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Invited review

Prostate cancer incidence review with emphasis on publications from the American Cancer Society & the International Agency for Research on Cancer

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Prostate carcinoma is one of the most important male cancers with, in various regions of the world, including the USA, a very high incidence. It is though, one of the cancers with a good prognosis with a range of treatment modalities available including radiotherapy and surgery.This review is based on the most recent data from the IARC and the American Cancer Society and presents a worldwide survey with representative data from Africa and central & south America, north America, Asia, eastern & western Europe including Scandinavia, and Australia & New Zealand. The etiology of this cancer is summarised with a commentary on factors including genetic predisposition, life-style, race and ethnicity, sex hormones, marital status, familial factors, diet, ionising radiation, socioeconomic status, smoking, and chronic exposure to cadmium oxide. Age-standardised as well as age-specific and crude rates are included in this review.

Key words: prostate cancer, incidence, risk factors
Słowa kluczowe: rak prostaty, czynniki ryzyka, występowanie

Introduction

Cancer of the prostate is the neoplasm with the highest incidence in the United States, although not the neoplasm with the highest mortality, as seen in Table I. This has been taken from the year 2001 American Cancer Society *Cancer Facts & Figures* publication [1] for comparisons between cancers of the prostate, lung & bronchus and colon & rectum. In the same publication [1] it is estimated that there will be 198,1000 new cases of prostate cancer in the USA in 2001 and an estimated 31,5000 deaths. The comparable estimates, for males and females combined, for cancer of the lung and bronchus are respectively 169,500 new cases and 157,400 deaths.

Table I. Incidence and mortality in males in the USA 1990-97 by site and race [1]. The rates are per 100,000 population age-adjusted to the 1970 USA standard population. The incidence data is from the 11 SEER (Surveillance, Epidemiology and End Results program) areas and the mortality data is from all states

Site	White population		Black population	
	Incidence	Mortality	Incidence	Mortality
Prostate	145.8	23.3	225.0	54.1
Lung & bronchus	71.9	69.5	111.1	99.5
Colon & rectum	52.7	21.3	58.3	27.7

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Etiology

Relatively little is known about the etiology of prostate cancer, although the data on the black population of Africa and the USA provides some evidence of a *genetic component* to prostate cancer risk, the geographical and temporal variations and the results of migrant studies indicate that *life-style* comprises a large fraction of the causes of prostate cancer [2]. At all ages, African-American men are more likely than whites to develop prostate cancer but cancer incidence rates have increased for both American white and African-American men with the rates for the latter rising from 106 per 100,000 in 1973 to 234 per 100,000 in 1994 [3].

Incidence rates vary among *racial and ethnic groups* and Table II shows the rates in the USA for the different

Table II. Prostate cancer age-adjusted incidence rates per 100,000 males, USA 1988-92, by race and ethnicity [3]

Race/ethnicity	Incidence rate
African-American	180.6
White	134.7
Hispanic	89.0
Japanese	88.0
Filipino	69.8
Hawaiian	57.2
American-Indian	52.5
Alaska Natives	46.1
Chinese	46.0
Vietnamese	40.0
Korean	24.2

Asian-American populations. The highest rate is for Japanese-Americans and the lowest for Korean-Americans [3].

Sex hormones have also been implicated in the etiology of this cancer, primarily on the basis that the growth and development of the prostate gland requires the presence of sex hormones. It has been reported [3] that men with high plasma testerostone levels may be at an increased risk of developing prostate cancer. However, the hormonal hypothesis has received only equivocal support from epidemiological studies and clinical observations. Prostatic cancer mortality rates are associated with *marital status*, increasing in the following order: single, married, widowed, divorced [2].

Some studies have shown an overall twofold to threefold increase in the risk of prostate cancer in men with a positive family history. The number of affected family relatives and younger age at diagnosis appear to be influential *familial factors* [3] and strong familial pre-disposition may be responsible for some 5-10% of prostate cancers [1].

Diet has also been suggested as a risk factor with a diet high in animal fat approximately doubling the risk. Alternatively, the consumption of lycopene, an antioxidant found in tomatoes and tomato-based products may be associated with a decreased risk [3].

Other risk factors which have been studied but which have failed to show any statistically significant correlation with the incidence of prostate cancer, include *ionising radiation, socioeconomic status, benign prostatic hyperplasia, vasectomy, smoking and farming & agricultural* work [4--9]. As well as farming, occupational risks have also been studied from chronic exposure to cadmium *oxide dust* over a period of 10 or more years [10] but the results are conflicting.

To conclude this short summary on etiology the following statement is reproduced from a discussion [11] on latent disease *versus* clinically manifest disease. 'The projected lifetime risk of developing histologic evidence of cancer of the prostate in a 50 year old man is 42%, of the clinical disease 9.5% and of dying from the disease is 2.9%'.

Age-Standardised & Crude Incidence Rates

The pattern of occurrence of prostate cancer is not similar in all countries. Figure 1 is reproduced from an IARC publication in 1990 on *Patterns of Cancer in Five Continents* [12] where the age-standardised incidence rates per 100,000 population are ranked from highest to lowest with the maximum and minimum rates at the base of the bar chart: 91.2 for the black population of Atlanta, USA and 1.2 for Tianjin in the Peoples' Republic of China. The population used for the standardisation is the 'world' population: not the 1970 US standard population used for the incidence rates in Table I. However, the ratio of Mortality/Incidence for black and white US populations

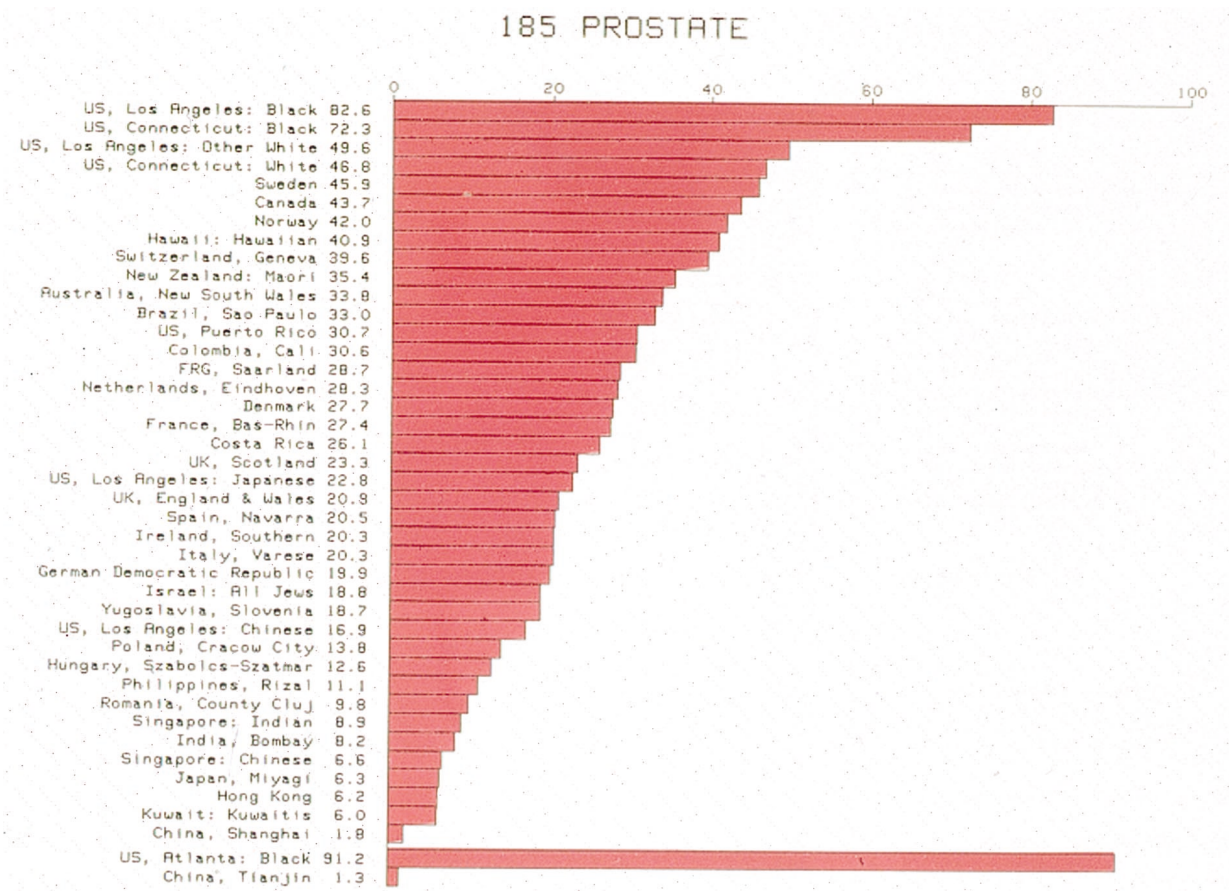

Figure 1. Age-standardised incidence rates per 100,000 population for selected populations in five continents [12]. Courtesy IARC.

Table III. Crude incidence rates per 100,000 males for selected populations, the age-standardised rate per 100,000 (ASR) and the percentage of all cancers which are prostate cancer [13]. When the absolute numbers of registered prostate cancer cases are small, the standard errors associated with the rate per 100,000 will be large. It should also be noted that not all cancer registries outside north America and Europe are as efficient and comprehensive as those for example in the USA, and there may be a significant element of missed registrations. Nevertheless, this IARC publication [13] gives the best available incidence estimates towards the end of the 20th century. Notation: *Skin other than Kaposi's sarcoma or melanoma is not considered: ICD 9th 173. **Includes all skin.

Table IIIa. Africa and Central & South America

Population	Total cases registered	Period of registration	Crude rate	ASR	% of all cancers**	Cancer with the highest ASR incidence*
			Africa			
Setif, Algeria	12	1990-93	0.5	1.8	1.2	Bronchus, lung
Bamako, Mali	33	1988-92	2.0	0.5	3.3	Liver
Kyadondo, Uganda	86	1991-93	5.7	27.7	7.9	Kaposi's sarcoma
Harare, African, Zimbabwe	112	1990-92	6.9	29.2	7.0	Kaposi's sarcoma
			Central & South America			
Concordia, Argentina	48	1990-94	14.1	16.2	6.8	Bronchus, lung
Belem, Brazil	145	1989-91	7.6	17.9	8.2	Stomach
Goiania, Brazil	291	1990-93	16.5	35.2	15.2	Prostate
Porto Allegre, Brazil	566	1990-92	32.0	42.8	12.2	Bronchus, lung
Cali, Colombia	693	1987-91	19.8	32.7	15.9	Stomach
Costa Rica	1179	1988-92	15.5	27.0	13.0	Stomach
Quito, Ecuador	386	1988-92	13.5	22.4	14.6	Stomach
Lima, Peru	767	1990-91	12.7	19.4	14.5	Stomach
Puerto Rico, USA	4831	1988-91	72.2	54.7	28.1	Prostate
Montevideo, Uruguay	939	1990-92	49.4	32.6	11.5	Bronchus, lung

Table IIIb. North America

Population	Total cases registered	Period of registration	Crude rate	ASR	% of all cancers**	Cancer with the highest ASR incidence*
			Canada			
All Canada	59546	1988-92	86.6	64.7	21.5	Prostate
Ontario	21472	1988-92	84.4	63.0	20.6	Prostate
Saskatchewan	2857	1988-92	112.7	66.8	25.6	Prostate
			USA White Populations			
All SEER Registries	66227	1988-92	142.2	100.8	29.0	Prostate
Los Angeles County	14961	1988-92	167.5	96.3	28.4	Prostate
San Francisco Bay Area	8194	1988-92	153.7	95.9	25.3	Prostate
Connecticut	9189	1988-92	128.8	79.1	24.4	Prostate
			USA Black Populations			
All SEER Registries	7129	1988-92	116.6	137.0	30.1	Prostate
Los Angeles County	2865	1988-92	116.1	130.6	30.3	Prostate
Atlanta	1235	1988-92	79.6	142.3	28.7	Prostate
Detroit	3397	1988-92	158.1	141.5	32.3	Prostate

Table IIIc. Asia

Population	Total cases registered	Period of registration	Crude rate	ASR	% of all cancers**	Cancer with the highest ASR incidence*
			Asia			
Shanghai, China	530	1988-92	2.9	2.3	1.0	Bronchus, lung
Hong Kong	1185	1988-92	8.1	7.9	2.5	Bronchus, lung
Bombay, India	764	1988-92	2.9	7.9	4.1	Bronchus, lung
Hiroshima, Japan	329	1986-90	12.6	10.9	3.4	Stomach
Osaka Prefecture Japan	1758	1988-92	8.2	6.8	2.5	Stomach
Kangwha County, Korea	3	1986-92	1.2	0.9	0.5	Stomach
Manila, Philippines	632	1988-92	5.9	17.6	5.9	Bronchus, lung
Singapore-Chinese	415	1988-92	7.8	9.8	3.7	Bronchus, lung
Chiang Mai, Thailand	122	1988-92	3.5	4.1	2.6	Bronchus, lung
Hanoi, Vietnam	24	1991-93	0.8	1.2	0.7	Bronchus, lung

Table IIId. Europe: Eastern & Western. Notation: The six states are Berlin, Brandenburg, Mecklenburg-Vorpommern, Sachsen-Anhalt, Sachsen and Thuringen

Population	Total cases registered	Period of registration	Crude rate	ASR	% of all cancers**	Cancer with the highest ASR incidence*
			Eastern Europe			
Belarus	3049	1988-92	12.8	12.2	4.6	Bronchus, lung
Czech Republic	8481	1988-92	33.8	24.1	8.6	Bronchus, lung
Estonia	931	1988-92	25.5	21.6	8.1	Bronchus, lung
Latvia	1185	1988-92	19.2	15.8	6.9	Bronchus, lung
Cracow, Poland	266	1988-92	14.9	13.4	5.2	Bronchus, lung
			Western Europe			
Somme, France	779	1988-92	58.1	36.5	14.0	Bronchus, lung
6 States, Germany	5017	1988-89	31.5	23.7	10.0	Bronchus, lung
Southern Ireland	631	1988-92	47.4	30.4	15.3	Bronchus, lung
Florence, Italy	1231	1988-91	54.9	24.4	9.4	Bronchus, lung
The Netherlands	17659	1989-92	59.5	39.6	15.2	Bronchus, lung
Asturias, Spain	720	1988-91	34.0	18.1	7.5	Bronchus, lung
Basel, Switzerland	1008	1988-92	97.3	50.3	20.9	Prostate
England & Wales, UK	38317	1988-90	51.6	28.0	12.3	Bronchus, lung

Table IIIe. Europe: Scandinavia

Population	Total cases registered	Period of registration	Crude rate	ASR	% of all cancers**	Cancer with the highest ASR incidence*
			Scandinavia			
Denmark	7392	1988-92	58.3	31.0	13.5	Bronchus, lung
Finland	8559	1987-92	59.0	41.3	17.7	Bronchus, lung
Iceland	529	1988-92	82.8	61.0	24.7	Prostate
Norway	10014	1988-92	95.4	48.4	22.7	Prostate
Sweden	25253	1988-92	119.5	55.3	27.1	Prostate

Table IIIf. Australia & New Zealand

Population	Total cases registered	Period of registration	Crude rate	ASR	% of all cancers**	Cancer with the highest ASR incidence*
			Australia			
New South Wales	10870	1988-92	74.8	53.5	18.2	Prostate
South Australia	2904	1988-92	81.5	53.6	18.4	Prostate
Victoria	7086	1988-92	65.4	47.6	16.8	Prostate
Western Australia	2534	1988-92	62.8	52.8	17.8	Prostate
			New Zealand			
Non-Maori	4192	1988-92	55.6	37.8	14.6	Bronchus, lung
Maori	135	1988-92	17.3	44.4	9.1	Bronchus, lung

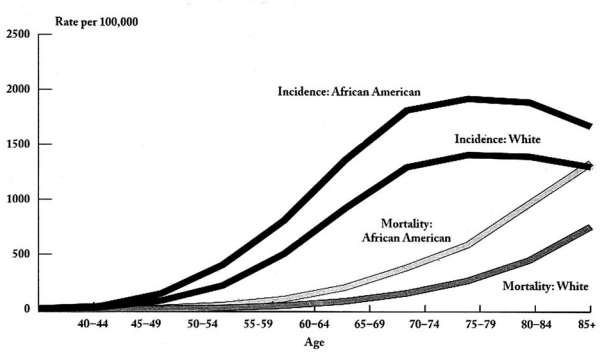

Figure 2. Incidence and mortality rates per 100,000 population, by race and five-year age group, USA 1990-94. [3]. These rates are age-adjusted to the 1970 US standard population. The data source is the NCI, Surveillance, Epidemiology, and End Results Program, 1997. Courtesy American Cancer Society.

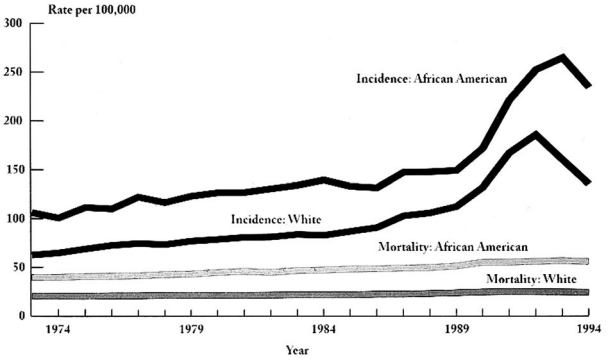

Figure 3. Incidence and mortality rates per 100,000 population, by race and registration year, USA 1973-94. [3]. These rates are age-adjusted to the 1970 US standard population. The data source is the NCI, Surveillance, Epidemiology, and End Results Program, 1997. Courtesy American Cancer Society.

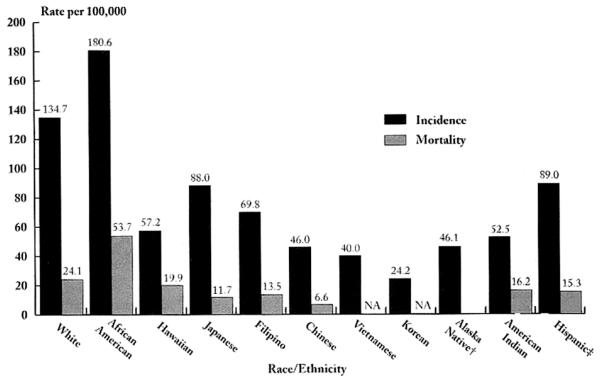

Figure 4. Incidence and mortality rates per 100,000 population, by race and ethnicity, USA 1988-92. [3]. These rates are age-adjusted to the 1970 US standard population. The data source is the NCI, Surveillance, Epidemiology, and End Results Program, 1997. Courtesy American Cancer Society.

are of the same order of magnitude, 1.54 in Table I [1] and 1.95 in Figure 1 for Atlanta/Connecticut.

The crude incidence rates per 100,000 males for selected populations in the 1997 IARC publication on *Cancer Incidence in Five Continents* [13] are given in Table III. The highest rates are observed amongst the USA black population, see also Figure 1, and the lowest rates in the countries of south-east Asia. It should also be noted that the incidence of prostate cancer is increasing in many European countries [2].

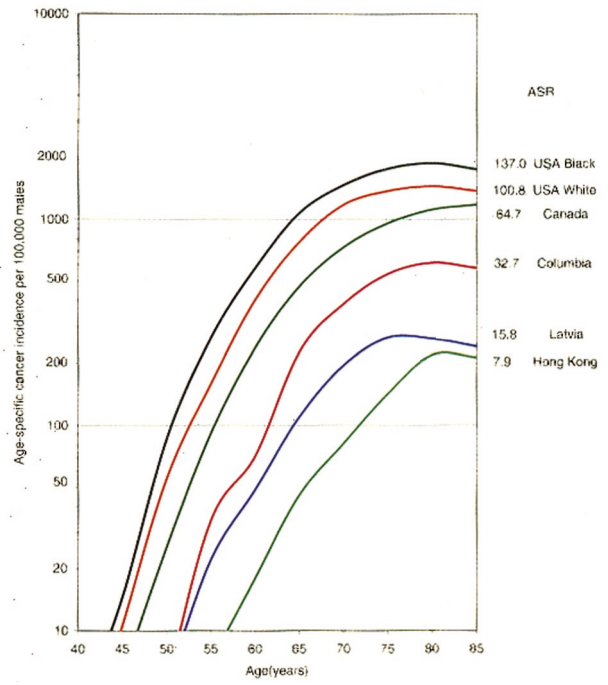

Figure 5. Age-specific incidence rates per 100,000 population for six selected countries, drawn using rates in the data tables in Cancer Incidence in Five Continents Volume VII [13]. These are the SEER USA black and white populations and that of all Canada (see Table IIIb), Cali, Colombia (see Table IIIa), Lativa (see Table IIId) and Hong Kong (see Table IIIc). They form a representative spectrum of incidence rates with age-standardised rates (ASR) in the range 137.0 to 7.9 and for example for age 80 years, the age-specific incidence for the USA black population is some 2000 per 100,000 whereas for Hong Kong it is a factor of 10 times lower at 200 per 100,000 males. At age 60 years the differences are even greater, 600 per 100,000 compared to only 20 per 100,000.

Age-Specific Incidence Rates

Age is the single most important risk factor for the development of prostate cancer [3] with this cancer being very rare before the age of 50 years. Figures 2 and 3 compares incidence and mortality rates for the African-American and USA white populations by five-year age group and by year. Figure 4 shows USA incidence and mortality rates by race and ethnicity. Figure 5 compares age-specific incidence rates for selected populations in north and south America, eastern Europe and Asia.

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References

1. American Cancer Society. *Cancer facts and figures 2001*. Atlanta: ACS; 2001.
2. Smans M, Muir CS, Boyle P, eds. *Atlas of cancer mortality in the European Economic Community*. IARC Scientific publication no. 107, Lyon: International Agency for Research on Cancer, 1992.
3. American Cancer Society. Cancer facts and figures 1998. *Special section: prostate cancer*. Atlanta: ACS; 1998.
4. Baba S. Epidemiology of cancer of the prostate: analysis of countries of high and low incidence. In: Jacobi GH, Hohenfellner R, eds. *Prostate cancer. International perspectives in urology*. Vol. 3. Baltimore: Williams & Wilkin;, 1982, p. 11-28.
5. Brawley OW, Kramer BS. Epidemiology of prostate cancer. In: Vogelzang NJ, Scardino PT, Shipley WU, et al. eds. *Comprehensive textbook of genitourinary medicine*. Baltimore: Williams & Wilkins; 1996, p. 565-572.
6. Gallagher RP. Recent developments in the epidemiology of prostate cancer. *Can J Urol* 116; 3:14-9.
7. Pienta KJ, Epidemiology and etiology and prostate cancer. In: Raghaven D, Scher HI, Leibel SA, et al. eds. *Principles and practice of genitourinary oncology*. Philadelphia: Lippincott-Raven; 1996, p. 379-411.
8. Platz EA, Kantoff PW, Giovannucci E, eds. Epidemiology of and risk factors for protate cancer. In: Klein EA, ed. *Management of prostate cancer*. Totowa: Humana Press, 2000; p.19-45.
9. Ross RK, Schottenfeld D. Prostate cancer. In: Schottenfeld D, Fraumeni JF, eds. *Cancer epidemiology and prevention*, 2nd edn. Oxford: Oxford University Press, 1996, p.1180-205.
10. Hirayama T, Waterhouse JAH, Fraumeni JF, eds. *Cancer risks by site. IARC Technical report series*. Vol. 41, Geneva: International Agency for Research on Cancer, 1980, p. 150-151.
11. Abeloff MD, Armitage JO, Lichter AS, et al, eds. *Clinical oncology*. New York: Churchill Livingstone; 1995, p. 1440.
12. Whelan SL, Parkin DM, Masuyer E, eds. Patterns of cancer in five continents. IARC Scientific publication no. 102, Lyon: International Agency for Research on Cancer, 1990.
13. Parkin DM, Whelan SL, Ferlay J, et al, eds. *Cancer incidence in five continents*. Vol. 7. IARC Scientific publication no. 143, Lyon: International Agency for Research on Cancer, 1997.

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