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ORIGINAL ARTICLE

Anthropometric Predictors of Elevated Prostate Specific Antigen among Rural and Urban Nigerians: A Population-Based Study

Predicteurs anthropmétriques de l'antigen spécifique de la prostate élevé chez les Nigérians en milieu rural et urbain : Une étude de Base.

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ABSTRACT

BACKGROUND: **Obesity has been associated with incidence and mortality of carcinoma of the prostate (CaP), but the relationship of BMI to CaP risk remains controversial across populations.**

OBJECTIVE: **To describe the anthropometric correlates of elevated prostate specific antigen in Nigeria, a low-incidence region for CaP that currently reports rising incidence.**

SUBJECTS AND METHODS: **Weight, height and skin fold thickness were measured for men, aged 40 years and older. Waist-to-hip ratio (WHR) and body mass index (BMI) were computed. Prostate specific antigen (PSA) status and prostate size were determined. Mean anthropometric indices were compared across groups using Student's t-test, association between anthropometry and PSA was by Spearman's correlation, and mean PSA was tested for linearity across tertiles of anthropometry. Prediction of elevated PSA was determined by multivariate logistic regression controlling for age and prostate size.**

RESULTS: **Of 350 consecutive men contacted, 281(80.3%) completed the survey, mean age 56.9(13.5) years , and elevated PSA prevalence 31(11.0%). WHR was 0.92 for rural and urban men, BMI (22.9 vs 24.7, p<0.002, and skin fold thickness was lower for rural men. PSA correlated directly with age, r=0.360, p<0.0001 and negatively with height, r=-0.136, p<0.023. WHR remained a significant predictor of elevated PSA,[OR 3.04 (95% CI 1.13 – 8.15)], after adjusting for age and enlarged prostate.**

CONCLUSION: **Central adiposity may be a more important predictor of elevated PSA than BMI in this population. There is need to investigate the role of hormonal, metabolic, and genetic correlates of central adiposity in carcinoma of the prostate risk in this population. WAJM 2007; 26(1): 7 – 13.**

Keywords: Prostate, Carcinoma, Prostate specific antigen, Nigerians, Obesity.

RESUMÉ

***Contexte** : L'obesité a été associé à l'incidence et à la mortalité du carcinome de la prostate (CP), mais la relation entre le CP et l'Index de Mass Corporelle (IMC) demeure contreversée chez nos populations.*

***Objectif:** C'est de décrire la correlation anthropometrique des markeurs élevés des antigens spécifiques à la prostate au Nigéria, une region à incidence du CP basse qui connait une hausse.*

***Sujets et Méthodes:** Le poids, la taille, et l'épaisseur de la peau étaient pris en consideration chez des hommes agés de 40 ans et plus.Le rapport tour de taille et l'Index de Mass Corporelle (IMC) étaient mesurés. Les markeurs spécifiques de la prostate et la grosseur de la prostate étaient également mesurés. L 'indice antrhopométrique était comparée entre groupes avec la formule t-test, l'association entre l'anthropométrie et l'antigen spécifique de la prostate était analysé par la formule de correlation de Spearman et la moyenne de l 'antigen spécifique de la prostate était par linéarité d'antropométrie.*

***Résultats:** Parmi les 350 hommes examinés, 281(80.3%) sont arrivés à bout de l'étude. La moyenne d'âge était de 56.9(13.5) et la prévalence des antigens spécifiques de la prostate élevée était de 31(11.0%). Le rapport tour de taille était de 0.92 chez des hommes en milieu rural et urbain, et l'Index de Mass Corporelle (IMC) (22.9 vs 24.7, p<0.002) et l'épaisseur de la peau était bas chez des hommes en milieu rural. L'antigen spécifique de la prostate était proportionel à l'âge, r=0.360, p<0.0001 et inversement proportionel à la taille, r=-0.136, p<0.023. Le rapport tour de taille était un prédicateur des markeurs élevés de la prostate après un adjustement de l'âge et la prostate élargie.*

***Conclusion:** L'adiposité centrale peut être a prédicateur plus important des markeurs élevés de la prostate que l'Index de Mass Corporelle dans cette population. Il est nécessaire d'investiguer le rôle des correlats génetiques, métaboliques et hormonales de l'adiposité dans le carcinome de la prostate.*

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Mots clés : Prostate, carcinome, antigen spécifique de la prostate, Nigérians, Obeisité.

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Abbreviations: BPH, Benign prostatic hyperplasia; BMI, Body mass index; CaP, carcinoma of the prostate; MAC,midarm circumference; PSA, Prostate specific antigen; WHR, Waist hip ratio.

INTRODUCTION

Obesity is associated with several diseases like hypertension, diabetes, and cancer, including carcinoma of the prostate (CaP). CaP is a serious problem among blacks in the United States of America (U.S.)[1,2], and is emerging as an important health risk in Nigeria[3],[4]. Evidence of increased CaP risk with excess body weight has been reported from the U.S.[2,5], and the European Union[6]. Obesity is associated with higher grade tumors, increased mortality, and worse outcome following radical prostatectomy.[7,8] Studies investigating the role of body fat in the incidence, aggressiveness, and fatality of CaP have been inconsistent.[9] A study of a very lean Chinese population reported three-fold risk for CaP between the lowest and highest waist-to-hip ratio (WHR) quartile.[10] Body-mass index (BMI),[11-13] and pre-adult BMI[14] have been reported as important risk factors for CaP incidence and mortality, but some studies did not find any association with BMI,[15,16] WHR[17] or skin fold thickness.[18] Pre-adult tallness[19] and adult height,[20] which are indices of early life hormonal milieu, are reported risk factors for aggressive and metastatic CaP.

No relationship was found between risk for CaP and BMI among Nigerians who were described as lean with low-normal BMI,[4,21] but studies from Cameroon,[22] and South African[23] alluded to increased risk with obesity, urbanization and prosperity. Since anthropometry is an expression of complex interactions between genetic and environmental factors, and a relatively inexpensive technique for assessing body fat composition,[24] this cross-sectional study was designed to investigate the anthropometric body fat correlates and predictors of elevated prostate specific antigen (PSA) of 4ng/dl and above. In view of the slow nature of CaP, body fat predictors of risk may not have been impacted sufficiently in the early stages of the disease process to obscure any association. This study was to also provide feasibility information, establish collaborative ties with local researchers, and build trust with communities, setting the foundation to develop a cohort study of dietary and genetic risk factors of CaP in this low-incidence region with differential dietary exposures and obesity rates in comparison with their African-American peers who exhibit higher CaP rates.

SUBJECT AND METHODS

Men 40 years and older in two rural and two urban communities of Southern Nigeria were recruited door-to-door, and consented after receiving detailed information about the study.[25] Of 350 men contacted, 334(95.4%) signed informed consent, and trained interviewers collected demographic information, history of urinary symptoms, family history of CaP, and anthropometric measurements (weight, height, waist, hip, and mid-arm circumference), by standardized protocol. BMI was computed as weight (kg) divided by height (m^2), and WHR was waist circumference divided by the hip circumference. Biceps, triceps, and subscapular skin fold thickness were measured on the right side with arm flexed and resting on the chest, using a Slim Guide skin fold calipers. Venous blood was drawn observing all precautions against transmission of blood borne pathogens, followed by digital rectal examination (DRE) by the experienced study surgeon, using a lubricated gloved index finger with the patient lying on their left side with both legs flexed. The blood sample was processed in accordance with a standardized protocol, stored at -20°C until shipped on dry-ice to the U.S. for PSA analysis by a commercial laboratory, using microparticles enzyme immunoassay technology.[26] Men with elevated PSA and/or abnormal DRE were referred to the urologist at the University of Benin Teaching Hospital, Benin-City.

Statistical analysis: The statistical program for the social sciences (SPSS 12.0) was used for data analysis. The study population was dichotomized by place of residency (rural and urban), occupation (farmers and non-farmers), age at cut-point of 55 years, and obesity status defined as BMI ³ 30 kg/m^2. Socio-economic status (SES) based on income was stratified to low, medium and high, and educational status to <7, 7–12 and >12 years of formal education. Mean anthropometry was compared across groups by Student's t-test. Spearman's correlation was used to assess relationship between anthropometry and PSA. Mean PSA was tested for linearity across SES, education, and tertiles of anthropometry. The SAS 8.2 program was utilized for multivariate logistic regression to determine predictors of elevated PSA as a continuous variable, and dichotomized as elevated PSA ³ 4ng/ml, controlling for age and enlarged prostate/ benign prostatic hyperplasia (BPH).

RESULTS

Of the 334 men who consented, 281(84.1%) completed the protocol, and 53(15.9%) who did not allow blood draw were excluded from further analysis. Due to scheduling problems, and not self-selection, 23(8.2%) did not have a DRE, and 12(3.6%) were not measured. There were 178(63.3%) rural and 103(36.7%) urban dwellers, aged 40–100 years, mean 56.9 + 13.5 years. Urban men were more educated, 30(30.0%) with >12 years formal education compared to 17(9.6%) for rural men. Farming was the occupation of 11(11.0%) urban and 130(73.9%) rural men, with equivalent 52(50.5%) and 20(11.2%) retirement rate, p< 0.0001. None of the men reported family history of CaP. Rural men were smaller than their urban counterparts, BMI, 22.9 vs 24.7, p<0.001, obesity rate was 6(3.5%) to 14(14.8%), p<0.001 (Table 1), and other anthropometric measures were significantly lower except WHR that was 0.92 in both groups (Table 2).

Prevalence of elevated PSA (³ 4ng/ml) was 13(12.6%) and 18(10.1%) for urban and rural men, and 44(48.9%) vs 52(31.0%) for BPH respectively. The rates for elevated PSA³ 4ng/ml was 30(20.8%) for men ³ 55 years and 1(0.8%) for those < 55 years, PSA correlating with age among the older men, r=0.29, p<0.0001. The prevalence of BPH was 74(54.8%) for older men vs 21(17.4%) for younger men, p<0.0001. The urban-rural difference was significant only for the young men, 7(8.9%) to 14(33.3%), p<0.001, but not for the older men, 44(50.6%) to 30(62.5%).

Older men were shorter than their young counterparts, 164.8 cm vs 166.3cm for rural, and significantly so for urban men, 167.2 cm vs 170.7 cm, p<0.05. Older men had higher WHR 0.93 vs 0.91 for

urban, and 0.94 vs 0.91, p<0.0001, for rural men. Farmers ³55 years were the leanest with BMI of 22.2, MAC 27.9cms but WHR 0.93, and farmers under 55 years had BMI of 22.9, MAC 29.2cms and WHR 0.90. The young non-farmers were the low-income artisans and semiskilled workers with BMI of 23.8, mean arm circumference (MAC) 30.2cms and WHR 0.91, while the older non-farmers were the local landlords, contractors and owners of small businesses, with BMI 27.0, MAC 31.4cms and WHR 0.97. The prevalence of elevated PSA ³ 4ngs/ml among men ³55 years was not different for rural and urban 17(18.9%) vs 13(24.1%) respectively (Table 3), nor for farmers and non-farmers 16(20.0%) vs. 14(23.0%). Age ³55 years was a significant predictor of elevated PSA and BPH, OR 34.74 (95% CI 4.66, 258.75), p<0.001, and OR 5.78 (95% CI 3.23, 10.32), p<0.001 respectively. The significant predictors of elevated PSA were height, OR 0.36 (95% CI 0.16 – 0.82),

Table 1: Comparison of Rural and Urban Nigerian Men in their Distribution of Demographic Characteristics, PSA and Prostate Size

Characteristic	Number (%) of subjects Rural	Urban	Total	p-value
Rural:Urban	178 (63.3)	103 (36.7)	281 (100)	ns
Age in years				
< 45	38 (21.7)	18 (17.6)	56 20.2	
45 – 54	47 (26.9)	30 (29.4)	77 27.8	
55 – 64	43 (24.6)	26 (25.5)	69 24.9	
65 – 74	29 (16.6)	17 (16.7)	46 16.6	
75 – 84	12 (6.9)	9 (8.8)	21 7.6	
≥85	6 (3.4)	2 (2.0)	8 2.9	
Not Recorded	3 --	1 --	4 --	
Mean Age	56.7±14.1	57.4±12.5	56.9±13.5	
Education				<0.0001
< 6 years	79 (44.6)	9 (9.0)	88 31.8	
6 – 12 years	81 (45.8)	61 (61.0)	142 51.3	
> 12 years	17 (9.6)	30 (30.0)	47 17.0	
Not Recorded	1 --	3 --	4 --	
Occupation				<0.0001
• Farming	130 (73.9)	11 (11.0)	141 51.1	
Semi-/Skilled	20 (11.4)	38 (38.0)	58 21.0	
Teaching/Jr. Admin	22 (12.5)	34 (34.0)	56 20.3	
• Manager/Professional	4 (2.3)	17 (17.0)	21 7.6	
: Not Recorded	2 --	3 --	5 --	
PSA (mg/ml)				ns
0 – 24	143 (80.3)	83 (80.6)	226 80.4	
2.5 – 3.9	17 (9.6)	7 (6.8)	24 8.5	
4.0 – 9.9	6 (6.2)	7 (6.8)	13 46	
10.0 – 49.9	11 (6.2)	3 (2.9)	14 5.0	
≥ 50.0	1 (0.6)	3 (2.9)	4 1.4	
Prostate Size				<0.007
Normal	116 69.0)	46 (51.1)	162 57.7	
Enlarged	52 (31.0)	44 (48.9)	96 34.1	
Not Done	10 --	13 --	23 --	
Obesity (BMI)†				<0.001
Underweight	17 (9.8)	3 (3.2)	20 7.4	
Normal	113 (64.9)	49 (51.6)	162 60.2	
Overweight	38 (21.8)	29 (30.5)	67 24.9	
Obese Class I	5 (2.9)	11 (11.6)	16 5.9	
Obese Class II	1 (0.6)	3 (3.2)	4 0.5	
Not recorded	4 --	8 --	12 --	

Obesity classes: 1= BMI 30.0 - 34.9; class II = BMI 35.0 - 39.9; Extreme Obesity = BMI ≥40.
† Underweight = BMI <18.5; Normal = BMI 18.5 - 24.9; Overweight = BMI 25.0 - 29.9
* p-value for comparison between rural and urban distributions.

biceps skin fold, OR 3.04 (95% CI 1.03 – 9.01), and WHR, OR 3.11 (95% CI 1.33 – 7.26). For men ³55 years only WHR was a significant predictor, OR 2.67 (95% CI 1.12 – 6.38), age-adjusted OR 2.76 (95% CI 1.10, 6.92), and age/BPH–adjusted OR 3.04 (95% CI 1.13, 8.15) (Tables 4 and 5). The incidence of elevated PSA among men in the lowest, middle and upper WHR tertiles was 13.5%, 18.0% and 34.9%, p<0.0001, with a three-fold increased risk in the upper WHR tertile, age/BPH-adjusted OR 3.20 (1.06, 9.64) (Table 6). Waist, skinfold thickness, obesity, income and farming occupation did not predict elevated PSA.

Table 2: Mean and Median Anthropometric Measurment of Rural and Urban Nigerian Men

Measurement	Mean		Median		p-value
	Rural	Urban	Rural	Urban	
Waist (cms.)	83.5	87.9	81.4	87.5	.000
Hip (cms.)	90.1	95.6	89	95.2	.000
MAC(cm)	28.2	29.3	28.1	29.1	.005
Height (cms.)	165.6	168.9	165.5	168.2	.001
Weight (kgs.)	62.9	70.7	61.0	69.4	.000
Biceps (mms.)	4.7	6.0	4.0	5.0	.000
Triceps (mms.)	7.6	10.9	7.0	10.0	.000
Subscapular (mm)	12.1	15.7	11.0	15.0	.000
BMI	22.9	24.7	22.5	23.8	.002
WHR	0.92	0.92	0.92	0.92	0.38

Table 3: Comparison of Mean Anthropometric Measurements and frequency of Elevated PSA by Age Cohort for Rural and Urban Nigerians

Variable	Mean (SD)			
	Rural		Urban	
No. of subjects	85	90	48	54
Age (y)	>55	<55	<55	>55
Age (y)	45.4(4.3)	67.2(11.6)	46.7(4.3)	67.0(9.1)
Waist (cm)	81.9(10.1)	84.8(11.9)	85.9(9.8)	89.5(11.3)
Hip (cm)	90.2(8.1)	90.1(9.3)	94.8(7.7)	96.1(9.3)
MAC (cm)	28.5(3.2)	28.0(3.1)	29.3(3.3)	29.3(3.6)
Height (cm)	166.3(6.8)	164.8(6.7)	170.7(7.6)	167.2(8.2)*
Weight (kg)	63.3(10.8)	62.3(12.1)	71.0(13.0)	69.8(15.0)
Biceps (mm)	4.5(2.1)	5.0(2.7)	5.6(2.8)	6.3(2.7)
Triceps (mm)	7.1(3.0)	8.2(3.7)	10.5(5.5)	11.0(4.4)
Subscapular (mm)	11.7(4.9)	12.6(5.7)	14.9(6.9)	16.4(7.0)
BMI	22.9(3.6)	22.9(3.9)	24.4(4.2)	25.0(4.8)
WHR	0.91(0.07)	0.94(0.06)†	0.91(.07)	0.93(.06)
% Elevated PSA	1(1.2%)	17(18.9%)†	0(0%)	13(24.1%)†

* $p < 0.05$, † $p < 0.0001$

Table 4: Anthropometric predictors of elevated PSA and BPH in Nigerian men.

Predictors	Mean (Standard Deviation)		Crude Odds Ratio (95% CI)	
	Elevated PSA	Normal PSA	Elvated PSA	BPH
Weight	66.19(19.59)	65.61(12.06)	0.72(0.34, 1.55)	0.42(0.25,0.71) ‡
Height	165.41 (7.30)	166.95 (7.48)	0.36(0.16, 0.82) †	0.94(0.57,1.57)
Waist	89.25(14.32)	4.56(10.64)	1.15(0.54, 2.46)	1.21(0.73,2.02)
Hip	93.07(11.64)	91.97 (8.73)	0.98(0.46, 2.08)	0.76(0.46,1,28)
MAC	28.53 (4.24)	28.64 (3.18)	0.68(0.32, 1.46)	0.55(0.33,0.92)*
Bicep	5.97 (3.11)	5.07 (2.55)	3.04(1.03, 9.01) *	1.52(0.84,2.72)
Tricep	10.18 (4.66)	8.63 (4.31)	1.61(0.75, 3.47)	1.14(0.68,1.92)
Subscapular	15.00 (7.75)	13.24 (5.95)	1.53(0.71, 3.29)	1.03(0.61,1.73)
BMI	23.96 (5.52)	23.51 (3.86)	0.74(0.34, 1.59)	0.82(0.49,1.36)
WHR	0.95 (0.63)	0.92 (0.65)	3.11(1.33, 7.26) †	1.45(0.87,2.43)

* $p < 0.05$, † $p < 0.01$, ‡ $p < 0.001$

Table 5: Anthropometric Predictors of Elevated PSA among Nigerian men with Odds Ratio adjusted for Age and Benign Prostatic Hyperplasia.

Predictors	Crude Odds Ratio (95% CI)	
	Age-Adjusted OR	Age/BPH-Adjusted OR
Weight	1.03 (0.44, 2.39)	1.15 (0.45, 2.89)
Height	0.45 (0.19, 1.08)	0.56 (0.22, 1.39)
Waist	1.36 (0.59, 3.16)	1.01 (0.41, 2.45)
Hip	1.04 (0.45, 2.39)	1.14 (0.47, 2.78)
MAC	0.90 (0.39, 2.08)	1.19 (0.48, 2.98)
Bicep	3.04 (0.85,10.9)	2.97 (0.77, 11.5)
Tricep	1.73 (0.73, 4.09)	1.62 (0.65, 4.03)
Subscapular	1.74 (0.73, 4.13)	1.47 (0.59, 3.65)
BMI	1.00 (0.43, 2.31)	0.86 (0.35, 2.13)
WHR	2.76 (1.10, 6.92) *	3.04 (1.13, 8.15) *

* $p < 0.01$

Table 6: Waist-Hip-Ratio and other Categorical Predictors of Elevated PSA among Nigerians: Age / BPH - Adjusted Odds Ratio.

Predictor	Cases (Elevated PSA)	Controls (Normal PSA)	Odds Ratio	95% CI	p-value
Age in years					
< 65	13 (41.9)	189 (76.8)	1.00		
≥ 65	18 (58.1)	57 (23.2)	4.59	2.12, 9.94	0.0001
Waist-hip-ratio					
0.66 – 0.90	6 (20.0)	89 (36.6)	1.00		
0.90 – 0.95	8 (26.7)	88 (36.2)	1.15	0.31, 4.22	0.43
0.95 – 1.17	16 (53.3)	66 (27.2)	3.20	1.06, 9.64	0.02
Obesity (BMI > 30)					
No	14 (56.0)	148 (66.1)	1.00		
Yes	11 (44.0)	76 (33.9)	1.53	0.66, 3.53	0.32
Income					
Low	21 (77.8)	146 (65.8)	1.00		
Medium	1 (3.7)	40 (18.0)	0.40	0.05, 3.42	0.25
High	5 (18.5)	36 (16.2)	2.01	0.71, 5.70	0.10
Occupation					
All Others	14 (45.2)	121 (49.4)	1.00		
Farming	17 (54.8)	124 (50.6)	0.72	0.29, 1.78	0.66

DISCUSSION

Central adiposity measured by WHR, but not BMI, skin fold thickness, nor height, was associated with risk for elevated PSA in this population, and this association remained after adjusting for age and BPH, the two strongest correlates of elevated PSA. Men with BPH were included in this analysis as prostate size does not preclude the risk for CaP. Results from case-control and cross-sectional studies show only modest association between CaP and measures of obesity probably because these measures have already undergone modification either as a result of the disease process or behavior change based on the understanding that weight reduction is beneficial for cancer prognosis. Patients in these studies included those with clinical CaP,[12] stage T2 and greater,[16] and aggressive CaP.[10] Cohort studies that recorded anthropometry before the onset of disease did show obesity, BMI, height and other aspects of body size to be risk factors for CaP incidence and mortality, especially when measurements were collected as part of a study protocol by trained staff.[7,13] That the association between body size and CaP is stronger for those who were diagnosed eleven years after the study was initiated underscores the importance of studying baseline measures long before the onset of disease, prior to changes in body fat distribution.[15,27] The confounding role of diet and circulating hormones[28] in cancer etiology is acknowledged.

Physical inactivity is another important cancer risk factors[29] indirectly addressed in this study by using farming as proxy for physical activity. Cross stratification by farming status and age cut-point 55 years provided four cohorts with differential past and present nutrition, physical activity and physical growth history. BMI runs a continuum with the older farmers having the lowest measure, followed by young farmers, followed by the young non-farmers, and then the older non-farmers with the highest BMI. Older farmers with past and present high levels of physical activity recorded similar prevalence of elevated PSA as their non-farmer peers who lacked physical activity. Although mean BMI was different for both groups of men, WHR and the prevalence of elevated PSA were similar. The association between central adiposity and the risk for elevated PSA was not attenuated by a history of high levels of occupational physical activity. That central adiposity predicts risk for CaP in a highly physically active and lean population in a CaP low-incidence region is serious implication for the African-American population with rising prevalence of obesity from 53.9% in 1960 to 71.3% in 2000.[30] This is particularly important especially as severe obesity has been reported to explain their relative disadvantage in prostate and breast cancer outcomes.[8,31] Likewise the rising prevalence of obesity in third world countries, and the reported increasing number of men diagnosed with CaP deserves attention. Further research into the metabolic and hormonal mechanisms of CaP etiology in blacks in Africa and America is necessary, as this will provide a wider range of body size, nutrient exposures, and genetic admixture.

This study is limited by small sample size, and lack of follow-up with prostate biopsy among men with elevated PSA. It however confirms the feasibility of a community-based cohort study with recruitment sites in Nigeria. The study strengths are that measurements were made by trained staff prior to overt disease, and did not depend on self-

report. Secondly WHR not routinely collected in hospitals was recorded. A follow-up study can be designed to more actively educate men and reduce their fear and negative attitude to prostate biopsy, identify men who subsequently get diagnosed with CaP, and evaluate the anthropometric predictors of CaP retrospectively. The fact that none of the study participants reported a family history of CaP may be as a result of general lack of awareness of the disease, inattention to pathological cause of death, competing causes of mortality, very low incidence of CaP in the previous generation, or a combination of these factors. This population provides a unique opportunity to prospectively study the anthropometric, metabolic, and hormonal predictors of CaP, provide data to estimate the true incidence of the disease in that region, and recruit families with multiple cases for more detailed genetic studies.

The prevalence of elevated PSA ^{3} 4.0 ng/ml was 11.0% among rural and urban Africans with an obesity rate of 8%. Central adiposity, not BMI, predicted the risk for elevated PSA, and the association was not attenuated by a history of increased physical activity. This is consistent with the current implication of hormonal or insulin-related mechanism in the aetiology of carcinoma of the prostate.

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