Cancer Worry Is Associated with Abnormal Prostate-specific Antigen Levels in Men Participating in a Community Screening Program

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Abstract

An accumulating body of research suggests that psychological factors can affect physiological parameters. We assessed the association between the perceived risk of prostate cancer, prostate cancer-specific worry, and cancer-related symptoms and prostate-specific antigen (PSA) levels or the findings from digital rectal examination (DRE) in a large sample of men undergoing a free prostate cancer screening. Participants ($n = 1635$) completed a background questionnaire and a questionnaire that assessed their prostate cancer history, screening behavior, perceived risk of prostate cancer, and prostate cancer worry. PSA levels were then determined, and a DRE was conducted. A PSA level of ≥4.0 ng/ml was considered abnormal. The sample size for the multivariate analyses was reduced because of missing data on certain items. Participants who had an abnormal PSA level reported a significantly higher perceived cancer risk ($P = 0.02$), cancer worry ($P = 0.004$), and a greater percentage indicated the reason for the current screening was cancer-related symptoms ($P = 0.014$) than did participants who had normal PSA levels. Multivariate logistic regression analyses controlling for age, past screening behavior, past screening results, and reason for current screening revealed that perceived cancer risk [$P = 0.01$; odds ratio (OR), 1.5; 95% confidence interval (CI), 1.1–2.1], cancer worry ($P = 0.001$; OR, 3.3; 95% CI, 1.7–6.5), and cancer-related symptoms ($P = 0.05$; OR, 3.4; 95% CI, 1.1–10.3) remained significantly associated with an abnormal PSA level. When perceived cancer risk, cancer worry, and cancer-related symptoms were entered in the same multivariate analysis, only cancer worry remained in the model. The present findings suggest that prostate cancer-specific worry was associated significantly with an abnormal PSA level.

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Introduction

Extensive research has shown that both the cognitive and affective aspects of health information processing influence cancer screening adherence behaviors (1). The cognitive aspects have often been defined as a person's perceived risk of developing cancer, and the affective aspects as disease-related worry and general distress (1, 2). However, less research has examined the association between the cognitive and affective aspects of the processing of health information and health outcomes. One interesting finding in the area of screening adherence behaviors has been that moderate levels of perceived cancer risk and cancer-related worry are associated with increased screening behaviors (2–5), but high levels of worry may actually interfere with screening behaviors (6–8).

Symptoms, a physical indicator of disease, must also be assessed when examining the potential associations between the cognitive and affective aspects of health information processing and health outcomes. The positive association typically found between affect (trait anxiety, fear, and worry; Ref. 9) and symptom perception has led some investigators to hypothesize that, like screening behaviors, symptom reports can also be biased by affect (10, 11). However, more recent research has shown that increased negative affect is associated with a greater awareness of symptoms, which may actually lead to a more accurate interpretation of symptoms (12–15). One theory for this association between negative affect and symptom reporting is that negative affect may actually influence disease processes. This has been the viewpoint drawn from an accumulating body of research suggesting that psychological factors can affect physical health. Most of this research has examined the physiological effects of psychological stress (16). Moreover, stress has been associated with increased vulnerability to upper respiratory tract infections (17), latent viral reactivation (18), and slower wound healing time (19). However, the converse could also be true, that the health-related symptoms of an individual lead to negative affect. This would mean that patients who have cancer-related symptoms would also have high levels of cancer-specific worry. Regardless, investigators have been unable to determine whether the combined effects of cognitive and affective aspects of health information processing, and symptoms are associated with objective health outcomes.

Therefore, this study additionally explored the association among subjective symptoms, cognitive and affective aspects of health information processing, and objective health outcomes. In particular, we assessed the association between prostate cancer-related symptoms, the perceived risk of prostate cancer, and cancer-specific worry and PSA[2] levels or DRE findings in a large sample of men attending a free prostate cancer screening clinic. We hypothesized that the perceived risk of prostate

[2] The abbreviations used are: PSA, prostate-specific antigen; DRE, digital rectal examination; OR, odds ratio; CI, confidence interval.

cancer and cancer-specific worry would be associated with an abnormal PSA level and/or DRE findings suspicious for cancer after controlling for the other factors that would likely be associated with an abnormal PSA level and/or DRE outcome [age, family history of prostate cancer, past screening behavior (PSA measurement, DRE, or biopsy), past screening results (abnormal PSA level or DRE results), and the reason for current screening (symptoms or physician recommendation)]. We also hypothesized that prostate cancer-related symptoms would be associated with an abnormal PSA level and/or DRE findings suspicious for cancer, and that there would be an interaction between symptoms and perceived risk of prostate cancer and cancer-specific worry, such that patients who reported high risk and worry and who had symptoms would be more likely to have an abnormal PSA level and/or DRE findings suspicious for cancer.

Materials and Methods

Participants. Participants attended the annual free prostate cancer screening conducted by The University of Texas M. D. Anderson Cancer Center on September 20–23, 2000. The screening was advertised through the media (television, radio, and newspapers), flyers, and postcards sent to men who had attended the screening previously. A valid PSA test result and DRE report were available for 1808 participants; the questionnaire portion of the screening was completed by 1680 of these participants. However, the sample size for the main analyses was reduced because of missing data on certain items. The mean age of the participants was 58 years (range, 34–79 years); 56% were Caucasian, 28% were African American, 11% were Hispanic, 4% were Asian, and 1% were classified as other (see Table 1).

Procedure. On their arrival to the clinic, participants completed a background questionnaire and a questionnaire assessing their prostate cancer history, past prostate cancer screening behaviors, and beliefs about prostate cancer. Blood was then drawn for measurement of PSA levels, and a urologist or other qualified health care provider conducted a DRE. All of the participants completed an informed consent form. This study was approved by the M. D. Anderson Surveillance Committee for research with human participants.

Participants were asked the following information on the questionnaire: if they had ever had a PSA test in the past and, if yes, when they had last been tested (<1 year ago, 1–2 years ago, or >2 years ago) and if their PSA level had ever been abnormal (≥4 ng/ml); if they had ever discussed the risks and benefits of PSA testing with a physician and, if yes, what the physician had recommended (recommended being tested, recommended not being tested, or made no recommendation); if they had ever had a DRE in the past and, if yes, when they had had the DRE (same as PSA time scale) and if their DRE findings had ever been abnormal and/or suspicious; if they had ever had a prostate biopsy; how many of their close friends had been diagnosed with prostate cancer; how many family members had been diagnosed with prostate cancer; questions about insurance and health care access; who accompanied them to the screening; and why they came for the screening (*i.e.*, symptoms, physician recommended, wanted free test, did not have a regular physician, best place to get the test, convenient, or received postcard).

Patients also rated their perceived risk of prostate cancer compared with that of other men their age (much lower, a little lower, about the same, a little higher, and much higher). Patients also completed the three-item cancer worry scale that was originally developed to examine psychosocial characteristics of participants undergoing genetic testing for cancer (20, 21). The cancer worry scale items included: (*a*) during the past month, how often have you thought about your own chances of getting prostate cancer; (*b*) during the past month, how often have your thoughts about getting prostate cancer affected your mood; and (*c*) during the past month, how often have your thoughts about getting prostate cancer affected your ability to perform your daily activities. Items were scored from 1 to 4: 1, not at all or rarely; 2, sometimes; 3, often; and 4, a lot. The inter-item correlations ranged from $r = 0.37$ to 0.53. The scale had adequate internal reliability (Cronbach's $\alpha = 0.71$), which is similar to the previous reports (0.70; Ref. 20; and 0.77; Ref. 21). Importantly, all three of the questions contributed to the overall score, because if any one item was removed the α for the scale went down. The correlation between perceived cancer risk and cancer worry was 0.30, suggesting that the two variables are related but also measure two distinct constructs.

Serum PSA levels were measured by the M. D. Anderson central laboratory using the Tosoh assay (San Francisco, CA). Between 0 and 3.9 ng/ml was considered normal, with a value of ≥4.0 ng/ml considered abnormal. The DRE was conducted

Table 1 Descriptive statistics for the medical, background, and demographic variables

Variable	*n*	Mean ± SD or percentage
PSA level	1680	1.7 ± 3.04 ng/ml
PSA ≥4 ng/ml		8%
DRE suspicious for cancer	1680	5%
Perceived cancer risk	1605	2.68 ± 1.09
Cancer worry	1635	1.35 ± 0.44
Age (yr)	1671	58.17 ± 7.54
Race	1664	
Caucasian		56%
African American		28%
Hispanic		11%
Asian		4%
Other		1%
PSA test in the past	1646	72%
Last PSA test	1185	
<1 year ago		28%
1–2 years ago		60%
>2 years ago		12%
PSA level abnormal in the past	1047	9%
Discussed PSA testing with physician	1655	48%
Physician recommendation	725	
Have PSA test		73%
Do not have PSA test		1%
No recommendation		26%
DRE in the past	1659	84%
Last DRE	1372	
<1 year ago		26%
1–2 years ago		55%
>2 years ago		19%
DRE abnormal in the past	1165	12%
DRE suspicious in the past	1059	9%
Past prostate biopsy	1626	9%
Family history	1230	31%
Reason for screening	1680	
Symptoms		8%
Physician recommendation		2%
Received postcard		28%
Test was free		41%
No regular physician		15%
Best place for test		54%
Convenient		22%

by a physician or by another qualified health care provider, and the findings were recorded as either normal or suspicious for cancer. All of the participants received a follow-up letter explaining the results from the screening. If the PSA level was abnormal or the DRE suspicious for cancer, they were strongly encouraged to "see either [their] primary care physician or a urologist as soon as possible for further evaluation." If the results were normal, it was explained that "while the PSA test is a good prognostic test for prostate cancer, it is not perfect. Prostate cancer has been diagnosed in men with PSA results less than 4.0 ng/ml. Conversely, 20% of men without prostate cancer have a PSA greater than 4.0 ng/ml."

Data Analyses. Standard descriptive statistics (*e.g.*, frequencies, means, and SDs) were calculated for demographic, background, and medical measures. *t* tests and χ^2 analyses were conducted to compare participants with complete data on the main outcomes of interest (cancer worry, perceived cancer risk, PSA levels, and DRE results) with participants whose data were incomplete. There were no statistically significant differences between the participants with and without main outcomes data in terms of demographic, background, and medical variables (an abnormal PSA level or a DRE suspicious for cancer).

Bivariate and multivariate statistical techniques were used to examine the association among cancer worry, perceived cancer risk, cancer-related symptoms, demographic variables, background variables, and PSA levels and DRE results. The bivariate association among cancer worry, perceived cancer risk, and age with an abnormal PSA level or a DRE finding suspicious for cancer was examined using *t* tests. The bivariate association between the background variables (including cancer-related symptoms) and an abnormal PSA level or DRE findings suspicious for cancer was examined using χ^2 analyses.

A series of logistic regression analyses were then conducted to examine the multivariate association of cancer worry, perceived risk, and cancer-related symptoms with abnormality of PSA levels or DRE results while controlling for other background variables. First, hierarchical logistic regression analyses were conducted, regressing abnormality of PSA level on either cancer worry, perceived risk, or cancer-related symptoms and the covariates associated with an abnormal PSA level using data from study participants with complete data in the original model. For these analyses, we also included all of the possible interactions of the study variables on a second step. We examined for interactions in two ways. First we included all of the possible interactions in one model, and then we also included each interaction term in separate models to examine the potential unique contribution. Because of the number of variables and the number of analyses associated with examining all of the possible interactions we set the α level at 0.01. The parameters for the resultant model were then re-estimated using data from study participants with complete data on only the variables that remained in the final model. A similar strategy was used for the regression of abnormality of DRE results on cancer worry, perceived risk, or cancer-related symptoms and the covariates associated with DRE results. Logistic regression analysis Wald statistic significance levels were examined for each model parameter, as were corresponding ORs and 95% CIs.

Only participants with complete data for all of the variables were entered into each analysis, which meant that the sample sizes for the multivariate analyses were reduced from the overall sample. When all of the variables associated with an abnormal PSA level were entered in the same model, the sample size was 732 men, 50 of whom had an abnormal PSA level. Similarly, when all of the variables associated with DRE findings suspicious for cancer were entered in the same model the sample size was 831, 54 of whom had DRE findings suspicious for cancer. To additionally examine the association among cancer worry, perceived cancer risk, or cancer-related symptoms and an abnormal PSA level or DRE findings suspicious for cancer using a larger sample, we conducted regression analyses in which the only variables entered were those that remained in the final model of the regression analyses described above. This resulted in a sample size of 1014 men for the PSA outcome, 85 of whom had an abnormal PSA level, and a sample size of 1029 men for the DRE outcome, 62 of whom had DRE findings suspicious for cancer. Only 10 participants had both an abnormal PSA level and a DRE suspicious for cancer. We again examined all of the possible interactions among cancer worry, perceived risk, cancer-related symptoms, and the demographic and background variables that remained significant in the final models.

For all of the models, standard regression graphical and statistical diagnostic procedures were used. Using graphical and statistical criteria, including studentized residual, DFBeta, DFFit, Cook, and Mahalanobis values, no heteroscedasticity was identified and no observations signaled for exclusion from the analyses as multivariate outliers or influential points. Furthermore, tolerance and variance inflation factor values did not indicate problematic levels of multicollinearity among the explanatory variables included in the final regression models.

Results

Table 1 shows the descriptive statistics for all of the variables analyzed: demographic, background, and medical. Participants who had an abnormal PSA level reported a significantly higher perceived cancer risk ($t = 2.3$; $P = 0.02$) and cancer worry ($t = 2.9$; $P = 0.004$), and a greater percentage reported the reason for the current screening was cancer-related symptoms ($\chi^2 = 6.1$; $P = 0.014$) than participants who had PSA levels below 4 ng/ml (Table 2). Overall, 136 participants reported the reason for the current screening was symptoms, of which 18 had abnormal PSA levels at the present screening (14% of all of the participants with abnormal levels), and 118 had normal PSA levels at the present screening (8% of all of the participants with normal levels). In contrast to the PSA findings, participants who had DRE findings suspicious for cancer reported a similar perceived cancer risk ($t = 0.4$; $P = 0.66$), marginally higher cancer worry ($t = -1.7$; $P = 0.09$), and a similar percentage of participants reported the reason for the current screening was symptoms ($\chi^2 = 0.02$; $P = 0.89$) than did participants who had normal DRE findings (Table 3). Not surprisingly, patients who reported the reason for the current screening was prostate cancer-related symptoms had significantly higher levels of cancer worry and perceived cancer risk than did patients who did not endorse cancer-related symptoms (cancer worry: 1.7 ± 0.6 *versus* 1.3 ± 0.4; $P < 0.0001$; perceived risk: 3.1 ± 1.1 *versus* 2.6 ± 1.1; $P < 0.0001$).

There were several significant associations of the past screening behaviors and background variables with an abnormal PSA level. These past screening behaviors included: PSA test ($\chi^2 = 4.2$; $P = 0.04$), an abnormal PSA level ($\chi^2 = 208.2$; $P < 0.0001$) [97 participants reported abnormal levels in the past, of which 46 had abnormal PSA levels at the present screening (52% of all of the participants with abnormal levels) and 51 had normal PSA levels at the present screening (5% of all of the participants with normal levels)], suspicious DRE findings ($\chi^2 = 17.0$; $P < 0.0001$), abnormal DRE findings ($\chi^2 = 26.1$; $P < 0.0001$), prostate biopsy ($\chi^2 = 133.46$; $P <$

Table 2 Cancer worry, perceived cancer risk, demographic, and background characteristics among men who had an abnormal or normal PSA level

Variable	Mean ± SD or percentage				*P*
	n	Abnormal PSA level (≥4 ng/ml)	Normal PSA level (<4 ng/ml)	*t* or χ^2	
Perceived cancer risk	1605	2.90 ± 1.06	2.66 ± 1.09	−2.27	0.02[a]
Cancer worry	1635	1.46 ± 0.52	1.34 ± 0.43	−2.87	0.004[a]
Age	1671	63.02 ± 6.79	57.75 ± 7.46	−7.81	0.0001[a]
Race	1664				
Caucasian		56%	58%		
African American		28%	26%		
Hispanic		11%	10%		
Asian		4%	6%		
Other		1%	0%	2.30	0.68
PSA test in the past	1646	80%	71%	4.17	0.04
PSA level abnormal in the past	1047	52%	5%	208.22	0.0001
Discussed PSA testing with physician	1655	59%	47%	6.00	0.014
Physician recommendation	725				
Have PSA test		79%	73%		
Do not have PSA test		2%	1%		
No recommendation		19%	27%	2.11	0.35
DRE test in the past	1659	83%	85%	0.24	0.62
DRE abnormal in the past	1165	30%	11%	26.12	0.0001
DRE suspicious in the past	1059	22%	8%	17.01	0.0001
Past prostate biopsy	1626	36%	6%	133.46	0.0001
Family history	1230	35%	31%	0.64	0.42
Reason for screening	1680				
Symptoms		14%	8%	6.10	0.014
Physician recommendation		7%	2%	11.71	0.001
Received postcard		23%	28%	1.55	0.21
Test was free		44%	41%	0.65	0.42
No regular physician		14%	16%	0.35	0.56
Best place for test		55%	54%	0.06	0.81
Convenient		15%	22%	3.72	0.054

[a] *t* tests (all other tests were χ^2 tests).

0.0001), discussion of PSA testing with their physician (χ^2 = 6.0; P = 0.014), and physician recommendation (χ^2 = 11.7; P = 0.001). Not surprisingly, older age was associated with an abnormal PSA level (t = −8.3; $P < 0.0001$; Table 2). Having had a DRE in the past, past physician recommendation for PSA testing, family history of prostate cancer, and race were not associated with an abnormal PSA level.

Hierarchical logistic regression analyses entering perceived cancer risk and the covariates that were associated with having an abnormal PSA level revealed that perceived cancer risk (β = 0.42, SE = 0.17, P = 0.01; OR, 1.5; 95% CI, 1.1–2.1), having had an abnormal PSA level (β = 2.78, SE = 0.40, $P < 0.0001$; OR, 16.1; 95% CI, 7.4–35.2), and having had a biopsy in the past (β = 1.00, SE = 0.44, P = 0.025; OR, 2.7; 95% CI, 1.1–6.5) were significantly related to an abnormal PSA level. Similarly, analyses entering cancer worry and the covariates that were associated with having an abnormal PSA level revealed that cancer worry (β = 1.19, SE = 0.35, P = 0.001; OR, 3.3; 95% CI, 1.7–6.5), having had an abnormal PSA level (β = 2.78, SE = 0.39, $P < 0.0001$; OR, 16.2; 95% CI, 7.5–35.0), and having had a biopsy in the past (β = 1.21, SE = 0.44, P = 0.006; OR, 3.4; 95% CI, 1.4–8.0) were significantly associated with an abnormal PSA level. Analyses entering cancer-related symptoms and the covariates that were associated with having an abnormal PSA level revealed that cancer-related symptoms (β = 1.22, SE = 0.57, P = 0.031; OR, 3.4; 95% CI, 1.1–10.3), having had an abnormal PSA level (β = 2.82, SE = 0.39, $P < 0.0001$; OR, 16.9; 95% CI, 7.9–36.0), and having had a biopsy in the past (β = 1.04, SE = 0.44, P = 0.018; OR, 2.8; 95% CI, 1.2–6.7) were significantly associated with an abnormal PSA level. When all of the possible interaction terms were entered on the second step for all of the above analyses, or in separate models, none of the interaction terms were significant. When perceived cancer risk, cancer worry, and cancer-related symptoms were entered together in the same model, the association among cancer worry, having had an abnormal PSA level, and having had a biopsy in the past and an abnormal PSA level remained the same, but perceived cancer risk and cancer-related symptoms dropped out of the final model.

To decrease the number of participants excluded from the analyses because of missing data, we conducted logistic regressions entering only cancer worry (or perceived cancer risk or cancer-related symptoms), having had an abnormal PSA level, and having had a biopsy in the past in the equation. In this analysis, cancer worry (β = 0.51, SE = 0.25, P = 0.037; OR, 1.7; 95% CI, 1.03–2.7), having had an abnormal PSA level (β = 2.5, SE = 0.29, $P < 0.0001$; OR, 12.4; 95% CI, 7.0–21.7), and having had a biopsy in the past (β = 1.23, SE = 0.31, P = 0.0001; OR, 3.4; 95% CI, 1.9–6.3) were still significantly associated with an abnormal PSA level. However, perceived cancer risk was only marginally associated with an abnormal PSA level (β = 0.22, SE = 0.12, P = 0.07; OR, 1.2; 95% CI, 0.98–1.6) and cancer-related symptoms was no longer associated with an abnormal PSA level (β = 0.41, SE = 0.42, P = 0.35; OR, 1.5; 95% CI, 0.65–3.4). When all of the possible interaction terms were entered on the second step for the above

Table 3 Cancer worry, perceived cancer risk, demographic, and background characteristics among men who had a DRE suspicious for cancer or a normal DRE

Variable	Mean ± SD or percentage				*P*
	n	DRE suspicious for cancer	DRE normal	*t* or χ^2	
Perceived cancer risk	1605	2.63 ± 1.11	2.69 ± 1.09	0.44	0.66[a]
Cancer worry	1635	1.43 ± 0.54	1.35 ± 0.43	−1.69	0.09[a]
Age	1671	60.53 ± 7.47	58.03 ± 7.52	−3.08	0.002[a]
Race	1664				
Caucasian		56%	65%		
African American		28%	25%		
Hispanic		11%	6%		
Asian		4%	3%		
Other		1%	1%	4.82	0.31
PSA test in the past	1646	76%	71%	0.91	0.34
PSA level abnormal in the past	1047	23%	8%	13.90	0.0001
Discussed PSA testing with physician	1655	55%	48%	1.49	0.22
Physician recommendation	725				
Have PSA test		84%	73%		
Do not have PSA test		0%	1%		
No recommendation		16%	27%	2.57	0.28
DRE test in the past	1659	83%	85%	0.12	0.73
DRE abnormal in the past	1165	22%	12%	5.62	0.018
DRE suspicious in the past	1059	12%	9%	0.77	0.38
Past prostate biopsy	1626	24%	8%	25.37	0.0001
Family history	1230	27%	31%	1.59	0.95
Reason for screening	1680				
Symptoms		8%	8%	0.02	0.89
Physician recommendation		7%	2%	6.97	0.008
Received postcard		19%	28%	3.80	0.051
Test was free		32%	42%	3.28	0.07
No regular physician		17%	16%	0.07	0.78
Best place for test		47%	54%	1.73	0.19
Convenient		18%	22%	1.08	0.30

[a] *t* tests (all other tests were χ^2 tests).

analyses, or in separate models, none of the interaction terms were significant.

There were also several significant associations between past screening behaviors and background variables with DRE findings suspicious for cancer. These included: an abnormal PSA level ($\chi^2 = 13.9$; $P < 0.0001$), abnormal DRE findings ($\chi^2 = 5.6$; $P = 0.018$) [142 participants reported abnormal DRE findings in the past, of which 14 had DRE findings suspicious for cancer at the present screening (22% of all of the participants with a suspicious DRE) and 128 had a normal DRE at the present screening (12% of all of the participants with normal DRE)], prostate biopsy ($\chi^2 = 25.4$; $P < 0.0001$), and physician recommendation as reason for current screening ($\chi^2 = 7.0$; $P = 0.008$; Table 3). Older age was also associated with abnormal DRE results ($t = -3.3$; $P < 0.001$; Table 3). Having had a DRE, a PSA test, or suspicious DRE findings in the past; discussion of PSA testing with physician or physician recommendation for PSA testing; reason for current screening was symptoms; family history of prostate cancer; and race were not associated with DRE findings suspicious for cancer.

Hierarchical logistic regression analysis entering perceived cancer risk (or cancer worry or cancer-related symptoms) and the demographic and background variables that were associated with DRE findings suspicious for cancer revealed that, in the final model, having had an abnormal PSA level in the past ($\beta = 0.82$, SE = 0.40, $P = 0.042$; OR, 2.3; 95% CI, 1.03–5.0), having had a biopsy in the past ($\beta = 0.80$, SE = 0.40, $P = 0.045$; OR, 2.2; 95% CI, 1.02–4.9), and physician recommendation as reason for current screening ($\beta = 1.54$, SE = 0.55, $P = 0.005$; OR, 4.7; 95% CI, 1.59–13.76) were significantly associated with DRE findings suspicious for cancer. Cancer worry, perceived cancer risk, and cancer-related symptoms were not associated with DRE findings suspicious for cancer. To additionally examine the associations between the study variables and DRE findings suspicious for cancer, we computed interaction terms for all of the possible combinations of variables and conducted the logistic analyses with these interactions on step two, or within separate models. None of the interactions were significantly associated with DRE findings suspicious for cancer. When we repeated the analyses using data from study participants with complete data on the variables that remained in the final model, having had an abnormal PSA level in the past ($\beta = 0.77$, SE = 0.37, $P = 0.038$; OR, 2.2; 95% CI, 1.05–4.5) and physician recommendation as reason for current screening ($\beta = 1.68$, SE = 0.50, $P = 0.001$; OR, 5.3; 95% CI, 1.99–14.35) remained in the model and having had a biopsy in the past was no longer significant ($\beta = 0.68$, SE = 0.37, $P = 0.065$; OR, 1.9; 95% CI, 1.05–4.5). The interaction between having had an abnormal PSA level in the past and physician recommendation as reason for current screening was not associated with DRE findings suspicious for cancer.

Discussion

The affective component, prostate cancer-specific worry, assessed before screening test results were known, was associated significantly with abnormal PSA levels. Importantly, this association remained significant even after controlling for other factors that were predictors of an abnormal PSA level. The cognitive component, perceived risk of prostate cancer com-

pared with that in other men the same age, assessed before learning the test results, and the potential physical indicator of disease, reason for the current screening being cancer-related symptoms, were also associated with abnormal PSA levels. However, these associations were not as robust as those with prostate cancer-specific worry, and when all three of the variables were entered into the same model, only prostate cancer-specific worry remained associated with an abnormal PSA level. There were no interactions between the main predictor variables, or any of the variables in the final model, in predicting abnormal PSA levels. In addition, none of these main predictor variables was associated with DRE findings suspicious for cancer. In fact, the only factors in the multivariate model associated with a DRE suspicious for cancer was having an abnormal PSA level in the past, having had a prostate biopsy, and having a physician-recommend the screening.

As hypothesized, a perceived risk of prostate cancer, cancer-specific worry, and prostate cancer-related symptoms were all associated with an abnormal PSA level, after controlling for other factors associated with an abnormal PSA level. There was also an association between the main predictor variables. Specifically, greater perceived risk was associated with greater cancer-specific worry, and patients who reported cancer-related symptoms had significantly higher levels of perceived risk and worry than did patients who reported no symptoms. However, contrary to our hypothesis, there were no interactions among these variables or among these variables and the demographic and medical variables in predicting an abnormal PSA level. This suggests that patients who reported cancer-specific worry and had symptoms were not more likely to have an abnormal PSA level than were patients who reported cancer-specific worry in the absence of symptoms. Moreover, cancer-specific worry was associated with an abnormal PSA level after controlling for perceived risk and cancer-related symptoms. Therefore, although having cancer-related symptoms was associated with an abnormal PSA level and increased cancer-specific worry levels, cancer-related symptoms did not appear to lead to cancer-specific worry or increase the probability of an abnormal PSA level. This suggests that the affective component is a better predictor of abnormal PSA levels than either the cognitive or the symptom-related measures and that the affective component is independent of the other factors.

Finding an association between affect and PSA levels is not unprecedented. Stone *et al.* (22) examined the association between perceived stress and social support in 318 men participating in a community-based prostate screening program. As in the current study, the measures were completed before the participants knew their PSA levels or DRE results. These researchers found a positive association between perceived stress and PSA levels, and a negative association between social support and PSA levels, after controlling for age, marital status, and family history of prostate cancer. They also observed that perceived stress and social support were associated with an abnormal PSA level. Similar to our findings, they also did not find an association between psychosocial factors and abnormal DRE findings.

There are several plausible explanations for the observed association between affective processes and abnormal PSA levels. One is that cancer-related worry may be associated with a variety of anxiety-related dispositions (9, 12). In this regard, extensive research has examined different pathways by which psychological factors can influence health (23–25). For example, psychological factors have been found to affect health by influencing health-promoting behaviors (26, 27). Affective processes can also influence health more directly by acting on regulatory systems such as the endocrine and immune systems. Such psychological factors have been associated with increased titers of latent viral antibodies (28), decreased cell-mediated immunity (29), alterations in T-lymphocyte receptor status (30), and alterations in DNA repair mechanisms (31, 32). This points to a direct association between psychological factors and the physiological mechanisms regulating PSA levels. However, in the present study we did not assess health-relevant behaviors or physiological functioning. Longitudinal assessments of affective processes, behavioral measures, and physiological variables are needed to more fully explore their association with prostate cancer risk factors.

There was no association between any of the cognitive or affective factors and a DRE suspicious for cancer. Those factors in the final model that were associated with a DRE suspicious for cancer were: having had an abnormal PSA level in the past and having a physician recommend the current screening. This suggests that the more physical measure of disease outcome, which should theoretically be associated with symptoms, was not associated with either the cognitive or affective aspects or the symptom reports. The fact that none of the cognitive or affective factors were associated with a DRE suspicious for cancer additionally supports the notion that cancer-specific worry and abnormal PSA levels are associated at a psychobiological level.

Although the association between prostate cancer-specific worry and an abnormal PSA level was robust, there are limitations to our study that call for some caution in the interpretation of this finding. Most importantly, because of the cross-sectional nature of this study, we cannot make any claims about causality. We did not, for example, assess prior perceived prostate cancer risk or prostate cancer-specific worry to determine whether a change in these variables was associated with the outcomes. However, we were able to at least account for past screening behaviors, prior abnormal results, family history, and other background variables by entering these variables into the models as control variables. Although we assessed information about prior abnormal PSA, we did not have any information regarding the exact PSA levels from previous PSA tests. It is possible that the levels of previous PSA tests might be associated with both cancer worry and the current abnormal PSA result. For example, a prior PSA of 10 mg may be associated with greater cancer worry than a PSA of 5 mg. Including precise levels of past PSA tests would allow for a more definitive examination of the association between cancer worry and PSA result, and future studies should include the past PSA level *versus* simply reporting normal or abnormal. Another limitation was that we relied on patient self-reporting to assess past screening behaviors and abnormal test results, which may not be as accurate as formal medical records. However, we were able to somewhat assess the accuracy of the reports of previous screening behaviors by asking the men how they had heard about the screening program. Of the men who said they had received the postcard (which was sent only to men who had participated in this free screening program in the past) or said they had been screened in the past, 94% said they had had a PSA test in the past, and 96% said they had had a DRE in the past. In contrast, of the men who said they had heard about the screening by some other means, only 65% said they had had a PSA test in the past, and 81% had had a DRE. Although medical validation of screening behavior is preferable, this supports the potential validity of the self-report data.

Another consideration is that, as indicated above, other factors that were not measured, such as health-relevant behaviors and past PSA levels, may have been influencing the main variables of interest and, therefore, may have resulted in residual confounding. We also cannot make any claims about the association between prostate cancer-specific worry and prostate cancer, because we did not determine whether the men with abnormal PSA levels had prostate cancer. Additionally, there was a variable amount of missing data for participants because of unanswered questions on questionnaires; however, we did not detect any specific bias between participants with and without data for the main variables. It is also important to note that although the OR accounted for by prostate cancer-specific worry was small, considering the fact that we were examining the association between a psychological and biological variable, the association was robust, and remained so even after the variance accounted for by other variables associated with an abnormal PSA level was removed.

There are extensive data suggesting that perceived cancer risk and cancer worry predict cancer-screening behaviors (33). This has been found for breast (4, 5, 20), prostate (34, 35), and colorectal (36, 37) cancer screening. Our finding that cancer worry is additionally associated with abnormal PSA levels is interesting, especially in light of the fact that men who worry about their cancer risk are more likely to be screened than men who do not worry about their cancer risk (34, 35). This suggests that men who are at increased risk for prostate cancer are more likely to be screened and that their level of worry may be justified by their level of risk. However, the reasons for the association of cancer worry with abnormal PSA levels are unclear, but as noted earlier, a biopsychological model is plausible. The significant association between prostate cancer-specific worry and abnormal PSA levels is a preliminary observation but consistent with findings in a previous study that assessed psychological factors and PSA levels (22). However, this is the first study to show that affective aspects of health information processing are associated with abnormal cancer screening outcomes, and to show that the association is independent of cognitive processes and cancer-related symptoms. In conclusion, these initial findings suggest that a psychological component is significantly associated with one prostate cancer risk factor. Future longitudinal research will need to additionally explore the association between psychological factors and physiological measures, and the risk of prostate cancer.

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