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Racial Differences in Risk of Prostate Cancer Associated with Metabolic Syndrome

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Abstract

Objectives—Metabolic syndrome refers to cluster of conditions serving as risk factors for cardiovascular disease. Metabolic syndrome is prevalent in the United States and the spectrum of specific features has been shown to differ by race and ethnicity. A number of recent reports link metabolic syndrome to prostate cancer, however most studies do not have racially diverse populations to explore differences in risk.

Methods—A case-control study was conducted to test the association between metabolic syndrome features and prostate cancer among 637 cases and 244 controls, with African Americans comprising 43% of the study population.

Results—Metabolic syndrome, defined using a modified version of the ATP III criteria, was marginally associated with increased risk of prostate cancer in African Americans (OR=1.71; 95% CI=0.97, 3.01), but not Caucasians (OR=1.02; 95%CI=0.64, 1.62). After stratifying cases on stage at diagnosis, African American men with organ confined disease were more likely to have a history of metabolic syndrome compared to controls (OR=1.82; 95% CI=1.02, 3.23), but no association was observed among those with advanced stage disease (OR=0.93; 95%CI=0.31, 2.77). When evaluating specific features of metabolic syndrome, obesity was inversely related to prostate cancer among Caucasians (OR = 0.51, 95% CI=0.33, 0.80), but unrelated to risk among African Americans (OR=1.15; 95% CI=0.70, 1.89).

Conclusions—In this investigation, metabolic syndrome was associated with prostate cancer risk in African American men, but not Caucasians. The prevalence of this syndrome, coupled with the racial disparity and prostate cancer incidence and outcomes after diagnosis warrant further investigation.

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Keywords

insulin resistance; aggressive prostate cancer; African American; hypertension; diabetes; obesity

Introduction

Metabolic syndrome refers to a cluster of conditions, all of which serve as risk factors for cardiovascular disease with insulin resistance as the defining feature¹. It has been estimated that 25% to 35% of U.S. adults can be characterized as having metabolic syndrome^{2, 3}. However, these estimates vary somewhat depending upon syndrome definition, with several different working definitions in existence³⁻⁵. The definition put forth by the National Cholesterol Education Program (NCEP) Expert Panel on Detection, Evaluation and Treatment of High Blood Cholesterol in Adults (Adult Treatment Panel III [ATP III]) is commonly used to characterize metabolic syndrome⁶. Individuals who possess at least three of the following five features are classified as having metabolic syndrome: 1) abdominal obesity (waist circumference of >102 cm in men or >88 cm in women), 2) hypertriglyceridemia (≥ 150 mg/dL), 3) low high-density lipoprotein (HDL) cholesterol (< 40 mg/dL in men and < 50 mg/dL in women), 4) high blood pressure ($\geq 130/85$ mm Hg) and 5) high fasting blood glucose ≥ 110 mg/dL.

In the United States, the prevalence of metabolic syndrome increases with increasing age. Overall, the age-adjusted prevalence of metabolic syndrome is similar among men and women and highest among Hispanics^{2, 3}. Certain racial and ethnic groups are predisposed to developing specific features of metabolic syndrome. Lipid abnormalities are most commonly observed among whites of European ancestry. Hypertension is most prevalent among African and Asian Americans. High fasting glucose is diagnosed more frequently among Hispanics and Native Americans⁷. An epidemic of obesity has occurred in the U.S. over the past four decades, with approximately 30% of all adults characterized as obese (Body Mass Index (BMI) ≥ 30 kg/m²)⁷.

A number of investigations suggest that metabolic syndrome is associated with an increased risk of prostate cancer⁸⁻¹². A recent pooled analysis indicates men with metabolic syndrome are 50% more likely to be diagnosed with prostate cancer¹³. However, with one exception¹¹, all positive studies have been conducted in exclusively in Northern European populations. Furthermore, few have examined the relationship between metabolic syndrome and specific prostate tumor characteristics (Gleason grade, stage) to determine whether one or more metabolic syndrome features is predictive of a particular disease phenotype.

The majority of studies connecting the biologic consequences of metabolic syndrome and prostate carcinogenesis have focused on relation of insulin resistance, serum concentrations of insulin-like growth factors, their associated binding proteins and sex-steroid hormones^{14, 15}. However, chronic inflammation, has been also proposed as a putative link between obesity, insulin resistance and prostate carcinogenesis^{13, 16}. Increased adiposity has shown to be associated with enhanced recruitment of immune players through a variety of cell signaling pathways which may lead to oxidative stress and tissue damage^{16, 17}.

The aim of the current investigation is to examine the association between metabolic syndrome, its specific features and prostate cancer in hospital-based, case-control study of Caucasian and African American men residing within metropolitan Detroit, Michigan. Analyses stratified by race and prostate cancer clinical characteristics were conducted to determine if racial differences in risk related to metabolic syndrome exist, as well as evaluate the role of specific syndrome features on risk of aggressive disease.

Materials and Methods

GECAP Study Population and Data Collection

The men participating in the Genes Environment and Prostate Cancer (GECAP) study were all patients in the Henry Ford Health System (HFHS). HFHS provides medical care to an ethnically-diverse population, representative of the larger Detroit metropolitan area. Eligibility criteria for cases and controls included: 1) ≤ 75 years of age at time of diagnosis (cases) or enrollment (controls); 2) use of the HFHS for primary medical care within past 5 years; 3) residence within the study area at the time of recruitment; 4) no history of prostate cancer; and 5) no serious medical problems that would prevent participation in the study. Cases were diagnosed with primary adenocarcinoma of the prostate between January 1, 1999 and December 31, 2004, identified and histopathologically confirmed through the centralized HFHS Department of Pathology. A race and age-stratified random sample of potential controls were identified from the HFHS patient database such that the final ratio of cases to controls was approximately 3:1. The strategy of over sampling cases was employed to address hypotheses related to the principal goal of GECAP, namely to evaluate the interaction between genes and environmental risk factors using primarily a case-only analytic approach.

Between July 1, 2001 and December 31, 2004, 637 eligible cases and 244 controls were enrolled into the study and completed all aspects of the protocol (response rates of 75% and 64% respectively). All subjects completed a two-part, interviewer-administered questionnaire, donated a blood sample for DNA analysis and prostate specific antigen (PSA) testing (controls). Informed consent was obtained from study participants, and all protocols were approved by the HFHS Institutional Review Board.

The survey questionnaire designed to collect information on sociodemographic characteristics, family history of prostate cancer, smoking, alcohol consumption, physical activity, height, weight, occupational history, diet and vitamin use. Medical record abstraction included history of prior cancers, hypertension, diabetes, as well as lipid profiles and prostate specific antigen (PSA) screening history prior to diagnosis (cases) and enrollment (controls). Additional clinical information abstracted on cases related to their diagnoses included pre-diagnostic PSA, primary treatment, clinical and pathologic (TNM) stage, biopsy Gleason grade, prostatectomy Gleason grade (for surgical patients).

Definition of Metabolic Syndrome and Aggressive Disease

The criteria to assess metabolic syndrome in this study were adapted from those outlined by ATP III, but modified to accommodate available data. Body mass index (in kg/m^2) was calculated based on self-reported weight and height and cases were asked to report their weight one-year prior to diagnosis. Obesity was defined as having a BMI $\geq 30 \text{ kg}/\text{m}^2$ and was used to replace waist circumference as a measure of abdominal obesity. Information on history of hypertension and diabetes abstracted from medical records were used instead of biometrical data (blood pressure and fasting glucose). The last recorded lipid profiles for cases (prior to diagnosis) and controls (prior to enrollment) were extracted to assess triglyceride and HDL cholesterol levels. The criteria for hypertriglyceridemia ($\geq 150 \text{ mg}/\text{dL}$) and low HDL cholesterol ($< 40 \text{ mg}/\text{dL}$) were consistent with ATP III definitions. Participants who possessed any three of the aforementioned five features were classified as having metabolic syndrome.

The definitions for aggressive disease were based on a combination of tumor grade and stage information. For surgical patients, pathologic stage and Gleason score based on prostatectomy specimen was preferentially used to clinical and biopsy information, while for non-surgical patients, we relied on the biopsy Gleason score and clinical stage information to define aggressive disease. High grade disease was defined as having a biopsy (or prostatectomy)

Gleason score of 7 (4+3) and higher. Advanced stage disease was defined as pathologic or clinical stage T3a and higher, pathologic confirmation of lymph node involvement or evidence of metastatic disease. Aggressive prostate cancer was defined as having either high grade or advanced stage disease.

Statistical Methods

All statistical analysis was performed using SAS software version 9.1 (SAS Institute, Cary N.C.). Crude associations between each metabolic syndrome feature by race and case/control status were tested using chi-square tests. Odds ratios and 95% confidence intervals were produced to quantify the relationship between specific features of the metabolic syndrome and prostate cancer among all subjects and stratified by race using unconditional logistic regression models simultaneously controlling for age, four remaining features and prostate cancer screening history. To address the issue of detection bias among participants with one or more metabolic syndrome features, we assessed the proportion of cases and controls with medical record documentation of at least one PSA test from 5 years prior to diagnosis or enrollment into the study through one year prior. This specific period of time was chosen to avoid the inclusion of pre-diagnostic PSA testing among symptomatic cases as part of their screening history. Polychotomous regression models were used to estimate the effect of metabolic syndrome comparing patients with aggressive disease (high grade/regionally advanced) and non-aggressive disease (low grade/organ confined) each to controls (referent). Formal tests of the heterogeneity of strata were not conducted as the study was largely underpowered to detect statistically significant interactions between metabolic syndrome features and race, particularly when data were further stratified on prostate cancer clinical features. An examination of the overlap in the 95% confidence boundaries between African American and Caucasian patients within clinical categories as well as between those with aggressive and non-aggressive clinical features among all patients and within race groups gave a sense of the magnitude of the difference in risk between strata.

Results

Characteristics of the GECAP study population are described in Table 1. By design, cases and controls did not differ significantly by age or race. Approximately 43% of subjects were African American and a mean age among all participants of 62 years. Cases were more likely than controls to report a family history of prostate cancer (21% versus 13%, $p=0.01$). Smoking behavior, vitamin intake and PSA screening history were similar between cases and controls. As expected, there were significant racial differences in the presence of specific features of metabolic syndrome (Table 2). Approximately 62% of the study population had a history of hypertension with African American men disproportionately affected ($p=0.002$). Twenty-five percent of African Americans subjects had a history of diabetes compared to 14% of Caucasians ($p<0.0001$). Recorded triglyceride and HDL cholesterol levels were significantly higher among Caucasian men compared to African Americans (p -values <0.0001 and 0.02 , respectively). The prevalence of obesity (34%) did not differ significantly by race. The prevalence of metabolic syndrome (three or more features) was not significantly different among African American and Caucasian subjects (24%). Among those classified as having metabolic syndrome ($n=216$), just 3% possessed all five features. The clustering of hypertension, diabetes and obesity was the most prevalent combination of features among all subjects (22%) and African Americans (33%) characterized as having metabolic syndrome. Hypertension, obesity and hypertriglyceridemia was the predominant cluster of features among Caucasians with metabolic syndrome (24%) (data not shown).

The estimated associations between metabolic syndrome features and prostate cancer are reported in Table 3. Among all subjects, there were no significant differences between prostate

cancer cases and controls in the prevalence of metabolic syndrome or any of its features. However, among Caucasians, prostate cancer cases were approximately 50% less likely to be obese compared to controls (OR = 0.51; 95% CI=0.33, 0.80) with no overall association among African American men (OR=1.15; 95% CI=0.70, 1.89). No other single syndrome feature was associated with prostate cancer risk in either race group. Among all subjects, metabolic syndrome was not associated with prostate cancer risk (OR =1.28; 95%CI = 0.89, 1.83). However, once data were stratified by race, metabolic syndrome was marginally associated with an increased risk of prostate cancer among African American subjects (OR= 1.71; 95% CI = 0.97, 3.01), but not Caucasians (OR= 1.02; 95% CI=0.64, 1.62).

Our analysis stratified by prostate cancer phenotype did not suggest any significant differences in risk associated with any specific metabolic syndrome feature comparing those aggressive versus non-aggressive disease characteristics among all subjects (Table 4). Yet, metabolic syndrome (3 or more features) was present more often among African American patients with organ confined disease compared to controls (OR =1.82; 95% CI=1.02, 3.23), but no association was observed among patients with advanced stage disease (OR=0.93; 95%CI=0.31, 2.77). We did not observe significant racial difference in risk associated with specific metabolic syndrome features according to disease phenotype with one notable exception. Obesity was inversely related to high grade disease among Caucasians (OR=0.30; 95%CI = 0.15, 0.59), but associated with an increase in risk of high grade disease among African Americans albeit not statistically significant (OR=1.75; 95% CI = 0.92, 3.31). Conversely, the estimates among patients with low grade disease indicate a persistent reduction in risk among obese Caucasians (OR=0.59; 95% CI=0.37, 0.93), but no association with obesity among African Americans (OR=0.98; 95% CI=0.58, 1.66).

Comment

Our study is one of the first to examine the role of metabolic syndrome on risk of prostate cancer in a racially diverse population and the first to examine its influence on risk of aggressive disease. We found that metabolic syndrome was modestly predictive of prostate cancer in African American men, but not Caucasians. This association was statistically significant among African American patients diagnosed with organ confined disease. Furthermore, there were distinct differences between African Americans and Caucasians in risk of high grade prostate cancer associated with obesity. No other single feature was significantly predictive of prostate cancer in either race group.

Our findings continue to support a link between prostate cancer and metabolic syndrome^{8-12, 18}. The first evidence connecting metabolic syndrome and prostate cancer was a report from a Swedish study of nearly 300 prostate cancer cases, where hypertension and abdominal obesity were more commonly observed among patients with T3 tumors compared to those with T2 tumors⁸. Subsequent cohorts have shown moderate increases in risk of prostate cancer among subjects with metabolic syndrome^{9, 10}. However, studies do not uniformly suggest that metabolic syndrome is important in prostate carcinogenesis. An inverse relationship between metabolic syndrome and prostate cancer risk was reported in a large cohort of men participating in the Atherosclerosis Risk in Communities (ARIC) study. The authors reported a 23% reduction in risk associated with metabolic syndrome with no racial difference in the magnitude of the inverse relationship¹⁸. The Flint Men's Health Study (FMHS), was the first study of metabolic syndrome features and prostate cancer conducted exclusively in a population of African American men¹¹. While, both the current investigation and FMHS observed an increase in risk of prostate cancer among African American men associated with obesity and no association with a history of diabetes, we (J.B.D) observed hypertension was associated with an increase in risk of prostate cancer in FMHS (OR=2.4; 95% CI=1.5, 3.7), but unrelated to risk in this study.

The increase in the prevalence of metabolic syndrome in the U.S. parallels the rates in the prevalence of obesity¹⁹. Interestingly, estimates of the prevalence of metabolic syndrome indicate African American men experience the lowest rates (16.4%) compared with men and women from other racial groups². Our findings indicate that the profile of symptoms among African American men with metabolic syndrome is different than Caucasian men. If there are racial differences in the underlying biology of the syndrome this may help to explain the variability in prostate cancer risk. The African American men participating in this study had significantly higher rates of hypertension and diabetes compared to Caucasian subjects. This specific cluster of metabolic syndrome features is associated with the most severe consequences of cardiovascular disease among African Americans²⁰. Our findings suggest that the same may be true of prostate cancer.

The major strengths of this investigation include its diverse population allowing the examination of racial differences in prostate cancer risk associated with metabolic syndrome. Our findings are likely generalizable to broader African American and Caucasian populations in the United States, as the prevalence of metabolic syndrome and specific features in this study are similar with estimates generated from a large national dataset². In addition, histologic verification of prostate cancer diagnosis among cases, as well as medical record abstraction of hypertension and diabetes diagnoses, lipid profiles, and PSA screening history reduces the likelihood of misclassification. However, there are some limitations worth considering in the interpretation of our findings. The GECAP study is powered to satisfy its principal aims, to conduct case-only analyses of the interaction of genes and environmental determinants of prostate cancer risk. The controls in the study were recruited for the purpose of testing the assumption of the independence of gene and environment in the evaluation of the primary analyses conducted among cases²¹. Our study was of limited power to detect statistically significant associations between metabolic syndrome features and prostate cancer risk, particularly when analyses were stratified by race and clinical phenotype. Our modification of the ATP III definition of metabolic syndrome used self-reported height and weight to calculate BMI as a surrogate measure of abdominal obesity. BMI is not considered an optimal measure of obesity, particularly abdominal obesity. Abdominal obesity is less common among African American men than men of other racial and ethnic groups². Because visceral fat is most closely tied to altered lipid concentrations and insulin resistance, our use of BMI may have inadequately captured racial differences in the metabolic consequences of abdominal obesity²². It is also possible that racial differences in the risk of prostate cancer associated with metabolic syndrome is related to differences in intensity of treatment and control of concurrent conditions. Relatively poor cardiovascular disease outcomes among African Americans have been attributed to under-treatment or less intense treatment among those with multiple comorbidities^{20, 23}. Unfortunately, because medication histories were not collected from subjects, we were unable to assess the impact of such use on subsequent prostate cancer risk. Finally, one might question the impact of detection bias on findings in that men with metabolic syndrome are more likely to be screened for prostate cancer by virtue of the fact that they are under close medical surveillance for treatment of co-morbidities and therefore increase their likelihood of a prostate cancer diagnosis. To address the issue of screening bias, adjustment for screening behavior (having been screened in a 5-year period prior to diagnosis or enrollment in the study) revealed no demonstrable impact of PSA screening history on the association between metabolic syndrome and its specific features on prostate cancer risk.

Conclusions

Our investigation is the one of the first to suggest that African American men with metabolic syndrome are at an increased risk of being diagnosed with prostate cancer. While no single feature was significantly, adversely associated with prostate cancer among these men, it appears that the collective effect of the cluster of metabolic syndrome conditions increases risk

of disease. Further investigation is clearly warranted to confirm this association. If metabolic syndrome proves causally linked to prostate cancer, then prevention or control of metabolic syndrome features represents a sensible approach that will not only reduce cardiovascular disease morbidity and mortality in African American men, but prostate cancer as well.

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Reference List

1. Reaven GM. Banting lecture 1988. Role of insulin resistance in human disease. *Diabetes* 1988;37(12):1595–1607. [PubMed: 3056758]
2. Ford ES, Giles WH, Dietz WH. Prevalence of the metabolic syndrome among US adults - Findings from the Third National Health and Nutrition Examination Survey. *JAMA* 2002;287(3):356–359. [PubMed: 11790215]
3. Day C. Metabolic syndrome, or What you will: definitions and epidemiology. *Diab Vasc Dis Res* 2007;4(1):32–38. [PubMed: 17469041]
4. Meigs JB, Wilson PW, Nathan DM, et al. Prevalence and characteristics of the metabolic syndrome in the San Antonio Heart and Framingham Offspring Studies. *Diabetes* 2003;52(8):2160–2167. [PubMed: 12882936]
5. Ford ES, Abbasi F, Reaven GM. Prevalence of insulin resistance and the metabolic syndrome with alternative definitions of impaired fasting glucose. *Atherosclerosis* 2005;181(1):143–148. [PubMed: 15939066]
6. Executive Summary of The Third Report of The National Cholesterol Education Program (NCEP) Expert Panel on Detection, Evaluation, And Treatment of High Blood Cholesterol In Adults (Adult Treatment Panel III). *JAMA* 2001;285(19):2486–2497. [PubMed: 11368702]
7. Smith SC Jr, Clark LT, Cooper RS, et al. Discovering the full spectrum of cardiovascular disease: Minority Health Summit 2003: Report of the Obesity, Metabolic Syndrome, and Hypertension Writing Group. *Circulation* 2005;111(10):e134–e139. [PubMed: 15769755]
8. Hammarsten J, Hogstedt B. Clinical, haemodynamic, anthropometric, metabolic and insulin profile of men with high-stage and high-grade clinical prostate cancer. *Blood Pressure* 2004;13(1):47–55. [PubMed: 15083641]
9. Laukkanen JA, Laaksonen DE, Niskanen L, et al. Metabolic syndrome and the risk of prostate cancer in Finnish men: a population-based study. *Cancer Epidemiol Biomarkers Prev* 2004;13(10):1646–1650. [PubMed: 15466982]
10. Lund Haheim L, Wisloff TF, Holme I, et al. Metabolic syndrome predicts prostate cancer in a cohort of middle-aged Norwegian men followed for 27 years. *Am J Epidemiol* 2006;164(8):769–774. [PubMed: 16952929]
11. Beebe-Dimmer JL, Dunn RL, Sarma AV, et al. Features of the metabolic syndrome and prostate cancer in African-American men. *Cancer* 2007;109(5):875–881. [PubMed: 17265528]
12. Tuohimaa P, Tenkanen L, Syvala H, et al. Interaction of factors related to the metabolic syndrome and vitamin D on risk of prostate cancer. *Cancer Epidemiol Biomarkers Prev* 2007;16(2):302–307. [PubMed: 17301263]
13. Hsing AW, Sakoda LC, Chua S Jr. Obesity, metabolic syndrome, and prostate cancer. *Am J Clin Nutr* 2007;86(3):s843–s857. [PubMed: 18265478]
14. Barnard RJ, Aronson WJ, Tymchuk CN, et al. Prostate cancer: another aspect of the insulin-resistance syndrome? *Obes Rev* 2002;3(4):303–308. [PubMed: 12458975]
15. Smith GD, Gunnell D, Holly J. Cancer and insulin-like growth factor-I. A potential mechanism linking the environment with cancer risk. *BMJ* 2000;321(7265):847–848. [PubMed: 11021847]
16. Tilg H, Moschen AR. Inflammatory mechanisms in the regulation of insulin resistance. *Mol Med* 2008;14(34):222–231. [PubMed: 18235842]

17. Tilg H, Moschen AR. Role of adiponectin and PBEF/visfatin as regulators of inflammation: involvement in obesity-associated diseases. *Clin Sci (Lond)* 2008;114(4):275–288. [PubMed: 18194136]
18. Tande AJ, Platz EA, Folsom AR. The metabolic syndrome is associated with reduced risk of prostate cancer. *Am J Epidemiol* 2006;164(11):1094–1102. [PubMed: 16968859]
19. Ford ES, Giles WH, Mokdad AH. Increasing prevalence of the metabolic syndrome among U.S. Adults. *Diabetes Care* 2004;27(10):2444–2449. [PubMed: 15451914]
20. Ferdinand KC, Clark LT. The epidemic of diabetes mellitus and the metabolic syndrome in African Americans. *Rev Cardiovasc Med* 2004;5(Suppl 3):S28–S33. [PubMed: 15303083]
21. Rybicki BA, Neslund-Dudas C, Nock NL, et al. Prostate cancer risk from occupational exposure to polycyclic aromatic hydrocarbons interacting with the GSTP1 Ile105Val polymorphism. *Cancer Detect Prev* 2006;30(5):412–422. [PubMed: 17067754]
22. Hall WD, Clark LT, Wenger NK, et al. The Metabolic Syndrome in African Americans: A review. *Ethnicity & Disease* 2003;13(4):414–428. [PubMed: 14632261]
23. Yood MU, McCarthy BD, Kempf J, et al. Racial differences in reaching target low-density lipoprotein goal among individuals treated with prescription statin therapy. *Am Heart J* 2006;152(4):777–784. [PubMed: 16996858]

Table 1

Patient characteristics of men participating in the Genes, Environment and Prostate Cancer (GECAP) study

Characteristic [†]	Cases (n=637)	Controls (n=244)	p-value [‡]
Age	62.4 (10.4)	61.9 (9.8)	0.36
Race			
Caucasian	363 (57.0)	140 (57.4)	
African American	274 (43.0)	104 (42.7)	0.92
Smoking History			
Ever	418 (65.6)	162 (66.4)	
Never	219 (34.4)	82 (33.6)	0.89
Vitamin Use (Current) [*]			
Yes	203 (32.7)	82 (38.3)	
No	418 (67.3)	132 (61.7)	0.13
PSA History [◇]			
Yes	498 (78.2)	202 (82.8)	
No	139 (21.8)	42 (17.2)	0.13
PSA concentration ^{**} (ng/mL)	5.2 (3.6)	0.9 (1.2)	<0.0001

[†] Characteristics expressed as median value (interquartile range) for continuous data or number of subjects (proportion of cases/controls) for categorical data.

[‡] p-value for corresponding chi-square or t-test statistic.

^{*} Use of vitamins in the 10 years prior to interview was also similar among cases and controls (p=0.43).

[◇] Having had at least one PSA test from a period of time one year prior to diagnosis or enrollment out 5 years prior.

^{**} Among cases, PSA concentration among cases refers to the pre-diagnostic PSA and among controls the concentration recorded at last PSA measure prior to enrollment.

Table 2

Racial differences in the prevalence of specific features of metabolic syndrome in the GECAP Study

Features of Metabolic Syndrome	All Men (N=881)	Caucasian (N=494)	African American (N=381)	p-value [*]
Hypertension	545 (62.1) [‡]	284 (57.7)	258 (67.9)	0.002
Diabetes	165 (18.8)	68 (13.8)	95 (25.0)	<0.0001
Obesity (BMI ≥ 30 kg/m ²)	299 (34.0)	164 (33.2)	134 (35.2)	0.54
Low HDL (<40 mg/dl)	164 (21.4)	108 (24.5)	56 (17.5)	0.02
High Triglycerides (>150 mg/dl)	298 (38.5)	200 (45.1)	96 (29.6)	<0.0001
3 or more features [†]	216 (24.5)	122 (24.7)	93 (24.4)	0.92

^{*} Based on Mantel-Haenszel chi-square comparing racial differences in prevalence of features

[‡] Expressed as n (%)

[†] Possession of at least 3 features characteristic of metabolic syndrome consistent with ATP III criteria (hypertension, diabetes, obesity, low HDL cholesterol and high triglycerides).

Table 3
Odds ratios and 95% confidence intervals for prostate cancer associated with specific features of metabolic syndrome among GECAP participants.

	Cases n (%)	Controls n (%)	All Men	Caucasian	African American
Features of Metabolic Syndrome				Adjusted* OR (95% CI)	
Hypertension	399 (62.7)	146 (60.3)	1.02 (0.73,1.43)	1.30 (0.83,2.02)	0.71 (0.42,1.23)
Diabetes	123 (19.3)	42 (17.4)	1.12 (0.75,1.69)	0.86 (0.47,1.59)	1.34 (0.75,2.38)
Obesity† (BMI ≥30 kg/m ²)	208 (32.7)	91 (37.3)	0.75 (0.54,1.03)	0.51 (0.33,0.80)	1.15 (0.70,1.89)
Low HDL (<40 mg/dl)	125 (22.1)	39 (19.3)	1.14 (0.74,1.74)	1.43 (0.81,2.53)	0.91 (0.46,1.78)
High Triglycerides (>150 mg/dl)	228 (40.0)	70 (34.3)	1.28 (0.90,1.82)	1.14 (0.71,1.82)	1.41 (0.79,2.52)
3 or more features†	164 (25.8)	52 (21.3)	1.28 (0.89,1.83)	1.02 (0.64,1.62)	1.71 (0.97,3.01)

* Individual feature models adjusted for age, prostate specific antigen screening history, and 4 remaining features. Metabolic syndrome (3+ features) adjusted for age, PSA screening history.

† Metabolic syndrome defined as possession of at least 3 features consistent with ATP III criteria (hypertension, diabetes, obesity, low HDL cholesterol and high triglycerides).

Table 4

Adjusted* odds ratios and 95% confidence intervals associated with features of metabolic syndrome and clinical markers of aggressive prostate cancer

Features of Metabolic Syndrome	Low-grade disease	High-grade disease	Organ confined disease	Advanced stage disease
Hypertension	1.01 (0.71,1.42)	1.10 (0.70,1.73)	0.99 (0.71,1.40)	1.26 (0.72,2.20)
Caucasian	1.19 (0.75,1.88)	1.81 (0.96,3.41)	1.32 (0.84,2.08)	1.25 (0.60,2.60)
African American	0.80 (0.45,1.41)	0.56 (0.28,1.13)	0.65 (0.38,1.13)	1.25 (0.49,3.21)
Diabetes	1.00 (0.65,1.54)	1.53 (0.91,2.59)	1.20 (0.79,1.83)	0.67 (0.32,1.43)
Caucasian	0.80 (0.42,1.49)	1.20 (0.52,2.75)	0.96 (0.52,1.78)	0.32 (0.09,1.21)
African American	1.24 (0.68,2.28)	1.64 (0.79,3.42)	1.44 (0.80,2.59)	0.82 (0.28,2.43)
Obesity (BMI ≥30 kg/m ²)	0.74 (0.53,1.05)	0.76 (0.48,1.18)	0.73 (0.52,1.02)	0.85 (0.49,1.46)
Caucasian	0.59 (0.37,0.93)	0.30 (0.15,0.59)	0.51 (0.32,0.80)	0.51 (0.24,1.09)
African American	0.98 (0.58,1.66)	1.75 (0.92,3.31)	1.11 (0.67,1.84)	1.66 (0.71,3.89)
Low HDL (<40 mg/dl)	1.20 (0.77,1.86)	0.98 (0.55,1.75)	1.11 (0.72,1.72)	1.25 (0.63,2.49)
Caucasian	1.42 (0.80,2.55)	1.49 (0.69,3.21)	1.35 (0.76,2.40)	2.23 (0.94,5.31)
African American	1.01 (0.50,2.02)	0.66 (0.25,1.72)	0.96 (0.49,1.91)	0.33 (0.07,1.61)
High Triglycerides (>150 mg/dl)	1.28 (0.88,1.84)	1.26 (0.78,2.03)	1.30 (0.91,1.86)	1.22 (0.68,2.18)
Caucasian	1.13 (0.70,1.83)	1.17 (0.61,2.26)	1.10 (0.69,1.78)	1.53 (0.70,3.37)
African American	1.40 (0.76,2.56)	1.33 (0.62,2.85)	1.56 (0.87,2.82)	0.55 (0.18,1.70)
3 or more features	1.24 (0.86,1.80)	1.41 (0.88, 2.26)	1.31 (0.91,1.88)	1.14 (0.62,2.09)
Caucasian	0.97 (0.60,1.57)	1.20 (0.64,2.27)	1.01 (0.63,1.62)	1.17 (0.55,2.51)
African American	1.73 (0.96,3.13)	1.67 (0.81,3.45)	1.82 (1.02,3.23)	0.93 (0.31,2.77)

* Individual feature models adjusted for age, PSA screening history and 4 remaining features. Metabolic syndrome (3+ features) adjusted for age, PSA screening history.

‡ High-grade prostate cancer based on prostatectomy or biopsy Gleason sum of 7(4+3) and higher.

† Advanced stage prostate cancer based on pathologic of clinical tumor staging of locally to regionally advanced tumor (T3 or T4), nodal involvement or metastatic disease.