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ORIGINAL INVESTIGATION

The PROMIS® Smoking Initiative: Initial Validity Evidence for Six New Smoking Item Banks

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ABSTRACT

Introduction: The Patient-Reported Outcomes Measurement Information System (PROMIS®) Smoking Initiative has developed 6 item banks for assessing smoking behaviors and biopsychosocial correlates of smoking among daily and nondaily adult cigarette smokers. This paper presents descriptive information and preliminary validity evidence for the item banks (Nicotine Dependence, Coping Expectancies, Emotional and Sensory Expectancies, Health Expectancies, Psychosocial Expectancies, and Social Motivations).

Methods: Using data from a large sample of daily ($N = 4,201$) and nondaily ($N = 1,183$) smokers, we generated mean daily and nondaily smoking bank scores according to select demographic groups. We also examined correlations among the 6 banks and examined the associations of bank scores with smoking behavior items (e.g., quantity of smoking, interest in quitting) and select health-related quality of life measures (i.e., physical functioning, anxiety, alcohol consumption).

Results: Correlations among the 6 banks are moderate (daily mean $r = .48$, range = .04–.80; nondaily mean $r = .47$, range = .12–.75). The pattern of associations between bank scores and other measures provides validity evidence for the bank domains (e.g., nicotine dependence is most strongly associated with smoking quantity and time to first cigarette of the day; health and psychosocial expectancies are most related to quitting recency and interest; coping expectancies are strongly associated with anxiety).

Conclusions: These analyses provide useful descriptive information about the 6 smoking item banks as well as preliminary evidence for their validity. Independent sample data are currently being collected to replicate these findings, to establish test–retest reliability, and to develop crosswalks to existing smoking measures (e.g., nicotine dependence to Fagerström Test for Nicotine Dependence). Future research will also evaluate the bank scores' sensitivity to change.

INTRODUCTION

The adoption of modern measurement theory approaches, including item response theory (IRT) and item banking, to behavioral health assessment has grown considerably in the past decade (Hays & Lipscomb, 2007). This growth, evidenced by large National Institutes of Health (NIH) initiatives such as NIH Toolbox (Gershon et al., 2010; http://www.nihtoolbox.org/Pages/default.aspx) and Patient-Reported Outcomes Measurement Information System (PROMIS®; Cella et al., 2010; http://www.nihpromis.org/default.aspx), is due, in large part, to the many benefits accrued by migrating assessment to a modern measurement theory framework. In addition to the improved precision and decreased respondent burden afforded by IRT item bank assessment systems, the IRT framework offers standardization hand-in-hand with extensive flexibility in administration and scoring (e.g., computer adaptive tests, tailored short forms, comparability of scores across forms; Cook, O'Malley, & Roddey, 2005; Edelen & Reeve, 2007; Embretson & Reise, 2000; Reeve et al., 2007).

The fact that IRT-based item banks have known characteristics allows developers to evaluate and exclude items that show unacceptable levels of differential item functioning so that measurement bias according to common demographic groupings (e.g., gender, age, ethnicity) is minimized. This feature of known characteristics also enables linking of scores from different forms and tailoring of tests for specific purposes while maintaining a pre-specified degree of measurement precision. This measurement flexibility also extends to a wide array of administration options and platforms—such as computer-based assessment, use of handheld devices such as smartphones and notepads, computer adaptive testing (CAT), and tailored paper and pencil short forms—all of which minimize respondent burden without sacrificing reliability and precision (Embretson,

1996; Hambleton & Swaminathan, 1985; Lord, 1980; Wainer, 2000; Wainer & Mislevy, 2000).

Another critically important feature of the IRT-based item banking approach is that it represents a sustainable measurement solution for any given domain of behavioral research. Not only are the various scores generated from a given item bank comparable to one another, it is also straightforward to relate these scores back to existing measures of similar constructs that are typically used in the field and to incorporate new items and subdomains into the system without creating the problem of "version control." This feature facilitates comparison of findings across studies and across time.

In response to this assessment modernization movement, the initial goal of the PROMIS Smoking Initiative was to develop, evaluate, and standardize IRT-based item banks to assess cigarette smoking behavior and biopsychosocial constructs associated with cigarette smoking. The genesis of this effort sprung from the importance of considering smoking-related constructs in assessing patient-reported outcomes and the notable absence of cigarette smoking from the PROMIS framework. However, the item banks produced by this initiative are potentially applicable to a broad array of epidemiological research and clinical contexts. Using a mixed methods approach (Edelen, Tucker, Shadel, & Stuckey, 2012), the PROMIS Smoking Initiative has identified six distinct cigarette smoking-related constructs and developed a set of psychometrically sound item banks for their assessment among current daily and nondaily cigarette smokers. Although we are ultimately interested in assessment among committed smokers as well as those in the process of quitting, this phase of the initiative focused on assessment of cigarette smokers who are not planning to quit in the next 30 days. Other papers in this issue provide detailed descriptions of the development and psychometric properties of each item bank.

The content of these banks is based primarily on the rich set of instruments currently available in the smoking research field (see Edelen et al., 2012) including, among others, the Fagerström Test for Nicotine Dependence (FTND; Heatherton, Kozlowski, Frecker, & Fagerström, 1991; more recently referred to as the Fagerström Test of Cigarette Dependence; Fagerström, 2012), the Nicotine Dependence Syndrome Scale (Shiffman, Waters, & Hickcox, 2004), the Wisconsin Inventory of Smoking Dependence Motives (WISDM; Piper et al., 2004), the Smoking Consequences Questionnaire (Brandon & Baker, 1991; Copeland, Brandon, & Quinn, 1995), the Smoking Effects Questionnaire (Rohsenow et al., 2003), the Perceived Risks and Benefits Questionnaire (McKee, O'Malley, Salovey, Krishnan-Sarin, & Mazure, 2005), the Coping with Temptations Inventory (Shiffman, 1988), the Reasons for Smoking Scale (Tate & Stanton, 1990), the Autonomy Over Smoking Scale (DiFranza, Wellman, Ursprung, & Sabiston, 2009), the Michigan Nicotine Reinforcement Questionnaire (Pomerleau et al., 2003), the Questionnaire on Smoking Urges (QSU; Tiffany & Drobes, 1991), the Smoking: Decisional Balance Long Form (Velicer et al., 1985), the Cigarette Dependence Scale, English-language version (Etter, Houezec, & Perneger, 2003), the Self-Efficacy/Temptations Scale-Long Form (Velicer et al., 1990), and the Transtheoretical Model Assessment (Prochaska, Velicer, DiClemente, & Fava, 1988). Initiating this assessment development process by compiling a set of items based on the "best of the best" and supplementing this content with direct input from smokers' own

current experiences, we aspired to transport smoking assessment into the 21st century while maintaining a bridge back to the strong measurement legacy established in the smoking research field.

The objective of this report is to present descriptive information and preliminary validity evidence for the six item banks: Nicotine Dependence, Coping Expectancies, Emotional and Sensory Expectancies, Health Expectancies, Psychosocial Expectancies, and Social Motivations. Specifically, we first provide basic descriptive information through presentation of group mean bank scores according to demographic characteristics. Next, we describe associations among the six bank scores. Finally, we examine associations of the six bank scores with four items reflecting smoking and quitting patterns as well as with three domains of health-related quality of life (HRQoL). The three domains of HRQoL selected to evaluate preliminary validity of the banks were (a) physical functioning, based on the known association between smoking and poor physical health (U.S. Department of Health and Human Services, Centers for Disease Control and Prevention, National Center for Chronic Disease Prevention and Health Promotion, & Office on Smoking and Health, 2014); (b) anxiety, given the high prevalence of smoking among individuals with mental health issues (Lasser et al., 2000; Morris et al., 2014) and the knowledge that many individuals smoke to relieve anxiety (Buckner, Farris, Schmidt, & Zvolensky, 2014; Piper, Cook, Schlam, Jorenby, & Baker, 2011); and (c) alcohol consumption, given the prevalence of co-use of cigarettes with alcohol, especially among young people and periodic smokers (Ames et al., 2010; Hughes & Kalman, 2006; Substance Abuse and Mental Health Services Administration, 2009).

The demographic analyses were intended to be descriptive. Thus, although we expected to see some differences, we did not evaluate the significance of item bank mean score differences according to demographic groups (this information is available from the first author upon request). We had several a priori expectations of bank scores' associations with the four smoking variables we examined (smoking quantity, time to first cigarette of the day, recency of latest quit attempt, interest in quitting). For example, we expected nicotine dependence, coping expectancies, and emotional and sensory expectancies to be strongly associated with smoking quantity (positively) and time to first cigarette of the day (negatively), but expected those associations to be strongest for nicotine dependence. We also expected scores reflecting health and psychosocial expectancies of smoking to be most strongly associated, relative to scores from the other banks, with interest in quitting (positively) and recency of quit attempts (negatively). Finally, we expected emotional and sensory expectancies scores to be negatively associated with interest in quitting.

For associations of bank scores with the three HRQoL domains of physical functioning, anxiety, and alcohol consumption, we expected that relative to other bank scores, health expectancies and nicotine dependence scores would be most strongly associated with physical functioning. Additionally, although we expected all of the bank scores to be positively associated with anxiety, we anticipated that the strongest association would be observed for coping expectancies; we also expected that both nicotine dependence and social motivations would be positively associated with alcohol consumption. We did not have any hypotheses regarding differences in associations for daily and nondaily smokers.

METHODS

Sample and Procedure

A national sample of smokers ($N_{(total)}$ = 5,384; $N_{(daily)}$ = 4,201; $N_{(nondaily)}$ = 1,183) was recruited by Harris Interactive through their online panel membership, and all assessments were completed via the Internet. All procedures were institutional review board approved. Individuals were eligible if they were 18 years or older, had been smoking for at least a year, had smoked in the past 30 days, and did not have plans to quit in the next 30 days. Based on their response to number of days smoked in the past 30 days, those participants indicating smoking 28–30 of the past 30 days were classified as daily smokers; respondents smoking less than 28 of the past 30 days were classified as nondaily smokers. Sample recruitment was targeted to reflect the demographic composition of U.S. adult smokers in terms of gender, race/ethnicity, and age. The survey was fielded between July and September 2011 via a randomized block design (Reeve et al., 2007). The block design was constructed to minimize respondent burden while maximizing the inter-item covariance coverage.

Mean age was 46.4 years for daily (D) smokers and 44.1 years for nondaily (ND) smokers. Females comprised about half the sample (D: 54.8%, ND: 47.0%). Most participants were employed full-time (D: 52.9%, ND: 60.6%) or part-time (D: 12.2%, ND: 14.4%). The racial/ethnic composition was primarily non-Hispanic White (D: 72.2%, ND: 55.2%), African American (D: 12.1%, ND: 15.5%), and Hispanic (D: 11.3%, ND: 24.4%). Most participants had attended at least some college (D: 80.5%, ND: 84%), and many had earned a bachelors or graduate degree (D: 29.8%, ND: 42.1%). More than half were currently married or cohabitating (D: 57.7%, ND: 55.1%), with fewer being divorced/separated/widowed (D: 21.8%, ND: 18.7%) or never married (D: 20.5%, ND: 26.1%). Although most differences are not large, chi-square tests (and *t*-test for age) indicated that daily and nondaily smokers significantly differed on each of these characteristics ($p < .001$). Most notably, relative to daily smokers, nondaily smokers were less likely to be non-Hispanic White, and more likely to be employed and further educated.

Measures

Demographic Characteristics
All respondents supplied basic demographic information including age, gender, race/ethnicity, marital status, education, and employment.

Smoking Patterns and Quitting History
In addition to indicating the number of days smoked in the past 30 days (1 = 0 days to 7 = 28 or more days), which was used to assign respondents to the daily and nondaily groups, all respondents completed four items that assessed their smoking behavior and quitting history. These questions were modified from the National Cancer Institute/Office on Smoking and Health Tobacco Use Supplement to the current population Survey 2006–2007 (U.S. Department of Commerce & Census Bureau, 2008), and the Smoking and Quitting History Survey (Woodruff, Lee, & Conway, 2006). Two smoking behavior items included (a) average number of cigarettes smoked per day in the past 30 days (1 = I did not smoke in the past 30 days to 7 = more than 20 per day) and (b) latency between waking

and first cigarette of the day (1 = within 5 min of waking to 4 = longer than 60 min after waking). Two Likert-scale quitting items were included querying interest in quitting (1 = not at all to 5 = very much), and recency of most recent quit attempt: "How long ago was your most recent quit attempt that lasted for one day or longer?" (1 = didn't quit, 2 = within the past month to 5 = a year or more ago).

HRQoL
Respondents completed one of eight PROMIS HRQoL short form measures, and three of these measures were used in the current analyses: physical functioning (10 items; Rose, Bjorner, Becker, Fries, & Ware, 2008), anxiety (7 items; Pilkonis, Choi, et al., 2012), and alcohol consumption (8 items; Pilkonis, Yu, et al., 2012).

Smoking Item Bank Scoring and Reliability
A total of 264 items with 5-point Likert response scales of either quantity (0 = not at all to 4 = very much) or frequency (0 = never to 4 = always), were administered as candidate items that were being considered for inclusion in one of the smoking item banks. These items were distributed across 26 overlapping administration forms containing an average of 147 items (range = 134–158); each respondent was randomly assigned one of the 26 forms. Following extensive quantitative analysis (see other papers in this issue), smoking item banks were finalized for each of the six domains and scores were generated based on final two-group (daily and nondaily) IRT models. Bank scores for daily smokers were set to a T-score metric (M = 50, SD = 10) to set the scale. The six banks are listed below along with domain content information, an example item, and the banks' marginal reliabilities (MR).

Nicotine Dependence (Shadel et al.): This bank is characterized by items measuring craving, withdrawal that occurs upon brief cessation of smoking, smoking temptations, compulsive use, and tolerance (e.g., "When I run out of cigarettes, I find it almost unbearable"). Daily smokers MR = .97 (27 items); nondaily smokers MR = .97 (27 items).

Coping Expectancies (Shadel et al.): This bank includes items that assess smoking as a means of coping with negative affect and stress (e.g., "I rely on smoking to deal with stress"). Daily smokers MR = .96 (15 items); nondaily smokers MR = .97 (18 items).

Emotional and Sensory Expectancies (Tucker et al.): This bank is characterized by items measuring perceptions of improved cognitive abilities, positive affective states, and pleasurable sensorimotor sensations due to smoking (e.g., "I feel better after smoking a cigarette"). Daily smokers MR = .95 (16 items); nondaily smokers MR = .95 (17 items).

Health Expectancies (Edelen et al.): This bank includes items that assess perceptions of current and long-term consequences of smoking on one's health (e.g., "Smoking is taking years off my life"). Daily smokers MR = .95 (18 items); nondaily smokers MR = .96 (19 items).

Psychosocial Expectancies (Stucky et al.): This bank consists of items measuring social disapproval of smoking, normative values associated with smoking, and negative beliefs about one's appearance when smoking (e.g., "People think less of me when they see me smoking"). Daily smokers MR = .93 (20 items); nondaily smokers MR = .95 (15 items).

Social Motivations (Tucker et al.): This bank consists of items broadly measuring the expected social benefit of smoking and the social cues that induce cigarette craving (e.g., "Smoking makes me feel better in social situations"). Daily smokers MR = .90 (12 items); nondaily smokers MR = .91 (12 items).

Due to the randomized block sampling design with planned missingness, it was necessary to account for the uncertainty in estimated IRT scale scores in subsequent analyses. Thus, a two-step method was used to generate 10 plausible values (Mislevy, Beaton, Kaplan, & Sheehan, 1992; Mislevy, Johnson, & Muraki, 1992) for each respondent for the six smoking domain scores. First, 10 sets of IRT scores were randomly drawn from the individual posterior distributions obtained by empirical Bayes scoring of the observed item responses with the calibrated item parameters. Second, these randomly drawn scores were regressed on a large number of background variables (i.e., covariates) and their two-way interactions. The fitted values from this regression (repeated with each of the random draws) provided the plausible values used in the analyses reported here.

Analyses

To maintain consistency with previously reported results, and to uncover any differences in validity for the daily and nondaily item banks, all results are presented separately for daily and nondaily smokers. We first characterize differences in smoking bank scores between daily and nondaily smokers and present descriptive smoking bank group means for each smoker type according to demographic variables. Next, we examine correlations among the six smoking bank scores for each smoker type. Evaluation of validity according to bank score associations with the four continuous smoking and quitting pattern variables are then presented for daily and nondaily smokers, and finally, we present correlations of the six smoking bank scores with the three PROMIS HRQoL short forms. All associations among continuous measures are represented as correlation coefficients, with 99% confidence intervals (CI) around parameter estimates. The 99% CI corresponds to a *p*-value of .01, which was adopted here to control for Type I error rate. For interpretation, 99% CIs that do not contain 0 are considered significantly different from 0, and correlation estimates with nonoverlapping 99% CIs are considered significantly different from one another. The MIANALYZE procedure was used in the computer software SAS 9.2 (SAS Institute, 2011) to combine the results of the 10 imputed data sets and provide significance tests.

RESULTS

Daily smokers had significantly higher scores than nondaily smokers on all smoking bank domains (see Table 1). As expected, differences between daily and nondaily smokers were largest in magnitude for the nicotine dependence domain ($d = 1.04$, $p < .001$), were moderate for the coping expectancies ($d = 0.54$, $p < .001$) and emotional and sensory expectancies ($d = 0.35$, $p < .001$) domains, and were somewhat smaller in magnitude for the social motivations ($d = 0.25$, $p < .001$), health expectancies ($d = 0.25$, $p < .001$), and psychosocial expectancies ($d = 0.14$, $p < .001$) domains. Table 1 also

contains mean smoking bank scores according to demographic groups for daily and nondaily smokers. Because we did not have any a priori hypotheses regarding these group means, tests were not conducted. However, a few trends in mean scores are noteworthy. For daily smokers, women tended to score higher than men on all bank scores, with the coping expectancies bank showing the largest gender difference. Although bank scores for both smoker types tended to decrease with increased age, this effect was more apparent among the daily smokers and most striking in the mean social motivations bank scores for both smoker types. Mean bank scores were fairly comparable according to marital status, employment, and education, and there were no discernable patterns of mean differences according to race/ethnicity groups.

Table 2 displays the inter-bank correlations for daily and nondaily smokers. With the exception of two correlations that were significant at $p<.05$ (italicized entries in Table 2), all correlations among item banks were significant at $p < .01$. The inter-bank correlations ranged in magnitude from .04–.80 ($M = .48$) for daily smokers and .12–.75 ($M = .47$) for nondaily smokers (see Table 2). Although the magnitude of correlations was slightly different, the pattern of associations was similar across the two smoker types. Associations among coping expectancies, emotional and sensory expectancies, and social motivations tended to be strong as did the correlations between the two negative expectancies (i.e., health and psychosocial). In fact, for both smoker types, the strongest inter-bank correlation was between these two banks. Correlations across banks from these two groupings (e.g., between emotional and sensory expectancies and health expectancies) tended to be smaller in magnitude. Although nicotine dependence scores were relatively highly correlated with scores from all other banks, the coping expectancies bank scores were most strongly associated with nicotine dependence.

The pattern of correlations between smoking bank scores and continuous measures of smoking behavior and quitting history were largely as expected and provide strong evidence for the validity of the item banks (see Table 3). For both daily and nondaily smokers, nicotine dependence was most strongly associated with smoking quantity and time to first cigarette of the day and associations of these variables with coping expectancies and emotional and sensory expectancies were also relatively strong. However, contrary to expectations, the associations of social motivations domain scores with quantity and time to first cigarette were similar in magnitude to those corresponding to the coping and emotional and sensory expectancies scores. As hypothesized, health expectancies and psychosocial expectancies were most strongly related to interest in quitting and recency of quitting; also as expected, emotional and sensory expectancies scores were negatively associated with interest in quitting. These patterns were similar for daily and nondaily smokers.

The correlations of daily and nondaily smoking item bank scores with the three PROMIS HRQoL measures, displayed in Table 4, were somewhat mixed in terms of supporting our expectations. Although nicotine dependence and health expectancies were strongly related to physical functioning as expected, the magnitude of association between psychosocial expectancies and physical functioning was comparable, and coping expectancies scores were also significantly associated with physical functioning, although to a lesser degree than the other three domains. Another unexpected but interesting

Table 1.   Synthesized Item Bank Means According to Demographic Groups and Daily and Nondaily Smokers

	N (%)		Nicotine Dependence		Coping Expectancies		Emotional and Sensory Expectancies		Health Expectancies		Psychosocial Expectancies		Social Motivations	
	D	ND	D	ND	D	ND	D	ND	D	ND	D	ND	D	ND
Overall	4,201	1,183	50.0	39.3	50.0	44.5	50.0	46.4	50.0	47.5	50.0	48.6	50.0	47.4
Gender														
Male	1,901 (45.3)	627 (53.0)	48.4	39.1	47.7	43.1	49.2	46.4	48.7	47.5	48.7	48.4	48.8	47.1
Female	2,300 (54.7)	556 (47.0)	51.2	39.5	52.0	46.1	50.6	46.5	51.1	47.5	51.2	48.9	51.0	47.6
Age, y														
18–30	421 (10.0)	190 (16.1)	51.6	39.3	53.2	45.8	52.5	48.4	51.5	48.2	51.2	48.8	53.5	50.7
31–50	1,955 (46.5)	575 (48.6)	50.9	39.3	51.4	44.9	50.8	46.8	51.1	47.5	50.9	48.5	51.0	47.9
51+	1,825 (43.4)	411 (34.7)	48.5	39.3	47.9	43.3	48.6	44.9	48.5	47.3	48.9	48.6	48.1	45.0
Race/ethnicity														
Hispanic	469 (10.9)	285 (24.1)	49.3	38.0	50.8	45.0	51.6	47.2	50.9	47.4	50.8	48.5	51.1	48.7
White	3,000 (71.4)	640 (54.1)	50.7	39.7	50.5	44.2	50.1	45.8	49.8	47.3	50.1	48.9	50.4	46.7
Black	504 (12.0)	181 (15.3)	47.2	40.6	47.6	45.1	48.4	46.7	51.2	49.2	49.9	48.9	47.3	47.4
Asian/other	182 (4.3)	57 (4.8)	47.9	37.9	48.8	44.4	49.4	48.2	48.2	45.4	48.1	46.0	47.9	48.3
Marital status														
Not Married	2,408 (57.3)	648 (54.8)	50.3	39.7	50.4	44.7	50.3	46.7	50.3	47.8	50.4	48.9	50.3	47.4
Married	1,768 (42.1)	527 (44.6)	49.4	38.7	49.5	44.3	49.6	46.1	49.5	47.1	49.6	48.2	49.7	47.3
Employment														
Full-time	2,222 (52.9)	712 (60.2)	49.3	38.5	49.6	43.9	49.8	46.1	50.1	47.4	50.1	48.6	49.8	47.4
Part-time	511 (12.2)	170 (14.4)	50.0	39.8	50.3	45.5	49.7	47.0	50.5	48.0	50.5	49.3	50.1	48.4
Not working	1,435 (34.2)	285 (24.1)	50.8	40.8	50.7	45.5	50.4	46.7	49.7	47.4	49.9	48.2	50.3	46.6
Education														
HS or less	820 (19.5)	187 (15.8)	51.0	41.9	51.3	46.3	50.7	46.8	49.9	49.4	49.7	49.2	50.8	48.0
Some college	2,124 (50.6)	493 (41.7)	50.0	40.3	50.1	45.2	50.0	46.9	50.0	47.5	49.9	48.6	50.1	47.2
BA or more	1,247 (29.7)	493 (41.7)	49.2	37.3	49.2	43.1	49.5	45.8	50.0	46.8	50.4	48.4	49.4	47.2

Note. D = daily; ND = nondaily; HS = high school; BA = bachelor's degree.
SD (not shown) are centered around 10 and range from 9 to 11.

Table 2. Synthesized Correlations and 99% Confidence Intervals Among Smoking Item Banks (Daily and Nondaily)

		Nicotine Dependence	Coping Expectancies	Emotional and Sensory Expectancies	Health Expectancies	Psychosocial Expectancies
Coping Expectancies	D (N = 4,201)	.73 (.70–.76)				
	ND (N = 1,183)	.68 (.63–.73)				
Emotional and Sensory Expectancies	D (N = 4,201)	.51 (.47–.55)	.70 (.67–.72)			
	ND (N = 1,183)	.48 (.39–.57)	.61 (.55–.68)			
Health Expectancies	D (N = 4,201)	.46 (.41–.49)	.32 (.27–.36)	*.04* (−.01–.09)		
	ND (N = 1,183)	.52 (.45–.59)	.36 (.25–.46)	.12 (.002–.24)		
Psychosocial Expectancies	D (N = 4,201)	.49 (.46–.53)	.36 (.32–.41)	.09 (.04–.14)	.80 (.78–.82)	
	ND (N = 1,183)	.50 (.41–.58)	.37 (.25–.48)	*.14* (−.01–.28)	.75 (.69–.80)	
Social Motivations	D (N = 4,201)	.66 (.62–.69)	.75 (.72–.78)	.71 (.67–.74)	0.28 (.24–.32)	.31 (.27–.36)
	ND (N = 1,183)	.52 (.43–.60)	.63 (.55–.69)	.70 (.65–.74)	.31 (.20–.41)	.31 (.19–.42)

Note. D = daily; ND = nondaily.
Except for italicized entries, all correlations are significant at $p < .01$.

result is that associations with physical functioning tended to be larger for nondaily smokers relative to daily smokers. For both smoker types, associations with anxiety were positive for all item banks as expected, but strongest for coping expectancies among daily smokers. The association of nicotine dependence with anxiety was stronger than expected—comparable to the coping association. Finally, associations with alcohol consumption were unexpectedly weak and none were significant.

DISCUSSION

The six smoking item banks were developed as part of the PROMIS Smoking Initiative using state-of-the-art measurement techniques. They have the advantage of attaining a high degree of measurement precision with very minimal respondent burden while maintaining a bridge back to the strong measurement tradition in cigarette smoking research. This paper presents descriptive information and preliminary validity evidence for each of these banks, which we hope will encourage smoking researchers and practitioners to consider using the new item banks in their own studies of cigarette smokers.

Results were encouraging, with patterns of associations lending support to the domain definitions and bank contents. The correlations among item banks were generally strong and positive as expected, and the pattern of associations among the banks was also in line with our expectations. However, the magnitude of some of these correlations raises questions as to the distinctiveness of some of the constructs—a question that will have to be addressed in future research. Despite some of these higher-than-desired correlations (e.g., between health and psychosocial expectancies), we contend that these banks are distinct by virtue of their distinct content and their potential use in various contexts (e.g., it is likely that the Health Expectancies bank will be of more interest to a primary care researcher than the Psychosocial Expectancies bank, despite their empirical similarities).

Associations of item bank scores with smoking items and HRQoL measures also provided encouraging validity evidence. For example, as expected, nicotine dependence was most strongly associated with smoking quantity and time to first cigarette of the day. Also consistent with our hypotheses, the health and psychosocial expectancies bank scores were most strongly associated with interest in quitting and recency of quit attempts. Concerning associations with the three HRQoL domains, results were somewhat in line with our expectations. Nicotine dependence and health expectancies were strongly associated with physical functioning, but psychosocial expectancies scores were also strongly correlated with this measure. The associations of item bank scores with anxiety were generally comparable across the six banks, in contrast to our expectation that coping expectancies would have the strongest associations with this domain. Finally, although there was a trend for the association between alcohol consumption and social motivations scores for daily smokers ($p < .05$), none of the bank scores were significantly correlated with alcohol consumption. Given the known association between alcohol consumption and cigarette use, it is surprising that we did not observe any significant associations in this sample, although some of this may be due to a lack of power. Future research will continue to explore the nature of this relationship.

The validity evidence presented here is considered preliminary and should be interpreted in light of several limitations. Although results are based on data from a large national

Table 3. Synthesized Correlations and 99% Confidence Intervals of Daily and Nondaily Item Banks With Smoking Measures

	Nicotine Dependence	Coping Expectancies	Emotional and Sensory Expectancies	Health Expectancies	Psychosocial Expectancies	Social Motivations
Smoking quantity						
D (*N* = 4,193)	**.31** (.26–.35)	**.17** (.12–.22)	**.12** (.08–16)	.04 (−.01 to .08)	.06 (.02–10)	**.17** (.12–.22)
ND (*N* = 1,182)	**.47** (.41–.54)	**.32** (.25–.39)	**.16** (.08–25)	**.23** (.15–.31)	**.21** (.13–.29)	**.16** (.08–.24)
Time to first cigarette of the day						
D (*N* = 2,538)	**−.32** (−.38 to −.25)	**−.21** (−.28 to −.14)	**−.12** (−.19 to −.06)	**−.11** (−.18 to −.05)	**−.12** (−.19 to −.05)	**−.17** (−.24 to −.10)
ND (*N* = 696)	**−.51** (−.59 to −.42)	**−.36** (−.46 to −.26)	**−.20** (−.31 to −.09)	**−.26** (−.38 to −.14)	**−.24** (−.36 to −.11)	**−.21** (−.31 to −.11)
Recency of last quit attempt						
D (*N* = 4,198)	−.6 (−.11 to −.02)	−.05 (−.09 to −.0003)	**.05** (.01–10)	**−.22** (−.27 to −.18)	**−.23** (−.28 to −.19)	−.03 (−.08 to .02)
ND (*N* = 1,180)	**−.12** (−.20 to −.04)	−.08 (−.17 to −.01)	.02 (−.08–.12)	**−.23** (−.31 to −.15)	**−.24** (−.33 to −.15)	−.03 (−.14–07)
Interest in quitting						
D (*N* = 4,197)	**.25** (.21–.29)	**.13** (.08–.17)	**−.09** (−.14 to −.05)	**.51** (.47–.55)	**.52** (.47–.56)	**.08** (.03–.13)
ND (*N* = 1,180)	**.34** (.27–.41)	**.20** (.12–.29)	−.02 (−.11–.06)	**.45** (.37–.53)	**.46** (.39–.53)	.09 (−.01–.18)

Note. D = daily, ND = nondaily. Sample sizes for smoking items varied due to randomized block design; time to first cigarette of the day high score = longer wait; recency of last quit attempt high score = less recent; interest in quitting high score = more interested. All correlations in bold are significant at *p* < .01.

Table 4. Synthesized Correlations and 99% Confidence Intervals of Daily and Nondaily Item Banks With Three PROMIS® Measures

		Nicotine Dependence	Coping Expectancies	Emotional and Sensory Expectancies	Health Expectancies	Psychosocial Expectancies	Social Motivations
Physical functioning	D (N = 520)	**−.26**	**−.17**	−.03	**−.23**	**−.26**	−.14
		(−.41 to −.10)	**(−.31 to −.02)**	(−.17–.12)	**(−.37 to −.09)**	**(−.39 to −.12)**	(−.29 –.01)
	ND (N = 149)	**−.39**	**−.29**	−.07	**−.34**	**−.34**	−.12
		(−.59 to −.15)	**(−.49 to −.06)**	(−.31–.17)	**(−.53 to −.12)**	**(−.54 to −.11)**	(−.39–.17)
Anxiety	D (N = 528)	**.45**	**.50**	**.28**	**.31**	**.34**	**.37**
		(.34–.57)	**(.37–.61)**	**(.12–.42)**	**(.17–.44)**	**(.22–.45)**	**(.24–.49)**
	ND (N = 145)	**.27**	**.28**	.22	**.29**	**.28**	**.32**
		(.04–.47)	**(.05–.49)**	(−.09–.49)	**(.05–.50)**	**(.02–.51)**	**(.04–.55)**
Alcohol consumption	D (N = 541)	.05	.06	.05	.07	.09	.12
		(−.08–.18)	(−.06–.17)	(−.11–.20)	(−.08–.22)	(−.03–.22)	(−.02–.25)
	ND (N = 130)	.02	.06	.07	.09	.07	.13
		(−.22–.26)	(−.20–.31)	(−.21–.34)	(−.16–.34)	(−.17–.31)	(−.16–.40)

Note. D = daily; ND = nondaily. With the exception of physical functioning, higher scores on the PROMIS® measures indicate more of the measured construct; sample sizes for PROMIS® measures varied due to randomized block design. Entries in bold are significant at $p < .01$.

sample of smokers, these data were also used to develop the item banks. Thus, these findings need to be replicated and expanded using an independent sample of smokers with varying levels of smoking dependence and quitting intentions. In addition, the results are technically limited to assessment in population studies. However, it is likely that the results are applicable to established committed smokers in other settings, although their validity in clinical settings remains to be established empirically. The findings are also limited by the randomized block design, which resulted in (planned) missing data patterns, and relatively small sample sizes for some comparisons (e.g., correlations with PROMIS HRQoL measures). The missing data patterns also introduced uncertainty in the item bank scores and prevented us from evaluating validity for the banks' short forms. However, we used a rigorous multiple imputations approach to account for this uncertainty, generating 10 imputed data sets and synthesizing results across these data sets. Nonetheless direct evaluation of the short forms' validity is the subject of future research.

Indeed, several additional analyses with these item banks, beyond the initial validity tests reported in this paper, are currently underway. We have collected data from a subset of the original cohort of daily and nondaily smokers to enable evaluation of the smoking bank short form and computer adaptive test performance. These data will also provide a glimpse into the performance of these measures over time, as we can evaluate changes in bank scores between the two timepoints in light of events taking place over the natural course of smoking (e.g., changes in smoking quantity, quit attempts, health service utilization). Further, analyses of these data will include development of scoring crosswalks from traditional smoking measures (i.e., FTND, WISDM, QSU) to the new item bank scores (e.g., FTND score to nicotine dependence bank score). These scoring crosswalks will facilitate interpretation of the smoking bank scores by smoking researchers who are accustomed to evaluating research using more traditional smoking assessments. In addition, the scoring crosswalks will enable direct comparison of traditional smoking assessment research results with results based on the new smoking item banks. Additional data collection activities are also underway in an independent community sample of smokers. These data will be used to replicate these preliminary validity findings, establish test–retest reliability, and evaluate the equivalence of short form scores administered via computer versus traditional paper and pencil.

Another caveat regarding these results is that the smoking item banks were developed and tested for use with current smokers with no concrete plans to quit in the near future. Thus, the reliability and validity information that is available to date is only generalizable to this target population, and the extent to which these reported relationships might change over the course of tobacco use is an area for further exploration. Future research is planned to expand the banks to be relevant for smokers who are motivated to quit and in the process of quitting. This research will involve administration of the current set of banks as well as testing of new item sets that are specifically relevant for the quitting process (e.g., withdrawal, quitting self-efficacy). These and other studies are essential to expand the clinical and research applicability of the banks to target populations other than current smokers (e.g., clinical trials of smoking cessation, interventions with special clinical populations such as those with chronic obstructive pulmonary disease or asthma).

There are a number of options for administering and scoring the item bank assessments to meet the particular needs of researchers and practitioners. These include using the full item banks, existing short forms, tailored short forms, and CATs. Further information regarding these various administration options is available by contacting the first author. In addition, we are maintaining a project Web site hosted at RAND (http://www.rand.org/health/projects/promis-smoking-initiative.html) to facilitate exchange of information about the PROMIS Smoking Initiative. The Web site includes short form assessments for download, links to web portals that can host CAT (i.e., Assessment Center, RAND MMIC-CAT), as well as synopses of results, links to relevant publications, and descriptions of ongoing and future research. The PROMIS Smoking Initiative employed a rigorous development approach based on modern measurement theory to improve assessment of six important domains of interest to smoking researchers. The resultant item banks have several attractive features including strong psychometric properties, encouraging preliminary validity evidence, flexible administration options, and easy access to these resources. We hope these features will make the suite of PROMIS smoking banks the option of choice for the assessment of these constructs.

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