Testing the Health Belief Model Using Prostate Cancer Screening Intention: Comparing Four Statistical Approaches Applied to Data from the 2008-09 Nashville Men's Preventive Health Survey

By

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Prostate cancer is the most frequently diagnosed cancer among men (CDC 2011). It causes the highest number of cancer-related deaths among men, second only to lung cancer (CDC 2011). These statistics indicate that prostate cancer screening, despite known problems with screening sensitivity and specificity (see Moyer 2012), is essential for protecting men's health. The importance of screening is especially true for particular groups of men because risk is correlated with age, race, and family history. Specifically, the greatest risk of prostate cancer occurs among men who are 50 years of age or older, African American, or have an immediate relative who has been diagnosed with prostate cancer (CDC 2010). Screening for prostate cancer often includes a blood test for the prostate specific antigen (PSA) and/or a digital rectal exam (DRE; CDC 2010).

Disagreement regarding guidelines for prostate cancer screening intensified recently (Bazell 2012). Issues of disagreement include the age at which men should begin screening for prostate cancer and the screening methods themselves. On May 21, 2012, the U.S. Preventive Services Task Force, which was appointed to complete a federally funded study of prostate cancer screening methods and guidelines, announced its final recommendation that men should no longer get regular PSA tests as part of screening for prostate cancer (Moyer 2012). The taskforce advised that the risk of possible misdiagnosis and side effects from treatment outweighed benefits of potential early detection and intervention (see Moyer 2012). Immediately following the federal taskforce's announcement, the American Urological Association (AUA) released a statement, expressing its counterclaim—that men should not be discouraged from obtaining PSA blood tests (see AUA 2012; Bazell 2012). However, almost a year later, at its annual meeting on May 3, 2013, the AUA announced new guidelines that advised against screening with a PSA blood test for men under the age of 55 with average-risk and for any man over the age of 70 (Pittman 2013). The AUA advocated for *targeted* screening and not universal guidelines (Pittman 2013). Men's perceptions of their risk and the benefits of screening change when recommendations regarding prostate cancer screening change. It is therefore important (and timely) to investigate men's intentions to get screened for prostate cancer.

The health belief model (HBM) is a very popular theoretical framework developed to explain preventive health behaviors such as prostate cancer screening. Despite numerous methodological and conceptual criticisms of it since its inception in the 1950's, the HBM guides the study of various preventive health behaviors, including ones involving multiple types of cancer, such as screenings for breast and cervical cancers (see Tanner-Smith and Brown 2010), self-examination for testicular cancer (see McClenahan et al. 2007), and genetic testing for colorectal cancer (see Cyr, Dunnagan, and Haynes 2010).

Invoking the HBM, the present study examines prostate cancer screening intention using community survey data from the 2008-09 Nashville Men's Preventive Health Survey (NMPHS). The present study also compares results from four statistical approaches typically used to test the HBM: (1) logistic regression, (2) logistic regression with interactions, (3) path analysis, and (4) structural equation modeling (SEM) with latent variables. Overall, the HBM has limited explanatory power when applied to prostate cancer screening intention. Based on results from the four statistical approaches, the present study recommends using path analysis to test the HBM. It also recommends two major revisions to the HBM—(1) adding a direct path from modifying factors to preventive health behavior, and (2) adding a direct path from cues to action to preventive health behavior. The next sections review what is known about the HBM and examine statistical approaches typically used to test it. Thereafter, I present analyses from the

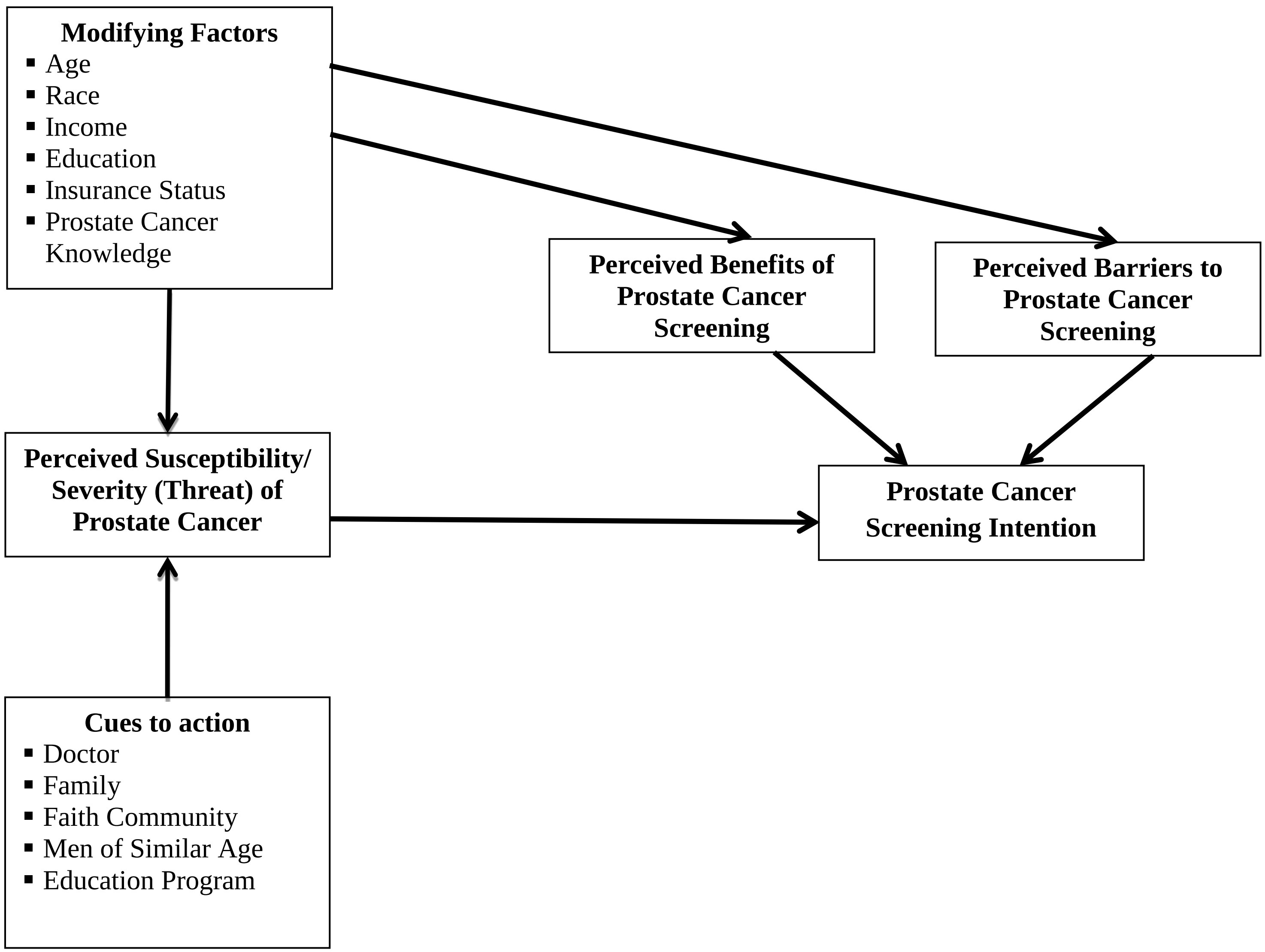
2008-09 NMPHS before advocating for theoretical revision to the HBM in the Discussion section.

LITERATURE REVIEW

The Health Belief Model

To explain why early screening programs for health conditions such as tuberculosis were unsuccessful, social psychologists in the 1950's constructed the Health Belief Model (HBM, see Figure 1) (Rosenstock 1974a). The HBM is a theoretical framework that explains preventive health behaviors. However, since its inception, the HBM also explained individuals' seeking of medical treatment/advice and compliance with actions related to symptoms and diagnosis (Janz and Becker 1984; Strecher and Rosenstock 1997). The model asserts that an individual will take preventive action if she believes that (a) she is at risk for developing a health condition, (b) the health condition will have severe negative impact, (c) there exists a preventive health behavior that could be beneficial in either reducing her risk or the seriousness of the health condition, and (d) the benefits of this preventive health behavior outweigh the barriers to or negative consequences of the preventive health behavior (Janz and Becker 1984; Rosenstock 1974a; Rosenstock 1974b; Strecher and Rosenstock 1997). The model also accounts for the influence of various sociodemographic variables, such as sex, race, socioeconomic status, and insurance status, which work to regulate individuals' assessments of health conditions and preventive health behaviors (Rosenstock 1974a). The HBM includes four major constructs: (1) perceived susceptibility and seriousness or threat of health condition, (2) perceived benefits of preventive health behavior, (3) perceived barriers to preventive health behavior, and (4) cues to action. Over

Figure 1: Diagram of Health Belief Model for Prostate Cancer Screening Intention
Adapted from Strecher and Rosenstock (1997, p. 115) and Tanner-Smith and Brown (2010, p.97)



the last decade, some studies also include *self-efficacy* as a correlate of preventive health behaviors and find that it accounts for a large part of the variance (Garcia and Mann 2003).

Perceived susceptibility/severity (threat) of health condition. Perceived susceptibility refers to the subjective perception of risk of developing the health condition. It ranges from an individual's belief that she is at no risk of acquiring the health condition to the belief that she is extremely vulnerable to getting the health condition. Likert scale response of *strongly agree* to *strongly disagree* to "It is extremely likely that I will develop [health condition] in my lifetime" (Bynum et al. 2011), and "I feel that my chances of getting [health condition] in the future are good if I fail to perform [preventive health behavior]" are examples of measures of this construct (McClenahan et al. 2007). Perceived severity encompasses beliefs regarding troubles the health condition could generate in the individual's life and also emotional responses when an individual thinks about developing the health condition. It can be measured in terms of whether the individual believes the health condition could affect her financial security (McClenahan et al. 2007) and how anxious or stressed she would feel if she had the health condition (Werner 2003). The perceived threat construct of the HBM is an incorporation of perceived susceptibility and severity. It is an overall measure of how great an individual believes her risk is of developing a specific health condition and how seriously she perceives developing that health condition will impact her life.

Perceived benefits of preventive health behavior. The perceived benefits construct includes aspects of how effective and beneficial the individual believes the preventive health behavior to be in reducing her risk of developing the health condition. Items such as, "I have a lot to gain by doing [preventive health behavior]" (McClenahan et al. 2007) or "Completing [preventive health behavior] could save my life" (Bynum et al. 2011) capture the construct.

Perceived barriers to preventive health behavior. The perceived barriers construct of the HBM encompasses the negative qualities or costs of the preventive health behavior. Aspects that can be considered here are whether the preventive health behavior is expensive, embarrassing, tedious, painful, or distressing. These features are characteristics which would trigger avoidance. Another possible barrier to a preventive health behavior includes the availability of alternative actions that have similar functions. To assess this construct, previous measures include responses to "It is embarrassing for me to do [preventive health behavior]" or "[preventive health behavior] can be painful" (McClenahan et al. 2007).

Cues to action. Cues to action are described as triggers or instigators. The inclusion of cues to action as a construct in the HBM is to account for a prompting moment "to set the process in motion" (Rosenstock 1974a:5). This construct encompasses various items, such as mass media campaigns, newspaper articles, advice from others, family member's or friend's illness (Rosenstock 1974a), media information (Strecher and Rosenstock 1997), and a reminder from doctor/friend (Tanner-Smith and Brown 2010).

Critiques of the Health Belief Model

There are several *conceptual* critiques of the HBM. First, it explains only a small amount of variation in preventive health behaviors (Harrison, Mullen, and Green 1992). Second, because it focuses on predominantly psychosocial elements, the HBM only explains variance in preventive health behaviors that is due to individuals' beliefs and attitudes (Janz and Becker 1984). Third, there is great variation in the way HBM constructs are understood and measured (see, for example, Abraham and Sheeran 2005; Janz and Becker 1984; Rosenstock 1974b). Literature advises that standardized tools and measures should be created for the operationalization of the various constructs of the model (see Harrison, Mullen, and Green 1992;

Janz and Becker 1984). Fourth, all constructs in the HBM are not always measured and modeled. For example, the cues to action construct is often omitted in studies using the HBM (see reviews by Harrison, Mullen, and Green 1992; Janz and Becker 1984).

In addition, there are several *methodological* criticisms. First, research using the HBM has been criticized for treating each HBM construct as equally weighted variables that work simultaneously in influencing preventive health behaviors (Strecher and Rosenstock 1997). One recommendation is that the model should be tested with interaction terms based on levels of perceived threat as each construct could work differently based on high or low one perceived threat (Strecher and Rosenstock 1997). Second, Abraham and Sheeran (2005) point out that there is inconsistent adherence to procedures or guidelines for how the constructs of the HBM should be related. Third, researchers test the HBM using inconsistent statistical approaches. In fact, four statistical approaches dominate: (1) logistic regression, (2) logistic regression with interactions, (3) path analysis, and (4) structural equation modeling (SEM).

The present study addresses a number of the conceptual and methodological criticisms of the HBM listed above by first, including all HBM constructs in the analyses and second, by comparing results from the four dominant statistical approaches used to test the HBM. Results reveal the consistent statistical significance of perceived threat in increasing prostate cancer screening intention. This study also finds that other HBM constructs (i.e., perceived barriers and perceived benefits) do not significantly predict prostate cancer screening intention. Notably, results show that cues to action does significantly increase prostate cancer screening intention. Also modifying factors, such as age and insurance status, have a significant effect in increasing prostate cancer screening intention. Based on results from the four statistical approaches, going forward I recommend using path analysis to test the HBM. I also recommend (1) adding a direct path from *modifying factors* to preventive health behavior and (2) adding a direct path from *cues to action* to preventive health behavior.

METHODS

Data

Data come from the 2008-09 Nashville Men's Preventive Health Survey (NMPHS). The NMPHS includes a random sample (based on a multi-stage stratified and clustered method) of 392 men aged 40 to 70, living in Davidson County, TN, with no history of prostate cancer (see Hull et al. 2013). Davidson County, TN was first divided into four distinct geographic areas, creating four strata. Five census tracts were randomly selected from each stratum and each designated tract was stratified into two substrata based on its proportion (greater than or less than 33%) of non-Hispanic black males ages 40 through 70. Ten census blocks were randomly chosen from each substratum, resulting in a total of 80 clusters. 651 of the successfully contacted households were confirmed to have men who met the eligibility criteria of the study (i.e., being a white or black male between the ages of 40 and 70 with no history of prostate cancer). Of the 651 eligible men, 392 surveys were completed with a response rate of 60%. The survey included an array of questions (i.e., demographics, prostate cancer knowledge, screening behavior and intent to screen, reasons for getting screened, assessment of screening techniques, health information sources, access to and experience with medical care, and psychosocial measures).

Excluding respondents with missing data on any variable used in the analyses, the estimation sample size is 251. Table 1 shows descriptive statistics for the overall sample and the

Table 1. Descriptive Statistics (Means or Percentages, Minimum and Maximum Values) of Variables Used in the Analysis from Nashville Men's Preventive Health Survey, 2008-09

	Mean/Percentage	**Standard Deviation**	**Minimum**	**Maximum**
Outcome				
Intention to Screen for Prostate Cancer	70.12%			
Health Belief Model Constructs				
Perceived Threat[a]	3.120	1.881	.000	8.000
Cues to Action[a]	2.068	1.203	.000	5.000
Perceived Benefits[a]	2.283	.931	.000	3.000
Perceived Barriers[a]	2.462	1.686	.000	7.000
Modifying Factors/Controls				
Self-Efficacy	23.180	4.126	9.000	30.000
Prostate Cancer Knowledge	12.920	2.349	5.000	18.000
Race				
African-American	50.60%			
White	49.40%			
Age	55.510	8.521	41.000	72.000
Family Income				
<$10,000-24,999	31.87%			
$25,000-44,999	15.94%			
$45,000-64,999	16.73%			
$65,000-84,999	12.75%			
$85,000-100,000+	22.71%			
Highest Education				
Less than High School	13.15%			
High School	24.70%			
Some College	29.08%			
Bachelor's Degree	21.51%			
Greater than Bachelor's	11.56%			
Insurance Status				
Insured	78.09%			
Not Insured	21.91%			
Total n	251			

[a] Descriptive statistics are based on summated items and are not scaled.

variables of interest, including HBM constructs. Considering the estimation sample, 49% of respondents are white and 51% are black. Average age is 55.5 years old and ranges from 41 to 72. 13% have less than a high school education whereas 25% have obtained a high school education, 29% have some college, and about 33% have a bachelor's degree or higher. 32% of respondents have an annual family income between <$10,000 and $24,999 while 16% have between $25,000 and $44,999 and 17% have between $45,000 and $64,999. The last two annual family income categories, $65,000-$84,999 and $85,000-$100,000+, represent 12.75% and 22.71% of the estimation sample, respectively. 78% of respondents have medical insurance whereas 22% are uninsured.

Measures

Prostate cancer screening intention. The dependent variable is a composite variable based on stated intention to be screened for prostate cancer in either the form of a PSA blood test and/or a digital rectal exam (DRE) in the next twelve months. It is coded as either a zero if the participant stated no to both questions of whether he planned to get a PSA blood test and a DRE exam in the next twelve months or a one if the participant stated yes to either one or both questions. 70.1% of respondents in the estimation sample express an intention to be screened for prostate cancer in the next twelve months.

Health belief model constructs. Table 2 includes a detailed list of the questions that correspond to each construct of the HBM. All items are coded as either zero or one so that greater values indicate higher perceived threat, more cues to action, greater perceived benefits, and more perceived barriers. Summated items for perceived threat range from 0 to 8 with a mean of 3.120. Summated values for cues to action range from 0 to 5 with a mean of 2.068. Perceived

Table 2. Questionnaire Items Used to Measure Health Belief Model Constructs for Prostate Cancer Screening Intention

Construct	Item
Intention	Do you plan to get a PSA blood test in the next 12 months?
	Do you plan to get a DRE exam in the next 12 months?
Perceived Susceptibility/Severity (Threat)	What do you think are your chances of getting prostate cancer at some time in your life?: Not at all (0) to Very likely (1)
	What do you think your chances are compared to other men?: Lower than most (0) to Higher than most (1)
	How worried are you about getting prostate cancer?: Not at all (0) to A lot (1)
	You were concerned about it because you are getting older.[a]
	Because a family member had prostate cancer.[a]
	Because you worry that prostate cancer could cause problems with your sex life.[a]
	Because you worry that prostate cancer could cause you problems with urinating.[a]
	Because you don't want to die from prostate cancer.[a]
Cues to Action	If your doctor recommended that you get screened for prostate cancer.[a]
	If your family encouraged you to get screened.[a]
	If members of your faith community encouraged you to get screened.[a]
	Because you feel it is common for men your age to get screened.[a]
	Have you ever attended a prostate cancer education program?
Perceived Benefits	You wanted to know if you have prostate cancer.[a]
	You thought that you might live longer if prostate cancer was detected early.[a]
	Getting prostate cancer screening was part of taking care of your health.[a]
Perceived Barriers	Do you think that getting a DRE is embarrassing?
	Getting a DRE feels uncomfortable.[b]
	Getting a DRE violates your manhood.[b]
	Getting a DRE violates your privacy.[b]
	Getting a DRE makes you feel like less of a man.[b]
	Getting a DRE hurts.[b]
	Getting a DRE could stimulate homosexual (gay) tendencies.[b]

[a] Please tell me which reasons caused you/would cause you to get screened, by answering Yes or No

[b] Please tell me your opinion of whether each one is true or false

benefits has a mean value of 2.283 and ranges from 0 to 3 while perceived barriers ranges from zero to seven with a mean of 2.462.

Modifying factors/controls. Modifying factors and controls in these analyses are prostate cancer knowledge, race, annual family income, highest education completed, and insurance status, and self-efficacy. Prostate cancer knowledge is measured utilizing eighteen True-or-False questions regarding the prostate and prostate cancer, including items about the location of the prostate, prostate cancer risk, screening, and treatment. Knowledge items are coded so that a correct answer is indicated with a 1 and a wrong answer is noted with a 0 and items are then summated. Higher values indicate greater prostate cancer knowledge. For this sample, prostate cancer knowledge values range from 5 to 18 with a mean of 12.92. Race is coded as a dummy variable with black as the excluded group. Age is treated as a continuous variable. Due to small cell counts and in order to prioritize parsimony, annual family income is collapsed into five categories from the original 20 that were utilized in the study questionnaire: (1) <$10,000-24,999 (the excluded group); (2) $25,000-44,999; (3) $45,000-64,999; (4) $65,000-84,999; (5) $85,000-100,000+. Highest education is also treated as an ordered categorical variable with five groups: (1) less than high school (excluded group); (2) high school; (3) some college; (4) bachelor’s degree; (5) greater than bachelor’s degree. Insurance status is coded as a dummy variable where 1 indicates that the participant is insured and 0 indicates that he is currently uninsured. Descriptive statistics for all variables used in the analyses are shown in Table 1. Self-efficacy is measured utilizing the 10 item General Self-Efficacy Scale (GSE) (Schwarzer and Jerusalem 1995). Each item is coded on a three-point scale in which 0=*not at all true*, 1=*hardly true*, 2=*moderately true*, and 3=*exactly true*. Items are summated so that higher values indicate greater self-efficacy. For this sample, self-efficacy ranges from nine to 30 with a mean of 23.2.

All analyses were conducted in the statistical environment R. The R script file is available upon request.

RESULTS

Results are divided into four sections based on the corresponding four statistical approaches used to test the HBM: (1) logistic regression, (2) logistic regression with interactions, (3) path analysis, and (4) structural equation modeling (SEM) with latent variables. Adequacy of the final models estimated by the four statistical approaches—logistic regression (Model 6), logistic regression with interactions (Model 11), path analysis (Model 12), and SEM with latent variables (Model 13)—can be assessed by examining model fit indices and explanatory power. Also, models can be evaluated based on whether estimated coefficients conform to expectations established by the HBM.

Section 1: Logistic Regression

For logistic regression HBM constructs are summated indices of their corresponding items. These sums are standardized. As shown in Table 3, in Models 1-4 each HBM construct is treated as an individual predictor of prostate cancer screening intention. This statistical approach reveals five major results regarding the HBM of prostate cancer screening intention. First, looking at Model 1, as a single predictor, an increase in perceived threat corresponds to a significant increase in one's odds of prostate cancer screening intention. Second, according to Model 2, as a single predictor, more cues to actions also significantly increases one's odds of prostate cancer screening intention. Third, as separate predictors, perceived benefits of getting screened in Model 3 and perceived barriers to getting screened in Model 4 do not have significant effects on the odds of prostate cancer screening intention. Fourth, in Model 5 and

Table 3. Standardized Logistic Regression Coefficients of the Effects of Health Belief Model Constructs and Modifying Factors on the Odds of Prostate Cancer Screening Intention

	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
Intercept	2.426***	2.411***	2.354***	2.354***	2.454***	1.405
	(.142)	(.141)	(.138)	(.138)	(.144)	(.506)
Health Belief Model Constructs						
Perceived Threat	1.500**				1.384•	1.432•
	(.148)				(.180)	(.196)
Cues to Action		1.443*			1.282	1.261
		(.146)			(.171)	(.189)
Perceived Benefits			1.133		.908	.942
			(.135)		(.157)	(.177)
Perceived Barriers				1.131	1.027	1.058
				(.141)	(.150)	(.167)
Modifying Factors/Controls						
Self-Efficacy						.948
						(.158)
Prostate Cancer Knowledge						1.148
						(.174)
Race (African-American=excluded)						
White						1.040
						(.322)
Age						1.798**
						(.180)
Education (Less than HS=excluded)						
High School						1.329
						(.528)
Some College						1.876
						(.550)
Bachelor's Degree						1.671
						(.620)
Greater than Bachelor's						2.262
						(.763)
Income (<$10,000-24,999=excluded)						
$25,000-44,999						.244**
						(.486)
$45,000-64,999						.434
						(.526)
$65,000-84,999						1.203
						(.670)
$85,000-100,000+						.642
						(.531)
Health Insurance (Not insured=excluded)						
Insured						2.429*
						(.387)
Psuedo R^2	.026	.022	.003	.003	.034	.167
AIC	302.13	303.54	309.31	309.37	305.85	290.98
Log Likelihood (df)	-149.07 (2)	-149.77 (2)	-152.65 (2)	-152.69 (2)	-147.93 (5)	-127.49 (18)
n	251	251	251	251	251	251

Notes: Numbers in parentheses are standard errors of log odds.
•p<0.1 *p < 0.05 **p < 0.01 ***p < 0.001 (two-tailed tests)

Model 6, perceived threat is the only HBM construct that is a significant predictor of prostate cancer screening intention. Fifth, in regards to modifying factors in Model 6, an increase in age as well as having medical insurance corresponds to an increase in odds of prostate cancer screening intention.

In concordance with previous critiques of the HBM, the final logistic regression model with all constructs and modifying factors (Model 6) is only able to explain 16.7% of the variance in prostate cancer screening intention based on Hosmer and Lemeshow's pseudo R^2. Another model fit statistic of notable importance for comparison is the Akaike information criterion (AIC), which for Model 6 is 290.98.

Section 2: Logistic Regression with Interactions

Strecher and Rosenstock (1997) suggest that, rather than assuming that every construct of the model works separately, the effect of each construct on the odds of a particular preventive health behavior could depend on one’s level of perceived threat. Therefore, in this statistical approach I test if perceived threat has a significant moderating effect on the relationships between other constructs of the HBM and the odds of prostate cancer screening intention.

For logistic regression with interactions HBM constructs are summated indices of their corresponding items. These sums are standardized. Models 7-9 (included in Table 4) test perceived threat, each construct, and their interaction separately. First, Model 7 reveals a marginally significant interaction between cues to action and perceived threat, suggesting that the effect of cues to action on odds of prostate cancer screening intention depends on ones perception of how threatening prostate cancer is. Although growth in perceived threat corresponds to a significant increase in odds of prostate cancer screening intention,

Table 4. Standardized Logistic Regression Coefficients (the Odds of Prostate Cancer Screening Intention) Testing Interactions between Perceived Threat and other Health Belief Model Constructs

	Model 7		Model 8		Model 9		Model 10		Model 11	
Intercept	2.805	***	2.266	***	2.470	***	2.738	***	1.794	
	(.168)		(.152)		(.147)		(.173)		(.537)	
Health Belief Model Constructs										
Perceived Susceptibility/Severity (Threat)	1.410	*	1.516	*	1.487	**	1.500	*	1.537	*
	(.175)		(.163)		(.152)		(.194)		(.212)	
Cues to Action	1.262						1.234		1.195	
	(.171)						(.185)		(.200)	
Perceived Benefits			1.048				1.033		1.088	
			(.165)				(.178)		(.199)	
Perceived Barriers					1.043		1.072		1.096	
					(.149)		(.154)		(.171)	
Interactions										
Perceived Threat*Cues to Action	.766	·					.667	*	.674	*
	(.154)						(.175)		(.200)	
Perceived Threat*Perceived Benefits			1.207				1.398	·	1.445	·
			(.156)				(.182)		(.201)	
Perceived Threat*Perceived Barriers					.927		.905		0.941	
					(.141)		(.143)		(.170)	
Modifying Factors/Controls										
Self-Efficacy									.934	
									(.163)	
Prostate Cancer Knowledge									1.207	
									(.176)	
Race (African-American=excluded)										
White									1.037	
									(.329)	
Age									1.849	***
									(.183)	
Education (Less than HS=excluded)										
High School									1.349	
									(.536)	
Some College									1.676	
									(.560)	
Bachelor's Degree									1.612	
									(.634)	
Greater than Bachelor's									1.833	
									(.784)	
Income (<$10,000-24,999=excluded)										
$25,000-44,999									.233	**
									(.504)	
$45,000-64,999									.410	·
									(.542)	
$65,000-84,999									1.320	
									(.682)	
$85,000-100,000+									.606	
									(.541)	
Health Insurance (Not insured=excluded)										
Insured									2.180	·
									(.399)	
Psuedo R^2	.042		.031		.027		.057		.185	
AIC	301.33		304.58		305.79		304.80		291.58	
Log Likelihood (df)	-146.67	(4)	-148.29	(4)	-148.90	(4)	-144.4	(8)	-124.789	(21)
n	251		251		251		251		251	

Notes: Numbers in parentheses are standard errors of log odds.
·$p<0.1$ *$p < 0.05$ **$p < 0.01$ ***$p < 0.001$ (two-tailed tests)

unexpectedly, the interaction term suggests that with this growth in threat the effect of cues to action corresponds to a decrease in odds of prostate cancer screening intention. Second, in Models 8 and 9, in which perceived threat's interaction with perceived benefits and its interaction with perceived barriers are tested respectively, only perceived threat's direct effect is significant and indicates an increase in odds of screening intention. These results suggests that, when considered in separate regressions, an increase in ones perceived threat does not trigger perceived benefits or barriers to have a significant effect on odds of prostate cancer screening intention.

Model 10 includes all interactions between perceived threat and the other HBM constructs. Model 11 adds modifying factors and controls. First, in Model 10 and Model 11 there is still a significant and negative moderating effect of perceived threat on the relationship between cues to actions and odds of prostate cancer screening intention. Second, Model 10 and Model 11 reveal a significant interaction between perceived threat and perceived benefits. As an individual perceives greater threat in getting prostate cancer, a growth in perceived benefits of screening corresponds to an increase in an individual's odds of prostate cancer screening intention. Third, as seen in Model 6, in Model 11 being older and insured increases ones odds of screening intention.

The final model (Model 11) for this statistical approach explains 18.5% of the variance in odds of prostate cancer screening intention according to Hosmer and Lemeshow's pseudo R^2. Also Model 11's AIC is 291.58.

Comparison of Logistic Regressions With and Without Interactions. When comparing the final logistic regression models (Models 6 and 11) the AIC captures model fit whereas Hosmer and Lemeshow's pseudo R^2 evaluates explanatory power. First, in terms of the AIC, smaller values indicate better fit than models with larger AIC values (Bollen and Curran 2006). Based on this assessment, Model 6 (logistic regression with summated constructs) has a smaller AIC than Model 11, although the difference is only 0.6. Second, based on pseudo R^2, Model 11 (logistic regression with interactions) explains greater variation in the outcome with 0.185 as compared to 0.167. Also Model 11 has significant interaction terms, indicating the role of perceived threat as a moderator that triggers the influence of other HBM constructs on prostate cancer screening intention.

However, in terms of estimated coefficients for the HBM constructs, both methods have problematic results. Constructs that theory suggests are significant are not found to be so. In Model 6 and Model 11 perceived threat is the only construct that has a significant direct effect on prostate cancer screening intention. Even when the other constructs act as sole predictors (Models 2-4) only cues to action has a significant direct effect on the outcome. These findings could point to the inadequacy of the overall HBM in explaining prostate cancer screening intention.

Section 4: Path Analysis

The diagram of the HBM (see Figure 1) depicts not only direct paths from constructs to prostate cancer screening intention but also indirect effects. The diagram indicates that cues to action indirectly effects screening intention through perceived threat rather than having a direct influence. Also based on Figure 1, there is no indication of direct effects of modifying factors, such as sociodemographics, on prostate cancer screening intention. Rather, the diagram shows modifying factors to have indirect effects through their impacts on perceived threat, perceived benefits of screening, and perceived barriers to screening. In this case path analysis can act as a better test of theory than logistic regressions as it can more accurately model relationships between constructs (Duncan 1966).

Some sociological HBM analyses attempt estimation of a path model by accounting for a relationship or direct effect between each pair of constructs (e.g., Jolly et al. 2009). Other studies include an analysis with an estimation of direct paths from each construct to the outcome but does not account for relationships between constructs (e.g., Cummings et al. 1979; McClenahan et al. 2007). As compared to other attempts in the literature, the path analysis in this study is an effort to most closely replicate the paths and effects indicated by the HBM diagram.

For the path analysis, the items for each HBM construct are summated before calculating the correlation matrix upon which the path analysis is run. As seen in Table 5, results from the path analysis suggest five significant relationships, two of which are only marginally significant. First, the cues to action construct has a significant effect on perceived threat. As expected, with an additional cue to action there is an increase in an individual’s perceived threat of prostate cancer. Second, higher income corresponds to lower levels of perceived threat. Third, prostate cancer knowledge has a marginally significant effect on perceived benefits, indicating that as an individual learns more about the prostate and prostate cancer the perceived benefits of getting screened increase. Fourth, the path analysis reveals that being white corresponds to fewer perceived barriers to getting screened for prostate cancer. Fifth, when looking at the direct paths to prostate cancer screening intention, results are consistent with the findings from the logistic regression analyses—only perceived threat has a significant effect on screening intention while the paths between screening intention and perceived benefits and barriers are not significant. Only an increase in perceived threat correlates to an increase in odds of prostate cancer screening intention.

Table 5. Model 12: Standardized Path Analysis Coefficients of the Health Belief Model for Prostate Cancer Screening Intention

	Dependent Variables			
Independent Variables	Perceived Threat	Perceived Benefits	Perceived Barriers	Screening Intention
Health Belief Model Constructs				
Perceived Threat				.243 ***
				(.061)
Perceived Benefits				-.026
				(.061)
Perceived Barriers				.018
				(.061)
Cues to Action	.508 ***			
	(.055)			
Modifying Factors/Controls				
Self-Efficacy				-.007
				(.061)
White	-.031	-.106	-.252 ***	
	(.056)	(.065)	(.064)	
Age	-.012	.022	.029	
	(.064)	(.073)	(.073)	
Income	-.129 •	-.134	.048	
	(.072)	(.082)	(.082)	
Education	-.055	-.063	-.019	
	(.072)	(.083)	(.082)	
Currently Insured	.083	.036	-.045	
	(.072)	(.082)	(.081)	
Prostate Cancer Knowledge	.056	.122 •	-.050	
	(.061)	(.070)	(.069)	
Variances	.715	.952	.933	.939
AIC	8113.506			
RMSEA	.192 ***			
χ^2	154.240 ***			
n	251			

Notes: Numbers in parentheses are standard errors.

•p<0.1   *p < 0.05   **p < 0.01   ***p < 0.001 (two-tailed tests)

Considering overall model fit indices, the path analysis (Model 12) has an AIC of 8113.506. The χ^2 test is a test of overall model fit with a null hypothesis of perfect fit (Bollen and Curran 2006). A significant χ^2 test statistic specifies that the null hypothesis of perfect fit must be rejected. Model 12 has a significant χ^2 statistic, indicating that that model does not fit the data well. According to the root-mean-square error of approximation (RMSEA) values greater than 0.1 represent a poor fit (Bollen and Curran 2006). Based on a RMSEA of 0.192 this model appears to be a poor fit.

Section 5: SEM with Latent Variables

Some sociological HBM research use SEM but in vastly different ways (e.g., Jolly et al. 2009; McClenahan et al. 2007; Sapp and Weng 2007). For example, there is no consistency in which relationships are estimated and whether constructs are included as latent or observed variables. Sapp and Weng (2007) justify their treatment of the HBM constructs as observed variables by stating that it reduces complexity (e.g., Sapp and Weng 2007). However, even within each construct vastly different aspects of the overall concept are measured. For example, in terms of perceived threat, worrying you might die could carry more weight in how threatening you perceive a health problem to be than knowing a relative who has the health problem. The present study tests whether the HBM constructs should be treated as latent factors as part of SEM rather than as summated observed variables and whether items within each construct should be weighted differently.

Table 6 includes the factor loadings and statistical significances of the items for each HBM construct. First, according to the factor loadings, there is a great variability in the weighting of some items, suggesting that an equal weighting when summated is not appropriate. Second, two items do not have significant loadings. Comparison of one’s chances of getting

Table 6. Model 13: Structural Equation Factor Loading Estimates for the Health Belief Model Latent Constructs for Prostate Cancer Screening Intention

Construct	Item	Estimate	
Perceived Risk	What do you think are your chances of getting prostate cancer at some time in your life?: Not at all (0) to Very likely (1)	1.00[a]	
	What do you think your chances are compared to other men?: Lower than most (0) to Higher than most (1)	.454	
	How worried are you about getting prostate cancer?: Not at all (0) to A lot (1)	.727	*
	You were concerned about it because you are getting older.	2.300	**
	Because a family member had prostate cancer.	1.341	**
	Because you worry that prostate cancer could cause problems with your sex life.	3.182	**
	Because you worry that prostate cancer could cause you problems with urinating.	3.113	**
	Because you don't want to die from prostate cancer.	1.479	**
Cues to Action	If your doctor recommended that you get screened for prostate cancer.	1.00[a]	
	If your family encouraged you to get screened.	2.410	***
	If members of your faith community encouraged you to get screened.	2.220	***
	Because you feel it is common for men your age to get screened.	1.269	***
	Have you ever attended a prostate cancer education program?	.333	
Perceived Benefits	You wanted to know if you have prostate cancer.	1.00[a]	
	You thought that you might live longer if prostate cancer was detected early.	1.596	***
	Getting prostate cancer screening was part of taking care of your health.	.679	***
Perceived Barriers	Do you think that getting a DRE is embarrassing?	1.00[a]	
	Getting a DRE feels uncomfortable.	.402	**
	Getting a DRE violates your manhood.	1.456	***
	Getting a DRE violates your privacy.	1.314	***
	Getting a DRE makes you feel like less of a man.	.931	***
	Getting a DRE hurts.	.492	***
	Getting a DRE could stimulate homosexual (gay) tendencies.	.484	***

[a]The first path for each factor was set to 1; therefore, no significance level is designated.

•p<0.1 *p < 0.05 **p < 0.01 ***p < 0.001 (two-tailed tests)

prostate cancer to those of other men does not significantly load onto the latent variable, perceived threat. Also, attendance at a prostate cancer education program is not significant in the cues to action construct.

Table 7 highlights the coefficients and their significance levels for the suggested paths outlined in Figure 1. The SEM approach estimated somewhat similar results in term of path coefficients as compared to path analysis. First, consistently, cues to action has a significant and positive effect on perceived threat. Second, contradictory to path analysis results, insurance status has a marginally significant effect on perceived threat. Having medical insurance correlates with greater perceived threat associated with prostate cancer. None of the modifying factors have a significant effect on perceived benefits. Third, as seen in path analysis results, being white corresponds to fewer perceived barriers to prostate cancer screening. Fourth, also consistent with our path analysis, greater perceived threat corresponds to an increase in odds of prostate cancer screening intention. And fifth, an unexpected finding and also one that diverges from the path analysis results, an increase in perceived benefits to screening corresponds to a decrease in odds of prostate cancer screening intention.

Overall fit indices for the structural equation model with latent variables (Model 13) include an AIC of 20988.343. The significant RMSEA of .085 suggests poor fit, although some suggest guidelines that a RMSEA between 0.05 and 0.1 indicate a moderate fit (Browne and Cudeck 1993). Also the significant chi-square statistic indicates that this model is not a perfect fit for the data.

Table 7. Model 13: Structural Equation Model Path Coefficients of the Health Belief Model for Prostate Cancer Screening Intention

Independent Variables	Dependent Variables: Perceived Threat		Perceived Benefits	Perceived Barriers		Screening Intention	
Health Belief Model Constructs							
Perceived Threat						1.618	**
						(.554)	
Perceived Benefits						-.312	*
						(.133)	
Perceived Barriers						.079	
						(.118)	
Cues to Action	.534	**					
	(.201)						
Modifying Factors/Controls							
Self-Efficacy						-.015	
						(.060)	
White	-.014		-.060	-.144	**		
	(.015)		(.041)	(.043)			
Age	.010		.037	.017			
	(.017)		(.045)	(.046)			
Income	-.029		-.032	.021			
	(.020)		(.051)	(.051)			
Education	-.007		-.051	.003			
	(.019)		(.051)	(.052)			
Currently Insured	.042	•	-.083	-.009			
	(.022)		(.052)	(.051)			
Prostate Cancer Knowledge	.020		.067	-.025			
	(.017)		(.045)	(.044)			
Variances	.024		.266	.298		.861	
AIC	20988.343						
RMSEA	.085	***					
χ^2	1124.343	***					
n	251						

Notes: Numbers in parentheses are standard errors.

•p<0.1 *p < 0.05 **p < 0.01 ***p < 0.001 (two-tailed tests)

Comparison of Path Analysis and SEM. For path analysis (Model 12) and SEM with latent factors (Model 13) there are corresponding model fit indices (chi-square and RMSEA) that indicate the models are a poor fit (or possibly moderate fit in the case of Model 13's RMSEA). Also with path analysis (Model 12) constructs thought to be significant based on theory are not. Paths from perceived benefits to outcome, from perceived barriers to outcome, and from self-efficacy to outcome are not significant. However, certain modifying factors do have significant effects on HBM constructs. Notably, growth in prostate cancer knowledge corresponds to greater perceived benefits to prostate cancer screening, which suggests that with proper education men can understand the advantages to getting screened.

With the SEM approach and the treatment of HBM constructs as latent variables there is the additional test of the significance of the various items and whether they have differential factor loadings. The present study's findings in Model 13 show variability in the significant factor loadings of the items for each construct. For example, worrying that prostate cancer could affect his sex life matters more in terms of how an individual perceives the threat of prostate cancer as compared to when a family member has prostate cancer. In regards to SEM there are again problems with the estimated path coefficients. Perceived barriers does not have a significant effect on prostate cancer screening intention. And in this final approach (Model 13) perceived benefits to screening has an unexpected negative effect on prostate cancer screening intention. This divergent finding may point to the inadequacy of the overall model and/or indicate that the perceived benefits construct is not completely measured by the corresponding items.

Comparison of All Four Statistical Approaches. Overall no statistical approach proves fully superior in testing the HBM. All four approaches show problems and insignificant or inverse coefficients according to the HBM predictions. These problems point to the widespread critique of the HBM, which is that constructs are not operationally defined in a sufficient and consistent way. When constructs are assessed utilizing different measures then inconsistent results, regarding significance and direction, can occur.

The more appropriate statistical approach for testing the HBM is indicated by how it is diagramed. The diagram of the HBM implies relationships and paths between constructs, outcome, and modifying factors. This diagram suggests that a statistical approach is required that can model how these constructs relate. Also, arguably, although this study's results show that when the HBM constructs are treated as latent variables factor loadings for items are significant and variable, it is problematic to think of these items as measuring latent factors. Arguably, these items are counts for the corresponding constructs rather than overall measures of the same common underlying factor. The need for an approach that can best model and test the relationships between HBM constructs without the problematic treatment of items as measures of underlying latent factors gives credence to path analysis as the more appropriate statistical approach for testing the diagramed HBM.

When considering the results of all four approaches as a collective some interesting patterns emerge, suggesting revisions to the HBM. A more precise understanding of how constructs, modifying factors, and outcome are related will improve analytic methods that appropriately estimate and test the HBM. In terms of revisions, based on this study's results, I suggest the following two additions to the model (see Figure 2 for revised HBM).

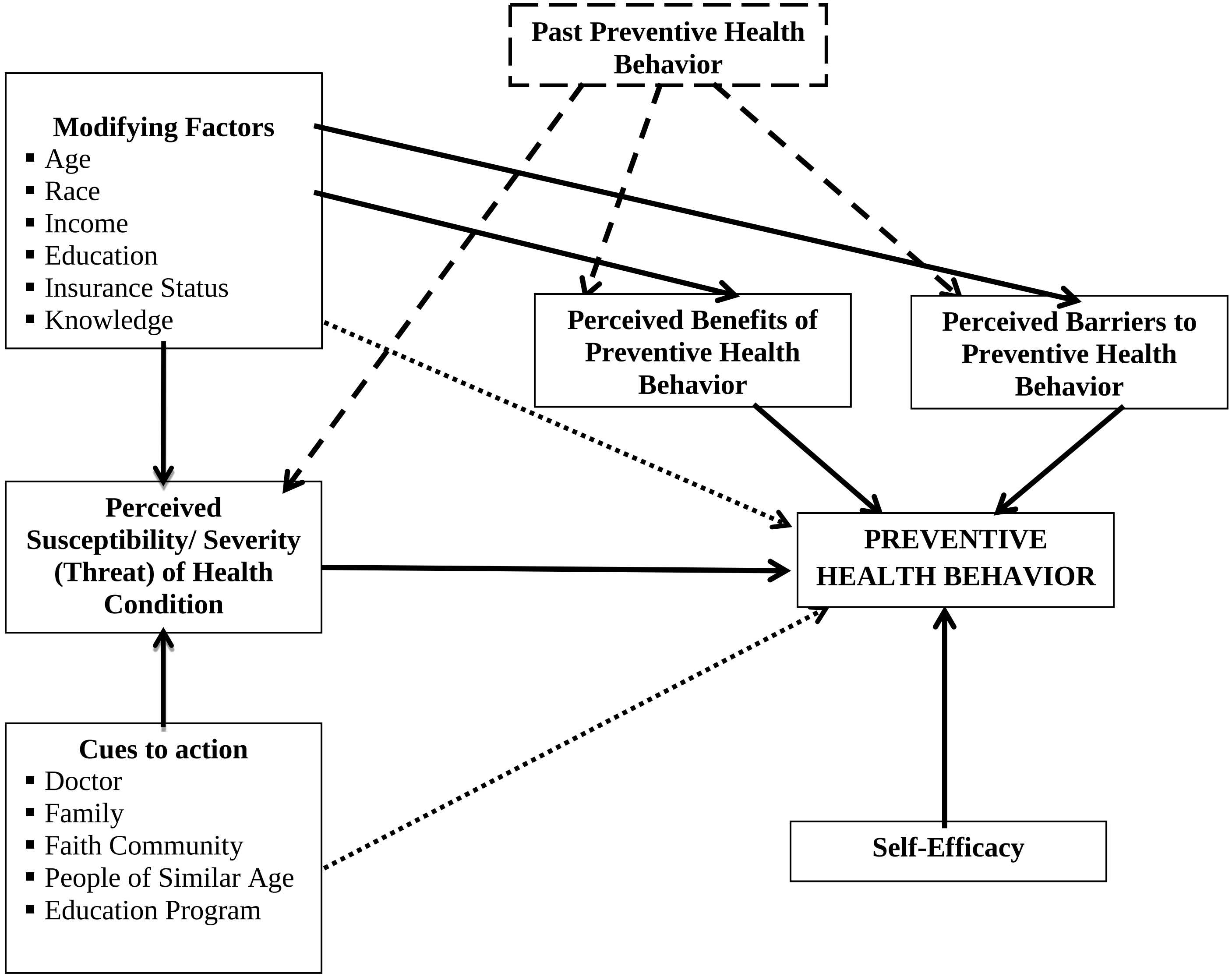
First, in the final logistic regression models (Models 6 and 11) age, insurance status, and one income category had significant effects on prostate cancer screening intention. These results suggest that there should be a direct path from the modifying factors to the preventive health behavior, which is not currently included in the diagram (see Figure 1).

Second, this study suggests the addition of a direct path from the cues to action construct to preventive health behavior as it functions as a trigger or catalyst to the behavior. Support for cues to action as more central HBM construct is found in four points in this study's results. First, in Model 2, when acting as a sole predictor of prostate cancer screening intention, cues to action has a significant effect. Second, in Model 11 an interaction between perceived threat and cues to action is significant. Third, the results of path analysis (Model 12) and SEM (Model 13) consistently show cues to action to have a significant effect on perceived threat. The revised diagram of the HBM with additional paths is included in Figure 2.

DISCUSSION

With the health belief model (HBM) as its framework, this study reveals four things about prostate cancer screening intention. First, there is an overall significant relationship between perceived threat of prostate cancer and prostate cancer screening intention. Second, when included as a sole predictor of prostate cancer screening intention, an additional cue to action corresponds to an increase in odds of prostate cancer screening intention. Third, path analysis and structural equation modeling (SEM) also support an indirect effect between cues to action and prostate cancer screening intention through perceived threat as more cues to action correspond to an increase in perceived threat. Fourth, modifying factors, such as age and being insured, correspond to an increase in odds of prostate cancer screening intention.

Figure 2: Revised Diagram of Health Belief Model



Notes: Revisions to the original Health Belief Model are in dotted lines. Pathways for future investigation are in dashed lines.

Based on the comparison of results from four statistical approaches for testing the HBM there are two major take-home points. First, this study argues that the emphasis should be on the proper analysis of diagramed paths between HBM constructs with the appropriate treatment of items as summed counts for the corresponding constructs. Thus, path analysis should be the preferred approach for testing the HBM. The second take-home point of the present study is the recommendation for two major revisions to the HBM in order to create a more accurate diagram (see Figure 2). First, a direct pathway should be drawn from modifying factors, such as age and insurance status, to preventive health behavior. The importance of these factors is especially true for health behaviors similar to prostate cancer screening (i.e. actions that are recommended to older individuals and require a medical professional for completion). Second, I recommend a revision in which the cues to action construct is given a more central position and direct effect. In discussing the origins of the HBM, Rosenstock (1974a) implies that, although with an adequate degree of susceptibility and seriousness there is the force to act and with the awareness of benefits and barriers to the preventive health behavior there is an optimal course of action, these elements might not be enough to lead to a particular health behavior. The crucial element is the stimulus or trigger to act.

In regards to implications for the larger field of HBM research, the present study encourages three things. First, as previous critiques have stated (see, for example, Harrison, Mullen, and Green 1992; Janz and Becker 1984), it is essential to have consistent measures of the HBM constructs. The present study maintains that future analyses must work towards measuring all constructs on the same metric. Consistent measurement will aid us in not only comparing results across studies but also in judging the actual adequacy of the HBM in predicting preventive health behaviors. Second, the present study also supports the critique that the HBM is unable to explain a significant amount of variation in preventive health behaviors. Therefore, as an individual's past state is often a good predictor of his present state, this study suggests a future investigation into how a measure of *past preventive health behavior* could be worked into the HBM diagram and through which pathways it could influence current or future preventive health behavior. Theoretically, the experience of past preventive health behavior could influence an individual's current or future preventive health behavior through pathways to his perception of how threatening the health condition is and how he perceives the benefits of and barriers to the preventive health behavior. The addition of previous preventive health behavior to the HBM could prove to explain greater variation in current or future preventive health behavior (see Figure 2). And lastly, as debates arise between major entities, such as medical professionals and health agencies, about what proper health guidelines should be regarding various preventive health behaviors, it will be important to understand whose recommendation matters. Therefore, future research should focus on cues to action as a significant construct of the HBM. Who the cue to action is coming from and whether that has a significant effect on its potency in triggering preventive health behaviors could be an important inquiry for future research.

The present study is not without limitations that could inform future research. First, the 2008-09 Nashville Men's Preventive Health Survey is cross-sectional data. Thus, there is no way to address temporal priority, which is essential to path analysis because it implies relationships located in time from distal to proximal. Second, we can say little about the impact of the new prostate cancer screening guidelines because the data is from 2008 and 2009, before changes went into effect. Some findings reported herein may be inconsistent with current beliefs regarding prostate cancer screening. Third, only men who have no history of prostate cancer between the ages of 40 and 70 years old who are living in Davidson County are included in the sample. Therefore, these data are not nationally representative. Fourth, items measuring barriers to prostate cancer screening only refer to screening aspects that involve the DRE. Prostate cancer screening can involve a DRE and/or a PSA blood test. However, items as part of the perceived barriers construct do not assess barriers to the PSA blood test. This omission might explain why perceived barriers is not a significant predictor of prostate cancer screening intention. Finally, there was a significant amount of missing data.

CONCLUSION

The risk that prostate cancer poses for men cannot be ignored. If left untreated, this condition can ravage the lives of the men most important to us and could eventually lead to the deaths of our fathers, husbands, brothers, and uncles. It is essential that men are diagnosed in a timely manner in order to ensure that prostate cancer can be treated most effectively. For this vulnerable population prostate cancer screening is a procedure that was once described as routine for aging men but is now under scrutiny over its utility. As men deal with the possibility of a diagnosis without exhibiting symptoms, they must also grapple with an experience that can be perceived as frightening and embarrassing. Therefore, it is important to understand the conflict men experience in struggling with the threat prostate cancer poses to their lives and the pros and cons of screening for this condition. And as men receive contradictory recommendations regarding prostate cancer screening, it is even more important to understand the complexity of their decision making process.

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