



Short communication

Brief original report: Does smoking status provide information relevant to screening for other substance use among US adults?

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A B S T R A C T

We assessed whether tobacco screening provides clinically meaningful information about other substance use, including alcohol and other drug use, potentially facilitating targeting of screening for substance use. Using data from the Veterans Aging Cohort Study survey sample (VACS; N = 7510), we calculated test performance characteristics of tobacco use screening results for identification of other substance use including sensitivity, specificity, positive-likelihood-ratio (+LR = [sensitivity/(1-specificity)]: increase in odds of substance use informed by a positive tobacco screen), and negative-likelihood-ratio (-LR: [(1-sensitivity)/specificity]: reduction in odds of substance use informed by a negative tobacco screen). The sample was 95% male, 75% minority, and 43% were current and 33% were former smokers. Never smoking, versus any history, indicated an approximate four-fold decrease in the odds of injection drug use (-LR = 0.26), an approximate 2.5-fold decrease in crack/cocaine (-LR = 0.35) and unhealthy alcohol use (-LR = 0.40), an approximate two-fold decrease in marijuana (-LR = 0.51) and illicit opioid use (-LR = 0.48), and an approximate 30% decrease in non-crack/cocaine stimulant use (-LR = 0.75). Never smoking yielded more information than current non-smoking (never/former smoking). Positive results on tobacco screening were less informative than negative results; current smoking, versus former/never smoking, provided more information than lifetime smoking and was associated with a 40% increase in the odds of non-crack/cocaine stimulant use (+LR = 1.40) and opioid use (+LR = 1.44), 50% increase in marijuana use (+LR = 1.52) and injection drug use (+LR = 1.55), and an 80–90% increase in crack/cocaine use (+LR = 1.93) and unhealthy alcohol use (+LR = 1.75). When comprehensive screening for substance use is not possible, tobacco screening may inform decisions about targeting substance use screening.

1. Introduction

Alcohol and drug use remain leading causes of morbidity and mortality in the United States (US). (Johnson et al., 2014; Jalal et al., 2018) Guidelines recommend screening for unhealthy alcohol (Centers for Disease Control and Prevention, 2014; Curry et al., 2018) and drug use (U.S. Preventive Services Task Force) in primary care, though financial or time constraints may hinder the ability for a clinic to conduct comprehensive screening for alcohol and other substance use. (Williams et al., 2016) Tobacco use, a leading cause of death that is routinely assessed in clinical practice (Jamal et al., 2012) is strongly associated with other substance use. (Ruggles et al., 2017; Lai et al., 2000; Moeller et al., 2018) Tobacco screening results may hence provide information

on clinic populations at increased risk of other substance use who should be targeted for more comprehensive substance use screening, in cases when universal screening is not possible. While prior studies have documented associations between tobacco use and other alcohol and drug use, (Ruggles et al., 2017) no prior study to our knowledge has examined tobacco use as a screening tool, in which test performance characteristics for detection of other substance use outcomes were calculated (i.e., sensitivity, specificity, positive and negative predictive values, positive and negative likelihood ratios). Prior research has suggested heavy alcohol use may serve as a useful screening tool for identification of those at elevated risk of other drug use. (Dawson et al., 2010) Tobacco use may likewise serve as a useful initial screen for other substance use and may have particular clinical relevance given it is

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nearly universally assessed in routine practice. The purpose of the current study was to measure the test performance characteristics of a smoking status “screener” in terms of its ability to identify past-year alcohol and other drug use.

2. Methods

2.1. Sample and data source

The current analysis uses data from the Veterans Aging Cohort Study (VACS) survey sample, (Justice et al., 2006) a cohort of US veterans receiving healthcare in eight Veterans Health Administration (VHA) centers:

Atlanta, Baltimore, the Bronx, Houston, Los Angeles, Manhattan/Brooklyn, Pittsburgh, and Washington, D.C. The sample is composed of approximately 3500 veterans with an HIV diagnosis and 3500 controls without HIV who are matched by age, race, gender, and site of care. Study enrollment began in 2002 and is ongoing. Institutional review boards at each participating VHA medical center and affiliated academic institutions approved all study activities. We used data from six annual surveys that assessed substance use; these surveys were administered from 2003 to 2012 in Atlanta, the Bronx, Houston, Los Angeles, Manhattan/Brooklyn, and Pittsburgh and from 2004 to 2012 in Baltimore and Washington, DC.

2.2. Measures

Participants reported on the VACS survey whether they currently smoke or have ever smoked. We assessed Alcohol Use Disorders Identification Test (AUDIT) scores of 8 and higher, given this score indicates a moderate level of alcohol problems (termed “unhealthy” alcohol use), and 16 and higher, given this score represents a high level of problems (termed “harmful” alcohol use). (Bohn et al., 1995) Participants self-reported past-year use of marijuana, crack/cocaine, opioids including heroin and/or prescription opioids “such as Oxycontin, Vicodin, Percocet,” and stimulants other than crack/cocaine and injection drug use. We additionally examined an indicator of weekly marijuana use defined as using once or more per week.

2.3. Statistical analyses

All analyses were conducted using R Version 3.6.1 at the New York University Grossman School of Medicine in New York, NY in 2020. We used logistic regression to estimate unadjusted odds ratios and 95% confidence intervals (CIs) for cross-sectional associations between two smoking exposure levels (current and former smoking status versus no prior smoking) and eight substance use outcomes including unhealthy alcohol use, harmful alcohol use, any marijuana use, weekly marijuana use, any illicit opioid use, any crack/cocaine use, any other stimulant use, and any injection drug use. We tested effect modification for associations by gender and HIV infection status.

We calculated test performance characteristics of tobacco use screening results (ever versus never, current versus non-current) for identification of past-year substance use. Specifically, we calculated the sensitivity, specificity, positive likelihood ratio (+LR = [sensitivity/(1-specificity)]: increase in odds of substance use informed by a positive tobacco screen), and negative likelihood ratio (-LR: [(1-sensitivity)/specificity]: reduction in odds of substance use informed by a negative tobacco screen), positive predictive value, and the percentage of individuals correctly classified when using tobacco screening for indication of other substance use. We calculated test performance in the overall sample and stratified by age (<45 years versus ≥45 years) given potential cohort differences in tobacco as a marker of other substance use given the difference prevalence of any prior tobacco use.

3. Results

The combined analytic sample (N = 7510) was 95% male, 66% African American, 24% white, and 9% Hispanic in the six survey waves from 2003 to 2012. Over three-fourths had a history of smoking (43% current, 33% former smokers). The prevalence of any smoking history was estimated to be 70% in those younger than 45 years versus 84% in those 45 years and older (p < 0.001). We estimated 13.1% had unhealthy alcohol use and 4.6% had harmful use. In the past year the most commonly used drugs were marijuana (19.3%) with 7.5% weekly use, crack/cocaine (13%), and opioids (11%), followed by stimulants other than crack/cocaine (2%), and 3% had used injection drugs.

3.1. Associations: Tobacco use and other substance use

Current smoking was strongly associated with crack/cocaine use (OR: 7.93, 95% CI: 5.12–12.29), unhealthy alcohol use (OR: 6.42, 95% CI: 4.14–9.96), harmful alcohol use (OR: 4.84, 95% CI: 2.39–9.77), injection drug use (OR: 5.88, 95% CI: 3.37–10.26), illicit opioid use (OR: 3.56, 95% CI: 2.91–4.36), marijuana use (OR: 3.51, 95% CI: 2.42–5.10), weekly marijuana use (OR: 2.69, 95% CI: 1.44–5.00), and non-crack/cocaine stimulant use (OR: 2.59, 95% CI: 1.17–5.74) (Table 1). Former smoking appeared to be most strongly associated with injection drug use (OR: 2.06, 95% CI: 1.14–3.72) and opioid use (OR: 1.80, 95% CI: 1.46–2.23), followed by crack/cocaine use (OR: 1.56, 95% CI: 0.99–2.46). There was less evidence of an association between former smoking and unhealthy alcohol use (OR: 1.32, 95% CI: 0.83–2.10), marijuana use (OR: 1.21, 95% CI: 0.82–1.77), and non-crack/cocaine stimulant use (OR: 0.96, 95% CI: 0.41–2.22).

When testing effect modification of tobacco use-other substance use associations by gender and HIV status, we observed no evidence of gender differences. We observed differences by HIV status in two of 16 alternative model specifications (Table 1). Current smoking was more strongly associated with any marijuana use and any injection drug use in those who are HIV-uninfected than in people with HIV. Yet, for both groups the ORs for the associations were strong across strata suggesting comparable clinical relevance.

3.2. Test performance of smoking status for identification of other substance use

Because we observed minimum evidence of difference in associations between tobacco use and other substance use by gender or HIV infection status, for parsimony and interpretability we present test performance characteristics aggregated across both gender and HIV infection status groups.

Alcohol Use: Never smoking, versus any prior smoking, indicated a 2.5-fold decrease in the odds of unhealthy alcohol use (-LR = 0.40) (Table 2). Current non-smoking (never or former smoking), versus current smoking, indicated an approximate two-fold decrease in the odds of unhealthy alcohol use (-LR = 0.49). Positive results on tobacco screening were less informative than negative results; lifetime and current smoking indicated a 17% and 75% increase in the odds of unhealthy alcohol use, respectively (lifetime + LR = 1.17, current + LR = 1.75). We observed comparable likelihood ratio value when assessing both current and ever smoking status and detection of an AUDIT score of ≥ 16.

Marijuana, Opioid, and Stimulant Use: Never smoking indicated an approximate two-fold decrease in the odds of marijuana use (-LR = 0.51) while current non-smoking indicated an approximate 50% decrease (-LR = 0.65). Lifetime and current smoking indicated a 14% and 52% increase in the odds of marijuana use, respectively (lifetime + LR = 1.14, current + LR = 1.52) (Table 2). We observed comparable likelihood ratio values when using ever smoking status for detection of more frequent marijuana use, though test performance was weaker when using current smoking status for detection of frequent marijuana use.

Table 1

Odds ratios and 95% confidence intervals for associations between smoking status and other substance use^a among Veterans Aging Cohort Study Participants (2003–2012): Assessment of differences by HIV infection status.

	Odds Ratios (95% Confidence Intervals)		
	Overall	HIV-uninfected	People with HIV
Unhealthy Alcohol Use^b			
Never	Referent	Referent	Referent
Former	1.32 (0.83–2.10)	1.55 (1.13–2.13)	1.15 (0.79–1.69)
Current	6.42 (4.14–9.96)	5.41 (4.03–7.28)	3.62 (2.70–4.84)
Harmful Alcohol Use^c			
Never	Referent	Referent	Referent
Former	1.28 (0.61–2.68)	1.06 (0.65–1.74)	0.99 (0.53–1.84)
Current	4.84 (2.39–9.77)	4.91 (3.13–7.69)	3.61 (2.24–5.80)
Marijuana			
Never	Referent	Referent	Referent
Former	1.21 (0.82–1.77)	1.97 (1.03–3.77)	0.88 (0.47–1.65)
Current	3.51 (2.42–5.10)	6.34 (3.36–11.96) ^f	2.40 (1.48–3.89) ^f
Weekly Marijuana			
Never	Referent	Referent	Referent
Former	1.63 (0.86–3.06)	3.60 (0.98–13.3)	1.14 (0.46–2.86)
Current	2.69 (1.44–5.00)	7.02 (1.91–25.7)	1.70 (0.56–2.86)
Illicit Opioids^d			
Never	Referent	Referent	Referent
Former	1.80 (1.46–2.23)	1.45 (1.14–1.85)	1.84 (1.34–2.53)
Current	3.56 (2.91–4.36)	3.18 (2.54–3.97)	2.82 (2.22–3.58)
Crack/Cocaine			
Never	Referent	Referent	Referent
Former	1.56 (0.99–2.46)	1.14 (0.77–1.71)	1.18 (0.77–1.80)
Current	7.93 (5.12–12.29)	6.30 (4.36–9.10)	4.88 (3.66–6.52)
Other Stimulants^e			
Never	Referent	Referent	Referent
Former	0.96 (0.41–2.22)	0.75 (0.18–3.19)	0.79 (0.23–5.03)
Current	2.59 (1.17–5.74)	1.69 (0.44–6.57)	2.95 (1.10–7.93)
Injection Drug Use			
Never	Referent	Referent	Referent
Former	2.06 (1.14–3.72)	2.56 (0.94–6.94)	1.91 (0.72–5.08)
Current	5.88 (3.37–10.26)	14.3 (5.84–34.8) ^f	3.85 (1.99–7.46) ^f

^a In the past year.

^b Participants with an Alcohol Use Disorders Identification Test score of 8 or greater were coded as having unhealthy alcohol use.

^c Participants with an Alcohol Use Disorders Identification Test score of 16 or greater were coded as having harmful/dependent alcohol use.

^d Non-medical use of prescription opioid/painkillers “such as Oxycontin, Vicodin, Percocet” or heroin use (note: prescription opioids were not assessed during the 2005–07 survey wave).

^e Amphetamines, uppers, speed, crank, crystal meth, or bam.

^f p-value for beta interaction term was significant at p < 0.05.

Never smoking and non-current smoking indicated an approximate 2.7-fold (-LR = 0.48) and 50% (-LR = 0.67) decrease in the odds of illicit opioid use. Lifetime and current smoking indicated a 15% and 44% increase in the odds (lifetime + LR = 1.15, current + LR = 1.44). Never smoking indicated nearly a three-fold decrease in the odds of crack/cocaine use (-LR = 0.35). Current non-smoking provided comparable signal for detection of crack/cocaine use (-LR = 0.39) as never smoking. Lifetime and current tobacco use indicated a 19% and 93% increase in

Table 2

Test Performance Characteristics of Ever (Versus Never) and Current (Versus Never or Former) Smoking Status for Indication of Other Substance use^a among Veterans Aging Cohort Study Participants.

Substance Use	Overall Sample		Age ≤ 45		Age > 45	
	Ever	Current	Ever	Current	Ever	Current
Unhealthy Alcohol Use^b						
Negative Likelihood Ratio	0.40	0.49	0.38	0.49	0.41	0.48
Positive Likelihood Ratio	1.17	1.75	1.30	1.68	1.13	1.77
Sensitivity	91%	71%	88%	72%	93%	71%
Specificity	22%	59%	33%	57%	18%	60%
Positive Predictive Value	16%	22%	18%	22%	15%	22%
% Correctly Classified	32%	61%	41%	59%	28%	61%
Harmful Alcohol Use^c						
Negative Likelihood Ratio	0.42	0.43	0.39	0.50	0.44	0.40
Positive Likelihood Ratio	1.15	1.75	1.27	1.60	1.11	1.81
Sensitivity	91%	76%	88%	73%	93%	77%
Specificity	21%	57%	31%	55%	17%	57%
Positive Predictive Value	6%	8%	6%	8%	5%	8%
% Correctly Classified	24%	58%	34%	56%	20%	58%
Marijuana						
Negative Likelihood Ratio	0.51	0.65	0.50	0.62	0.49	0.66
Positive Likelihood Ratio	1.14	1.52	1.26	1.54	1.11	1.50
Sensitivity	88%	62%	83%	64%	91%	61%
Specificity	23%	59%	34%	59%	18%	60%
Positive Predictive Value	22%	28%	28%	32%	20%	26%
% Correctly Classified	36%	60%	46%	60%	32%	60%
Marijuana (1 + a week)						
Negative Likelihood Ratio	0.54	0.76	0.48	0.68	0.54	0.81
Positive Likelihood Ratio	1.12	1.30	1.23	1.38	1.09	1.24
Sensitivity	89%	58%	85%	63%	91%	55%
Specificity	21%	55%	31%	54%	16%	56%
Positive Predictive Value	9%	10%	12%	14%	8%	9%
% Correctly Classified	26%	55%	36%	55%	22%	56%
Illicit Opioid^d						
Negative Likelihood Ratio	0.48	0.67	0.49	0.66	0.49	0.68
Positive Likelihood Ratio	1.15	1.44	1.25	1.43	1.11	1.44
Sensitivity	89%	61%	84%	63%	91%	60%
Specificity	22%	57%	32%	56%	18%	58%
Positive Predictive Value	13%	16%	13%	15%	13%	17%
% Correctly Classified	30%	58%	38%	57%	27%	58%
Crack/Cocaine						
Negative Likelihood Ratio	0.35	0.39	0.34	0.45	0.37	0.36
Positive Likelihood Ratio	1.19	1.93	1.33	1.76	1.15	2.00
Sensitivity	92%	77%	88%	74%	94%	78%
Specificity	23%	60%	34%	58%	18%	61%
Positive Predictive Value	16%	23%	18%	23%	15%	23%
% Correctly Classified	32%	62%	41%	60%	28%	63%
Other Stimulants^e						
Negative Likelihood Ratio	0.75	0.68	0.58	0.75	0.85	0.64
Positive Likelihood Ratio	1.07	1.40	1.19	1.30	1.03	1.47
Sensitivity	84%	62%	82%	59%	86%	64%
Specificity	21%	56%	31%	54%	17%	56%
Positive Predictive Value	2%	3%	4%	4%	2%	3%
% Correctly Classified	22%	56%	33%	54%	18%	56%
Injection Drug						

(continued on next page)

Table 2 (continued)

Substance Use	Overall Sample		Age ≤ 45		Age > 45	
	Ever	Current	Ever	Current	Ever	Current
Negative Likelihood Ratio	0.26	0.45	0.22	0.46	0.30	0.45
Positive Likelihood Ratio	1.15	1.55	1.23	1.47	1.12	1.59
Sensitivity	96%	77%	95%	79%	96%	77%
Specificity	17%	50%	23%	46%	14%	52%
Positive Predictive Value	6%	8%	5%	6%	6%	8%
% Correctly Classified	21%	52%	23%	48%	19%	53%

^a In the past year.

^b Participants with an Alcohol Use Disorders Identification Test score of 8 or greater were coded as having unhealthy alcohol use.

^c Participants with an Alcohol Use Disorders Identification Test score of 16 or greater were coded as having harmful/dependent alcohol use.

^d Non-medical use of prescription opioid/painkillers “such as Oxycontin, Vicodin, Percocet” or heroin use (note: prescription opioids were not assessed during the 2005–07 survey wave).

^e Amphetamines, uppers, speed, crank, crystal meth, or bam.

the odds of crack/cocaine use, respectively (lifetime + LR = 1.19, current + LR = 1.93). Lifetime tobacco use and current tobacco use yielded negative likelihood ratio values of 0.75 and 0.68, respectively, and positive likelihood ratios of 1.07 and 1.40, respectively for identification of other stimulant use.

Injection Drug Use: Never smoking and non-current smoking indicated nearly a four-fold decrease (-LR = 0.26) and a two-fold decrease (-LR = 0.45) in the odds of injection drug use, respectively. Never smoking was slightly more informative for individuals younger than 45 years old those versus 45 years and older (-LR: 0.22 versus 0.30). Lifetime and current tobacco use indicated a 15% and 55% increase in the odds of injection (lifetime + LR = 1.15, current + LR = 1.55) (Table 2).

4. Discussion

We evaluated the extent to which tobacco screening results may inform other screening decisions in settings where comprehensive screening for other substance use is not possible. Our findings suggest tobacco screening has the potential to provide actionable information regarding other substance use. Specifically, because those who have never smoked have a substantially lower likelihood of other substance use, particularly unhealthy drinking, crack/cocaine use, and injection drug use, never smokers may constitute a lower priority group for substance use screening. We observe comparable negative likelihood ratio values for moderate versus high AUDIT score and for any versus frequent marijuana use, implying that tobacco screening results apply to those with moderate as well as increased severity of alcohol and marijuana use.

Our findings are consistent with prior studies documenting associations between tobacco and unhealthy alcohol use (Ruggles et al., 2017) and drug use. (Moeller et al., 2018) Our observation that current tobacco use is in particular very strongly associated with crack/cocaine use and associated with moderate elevations in other substance use is consistent with prior studies. (Moeller et al., 2018) In addition, as observed previously, we observed stronger odds ratios for associations between current versus former smoking and other substance use. (Lai et al., 2000) However, the novel contribution of the current analysis was to not only calculate odds ratios for the associations between tobacco use and other substance use, but to calculate test performance characteristics (e.g., sensitivity, specificity, likelihood ratio values) to assess the utility of tobacco use as a screener for other substance use. We found any prior smoking, including current and/or former smoking, provides more information (e.g., more robust likelihood ratio values) than current smoking alone. The findings suggest clinicians should screen for any prior history of smoking as well as current smoking in order for smoking

to best inform screening and diagnosis of other substance use.

The current study contributes to the literature suggesting endorsement of one form of substance use during a clinical encounter may indicate the need to screen for other forms of substance use. There is evidence heavy alcohol use can improve screening decisions regarding other substance use. (Dawson et al., 2010) We likewise suggest tobacco use screening may improve screening for other substance use, and there are advantages to using tobacco use as an initial screen because it is nearly universally assessed in routine clinical practice.

The most important study limitations included reliance on self-reported substance use variables, which may be influenced by social desirability bias (Latkin et al., 2017) and limited generalizability given the sample, veterans receiving care in the VA who include people with HIV and matched controls. In particular, the prevalence of any prior smoking in the VACS cohort, reported by over three-fourths of the sample, is substantially higher than in the general population (Centers for Disease Control and Prevention NcFCDPaHP, 2021) (approximately 40%). While those in the age cohort of younger than had a lower prevalence of any prior smoking than those 45 years and older, and the results for these two groups were generally comparable, smoking levels in both the younger and older groups are higher than observed in the general population. Findings of the current study are likely more generalizable to populations with a moderate to high prevalence of smoking. Additional comparable studies in populations with a lower prevalence of smoking are warranted. An additional limitation is that smoking status was ascertained via survey data rather than data taken from the electronic health record, the tool available in clinical practice. However, given evidence of the validity of the EHR for measuring tobacco use in large integrated systems such as the VA is high. (Chen et al., 2013; Calhoun et al., 2017) these results are likely to provide insight into the importance of smoking status captured in the EHR.

Despite the noted limitations, our findings suggest that endorsement of “never use” on a tobacco screen may serve as an indicator of reduced likelihood of substance use – in particular unhealthy alcohol, crack/cocaine, and injection drug use. The findings hence suggest that in primary care settings where comprehensive screening for alcohol and other substance use is not feasible, less intensive substance use screening among never tobacco users may be justified. Stratifying the intensity of substance screening based on results of tobacco use screening may hence permit resources for substance use detection and treatment to be more effectively deployed.

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CRediT authorship contribution statement

Maria R. Khan: Conceptualization, Methodology, Validation, Writing - original draft, Supervision. **Kaoon Ban:** Software, Validation, Formal analysis, Investigation, Visualization, Writing - review & editing. **Ellen C. Caniglia:** Validation, Writing - review & editing. **E. Jennifer Edelman:** Writing - review & editing. **Julie Gaither:** Writing - review & editing. **Stephen Crystal:** Writing - review & editing. **Natalie E. Chichetto:** Writing - review & editing. **Kailyn E. Young:** Writing - review & editing. **Janet Tate ScD:** Writing - review & editing. **Amy C. Justice:** Writing - review & editing. **R. Scott Braithwaite:** Conceptualization, Writing - review & editing, Supervision, Funding acquisition.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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