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Is unhealthy substance use associated with failure to receive cancer screening and flu vaccination? A retrospective cross-sectional study

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ABSTRACT

Objective: To compare cancer screening and flu vaccination among persons with and without unhealthy substance use.

Design: The authors analysed data from 4804 women eligible for mammograms, 4414 eligible for Papanicolou (Pap) smears, 7008 persons eligible for colorectal cancer (CRC) screening and 7017 persons eligible for flu vaccination. All patients were screened for unhealthy substance use. The main outcome was completion of cancer screening and flu vaccination.

Results: Among the 9995 patients eligible for one or more of the preventive services of interest, 10% screened positive for unhealthy substance use. Compared with women without unhealthy substance use, women with unhealthy substance use received mammograms less frequently (75.4% vs 83.8%; $p<0.0001$), but Pap smears no less frequently (77.9% vs 78.1%). Persons with unhealthy substance use received CRC screening no less frequently (61.7% vs 63.4%), yet received flu vaccination less frequently (44.7% vs 50.4%; $p=0.01$). In multivariable analyses, women with unhealthy substance use were less likely to receive mammograms (adjusted odds ratio 0.68; 95% CI 0.52 to 0.89), and persons with unhealthy substance use were less likely to receive flu vaccination (adjusted odds ratio 0.81; 95% CI 0.67 to 0.97).

Conclusions: Unhealthy substance use is a risk factor for not receiving all appropriate preventive health services.

ARTICLE SUMMARY

Article focus

- Do persons with unhealthy substance use receive breast, cervical and colorectal cancer screening less frequently than persons without unhealthy substance use?
- Do persons with unhealthy substance use receive flu vaccination less frequently than persons without unhealthy substance use?

Key messages

- Women with unhealthy substance use are less likely to receive mammograms than women without unhealthy substance use.
- Persons with unhealthy substance use are less likely to receive flu vaccination than persons without unhealthy substance use.
- Unhealthy substance use is not a risk factor for not receiving cervical or colorectal cancer screening.

Strengths and limitations of this study

- Strengths: the study used validated measures of unhealthy substance use and encompassed a wide range of substance-use severity.
- Limitations: the findings from our sample of an inner-city patient population with health insurance and access to care who receive primary care at an urban safety-net hospital may not be generalisable to other patient populations. The study cannot determine whether unhealthy substance use causes patients not to receive certain services, or whether screening, brief intervention and substance-use treatment led some patients to complete screenings or vaccination. The study did not obtain records of services performed outside Boston Medical Center, and relied on patient self-report of substance use.

INTRODUCTION

Cancer and flu are among the leading causes of mortality in the USA.[1 2] Flu is preventable, in part, through vaccination, and mortality from cervical, breast and colorectal cancer (CRC) can be reduced through routine screening.[3–5] Nevertheless, many eligible US adults do not receive these recommended preventive services,[6] in particular, low-income persons,[7] racial and ethnic minorities,[8–11] the uninsured[12] and the foreign-born.[13] Despite this knowledge, and the implementation of interventions targeting these groups, preventive services are still underused, which has led

some to believe that high-risk 'pockets' of the population may account for gaps in service receipt. Persons with unhealthy substance use (for alcohol, the spectrum that ranges from risky use to dependence; for drugs, the spectrum from any illicit drug use (including prescription drugs) to dependence) may represent one such 'pocket.' Disorganisation, intoxication, comorbid mental illness and low utilisation of primary care among persons with unhealthy substance use[14] might lead to lower use of preventive services.

Prior studies of cancer screening[15–19] and flu vaccination[18 20] suggest that receipt of these services may be low among persons with substance-use disorders (with levels of use that are severe enough to warrant a diagnosis of abuse or dependence). These studies have been limited by their reliance on ICD-9 codes to define substance-use disorders, their exclusion of persons whose substance use is undiagnosed or does not meet criteria for abuse or dependence, and the fact that they have largely been conducted in Veterans Administration (VA) settings, where patients may not be representative of the general population.

We analysed data on unhealthy substance use collected prospectively and systematically by staff whose sole responsibility across a variety of healthcare settings was screening with brief intervention for substance use, and referral to treatment for substance-use disorders. We linked these data to electronic medical record data at eight urban safety-net hospital-based primary care practices to examine preventive service receipt among persons with and without unhealthy substance use. We hypothesised that persons with unhealthy substance use would receive preventive services less frequently than persons without unhealthy substance use.

METHODS

Study setting and sample

Boston Medical Center is an urban safety-net hospital with eight academic primary care practices staffed by 105 primary care practitioners, including both general internists and family practitioners, and staff and resident physicians. The primary care practices predominantly serve a minority and multicultural low-income population. We identified women eligible for breast cancer screening, women eligible for cervical cancer screening, and men and women eligible for CRC screening. Among these groups examined for cancer screening, we also identified individuals eligible for flu vaccination. We linked these four cohorts of patients to unhealthy substance-use screening data that were obtained over a similar time period in the outpatient, inpatient, and emergency department settings.

From 2007 to the present, Boston Medical Center participated in a universal substance-use screening programme supported by the federal government known as the Massachusetts Screening, Brief Intervention, Referral and Treatment (MASBIRT) programme. As part of the programme, trained lay-persons ask the following three questions of all patients in multiple settings to identify unhealthy substance use:

1. In the past 3 months, how often have you had more than four drinks (with alcohol) in a day (for men; women and men 65 years and over were asked about more than three drinks in a day)?
2. In the past 3 months, how often have you used narcotic pain medicines, sedatives (benzodiazepines), or Ritalin/amphetamine without a doctor's prescription or in greater amounts than prescribed?
3. In the past 3 months, how often have you used marijuana, cocaine, heroin or other drugs?

Unhealthy substance use was defined as any response other than 'never' to any of the above questions. In its clinician's guide, the National Institute on Alcohol Abuse and Alcoholism recommends the single-question screen for unhealthy alcohol use (similar to question 1 above).[21] Smith *et al* validated the single-question screen at Boston Medical Center, finding that it is both sensitive and specific for the detection of unhealthy alcohol use.[22] Since brief validated screening questions for illicit drug use or prescription drug misuse in the primary care setting have only recently been published,[23] the MASBIRT programme used screening questions (questions 2 and 3 above) that were derived from the more extensive Alcohol, Smoking and Substance Involvement Screening Test (ASSIST) questionnaire[24] (validated in primary care settings) and the National Household Survey on Drug Use and Health.[25] The MASBIRT programme specifically asked about marijuana, cocaine and heroin, as these are the three most common illicit drugs used in Massachusetts.[26] Instead of past-year use, all screening questions asked about use in the past 3 months to increase the likelihood that a positive test would make logical sense for a clinician to address (current use) and to match the time frame in the ASSIST questionnaire. The ASSIST questionnaire was administered to all patients who reported drug use or risky alcohol use (an affirmative response to question 1 above), providing a measure of current (or risk of developing) substance-related problems. We defined high-risk drug use according to a WHO ASSIST Specific Substance Involvement Score of ≥27, moderate-risk drug use as a score of 4–26 and low-risk drug use as a score of 0–3.[27] Similarly, we defined high-risk alcohol use as a score of ≥27, moderate-risk alcohol use as a score of 11–26 and low-risk alcohol use as a score of 0–10. Patients who screened positive for unhealthy substance use received a single brief counselling intervention and, if indicated, referral for addiction treatment.

We linked clinical information to data on unhealthy substance use among individuals who were screened for unhealthy substance use from 2007 to 2009. We based our eligibility criteria for the cancer-screening measures on modified versions of the corresponding 2007 *Healthcare Effectiveness Data and Information Set* (HEDIS) measures and recommendations of the US Preventive Services Task Force,[3 28–30] and eligibility criteria for flu

vaccination on CDC guidelines.[31] The Boston Medical Center institutional review board approved the study protocol.

Preventive service measures

Using a clinical data warehouse that makes electronic medical records available for research, we identified three groups of patients: (1) female patients aged 21–64 years; (2) female patients aged 42–69 years; and (3) male and female patients age 51–75 years. We chose these age ranges because we sought consistency with the HEDIS measures on cervical- and breast-cancer screening (groups 1 and 2, respectively), and with the United States Preventive Services Task Force recommendations on CRC screening (group 3).[29] Given the questionable value of CRC screening in persons with limited life expectancy,[32] we chose to follow the United States Preventive Services Task Force colorectal cancer recommendations, with age 75 as an upper age limit of screening, rather than age 80, as specified by HEDIS.

We modified the denominator of the cervical cancer screening measure to include any female patient aged 21–64 who had at least one visit to a primary care site at Boston Medical Center in each of the three previous years. We required a minimum of one visit per year to approximate the HEDIS requirement that patients be 'continuously enrolled' in a health plan. The numerator included any patient who received a Papanicolou (Pap) smear in the past 3 years. We excluded women who had undergone a hysterectomy (based on current procedural terminology (CPT) and International Classification of Diseases, version 9 (ICD-9) codes) from both the numerator and the denominator, as Pap smears are rarely indicated in this group.[30]

For the breast-cancer screening measure, we required that female patients aged 42–69 have one visit to a hospital primary care site in each of the two previous years. The numerator included any patient who received a mammogram in the past 2 years. We excluded women who had undergone a bilateral mastectomy or unilateral mastectomy on two separate dates (based on CPT and ICD-9 codes) from both the numerator and the denominator.

For the CRC screening measure, we required that patients aged 51–75 have one visit to a Boston Medical Center primary care site in each of the two previous years. The numerator included any patient who completed home faecal occult blood cards (based on results in the electronic medical record) in the past year, flexible sigmoidoscopy or barium enema in the past 5 years, or colonoscopy in the past 10 years.

We also examined whether patients eligible for cervical, breast and CRC screening who were eligible for flu vaccination were vaccinated. Patients were eligible for flu vaccination as per CDC recommendations during this period if they were aged 65 or older or had one of the following chronic conditions: asthma, chronic obstructive pulmonary disease, congestive heart failure, moderate or severe liver disease, HIV infection, diabetes mellitus or renal insufficiency.

Covariate measures

Guided by Gelberg's adaptation of Andersen's model of health services use,[33] we examined covariates known to affect healthcare utilisation such as gender, race, age, insurance status and language. We defined the burden of medical comorbidity by using the Deyo adaptation of the Charlson Comorbidity Index.[34] Patients were categorised as having significant comorbidity if they had a Charlson–Deyo Score of one or greater. We obtained psychiatric diagnoses from the electronic medical record problem list. In most cases, these diagnoses were made by the patient's primary care provider or by a mental-health specialist. We also examined primary-care utilisation, analysing the number of primary-care visits over the study period.

Statistical methods

Using the SAS computer statistical package, Version 9.1, we performed χ^2 tests to compare differences in preventive-services receipt between persons with and without unhealthy substance use. In exploratory subgroup analyses, we also compared differences in preventive-services receipt between persons with and without unhealthy alcohol use, and with and without any drug use. We used multiple logistic regression to analyse unhealthy substance use as a predictor of receiving each preventive service. Data were missing at random among <5% of all observations. We included all variables in the model based on their a priori clinical significance, and computed adjusted ORs and 95% CIs based on the multiple logistic model. To minimise the potential for collinearity, we examined the variance inflation factor for each covariate. Analyses were conducted using two-sided tests and a significance level of 0.05. We used general estimating equations to account for clustering of patients within clinicians, and clinicians within practices. To detect differences between men and women with unhealthy substance use, we included interaction terms between unhealthy substance use and sex in the multivariable models of CRC screening and flu vaccination.

RESULTS

There were 9995 primary care patients who were eligible for one of the preventive services of interest and had been screened for unhealthy substance use from 2007 to 2009. Table 1 shows the demographic and clinical characteristics of the sample. Patients with unhealthy substance use were slightly younger, and were more likely to be male, English-speaking and of white or black race (vs Hispanic or other race) than were patients without unhealthy substance use. Patients with unhealthy substance use were also less likely to have private insurance and more likely to have Medicaid or Commonwealth Care (a Massachusetts insurance programme for poor and near-poor uninsured adults). Approximately 10% of the sample screened positive for unhealthy substance use. Among these patients, most had unhealthy alcohol use (72.3%), 41.7% had any illicit drug use, and 30.0% had any marijuana

Table 1 Demographic and clinical characteristics of patients engaged in primary care and screened for unhealthy substance use (SU) in Boston, Massachusetts between 2007 and 2009*

Variable	Unhealthy SU n=975 (%)	No unhealthy SU n=9020 (%)	p Value
Mean (SD) age	52.1 (12.3)	54.7 (12.5)	<0.001
Gender, female	52.0	72.6	<0.0001
Language			
English	93.5	73.2	<0.0001
Spanish	4.4	7.6	
Haitian Creole	0.7	9.5	
Other	1.3	9.7	
Race†			
White	21.6	15.9	<0.0001
Black/African−American	63.3	55.3	
Hispanic/Latino	10.8	31.1	
Other	4.3	15.8	
Insurance			
Medicare	29.3	29.8	<0.0001
Health maintenance organization	20.1	26.3	
Medicaid	22.8	17.4	
Free care	5.5	7.7	
Commonwealth care‡	20.0	16.1	
Other	2.3	2.6	
Six or more primary care visits over study period	51.9	53.8	0.25
Significant medical comorbidity§	58.0	54.5	0.04
SU severity			
Unhealthy alcohol use¶	72.3		
Any drug use, past 3 months	41.7		
Marijuana	30.0		
Cocaine	9.0		
Any opioids	7.0		
Drug Involvement Score**			
Low risk	70.4		
Moderate risk	27.2		
High risk	2.5		
Alcohol Involvement Score††			
Low risk	77.4		
Moderate risk	18.5		
High risk	4.1		
Any mental disorder	44.6	35.8	<0.0001
Anxiety	15.4	12.4	0.008
Bipolar disorder	3.9	1.6	<0.0001
Depression	37.4	28.6	<0.0001
Post-traumatic stress disorder	5.9	3.7	0.0006
Panic disorder	1.7	1.5	0.61
Schizophrenia	0.82	1.2	0.28

*Data presented are for unique patients from all four cohorts of patients: (1) women eligible for mammograms (n=4804), (2) women eligible for Papanicolaou tests (n=4414), (3) men and women eligible for colorectal cancer screening (n=7008) and (4) men and women from cohorts 1, 2 and 3 who were eligible for flu vaccination (n=7017).
†Patient race and ethnicity were determined by clinical registration staff.
‡Commonwealth Care, a Massachusetts insurance programme for poor and near-poor uninsured adults.
§Charlson−Deyo Score of ≥1.
¶Defined as more than four drinks with alcohol in 1 day within the past 3 months (for men; more than three drinks with alcohol for women and men over 65 years).
**Risk level based on WHO Alcohol Smoking and Substance Involvement Screening Test Specific Substance Involvement Score. A score of 0−3 is defined as low risk, 4−26 as moderate risk and ≥27 as high risk.
††Risk level based on WHO Alcohol Smoking and Substance Involvement Screening Test Specific Substance Involvement Score. A score of 0−10 is defined as low risk, 11−26 as moderate risk and ≥27 as high risk.

use. Few patients met criteria for high-risk alcohol or drug use (4.1% and 2.5%, respectively). A higher proportion of patients with unhealthy substance use had a mental disorder (p<0.0001) or significant medical comorbidity (p=0.04) relative to patients without unhealthy substance use. Primary care utilisation did not differ among patients with and without unhealthy substance use.

In bivariable analyses, patients with unhealthy substance use were significantly less likely to receive mammograms or flu vaccination than were patients

Table 2 Use of cancer-screening services and flu vaccination according to substance-use characteristics between 2007 and 2009 in Boston, Massachusetts

	Flu vaccination (n=7017), %	Pap smear (n=4414), %	Mammogram (n=4804), %	Colorectal cancer screening (n=7008), %
Substance use				
None	50.4	78.1	83.8	63.4
Unhealthy substance use*	44.7†	77.9	75.4‡	61.7
Unhealthy alcohol use	45.7	79.1	78.2§	61.1
Any drug use	41.7†	75.5	70.0‡	60.8

*Unhealthy alcohol or any drug use.
†Significantly different from persons without unhealthy substance use, χ^2 p≤0.01.
‡Significantly different from persons without unhealthy substance use, χ^2 p<0.0001.
§Significantly different from persons without unhealthy substance use, χ^2 p<0.05.

without unhealthy substance use (table 2). Women with unhealthy alcohol use were less likely to receive mammograms, while patients with any drug use were less likely to receive flu vaccination or mammograms (p<0.05 for all comparisons). Patients with and without unhealthy substance use did not differ in their receipt of colorectal or cervical cancer screening. Among women who were eligible for both a mammogram and a Pap smear, fewer women with unhealthy substance use (56.5%) completed both tests when compared with women without unhealthy substance use (64.5%, p=0.02).

In the multivariable model predicting receipt of mammograms, unhealthy substance use was significantly associated with a lower odds of mammogram receipt (OR 0.69, CI 0.59 to 0.80). Unhealthy substance use was also significantly associated with a lower odds of flu vaccination receipt (OR 0.80, CI 0.66 to 0.97). There were no significant interactions between gender and unhealthy substance use for either CRC screening or flu vaccination. Unhealthy substance use was not an independent predictor of receiving the other preventive services assessed (table 3).

DISCUSSION

Among this sample of patients engaged in primary care, women who screened positive for unhealthy substance use received mammography screening less frequently than women who screened negative. Similarly, men and women who screened positive for unhealthy substance use were less likely to receive flu vaccination than other patients. Not withstanding this identified disparity in the provision of preventive services, delivery of appropriate preventive clinical care in this primary care patient sample was remarkably high, when compared with national estimates.[35] We speculate that persons with unhealthy substance use who are not engaged in primary care at the high thresholds used in these analyses may have substantially lower receipt of preventive services.

Notably, patients with any drug use (which in this study was predominantly marijuana) were also less likely to receive mammography screening and flu vaccination. Because marijuana users are more likely to use tobacco,[36] lower receipt of flu vaccination may have particular clinical significance. Despite large numbers of patients with marijuana use, there are very few studies of

Table 3 Multivariable analyses of the association between unhealthy substance use and receipt of preventive services by primary care patients* between 2007 and 2009 in Boston, Massachusetts

	Flu vaccination OR (95% CI)	Pap smear OR (95% CI)	Mammogram OR (95% CI)	Colorectal cancer screening OR (95% CI)
Unhealthy substance use	0.80 (0.66 to 0.97)	0.95 (0.70 to 1.29)	0.69 (0.59 to 0.80)	0.93 (0.74 to 1.17)
Older age†	1.49 (1.31 to 1.70)	0.30 (0.26 to 0.35)	1.55 (1.26 to 1.90)	0.98 (0.85 to 1.14)
Female	0.74 (0.68 to 0.82)	NA	NA	0.91 (0.80 to 1.04)
Public insurance‡	1.10 (0.98 to 1.24)	0.92 (0.81 to 1.06)	0.86 (0.74 to 0.99)	0.78 (0.66 to 0.93)
Black race	0.79 (0.69 to 0.90)	1.11 (0.98 to 1.26)	1.05 (0.93 to 1.19)	0.94 (0.85 to 1.04)
English-speaking	0.94 (0.77 to 1.14)	0.84 (0.65 to 1.08)	0.75 (0.66 to 0.86)	1.01 (0.84 to 1.22)
Medical comorbidity§	1.54 (1.17 to 2.02)	0.73 (0.57 to 0.93)	0.88 (0.74 to 1.05)	0.98 (0.92 to 1.05)
Psychiatric comorbidity¶	1.20 (1.13 to 1.29)	0.93 (0.74 to 1.18)	0.73 (0.64 to 0.83)	1.04 (0.93 to 1.15)
High primary-care-practice utilisation**	1.89 (1.70 to 2.11)	1.02 (0.78 to 1.33)	1.60 (1.14 to 2.26)	1.59 (1.40 to 1.81)

*The variable unhealthy substance use was included in all models as it is the primary predictor of interest.
†Analyses of flu vaccination receipt compared patients aged 65–75 with those aged 21–64; analyses of Papanicolou (Pap) smear receipt compared patients aged 50–64 with those aged 21–49; analyses of mammogram receipt compared patients aged 50–69 with those aged 40–49; analyses of receipt of colorectal cancer screening compared patients aged 65–75 with those aged 50–64.
‡Defined as Free Care, Medicaid or Commonwealth Care (the new subsidised Massachusetts insurance programme).
§Defined as Charlson–Deyo Score of 1 or greater.
¶Defined as diagnosis of anxiety, bipolar, depression, post-traumatic stress disorder, panic or schizophrenia on medical problem list.
**Defined as at least six primary care visits in the past 2 years for patients eligible for mammograms and flu vaccination, and at least six primary care visits in the past 3 years for patients eligible for Pap smears and colorectal cancer screening.

marijuana and health-services use.[37] Unexpectedly, the proportions of patients with cervical and CRC screening were not lower among persons with unhealthy substance use. It is possible that substance-using women are more likely to have unprotected sex, contract sexually transmitted diseases and then visit a women's health provider who may offer cervical-cancer screening.[38 39] Further, in the medical care system in which this study was performed, a Pap smear can be carried out at the time it is recommended, whereas a mammogram must be scheduled on a different day. This additional requirement to schedule a new appointment on a different day and arrange transportation, and possibly childcare, may explain why women with substance-use disorders had lower odds of receiving mammograms but were no less likely to receive Pap tests. CRC screening is the most complex of the screening services that we examined, potentially requiring advanced scheduling, administration of the preparation and having someone accompany the patient home after the procedure. Thus, there may be other factors more important than substance use affecting its completion. Furthermore, before stating that unhealthy substance use does not appear to be a barrier to completion of this most involved screening test, alternative possibilities merit examination such as disproportionately high numbers with evaluation of gastrointestinal bleeds in this population compensating for fewer with standard screening evaluations.

Prior studies found lower rates of CRC screening among veterans with substance-use disorders.[17 18] The lack of a difference in completion of CRC screening in our study between those with and without unhealthy substance use may be explained by inclusion of the spectrum from mild to severe in that definition, as opposed to limiting substance use to the most severe, those with substance-use disorders. Our finding of a lower frequency of mammogram and flu vaccination receipt and a similar frequency of Pap smear receipt among women with unhealthy substance use is consistent with prior studies.[15 18–20] Our study also showed a lower odds of mammogram receipt among English speakers. It is possible that unmeasured confounders such as low socio-economic status, low health literacy and lower levels of education may account for this finding. Our observation of a lower odds of mammogram receipt among individuals with psychiatric comorbidity is consistent with prior studies,[15] yet contradicts our prior work.[19] In the latter study, primary care and mental-health services were well integrated, which may have accounted for improved preventive screenings among persons with mental illness. It is also possible that individuals with psychiatric comorbidity are more likely to receive preventive services because of their more frequent contact with the health system. Yet, the presence of psychiatric comorbidity can also decrease the likelihood of receiving services if the service requires patient organisation to attend an appointment or to take a preparation. Our finding of a lower odds of Pap tests among women with medical comorbidity is consistent with prior studies.[40]

This study has several limitations. The findings from our sample of an inner-city patient population with health insurance and access to care who receive primary care at an urban safety-net hospital may not be generalisable to other patient populations. Yet, the fact that patients were insured and engaged in primary care helps to isolate the effect of substance use on service receipt. We also cannot determine whether unhealthy substance use causes patients not to receive certain services, or whether screening, brief intervention and substance-use treatment led some patients to complete screenings or vaccination. Further, the periods during which patients were screened for unhealthy substance use and were eligible to receive preventive services overlapped, but some patients may have been screened for unhealthy substance use before or after primary care visits in which prevention was addressed. For example, a patient may have been screened by colonoscopy several years ago, yet was found to have unhealthy substance use more recently. In such cases, it may be difficult to draw conclusions about the association between obtaining a colonoscopy and having substance use. However, the chronic, relapsing and remitting nature of substance use suggests that such use may influence preventive-healthcare utilisation over time.

We did not obtain any records of services performed outside Boston Medical Center. We believe that it is unlikely that patients receiving primary care at Boston Medical Center would have sought and received primary preventive care elsewhere, with the possible exception of the flu vaccine, which is widely available in the community. But even if patients had received services elsewhere, such use would have been associated with non-differential misclassification bias, as we suspect patients with unhealthy substance use are no more likely than other patients to obtain care in other health systems. In multivariable analyses, we observed higher rates of flu vaccination among those with psychiatric comorbidity. It is possible that such patients are less likely than others to seek preventive care outside Boston Medical Center. We relied on patient self-report of substance use. Others have found that self-report of substance use is valid when there are assurances of confidentiality and when validated tools are used.[23] While we used a validated tool, it is possible that some patients under-reported their substance use in the clinical setting. Such under-reporting would have biased our findings to the null.

CONCLUSION

In conclusion, our findings suggest that unhealthy substance use is a barrier to completion of mammography screening and flu vaccination. Future interventions to promote mammography screening might target women with unhealthy substance use, and those to promote flu vaccination might target both men and women with unhealthy substance use. Clinical interventions could embed mammography screening and flu vaccination in

other services delivered to individuals with substance-use problems. Training interventions could enhance skills and systems for healthcare personnel who screen for substance-use disorders to include referrals for preventive health services.

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Competing interests None.

Contributors KEL conceived and planned the work that led to the article. She wrote the paper and approved the final version. TWK played an important role in interpreting the results, made substantive suggestions for revision and approved the final version. DPA played an important role in interpreting the results, made substantive suggestions for revision and approved the final version. HC played an important role in interpreting the results, made substantive suggestions for revision and approved the final version. RS played an important role in interpreting the results, made substantive suggestions for revision and approved the final version. JHS played an important role in interpreting the results, made substantive suggestions for revision and approved the final version.

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STROBE 2007 (v4) Statement—Checklist of items that should be included in reports of *cross-sectional studies*

Section/Topic	Item #	Recommendation	Reported on page #
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract	1
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found	2
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	4
Objectives	3	State specific objectives, including any prespecified hypotheses	4
Methods			
Study design	4	Present key elements of study design early in the paper	5
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	5-6
Participants	6	(*a*) Give the eligibility criteria, and the sources and methods of selection of participants	6-7
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	6-7
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	6-7
Bias	9	Describe any efforts to address potential sources of bias	7-8
Study size	10	Explain how the study size was arrived at	6-8
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	8
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding	7-8
		(*b*) Describe any methods used to examine subgroups and interactions	8
		(*c*) Explain how missing data were addressed	8
		(*d*) If applicable, describe analytical methods taking account of sampling strategy	n/a
		(*e*) Describe any sensitivity analyses	n/a
Results			

Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	8
		(b) Give reasons for non-participation at each stage	n/a
		(c) Consider use of a flow diagram	n/a
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	8-9
		(b) Indicate number of participants with missing data for each variable of interest	8
Outcome data	15*	Report numbers of outcome events or summary measures	10
Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	10-11
		(*b*) Report category boundaries when continuous variables were categorized	9
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	n/a
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	n/a
Discussion			
Key results	18	Summarise key results with reference to study objectives	12
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	13
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	13-14
Generalisability	21	Discuss the generalisability (external validity) of the study results	13-14
Other information			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	15

*Give information separately for cases and controls in case-control studies and, if applicable, for exposed and unexposed groups in cohort and cross-sectional studies.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at www.strobe-statement.org.