (2.5–33.5), 10.4 (2.9–100.0), and (3.8–100.0) respectively. The tPSA threshold of ≥2.1 ng/ml diagnosed 128/138 (92.8%) cancers. There were 109 of 138 (79%) men with cancer who had an f/PSA of ≤15%, while 152 of 305 (49.8%) with benign biopsies had an f/PSA of ≤15%, which corresponds to a PPV of 30.8% (Table 3).

Removing 153 men from biopsy reduced false-positives by 50.2% at the expense of missing 19 of 138 cancers (13.8%) with an f/PSA of ≥15%. A threshold at ≤18% rather then ≤15% increased the sensitivity for detecting cancer from 85.2% to 94.5% while false-positives decreased by 30.8% (Table 3).

Twenty-two men with cancer and a tPSA of >20 ng/ml were investigated with radionuclide bone scans; none was diagnosed with bone metastases. Three patients were diagnosed with lymph node metastasis (stage N1).

Previously, most screening studies used a PSA concentration of 4.0 ng/ml as the upper limit of normal. In this mass screening project, normal PSA cut-off of 2.0 ng/ml was used. Of the 433 men with elevated tPSA levels, 127 (29.3%) presented with levels higher than 2.0 ng/ml but lower than 4.0 ng/ml. DRE findings were negative in all 127 subjects; all of them underwent radical prostatectomy and seven had received hormone therapy. In these 88 patients who underwent radical prostatectomy, histological examination revealed organ-confined disease in all but seven. The mean Gleason grade (score) was 7.4 (range 7 ± 9) for PZ cancers, 6.8.2 (range: 4 ± 8) for TZ cancers, and 7.6 (range: 7 ± 9) originating from the TZ as well as the PZ. Overall, 95% (131 of 138) of the cancers were found to be organ-confined. All four combined TZ and PZ cancers were advanced lesions showing invasion of the seminal vesicles in all men and, in addition, invasion of the pelvic lymph nodes in one patient. Altogether, 29% (40) of the cancers detected were so-called TZ cancers.

### Discussion
Several studies have explored the efficacy of serum PSA alone as a screening tool for prostate cancer [12, 13, 29, 30]. In a study on more than 20,000 males carried out by Andreiolo and Catalona, extensive PSA-based screening for prostate cancer was established highly valuable in detecting clinically significant prostate cancers [31]. The Washington University group demonstrated a PPV of 33% and a detection rate of 2.6%. Bravera et al. reported a PPV of 30.5% and a detection rate of 2.6% [12, 29]. The present incidence of elevated tPSA in serum (11.8%) is lower than the 17.9% reported by Labrie et al. [32] and is similar the 11.3% reported by Hugoson et al. [33]. Of 3237 men with tPSA <2.1, 30.4% (1115) had levels of ≤1.0 ng/ml. Our cancer detection rate of 3.8% is similar the 3.6% reported by Gustafsson et al. [34] but higher than in most other studies. The lower detection rates reported by Labrie et al. [32] of 3.5%, Horninger et al. [35] of 1.2%, Auvinen et al. [14] of 2.5% and Uchida et al. [36] of 1.53%, may be

### Table 2. Age distribution, number of volunteers, number of biopsies and number of carcinomas

<table>
<thead>
<tr>
<th>Age group (years)</th>
<th>No. of volunteers n (%)</th>
<th>No. of biopsies n (%)</th>
<th>No. positive for carcinoma n (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>40–49</td>
<td>954 (26)</td>
<td>45 (10)</td>
<td>13 (9.4)</td>
</tr>
<tr>
<td>50–59</td>
<td>1101 (30)</td>
<td>98 (22)</td>
<td>26 (18.8)</td>
</tr>
<tr>
<td>60–69</td>
<td>918 (25)</td>
<td>133 (29.8)</td>
<td>44 (31.9)</td>
</tr>
<tr>
<td>≥70</td>
<td>697 (19)</td>
<td>171 (38.2)</td>
<td>55 (39.9)</td>
</tr>
<tr>
<td>Totals</td>
<td>3670 (100)</td>
<td>447 (100)</td>
<td>138 (100)</td>
</tr>
</tbody>
</table>

### Table 3. Number of men with cancer versus men with benign biopsies using different thresholds of f/PSA at various tPSA levels

<table>
<thead>
<tr>
<th>tPSA, ng/ml</th>
<th>Group</th>
<th>No. of men with carcinoma and f/PSA</th>
<th>No. of men with benign biopsies and f/PSA</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>2.1–4</td>
<td>≤15% 23 15 20 15 36 109</td>
<td>≤15% 56 36 35 12 13 152</td>
</tr>
<tr>
<td></td>
<td>4.1–6</td>
<td>≤18% 28 16 23 15 39 121</td>
<td>≤18% 85 48 49 17 12 211</td>
</tr>
<tr>
<td></td>
<td>6.1–8</td>
<td>Total 30 17 26 16 39 128</td>
<td>Total 137 68 62 24 14 305</td>
</tr>
<tr>
<td></td>
<td>8.1–10</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>&gt;10</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>All</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

PSA, prostate-specific antigen.
f/PSA, total prostate-specific antigen.
f/PSA, free-to-total prostate-specific antigen.
a result of the higher tPSA cut-off value, lower elderly men and different prostate biopsy criteria. Catalona et al. [12] conducted screening using PSA and DRE in males ≥50 years old and reported that the detection rate for prostate cancer was 5.8% when these two detection modalities were used. Yet, they demonstrated that the detection rate was 4.6% when PSA alone was used. Egawa et al. [37] conducted screening using PSA alone as a screening tool in males ≥55 years old and showed that the detection rate for prostate cancer was 1.3% [16 of 1189]. In western countries, Brawer et al. [29] recognized the cut-off value for PSA as 4.0 ng/ml in males ≥50 years old and reported that the detection rate for prostate cancer was 2.6% (32 of 1249). In our study, the detection rate for prostate cancer was 3.5% when screening using PSA alone included males >40 years old. This percentage was the highest in Iran, and higher than the percentages reported in other Asian countries. Our finding may reflect a recent increase in the incidence of prostate cancer in Iran. In addition, when considering the difference in the cancer detection rates, four factors should be considered: a technical problem in prostate biopsy, differences in the biopsy rate in the PSA-positive men, case selection bias and prostate biopsy criteria.

We were able to obtain biopsies from all males (100%) with elevated PSA or suspicious DRE findings. This clearly shows that the screening procedure was acceptable to the patients and confirms our recruitment method.

The proportion of cancers among those with a positive screening test is different, at 29.6% (128 of 433) in the present study, to 19.3% [31], 21.9% [32] and 20.1% [20]. Bangma et al. [39] combined tPSA in serum with a DRE in 1726 men aged 55–76 years; they founded a cancer detection rate of 4.0% from the biopsy of men with an abnormal DRE, TRUS or tPSA of 2.40 ng/ml. Gustafsson et al. [34] reported a detection rate of 3.6% using an abnormal DRE or TRUS, or PSA of ≥10 ng/ml as indications for biopsy in 1782 men aged 55–70 years.

The present study detected cancers of early stage; 95% were clinically localized, there were no distant metastases, three had lymph node metastases and four had locally advanced disease. This stage distribution resembles that in other screening studies; Labrie et al. [32] reported that 8% had disseminated disease and 71% were found with localized disease. Catalona et al. [20] reported that 94% had clinically localized disease and 63% had negative margins at radical prostatectomy. Gustafsson et al. [34] reported that 3% had disseminated disease and 62% clinically localized disease. We used tPSA levels of ≥2.1 ng/ml and abnormal DRE as the biopsy indications. Standard indications for biopsy are still an abnormal DRE or a tPSA of ≥4.0 ng/ml. Partin et al. [21] reported that 47% of tumors had spread outside the capsule at tPSA levels of 4–10 ng/ml. Men with cancer at these tPSA levels may have a higher risk of disease progression than those with lower tPSA levels [22]. In our study, 25% of the men with a tPSA of 2.0–4.0 ng/ml had cancer. Therefore, 42 of 138 (30.4%) of all men detected with cancer had a tPSA of 2.1–4.0 ng/ml but only 10 of 42 (23.8%) were palpable. The DRE is less sensitive for detecting cancer at low PSA levels (Table 4). Catalona et al. [40] reported that 81% of cancers with a tPSA of 2.6–4.0 ng/ml to be organ-confined. In that study, 39% of the cancers were impalpable. In our study the proportion of palpable cancers increased from 0% at a tPSA of 2.1–4.0 ng/ml to 29.7% in cancers at a tPSA of ≥20 ng/ml (Table 4). This indicates that the DRE is insensitive both at high and at low tPSA levels. Also TRUS does not increase the sensitivity, as only 39.1% of cancers were visible on TRUS and 25.8% were both impalpable and invisible.

An important disadvantage of low tPSA thresholds is the decrease in specificity. In this study the PPV at a tPSA of 2.1–4.0 ng/ml was 25% (Table 5), but disadvantages of low PPVs caused by low tPSA thresholds can be significantly diminished by using f/tPSA. The use of the free-to-total PSA ratio offers better prostate cancer detection than total PSA [41]. In the present study we used f/tPSA ≤15% to decide whether a prostate biopsy should be taken or not.

The mean PSA levels with respect to age obtained in this study were compared with the findings reported by Brawer et al. [38] and Uchida et al. [36]. In males 50–59 years old mean PSA levels were 1.3, 1.1 and 1.6 ng/ml, in males 60–69 years old 1.8, 1.8 and 2.7 ng/ml and in males 70–79 years old 2.1, 2.2 and 3.1 ng/ml, respectively. In all three studies, PSA levels increased with advancing age, showing a similar tendency. However, the latter showed relatively higher values for all ages. In Western countries, the proportion of PSA abnormalities has been reported to be approximately 10% of subjects when the cut-off value for PSA is 4.0 ng/ml [11–13]. Our results showed that the proportion was 11.8% with a cut-off value of 2.1 ng/ml, which is similar to the percentage reported in western countries. With a cut-off value of 4 ng/ml this will be 8.3%, although the results should not be simply compared using differences in patient ages and environment. Thus, PSA levels in Iranian males may be relatively lower than those in western countries of the same age.

For ethical rationale, none of the men with normal findings on PSA measurement and DRE underwent biopsy. Thus, no data relating to false-negative results are available.

### Table 5. Number of PSA-tested men, detected carcinomas and percentage of palpable cancers stratified for various tPSA ranges

<table>
<thead>
<tr>
<th>tPSA ng/ml</th>
<th>No. of palpable carcinomas (%)</th>
<th>No. of men biopsied</th>
<th>No. with carcinoma (PPV)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0–1</td>
<td>1115 (30.4)</td>
<td>0</td>
<td>NA</td>
</tr>
<tr>
<td>1.1–2</td>
<td>2122 (57.8)</td>
<td>0</td>
<td>NA</td>
</tr>
<tr>
<td>2.1–4</td>
<td>127 (3.5)</td>
<td>127</td>
<td>32 (25)</td>
</tr>
<tr>
<td>4.1–6</td>
<td>41 (1.1)</td>
<td>41</td>
<td>4 (9.8)</td>
</tr>
<tr>
<td>6.1–8</td>
<td>48 (1.3)</td>
<td>48</td>
<td>9 (18.8)</td>
</tr>
<tr>
<td>8.1–10</td>
<td>105 (2.9)</td>
<td>105</td>
<td>21 (20)</td>
</tr>
<tr>
<td>10.1–20</td>
<td>84 (2.3)</td>
<td>84</td>
<td>40 (47.6)</td>
</tr>
<tr>
<td>20.1–100</td>
<td>26 (0.7)</td>
<td>26</td>
<td>20 (77)</td>
</tr>
<tr>
<td>&gt;100.1</td>
<td>2 (0.05)</td>
<td>2</td>
<td>2 (100)</td>
</tr>
<tr>
<td>Totals</td>
<td>3670 (100)</td>
<td>433</td>
<td>128 (29.6)</td>
</tr>
</tbody>
</table>

PSA, prostate-specific antigen.

tPSA, total prostate-specific antigen.

PPV, Positive predictive value.
The percentage of pathologically staged organ-confined cancers in our study was 95%. Other researchers reported more than 90% of the tumors detected by PSA screening to be histologically significant cancers [43-46].

Our results are encouraging mainly because of the age of the men screened. A relatively high number of prostate cancers were diagnosed in the 40 to 49 year age group, similar to the findings of Sakr et al. [47]. He found a high prevalence of prostate cancer in this age group based on an autopsy study. This would support screening for prostate cancer in younger men.

One way to increase the PPV would be to reduce the number of positive tests by choosing a higher PSA cut-off value as a criterion for positive screening test. This would, however, lead to a decrease in the diagnostic yield. The present study reveals that PSA alone can be used efficiently as a first-line and as a repeat screening test for prostate cancer. PSA levels >2.1 ng/ml deserve prostatic biopsy, yet if the findings on DRE and TRUS findings are unremarkable.

From detected cancers, 40 (29%) had their origin exclusively from the transitional zone of the gland. Ninety-four (68%) patients had peripheral zone (PZ) cancer while four (3%) had cancers existing in both areas of the prostate. None of the patients had palpable abnormalities on DRE. Twenty two men showed TZ abnormalities on TRUS; in seven of them the biopsies were positive for TZ cancer. Twenty nine patients with proven TZ cancer had preoperative serum PSA levels ranging from 2.2 to 7.8 ng/ml (mean: 4.9 ng/ml), whilst 11 patients presented with levels higher than 10 ng/ml (mean: 13.5 ng/ml).

Conclusion

In summary, prostate cancer can be detected earlier by screening. Prostate cancer is frequent among different ethnic groups. Better understanding of the epidemiology of prostate cancer is vital to plan effective treatment and prevention strategies. Still more epidemiologic research is essential to further understand the distribution as well as the prevalence and incidence of prostate cancer in certain ethnic groups.

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