Multiple Risk-Behavior Profiles of Smokers With Serious Mental Illness and Motivation for Change

Judith J. Prochaska,
Stanford Prevention Research Center, Department of Medicine, Stanford University

Sebastien C. Fromont,
Department of Psychiatry, University of California, San Francisco

Kevin Delucchi,
Department of Psychiatry, University of California, San Francisco

Kelly C. Young-Wolff,
Stanford Prevention Research Center, Department of Medicine, Stanford University

Neal L. Benowitz,
Division of Clinical Pharmacology, Departments of Medicine and Bioengineering & Therapeutic Sciences, University of California, San Francisco

Stephen Hall,
Department of Psychiatry, University of California, San Francisco

Thomas Bonas, and
Alta Bates Summit Medical Center, Herrick, Berkeley, California

Sharon M. Hall
Department of Psychiatry, University of California, San Francisco

Abstract

Objective—Individuals with serious mental illness (SMI) are dying on average 25 years prematurely. The leading causes are chronic preventable diseases. In the context of a tobacco-treatment trial, this exploratory study examined the behavioral risk profiles of adults with SMI to identify broader interventional needs.

Method—Recruited from five acute inpatient psychiatry units, participants were 693 adult smokers (recruitment rate = 76%, 50% male, 45% Caucasian, age $M = 39$, 49% had income < $10,000) diagnosed with mood disorders (71%), substance-use disorders (63%), posttraumatic stress disorder (39%), psychotic disorders (25%), and attention deficit-hyperactivity disorder (25%). The Staging Health Risk Assessment, the primary measure used in this study, screened for risk status and readiness to change 11 health behaviors, referencing the period prior to acute hospitalization.
Results—Participants averaged 5.2 ($SD = 2.1$) risk behaviors, including smoking (100%), high-fat diet (68%), inadequate fruits/vegetables (67%), poor sleep (53%), physical inactivity (52%), and marijuana use (46%). The percent prepared to change ranged from 23% for tobacco and marijuana to 76% for depression management. Latent class analysis differentiated three risk groups: the global higher risk group included patients elevated on all risk behaviors; the global lower risk group was low on all risks; and a mood and metabolic risk group, characterized by inactivity, unhealthy diet, sleep problems, and poor stress and depression management. The global higher risk group (11% of sample) was younger, largely male, and had the greatest number of risk behaviors and mental health diagnoses; had the most severe psychopathologies, addiction-treatment histories, and nicotine dependence; and the lowest confidence for quitting smoking and commitment to abstinence.

Conclusion—Most smokers with SMI engaged in multiple risks. Expanding targets to treat co-occurring risks and personalizing treatment to individuals’ multibehavioral profiles may increase intervention relevance, interest, and impact on health.

Keywords
multiple risk behaviors; stage of change; mental illness; tobacco

Practices to prevent disease and promote health are key to addressing the current U.S. health-care crisis (Fani Marvasti & Stafford, 2012). Largely driven by hospital costs and chronic care conditions, the Agency for Health Care Research and Quality estimates that 20% of the U.S. population accounts for 80% of total health-care expenditures (Conwell & Cohen, 2005; Stanton, 2006), and mental health disorders rank among the top five most costly conditions in terms of total health-care spending (Stanton, 2006).

Individuals with serious mental illness (SMI) have high levels of acute health-care utilization and, relative to age- and gender-matched controls, are at greater risk for heart disease, cancer, and lung disease (Miller, Paschall, & Svendsen, 2006; Sokal et al., 2004). Many of these chronic illnesses are largely preventable through health-behavior change. In particular, the elevated prevalence of tobacco use in this vulnerable population is increasingly recognized as a major health concern (J. J. Prochaska, 2011; Schroeder & Morris, 2010), and recent trials have demonstrated success with treating tobacco dependence in smokers with SMI while supporting their mental health recovery (Hall et al., 2006; J. J. Prochaska et al., 2008; McFall et al., 2010; Tsoi, Porwal, & Webster, 2010).

Risk behaviors tend to co-occur, however, and most smokers (90%) in the general population carry additional cardiovascular and cancer-related risk behaviors, including poor diet, low activity levels, high stress, and heavy alcohol and illicit drug use (Fine, Philogene, Gramling, Coups, & Sinha, 2004; Pronk et al., 2004; Kendzor et al., 2008). The negative health effects can be additive or synergistic, as seen with the neurotoxic and carcinogenic effects of combined chronic tobacco and heavy alcohol use (Xu et al., 2007; Durazzo, Gazdzinski, Banys, & Meyerhoff, 2004). For some risk behaviors, such as smoking, even low levels are dangerous (Schane, Ling, & Glantz, 2010). Smokers struggling with multiple risk behaviors have greater levels of nicotine dependence, indicating the need for more
intensive tobacco-treatment interventions (Sherwood, Hennrikus, Jeffery, Lando, & Murray, 2001).

Excess risks lead to excess health-care costs and lost productivity (Goetzel et al., 1998). In psychiatry, risk behaviors also are treatment relevant—cigarette smoking induces the metabolism and decreases blood levels of some psychotropics (Kroon, 2007); antipsychotics, mood stabilizers, and antidepressants can impact sleep quality and contribute to high cardiometabolic risk, including obesity, hypertension, and hyperglycemia (Amiel, Mangurian, Ganguli, & Newcomer, 2008; De Hert et al., 2011; Dent et al., 2012; Newcomer, 2005).

Investigating relationships among health-risk behaviors is important for identifying the populations at highest risk and prioritizing interventions. The research conducted to date provides an initial indication of behavioral clustering and understanding of subgroups at elevated risk. Among U.S. adults, predictors of engagement in multiple risk behaviors include lower educational level, higher mental distress, ethnic minority status, and being uninsured (Fine et al., 2004; Pronk et al., 2004; Kendzor et al., 2008; de Vries et al., 2008; Berrigan, Dodd, Troiano, Krebs-Smith, & Barbash, 2003). Though research in this area is limited, with poor access to treatment and prevention services and exposure to stress and discrimination (Lawrence & Kisely, 2010), we anticipated individuals with SMI would engage in multiple risk behaviors.

There is growing evidence to suggest that interventions that target two or more health behaviors can effectively generate behavior change (J. O. Prochaska, 2008). Recent population-based multiple health behavior change studies have demonstrated population-wide improvements across a range of behaviors, including smoking, high-fat diet, high-risk sun exposure, physical activity, and stress (J. O. Prochaska et al., 2008). Studies aimed at secondary prevention (e.g., among individuals diagnosed with cardiovascular disease or diabetes), have been particularly effective in successfully promoting multiple behavior change (Emmons et al., 2005; Ketola, Sipilä, & Mäkelä, 2002; Norris, Engelgau, & Venkat Narayan, 2001; Ornish et al., 1998). Further, interventions that effectively impact change in one health behavior can promote changes in additional untreated health behaviors, providing evidence for paired motivational processes for behavior change (Johnson et al., 2008).

The existing studies, however, have largely focused on the general population and have not included clinical samples with SMI; they have been limited in the number of behaviors assessed; and they have only examined risk level and not motivation to change. Although extant single behavior interventions in SMI samples have been successful in reducing tobacco use (Hall et al., 2006; McFall et al., 2010; Tsoi et al., 2010), decreasing weight and body fat (Faulkner, Cohn, & Remington, 2007; Hassapidou et al., 2011), and promoting physical activity (Vancampfort et al., 2010), we are unaware of research examining the extent to which individuals with SMI are ready and able to address multiple risk behaviors for change.

The transtheoretical model (TTM) has been applied to understand the process of multiple risk behavior change. TTM conceptualizes behavior change as a progression through a series
of stages: precontemplation (the individual has no intention of changing the risk behavior in the next 6 months); contemplation (the individual intends to change in the next 6 months but not in the next 30 days); preparation (individual meets the behavioral goal for ≤6 months); and maintenance (individual meets the behavioral goal for ≥6 months; J. O. Prochaska & DiClemente, 1983). TTM may be especially well-suited for efforts addressing multiple risk behaviors because it assumes individuals may not be ready to take action immediately and it tailors intervention strategies accordingly. Further, interventions built upon the TTM have demonstrated success with smokers with mental illness (Hall et al., 2006).

The current exploratory study examined the frequency of engagement in multibehavioral risks, motivation to change behavior, and correlates of multiple risks among adult smokers with SMI. Ten risk behaviors in addition to tobacco use were studied, with risk status defined consistent with Healthy people 2020 goals for the nation (U.S. Department of Health & Human Services, 2010). We anticipated that smokers with SMI would carry additional risk behaviors; however, we also anticipated heterogeneity in patterns of engagement. An understanding of the frequencies of risks and patterns of clustering can help with prioritizing intervention targets and potentially packaging behavior-change programs. To inform health-promotion interventions for adults with SMI, we used latent class analysis (LCA) to identify typologies based on individuals’ risk statuses on the 10 behaviors assessed and further examined the identified group probabilities in relation to demographic, tobacco, other substance use, and psychiatric characteristics.

Method

Study Design

This cross-sectional study analyzed baseline data from a randomized controlled tobacco-treatment trial conducted in inpatient psychiatry settings. The smoking-cessation intervention included a TTM-tailored computer-delivered intervention, motivational enhancement and cognitive–behavioral counseling, and nicotine-replacement therapy (J. J. Prochaska, Hall, & Hall, 2009). The hospital and university institutional review boards (IRBs) approved of the study design and procedures.

Sample and Recruitment

Participants were recruited between 2009–2012 and interviewed on one of five, acute inpatient psychiatry units at an academic medical center and nonprofit community hospital in the San Francisco area. All inpatient units were 100% smoke-free. Eligible participants self-reported smoking ≥5 cigarettes/day in the week prior to hospitalization, a study requirement due to provision of nicotine replacement in the treatment conditions. Participants were screened for capacity to consent in English (Hickman, Prochaska, & Dunn, 2011), planned to reside in the greater San Francisco Bay Area during their 18-month study involvement, and had no contraindications to nicotine replacement (e.g., recent myocardial infarction, pregnancy). Intention to quit smoking was not required, as the intervention was tailored to one’s stage of change. Participants received $10 for their time to complete the baseline interview and up to $120 for their involvement over the 18-month study period.
With IRB approval, research staff reviewed medical records of new admissions to identify patients potentially study-eligible, asked for an introduction by clinical staff to identify patients interested in hearing about the study, and obtained fully informed study consent. Of 1,103 identified smokers, 912 met study-inclusion criteria and of those, 693 enrolled, for a recruitment rate of 76%. Reasons for exclusion were smoking ≤5 cigarettes per day in the week prior to hospitalization (n = 229; 56% of those excluded), lack of cognitive capacity to participate (n = 58; 15%), health contraindications (n = 42; 10%); severe agitation/violence risk (n = 31; 8%); living out of area (n = 22; 5%); discharged quickly (n = 15; 4%); lack of secondary contacts (n = 9; 2%); and non-English speaking (n = 4; 1%).

**Measures**

The measures assessed behavioral patterns prior to hospitalization and were administered generally within 72 hr of admission. All measures were conducted in one-on-one interviews by research staff. The primary measure of interest for the current analysis was the Staging Health Risk Assessment (S-HRA) developed by Pro-Change Behavior Systems (South Kingstown, RI). The measure, with all items referencing the time period prior to hospitalization, screened for current risk status (present/absent) for the following 11 health behaviors: tobacco use; binge drinking (i.e., ≥4 drinks for women and ≥5 drinks for men in a 4-hr period); use of marijuana, stimulants, and nonprescribed opiates; healthy low-fat diet (e.g., paying attention to serving sizes, low-fat dairy, poultry without skin, light/nonfat dressings); fruit and vegetable consumption (i.e., ≥5 servings/day, with serving sizes defined for raw, cooked, juiced, and salad preparations); engagement in moderate physical activity (i.e., ≥50 min/week); sleep hygiene (e.g., regular bed- and wake-time schedule; ≥7 hr/night; quiet, dark, comfortable, and cool sleep environment); and engagement in one or more practices at a level consistent with effectively preventing depression (e.g., controlling negative thinking, engaging in pleasant activities, exercising for ≥30 minutes on most days, getting professional help when needed) and managing stress (e.g., relaxation exercises, talking with others, making time for social activities). Risk-status criteria were based on Healthy people 2020 goals for the nation (U.S. Department of Health & Human Services, 2010). In addition to providing an indication of risk status (i.e., at risk or not), the S-HRA assessed stage of change for each risk behavior. To differentiate those in action versus maintenance, participants screened as not at risk (e.g., eating five or more servings of fruits and vegetables prior to hospitalization), were asked about adherence over the previous 6 months. The staging algorithms for the health behaviors have been well studied, including among smokers with clinical depression (J. J. Prochaska, Rossi et al., 2004); have strong predictive validity over 24 months; and have demonstrated sensitivity to multibehavioral intervention effects in studies targeting inactivity, stress, diet, and smoking in nonclinical samples (J. O. Prochaska et al., 2008; J. O. Prochaska et al., 2004; Johnson et al., 2008; Evers et al., 2006). In the current sample, we conducted a validity check to compare risk status against validated measures, including the Behavior and Symptom Identification Scale (BASIS-24; Eisen, Gerena, Ranganathan, Esch, & Idiculla, 2006) for depression and the 12-Item Short Form Health Survey (SF-12) (Ware, Kosinski, & Keller, 1996) mental health functioning scale () and found significant group differences at p < .001 for S-HRA depression-prevention and stress-management items.
To characterize the complexity of the sample, a variety of descriptive measures were included. In addition to basic demographic characteristics, we assessed self-reported height and weight to calculate body-mass index (BMI), which is weight in kilograms divided by height in meters squared (kg/m²); unstable housing status, defined as current residence for ≤6 months; and the MacArthur Scales of Subjective Social Status (Adler, Epel, Castellazzo, & Ickovics, 2000), which use 10 points on the rungs of two pictorial ladders to assess perceived place in one’s self-defined community, and the U.S. more broadly (range 1–10, with higher scores indicative of higher social status). Measured BMI recorded in the medical record correlated at $r = .95 \ (p < .001)$ with BMI based on participant self-reported weight and height, and did not vary by diagnosis. Unstable housing may relate to a variety of risk behaviors, (e.g., substance use, poor diet, poor sleep hygiene), and in our prior work, has predicted psychiatric rehospitalization (J. J. Prochaska, Hall, Delucchi, & Hall, in press).

Tobacco measures included usual number of cigarettes/day prior to hospitalization, age of first cigarette, age of regular use, the Fagerstrom Test for Nicotine Dependence (FTND; range 0–10, with 1–4 indicating low and 5 indicating moderate nicotine dependence; Heatherton, Kozlowski, Frecker, & Fagerstrom, 1991), and the Thoughts About Abstinence scale (TAA, Hall, Havassy, & Wasserman, 1990) with three 10-point items assessing desire to quit smoking, anticipated success with quitting, and perceived difficulty with staying tobacco-free after quitting, and a fourth item assessing abstinence goal, categorized as no goal, complete abstinence, or goal of reduction or temporary cessation.

We also utilized a range of mental health and substance-abuse measures to capture the diversity in psychiatric symptoms (BASIS-24; Eisen et al., 2006) and level of functioning (SF-12; Ware, Kosinski, & Keller, 1996) in the current sample. More focused measures of depression (e.g., Centers for Epidemiologic Studies Depression scale; CESD; Andresen, Malmgren, Carter, & Patrick, 1994) and substance use (Addiction Severity Index; ASI; McLellan, Alterman, Cacciola, Metzger, & O'Brien, 1992) were included to specifically test associations with risk profiles, given the literature (Hall & Prochaska, 2009). The 24-item BASIS-24 was developed and validated and has been used widely among psychiatric inpatients, with an overall summary score and scales for depression, interpersonal relationships, self-harm, psychosis, emotional lability, and substance abuse (scales range from 0–4; higher scores indicate greater symptom/problem severity). The 10-item CESD scale (range 0–30, ≥10) indicates significant depressive symptomology. The Medical Outcomes Short Form (Ware, Kosinski, & Keller, 1996) yields composite indices of physical and mental health functioning (range 0–100, national norm = 50, SD =10, lower scores indicate worse functioning; SF-12). Items were used from the ASI that assessed the number of treatment episodes in inpatient psychiatry and alcohol and drug treatment settings. Lastly, diagnosable current (past month) psychiatric disorders were assessed with the Mini-International Neuropsychiatric Interview (MINI; Sheehan et al., 1998) including unipolar and bipolar (I, II) depression, psychotic disorder (schizophrenic, schizoaffective), alcohol and drug abuse/dependence, attention-deficit/hyperactivity disorder (ADHD), posttraumatic stress disorder (PTSD), eating disorders (anorexia, bulimia, binge eating), and antisocial personality disorder (ASPD). All measures were established scales with evidence
of reliability and validity among clinical populations (e.g., J. J. Prochaska, Rossi, et al., 2004; J. J. Prochaska, Leek, Hall, & Hall, 2007).

Analyses

Descriptive statistics were run to characterize the sample. The S-HRA measure was analyzed to determine the frequency of each risk behavior (i.e., % at risk) and participants’ average number of risk behaviors. Correlations and chi-square tests examined associations between multibehavioral risks and demographic, tobacco, other substance-use, and psychiatric measures. We examined stage distributions to determine the proportion of the sample prepared to take action on one or more risk behavior and to compare stage distributions for tobacco (the targeted behavior in the intervention trial) to other risks. In addition to descriptive statistics, we utilized LCA to identify meaningful classes (i.e., subgroups) of smokers with distinct patterns of risk behaviors. Unlike variable-centered approaches (e.g., correlations, regression), person-centered approaches, such as LCA, are ideal for clustering individuals based on similar responses to measured items (Nylund, Asparouhov, & Muthen, 2007). We estimated latent class models from two through five classes to look for evidence of the existence of latent-risk groups (Nylund et al., 2007). The variables included in the model, all dichotomous indicators, were risk status (yes/no) for each behavior excluding tobacco, given that all participants were smokers. Multiple starts were used to avoid a solution based on a local maximum. The most parsimonious model was selected based on several criteria: BIC, Lo-Mendell-Rubin (LMR) test, and the size of the smallest class (at least 10% of the sample). The identified latent classes were compared on demographic, psychiatric, tobacco- and substance-use characteristics. Significant univariate associations were examined collectively in a multinomial logistic regression model. Initial variable retention was based on a criterion of $p < .20$, with further refinement and re-estimation, until only variables significant at $p < .05$ were retained.

Results

Sample Characteristics

The sample ($N = 693$) was 50% male, 58% unemployed, 38% unstably housed, 49% with annual household income < $10,000, 39 years old on average ($SD = 13$), and 13 years of education ($SD = 3$). Race/ethnic representation was 45% non-Hispanic Caucasian, 6% Hispanic, 25% African American, 4% Asian/Pacific Islander, 20% multiracial or other. Marital status was 57% never married, 15% married/cohabiting, and 28% divorced/separated/widowed. A third was overweight (BMI = 25–29.9) and 38% were obese (BMI ≥ 30). Participants' subjective social standing ratings averaged 4.9 ($SD = 2.7$) out of 10 in one's self-defined community and 4.3 ($SD = 2.7$) in the broader U.S. Patients were recruited into the study within a median of 2 days from hospital admission (interquartile range ($IQR$): 1,3), and length of stay was a median of 5 days ($IQR$: 3,9).

Based on diagnostic interviews with the MINI, the frequency of DSM–IV disorders were: unipolar depression (29%), bipolar depression (42%), PTSD (39%), psychotic disorders (25%), drug(-48%) and alcohol-use (40%) disorders, ADHD (25%), and ASPD (20%); eating disorders (7%) were less prevalent. Approximately 24%, 25%, 21%, and 30% of
participants had one, two, three or four or more DSM–IV disorders, respectively. The sample had a median of four lifetime inpatient psychiatric hospitalizations and one prior alcohol-/drug-treatment episode. CESD depression scores (Andresen, Malmgren, Carter, & Patrick, 1994) averaged 18.5 (SD = 7.6) with 83% scoring > 10, in the clinical depression range. Reported mental health functioning on the SF-12 was nearly two standard deviations below normative t-score values of 50, M = 31, SD = 14; physical functioning was higher, with M = 46 and SD = 13. Scores on the BASIS-24 (Eisen et al., 2006) were characteristic of an inpatient mental health sample with a mean summary score of 2.1 (SD = 0.8).

Participants reported smoking an average of 17 cigarettes per day (SD = 10) prior to hospitalization with a mean FTND (Heatherton, Kozlowski, Frecker, & Fagerstrom, 1991) score of 4.7 (SD = 2.2), in the moderate range. On 10-point scales, the sample reported a mean (SD) of 5.9 (3.1) for desire to quit, 6.1 (3.0) for anticipated success with quitting, and 6.9 (2.8) for perceived difficulty with staying tobacco-free once quit. Goals regarding smoking behavior were no goal (15.4%), temporary cessation or reduction goal (51.4%), and quit for good (33.2%).

**Multiple Risk Behaviors**

The sample averaged 5.2 risk behaviors (SD = 2.1); only 4.6% reported tobacco as their only risk. The most prevalent additional risks were dietary, poor sleep, inactivity, and marijuana use (see Table 1). In bivariate correlations, number of risk behaviors was positively associated with number of psychiatric diagnoses ($r = .30, p < .001$) and with worse psychiatric symptoms on all BASIS-24 (Eisen et al., 2006) subscales (depression, $r = .35$; interpersonal relationships, $r = .16$; self-harm, $r = .29$; emotional lability, $r = .25$; psychosis, $r = .16$; and substance abuse, $r = .37$) and the summary score ($r = .40$), more severe depressive symptoms on the CESD ($r = .39$), poorer mental health functioning on the SF-12 ($r = −0.31$), and lower subjective social standing on the MacArthur community ($r = −0.25$) and U.S. ($r = −0.22$) ladder scales, all $p$s < .001. Total number of risks was greatest among African Americans ($M = 5.5, SD = 2.2$), followed by non-Hispanic Caucasians ($M = 5.3, SD = 2.1$), and was lowest among individuals identifying as multiracial or other, which included Hispanic, Asian/Pacific Islander, and Native American ($M = 4.9, SD = 2.1$), $F(2, 691) = 3.94, p = .02$. Associations between total number of risks with age ($r = −0.10$), anticipated success with quitting smoking ($r = .11$), and housing stability ($r = .13$) were significant but weak, and nonsignificant for gender, marital status, income, education, BMI, SF-12 physical health functioning, cigarettes per day, FTND, desire to quit smoking, or abstinence goal ($r < |0.09| \text{ and } p > .10$).

**Stage of Change for Individual and Multiple Risks**

Table 1 displays the percentage at risk for each behavior and, within each behavior, the percentage prepared to change in the next 30 days. All participants were smokers (100% at risk), yet only 23% were in the preparation stage for quitting smoking. Similarly, among marijuana users (46% of the sample), only 23% reported that they were preparing to quit. In contrast, a majority of those at risk for each behavior reported that they intended to adopt behaviors to prevent depression (76%), manage stress (69%), quit stimulants (74%), improve sleep (69%), cease nonprescription opiate use (68%) and binge drinking (57%), and...
meet physical activity guidelines (51%), and nearly half (43–46%) were prepared to adopt healthier dietary practices.

We examined the number of behaviors for which the sample was at risk and prepared to change in the next 30 days and found 17% was not prepared to change any risk behavior, 22% was prepared to change one, 18.5% two, 14% three, 11% four, 8% five, 4.5% six, 4% seven, and 1% was at risk and prepared to change eight or more behaviors. The paired behaviors for which participants were most frequently prepared to change in the next month were stress and depression (134/200 in preparation for both risks, 67%), sleep hygiene and depression (115/185, 62%), and sleep and stress (99/179, 55%). Only 29 of 312 users of tobacco and marijuana (9%) were prepared to quit both in the next 30 days.

Among smokers preparing to quit in the next 30 days (n = 160), 82% were in preparation to change an additional risk behavior, most frequently sleep hygiene (42%), fruits and vegetables (38%), and high-fat diet (35%). Preparing for quitting smoking was significantly associated with preparing to improve sleep: odds ratio (OR) = 2.7, 95% confidence interval (CI [1.4, 5.0]) and diet (low-fat OR = 1.9, CI [1.2, 3.0]; fruits and vegetables OR = 2.1, CI [1.3, 3.3]), managing stress (OR = 2.5, CI [1.2, 5.0]), adopting physical activity (OR = 1.7, CI [1.0, 2.8]), and quitting marijuana (OR = 3.5, CI [1.9, 6.2]) and stimulants (OR = 6.1, CI [1.4, 26.9]), but unrelated to motivation to address binge drinking, opiate use, or prevent depression.

Nearly a third (30%) of the sample was not intending to quit smoking in the next 6 months; yet these individuals were ready to change other risk behaviors. Limiting our analysis to smokers in precontemplation at risk for each behavior, 68% were in preparation for depression prevention, 59% for quitting stimulants, 52% for improving sleep, 50% for quitting nonprescription opiates, 52% for managing stress, 40% for increasing physical activity, 36% for controlling drinking, 32% for increasing fruits and vegetables, 28% for decreasing dietary fat, and only 12% for abstaining from marijuana.

**Latent Class Analysis**

For the LCA, a three-class model provided the best fit. As seen in Table 2, while the LMR p value was just below the standard cutoff of .05, BIC was larger for the 4-class model and the smallest class size (based on most likely class) was only 3% of the sample. Entropy for this model was 0.70.

Conditional response probabilities by class are shown in Figure 1. Class 1 tended to have the greatest risk level for all indicators (global higher risk group) while Class 2 comparatively tended to have the lowest (global lower risk group). Class 3 was more differentiated, with high probabilities of risk for depression and stress, sleep hygiene, physical inactivity and poor diet, and low risk for alcohol and illicit drug use (mood and metabolic group). The mean (SD) number of risk behaviors differed significantly by group: highest for Class 1 with 7.6 (1.5) risks, intermediate for Class 3 with 6.6 (1.2), and lowest for Class 2 with 3.6 (1.4), F (2, 691) = 546, p < .001.
Significant group differences also were found in demographic characteristics, tobacco use, substance use, and psychiatric measures (see Table 3). Relative to the other groups, those in Class 1 (global higher risk) were younger, more likely to be men, never married, African American, and unstably housed; they started smoking at a younger age; were the heaviest smokers and most nicotine dependent; expected less success with quitting smoking; were the least likely to have a goal to change their smoking behavior; had the most severe difficulties with emotional lability, psychosis, self-harm, and substance use on the BASIS-24 (Eisen et al., 2006); had the highest prevalence of bipolar disorder, psychotic disorders, substance-use disorders, ADHD, PTSD, and ASPD; and had the lowest prevalence of unipolar depression. They also had the greatest number of psychiatric disorders and the greatest number of treatment episodes for alcohol and drugs.

Those in Class 2 (global lower risk) reported the least severe levels of psychiatric symptoms on the BASIS-24, CESD, and SF-12 and had the highest subjective social status. They were also the most likely to have goals to change their smoking behavior and had the greatest perceived likelihood of success with quitting smoking.

Class 3 (mood and metabolic risks) had the largest proportion of non-Hispanic Caucasian participants and was characterized by poor mental health functioning on the SF-12, high depressive symptoms on the CESD and BASIS-24, and low perceived social status.

No significant group differences were found for years of education; employment status; BMI; physical health functioning on the SF-12; desire to quit smoking and perceived difficulty with staying tobacco-free once quit; prevalence of unipolar depression, PTSD, or eating disorders; or the number of times hospitalized for psychiatric illness.

The variables that differed significantly by class, shown in Table 3, were entered in a multinomial logistic regression analysis. Relative to the global lower risk group, the global higher risk group used tobacco regularly at a younger age ($OR = 0.86, 95\%\ CI [0.79, .93]$), had greater depression ($OR = 1.07, 95\%\ CI [1.01, 1.14]$) and substance use problems ($OR = 1.52, 95\%\ CI [1.09, 2.11]$), and were more likely to have diagnoses of ADHD ($OR = 2.13, 95\%\ CI [1.06, 4.35]$), alcohol ($OR = 2.17, 95\%\ CI [1.04, 4.55]$) or drug use ($OR = 5.26, 95\%\ CI [2.17, 12.50]$) disorders; whereas those in the mood and metabolism group had lower standing in their self-defined communities ($OR = 0.88, 95\%\ CI [0.80, 0.96]$), greater depression ($OR = 1.08, 95\%\ CI [1.03, 1.12]$), and poorer mental health functioning on the SF-12 ($OR = 0.97, 95\%\ CI [0.95, 0.99]$).

Conclusion

In a representative sample of smokers recruited from inpatient psychiatry units in the San Francisco Bay Area, 95% had multiple risks averaging five out of the 11 behaviors assessed. The sample endorsed problems with managing stress and depression. Disturbed sleep, associated with many psychiatric disorders, also was common. More prevalent, however, were unhealthy dietary behaviors, reported by over two thirds, and physical inactivity, reported by the majority. In addition, nearly half the sample used marijuana. Informing
future interventional needs, the current findings indicate that clinical attention to multiple risk behaviors among smokers with SMI is warranted.

Suggestive of a paired motivational process for behavior change, most (82%) participants who were intending to quit smoking in the next 30 days also were prepared to change an additional risk behavior, most frequently sleep hygiene and dietary behaviors. Multibehavioral interventions that combine attention to good sleep practices and smoking or smoking and nutrition, may be particularly salient. For smokers not looking to quit in the next 6 months (i.e., precontemplators), many were ready to change other risk behaviors, most frequently depression prevention and stress management, sleep hygiene, and illicit drug use. Intervention on these additional risks may serve to engage resistant smokers into the change process.

The current study yielded new information with regard to profiles of engagement in multiple risk behaviors, with implications for tailoring prevention and intervention efforts, at least among smokers with SMI. Class 1 (global higher risk) was the smallest group (11%) but of greatest concern given the number of risk behaviors, frequency of addiction-treatment episodes, and severity of psychiatric symptoms. Consistent with prior research in the general U.S. adult population, the global higher risk group was more likely to be male, young, and African American (Berrigan et al., 2003) and more likely to have a range of psychiatric disorders. This group also appeared to be the most treatment-resistant with respect to their tobacco use, reporting more severe nicotine dependence, lower confidence for quitting smoking, and less commitment to abstinence. In the multivariate model, the global higher risk group, relative to the global lower risk group, was characterized as younger overall and younger to initiate regular tobacco use; more impulsive; meeting criteria for ADHD; more depressed; and more severe in their problems with substance use. For this high-risk group, the findings suggest the need for comprehensive multibehavioral interventions that address the combination of substances abused and psychiatric diagnoses, and combine pharmacotherapy with motivational approaches for engagement.

Class 2 (global lower risk), representing half the sample, had lower psychiatric severity and a lower likelihood of risk behaviors. Yet, even among this group, a majority was overweight and reported poor diet, indicating the broad need for combined tobacco and nutrition intervention. Clinical practice guidelines for treating tobacco dependence discourage dieting out of concern that abstinence efforts will be compromised (DHHS Tobacco Use & Dependence Guideline Panel, 2008), though findings in the literature are inconsistent (Spring et al., 2004; Hall, Tunstall, Vila, & Duffy, 1992). When smoking and nutrition intervention strategies are tailored to readiness to change (i.e., not forcing coaction), research has not shown nutritional interventions to be detrimental to tobacco abstinence (Prochaska, Velicer, Prochaska, Delucchi, & Hall, 2006). Replication is needed in samples of smokers with co-occurring psychiatric or addictive disorders.

Class 3 (mood and metabolic risks), consisting of 40% of the sample, had elevations on mood, stress, and sleep disturbance; poor nutrition and inactivity; was characterized by lower subjective social standing in their respective communities; and had poorer mental health functioning, including greater depressive symptoms, relative to the global lower risk
group. Physical activity has demonstrated promise for treating depression and quitting smoking (Blumenthal et al., 1999; Marcus et al., 1999) and is recommended by tobacco-treatment clinical practice guidelines (Tobacco Use & Dependence Guideline Panel, 2008). Ancillary effects of exercise on sleep and stress merit future evaluation.

The study recruited a representative sample of patients with SMI who smoked at least five cigarettes/day in the week prior to hospitalization. Intention to quit smoking was not required to participate, and notably only 23% of the sample was prepared to quit smoking, which is comparable to findings from large population studies of smokers without mental illness (e.g., Velicer et al., 1995), as well as previous research with psychiatric outpatients (Acton, Prochaska, Kaplan, Small, & Hall, 2001; J. J. Prochaska, Rossi et al., 2004). Strategies for increasing smokers’ readiness to take action include increasing the salience of the benefits of quitting and drawbacks of smoking, promoting cognitive processes (e.g., exposure to dramatic imagery of the harms of risk behaviors and considering environmental impacts), and supporting smokers’ belief in their ability to successfully quit by assisting with goal-setting, stimulus control (e.g., removing cigarettes and ashtrays from the home), and counter conditioning (e.g., replacing smoking with more adaptive behaviors). Initiated on a psychiatric unit and continued posthospitalization, our recent research demonstrated the success of these strategies in motivating smokers to quit (J. J. Prochaska et al., in press).

Though enrolled in a tobacco-treatment trial, participants were more prepared to engage in behaviors to better manage their mood and stress, abstain from alcohol and illicit substances (stimulants and opiates), improve sleep, and increase physical activity. Given strong evidence that the adoption of healthy behaviors (e.g., physical activity) can reduce tobacco withdrawal and cravings (Ussher, Taylor, & Faulkner, 2012), expanding intervention targets to co-occurring risks for which individuals have greater motivation to change may provide healthier coping strategies and increase tobacco-treatment relevance, interest, and impact on health. Further, success in changing one or more addiction or lifestyle behavior(s) may increase confidence to improve additional risk behaviors, thereby serving as a gateway to an overall healthful lifestyle (Emmons, Marcus, Linnan, Rossi, & Abrams, 1994; Emmons, Shadel, Linnan, Marcus, & Abrams, 1999; Johnson et al., 2008; J. O. Prochaska, 2008; Unger, 1996). A meta-analysis of tobacco-cessation interventions initiated during addictions treatment found evidence of enhanced long-term sobriety relative to usual care (J. J. Prochaska, Rossi et al., 2004). A third of the interventions included in the meta-analysis were tailored to readiness to quit. In the current study, intent to quit tobacco and binge drinking were unrelated, suggesting the value of tailoring motivational strategies to each substance individually. With tobacco and marijuana, motivation to quit was much lower than motivation to abstain from other substances, and few users of both substances were prepared to quit both concurrently. It is well-known that smokers give higher priority to cigarette smoking than other risk behaviors, such as the use of alcohol and illicit drugs, reflecting the severity of nicotine dependence (Kozlowski et al., 1989; Spring, Pingitore, & McChargue, 2003). The priority for marijuana use is less widely recognized. Thought to be less addicting than tobacco cigarettes or other drugs of abuse, the present findings of prevalent marijuana use, and low motivation to quit, suggest that this may not be the case. Future research is needed to determine whether low motivation to quit marijuana in this

*Health Psychol.* Author manuscript; available in PMC 2015 May 08.
sample is specific to Northern California, adults with SMI, or is more broadly characteristic of adult tobacco and marijuana co-users.

Smoking status has utility for identifying populations struggling with multiple risks (Fine et al., 2004; Kendzor et al., 2008). Although quitting smoking is critical for heart and lung health and cancer prevention, interventions targeted at single risks, even if effective, will inevitably have limited impact. Further, it is well demonstrated that fragmented and uncoordinated programs create service gaps for persons with co-occurring disorders (Watkins, Burnam, Kung, & Paddock, 2001). Dual diagnosis treatment models for drug addiction and mental illness provide a framework for integrating interventions with key elements, such as assertive, proactive rather than reactive, outreach for treatment engagement; stage-tailored or motivational interventions; cognitive and behavioral counseling; social support; culturally sensitive and competent approaches; taking a long-term perspective; and providing comprehensive treatment (Substance Abuse & Mental Health Services Administration, 2002; Work Group on Substance Use Disorders, 2007).

Individuals with SMI have low utilization of preventive healthcare services and frequently turn to costly emergency services to manage physical health conditions (Carr et al., 2003; DeCoux, 2005; Prince et al., 2007; Salsberry, Chipps, & Kennedy, 2005). The current findings support the need for efforts to broaden early prevention and treatment goals to address the many health risks with which mental health clients present. The great majority of smokers who were preparing to quit in the next 30 days was also preparing to change one or more additional risk behavior. Interventions that teach common skills for behavior change that can be easily applied across a variety of target behaviors (e.g., examining pros and cons of behavior; Noar, Chabot, & Zimmerman, 2008) may be particularly useful for facilitating behavior change in this population. Single behavior interventions have demonstrated success among persons with SMI (Faulkner, Cohn, & Remington, 2007; Hall et al., 2006; Hassapidou et al., 2011; McFall et al., 2010; Tsoi et al., 2010; Vancampfort et al., 2010). Psychiatric hospitalization provides an opportunity for reaching, engaging, and treating single risk behaviors, such as smoking (J. J. Prochaska et al., in press) and potentially multiple risks. By broadening the focus of psychiatric treatment to include additional risks, a considerable amount of mortality and morbidity might be reduced before serious and costly chronic health problems develop. Additional research is needed to determine the benefits and costs of multiple versus single behavior interventions in this disproportionately impacted population.

The current sample, though large and diagnostically, socioeconomically, and ethnically diverse, was limited to adult smokers of ≥5 cigarettes daily, hospitalized for acute mental illness in the San Francisco Bay Area. A vulnerable and understudied group, the findings may not generalize to all adults with SMI or nondaily or lighter smokers. Data were based on retrospective self-report, which may limit the accuracy of our findings. The S-HRA’s brief behavioral assessments correlated well with established measures in the current sample and in earlier studies (J. J. Prochaska, Rossi, et al., 2004; J. O. Prochaska et al., 2008, 2004; Johnson et al., 2008; Evers et al., 2006). All measures were read to participants to avoid problems with reading comprehension. Having had a diagnostically diverse sample, we did not observe difficulty with responding among those with psychotic disorders, and few
patients (5% of those approached) were excluded due to lack of capacity to consent. More research is warranted; other research groups have similarly reported on valid lifestyle assessments of individuals with SMI (Baker et al., 2011; Daumit et al., 2013). With the LCA, primarily for the sake of parsimony, we chose to assign subjects to classes based on their greatest probability of class membership. The average probabilities of classification for the most likely class and the class assigned to were all ≥ .80 (.80, .89, .88) and median values were ≥ .85 (.85, .95, .98) indicating that the most likely class resulted in a limited loss of information. This method of assignment, however, assumes that the cost of misclassification is uniform and ignores the associated probabilities for the other classes. In making decisions regarding treatment, this assumption may not be warranted. Last, the data were cross-sectional. Future research is needed to examine the likelihood of changes over time in multirisk behaviors, transitions among the profiles identified, and most critical, the associated impacts of multiple behavior change interventions on health and wellbeing.

**Supplementary Material**

Refer to Web version on PubMed Central for supplementary material.

**Acknowledgments**

This work was supported by the United States Department of Health and Human Services, National Institutes of Health, National Institute of Mental Health Grant R01 MH083684; National Institute on Drug Abuse Grants K23 DA018691, K05 DA016752, and P50 DA09253; and the State of California Tobacco-Related Disease Research Program Grant 21BT-0018; ClinicalTrials.gov registry No. NCT00968513.

**References**

Acton GS, Prochaska JJ, Kaplan AS, Small T, Hall SM. Depression and stages of change for smoking in psychiatric outpatients. Addictive Behaviors. 2001; 26:621–631.10.1016/S0306-4603(01)00178-2 [PubMed: 11676374]

Adler NE, Epel ES, Castellazzo G, Ickovics JR. Relationship of subjective and objective social status with psychological and physiological functioning: Preliminary data in healthy white women. Health Psychology. 2000; 19:586–592.10.1037/0278-6133.19.6.586 [PubMed: 11129362]

American Psychiatric Association Work Group on Substance Use Disorders. Practice guideline for the treatment of patients with substance use disorders. American Journal of Psychiatry (2nd). 2007; 164:1–124. [PubMed: 17202533]

Amiel JM, Mangurian CV, Ganguli R, Newcomer JW. Addressing cardiometabolic risk during treatment with antipsychotic medications. Current Opinion in Psychiatry. 2008; 21:613–618.10.1097/YCO.0b013e328314b7474b [PubMed: 18852570]

Andresen EM, Malmgren JA, Carter WB, Patrick DL. Screening for depression in well older adults: Evaluation of a short form of the CES-D (Center for Epidemiologic Studies Depression Scale). American Journal of Preventive Medicine. 1994; 10:77–84. [PubMed: 8037935]

Baker A, Kay-Lambkin FJ, Richmond R, Filia S, Castle D, Williams J, Lewin TJ. Study protocol: A randomised controlled trial investigating the effect of a healthy lifestyle intervention for people with severe mental disorders. BMC Public Health. 2011; 1110.1186/1471-2458-11-10

Berrigan D, Dodd K, Troiano RP, Krebs-Smith SM, Barbash RB. Patterns of health behavior in U.S. adults. Preventive Medicine. 2003; 36:615–623.10.1016/S0091-7435(02)00067-1 [PubMed: 12689807]

Blumenthal JA, Babyak MA, Moore KA, Craighead WE, Herman S, Khatri P, et al. Krishna KR. Effects of exercise training on older patients with major depression. Archives of Internal Medicine. 1999; 159:2349–2356.10.1001/archinte.159.19.2349 [PubMed: 10547175]
Carr VJ, Johnston PJ, Lewin TJ, Rajkumar S, Carter GL, Issakidis C. Patterns of service use among persons with schizophrenia and other psychotic disorders. Psychiatric Services. 2003; 54:226–235.10.1176/appi.ps.54.2.226 [PubMed: 12556605]

Conwell, LJ.; Cohen, JW. Rockville, MD: Agency for Healthcare Research and Quality; 2005. Characteristics of persons with high medical expenses in the U.S. civilian noninstitutionalized population, 2002. Statistical Brief No. 73 Retrieved from http://meps.ahrq.gov/mepsweb/data_files/publications/st73/stat73.pdf

Daumit GL, Dickerson FB, Wang NY, Dalcin A, Jerome GJ, Anderson CAM, et al. Appel LJ. A behavioral weight-loss intervention in persons with serious mental illness. The New England Journal of Medicine. 2013; 368:1594–1602.10.1056/NEJMoa1214530 [PubMed: 23517118]

DeCoux M. Acute versus primary care: The health care decision making process for individuals with severe mental illness. Issues in Mental Health Nursing. 2005; 26:935–951.10.1080/01612840500248221 [PubMed: 16203647]

De Hert M, Correll CU, Bobes J, Cetkovich-Bakmas M, Cohen D, Asai I, et al. Leucht S. Physical illness in patients with severe mental disorders: I. Prevalence, impact of medications and disparities in health care. World Psychiatry: Official Journal of the World Psychiatric Association. 2011; 10:52–77.

Dent R, Blackmore A, Peterson J, Habib R, Kay GP, Gervais A, et al. Wells G. Changes in body weight and psychotropic drugs: A systematic synthesis of the literature. PloS ONE. 2012; 7:e36889.10.1371/journal.pone.0036889 [PubMed: 22719834]

de Vries H, van’t Riet J, Spigt M, Metsemakers J, van den Akker M, Vermunt JK, Kremers S. Clusters of lifestyle behaviors: Results from the Dutch SMILE study. Preventive Medicine. 2008; 46:203–208.10.1016/j.ypmed.2007.08.005 [PubMed: 17904212]

Durazzo TC, Gazdzinski S, Banyas P, Meyerhoff DJ. Cigarette smoking exacerbates chronic alcohol-induced brain damage: A preliminary metabolite imaging study. Alcoholism: Clinical and Experimental Research. 2004; 28:1849–1860.10.1097/01.ALC.0000148112.92525.AC

Eisen SV, Gerena M, Ranganathan G, Esch D, Idiculla T. Reliability and validity of the BASIS-24 Mental Health Survey for Whites, African Americans, and Latinos. The Journal of Behavioral Health Services & Research. 2006; 33:304–323.10.1007/s11414-006-9025-3 [PubMed: 16752108]

Emmons KM, Marcus BH, Linnan L, Rossi JS, Abrams DB. Mechanisms in multiple risk factor interventions: Smoking, physical activity, and dietary fat intake among manufacturing workers. Working Well Research Group. Preventive Medicine. 1994; 23:481–489.10.1006/pmed.1994.1066 [PubMed: 7971876]

Emmons KM, McBride CM, Puleo E, Pollak KI, Clipp E, Kuntz K, et al. Fletcher R. Project PREVENT: A randomized trial to reduce multiple behavioral risk factors for colon cancer. Cancer Epidemiology Biomarkers & Prevention. 2005; 14:1453–1459.10.1158/1055-9965.EPI-04-0620

Emmons KM, Shadel WG, Linnan L, Marcus BH, Abrams DB. A prospective analysis of change in multiple risk factors for cancer. Cancer Research, Therapy & Control. 1999; 8:15–23.

Evers KE, Prochaska JO, Johnson JL, Mauriello LM, Padula JA, Prochaska JM. A randomized clinical trial of a population- and transtheoretical model-based stress-management intervention. Health Psychology. 2006; 25(4):521–529.10.1037/0278-6133.25.4.521 [PubMed: 16846327]

Fani Marvasti F, Stafford RS. From sick care to health care: Reengineering prevention into the US system. The New England Journal of Medicine. 2012; 367:889–891.10.1056/NEJMp1206230 [PubMed: 22931257]

Faulkner G, Cohn T, Remington G, Irving H. Body mass index, waist circumference and quality of life in individuals with schizophrenia. Schizophrenia Research. 2007; 90:174–178. [PubMed: 17140768]

Fine LJ, Philogene GS, Gramling R, Coups EJ, Sinha S. Prevalence of multiple chronic disease risk factors. 2001 National Health Interview Survey. American Journal of Preventive Medicine. 2004; 27:18–24.10.1016/j.amepre.2004.04.017 [PubMed: 15275670]

Goetzl RZ, Anderson DR, Whitmer RW, Ozminowski RJ, Dunn RL, Wasserman J. The relationship between modifiable health risks and health care expenditures. An analysis of the multi-employer HERO health risk and cost database. Journal of Occupational and Environmental Medicine. 1998; 40:843–854.10.1097/00043764-199810000-00003 [PubMed: 9800168]
Hall SM, Havassy BE, Wasserman DA. Commitment to abstinence and acute stress in relapse to alcohol, opiates, and nicotine. Journal of Consulting and Clinical Psychology. 1990; 58:175.10.1037/0022-006X.58.2.175 [PubMed: 2335634]

Hall SM, Prochaska JJ. Treatment of smokers with co-occurring disorders: Emphasis on integration in mental health and addiction treatment settings. Annual Review of Clinical Psychology. 2009; 5:409–431.10.1146/annurev.clinpsy.032408.153614

Hall SM, Tsoh JY, Prochaska JJ, Eisendrath S, Rossi JS, Redding CA, et al. Gorecki JA. Treatment for cigarette smoking among depressed mental health outpatients: A randomized clinical trial. American Journal of Public Health. 2006; 96:1808–1814.10.2105/AJPH.2005.080382 [PubMed: 17008577]

Hall SM, Tunstall CD, Vila KL, Duffy J. Weight gain prevention and smoking cessation: Cautionary findings. American Journal of Public Health. 1992; 82:799–803.10.2105/AJPH.82.6.799 [PubMed: 1585959]

Hassapidou M, Papadimitriou K, Athanasiadou N, Tokmakidou V, Pagkalos I, Vlahavas G, Tsofliou F. Changes in body weight, body composition and cardiovascular risk factors after long-term nutritional intervention in patients with severe mental illness: an observational study. BMC Psychiatry. 2011; 11:31. [PubMed: 21332986]

Heatherton TF, Kozlowski LT, Frecker RC, Fagerstrom KO. The Fagerstrom Test for Nicotine Dependence: A revision of the Fagerstrom Tolerance Questionnaire. British Journal of Addiction. 1991; 86:1119–1127.10.1136/bja.86.6.1119 [PubMed: 1932883]

Hickman NJ, Prochaska JJ, Dunn LB. Screening for research consent capacity in the inpatient psychiatry setting. Journal of Empirical Research on Human Research Ethics. 2011; 6:65–72.10.1525/jer.2011.6.3.65 [PubMed: 21931239]

Johnson SS, Paiva AL, Cummins CO, Johnson JL, Dyment SJ, Wright JA, et al. Sherman K. Transtheoretical model-based multiple behavior intervention for weight management: Effectiveness on a population basis. Preventive Medicine. 2008; 46:238–246.10.1016/j.ympmed.2007.09.010 [PubMed: 18055007]

Kendzor DE, Costello TJ, Li Y, Vidrine JI, Mazas CA, Reitzel LR, et al. Wetter DW. Race/ethnicity and multiple cancer risk factors among individuals seeking smoking cessation treatment. Cancer Epidemiology, Biomarkers & Prevention. 2008; 17:2937–2945.10.1158/1055-9965.EPI-07-2795

Ketola E, Sipilä R, Mäkelä M. Effectiveness of individual lifestyle interventions in reducing cardiovascular disease and risk factors. Annals of Medicine. 2000; 32:239–251.10.1080/07853890009011767 [PubMed: 10852140]

Kozlowski LT, Wilkinson DA, Skinner W, Kent C, Franklin T, Pope M. Comparing tobacco cigarette dependence with other drug dependencies. Greater or equal “difficulty quitting” and “urges to use,” but less “pleasure” from cigarettes. JAMA: Journal of the American Medical Association. 1989; 261:898–901.10.1001/jama.1989.03420060114043

Kroon LA. Drug interactions with smoking. American Journal of Health-System Pharmacy. 2007; 64:1917–1921.10.2146/ahjp060414 [PubMed: 17823102]

Lawrence D, Kisely S. Inequalities in healthcare provision for people with severe mental illness. Journal of Psychopharmacology. 2010; 24:61–68.10.1177/1359786810382058 [PubMed: 20923921]

Marcus BH, Albrecht AE, King TK, Parisi AF, Pinto BM, Roberts M, et al. Abrams DB. The efficacy of exercise as an aid for smoking cessation in women: A randomized controlled trial. Archives of Internal Medicine. 1999; 159:1229–1234.10.1001/archinte.159.11.1229 [PubMed: 10371231]

McFall M, Saxon AJ, Malte CA, Chow B, Bailey S, Baker DG, et al. Lavori PW. Integrating tobacco cessation into mental health care for posttraumatic stress disorder: A randomized controlled trial. JAMA: Journal of the American Medical Association. 2010; 304:2485–2493.10.1001/jama.2010.1769

McLellan AT, Alterman AI, Cacciola J, Metzger D, O’Brien CP. A new measure of substance abuse treatment. Initial studies of the treatment services review. Journal of Nervous and Mental Disease. 1992; 180:101–110.10.1097/00005053-199202000-00007 [PubMed: 1737971]
Miller BJ, Paschall CB III, Svendsen DP. Mortality and medical comorbidity among patients with serious mental illness. Psychiatric Services. 2006; 57:1482–1487.10.1176/appi.ps.57.10.1482 [PubMed: 17035569]

Newcomer JW. Second-generation (atypical) antipsychotics and metabolic effects. a comprehensive literature review. CNS Drugs. 2005; 19:1–93.10.2165/00023210-200519001-00001 [PubMed: 15998156]

Noar SM, Chabot M, Zimmerman RS. Applying health behavior theory to multiple behavior change: Considerations and approaches. Preventive Medicine. 2008; 46:275–280.10.1016/j.ypmed.2007.08.001 [PubMed: 17825898]

Norris SL, Engelgau MM, Venkat Narayan KM. Effectiveness of self-management training in Type 2 diabetes A systematic review of randomized controlled trials. Diabetes Care. 2001; 24:561–587.10.2337/diacare.24.3.561 [PubMed: 11289485]

Nylund KL, Asparouhov T, Muthen BO. Deciding on the number of classes in latent class analysis and growth mixture modeling: A Monte Carlo simulation study. Structural Equation Modeling. 2007; 14:535–569.10.1080/10705510701575396

Ornish D, Scherwitz LW, Billings JH, Gould KL, Merritt TA, Sparler S, et al. Brand RJ. Intensive lifestyle changes for reversal of coronary heart disease. JAMA: Journal of the American Medical Association. 1998; 280:2001–2007.10.1001/jama.280.23.2001

Prince M, Patel V, Saxena S, Maj M, Maselko J, Phillips MR, Rahman A. No health without mental health. The Lancet. 2007; 370:859–877.10.1016/S0140-6736(07)61238-0

Prochaska JJ. Smoking and mental illness–breaking the link. The New England Journal of Medicine. 2011; 365:196–198.10.1056/NEJMp1105248 [PubMed: 21774707]

Prochaska JJ, Hall SE, Delucchi K, Hall SM. in press. Efficacy of initiating tobacco dependence treatment in inpatient psychiatry: A randomized controlled trial. American Journal of Public Health.

Prochaska JJ, Hall SE, Hall SM. Stage-tailored tobacco cessation treatment in inpatient psychiatry. Psychiatric Services. 2009; 60:848.10.1176/appi.ps.60.6.848 [PubMed: 19487360]

Prochaska JJ, Hall SM, Tsoh JY, Eisendrath S, Rossi JS, Redding CA, et al. Gorecki JA. Treating tobacco dependence in clinically depressed smokers: Effect of smoking cessation on mental health functioning. American Journal of Public Health. 2008; 98:446–448.10.2105/AJPH.2006.101147 [PubMed: 17600251]

Prochaska JJ, Leek DN, Hall SE, Hall SM. Cognitive interviews for measurement evaluation of the Fagerström Test for Nicotine Dependence (FTND) in smokers with schizophrenia spectrum disorders. Addictive Behaviors. 2007; 32:793–802.10.1016/j.addbeh.2006.06.016 [PubMed: 16839695]

Prochaska JJ, Rossi JS, Redding CA, Rosen AB, Tsoh JY, Humfleet GL, et al. Hall SM. Depressed smokers and stage of change: Implications for treatment interventions. Drug and Alcohol Dependence. 2004; 76:143–151.10.1016/j.drugalcdep.2004.04.017 [PubMed: 15488338]

Prochaska JJ, Velicer WF, Prochaska JO, Delucchi K, Hall SM. Comparing intervention outcomes in smokers treated for single versus multiple behavioral risks. Health Psychology. 2006; 25:380–388.10.1037/0278-6133.25.3.380 [PubMed: 16719610]

Prochaska JO. Multiple health behavior research represents the future of preventive medicine. Preventive Medicine. 2008; 46:281–285.10.1016/j.ypmed.2008.01.015 [PubMed: 18319100]

Prochaska JO, Butterworth S, Redding CA, Burden V, Perrin N, Leo M, et al. Prochaska JJ. Initial efficacy of MI, TTM tailoring and HRIs with multiple behaviors for employee health promotion. Preventive Medicine. 2008; 46:226–231.10.1016/j.ypmed.2007.11.007 [PubMed: 18155287]

Prochaska JO, DiClemente CC. Stages and processes of self-change of smoking: Toward an integrative model of change. Journal of Consulting and Clinical Psychology. 1983; 51:390–395.10.1037/0022-006X.51.3.390 [PubMed: 6863699]

Prochaska JO, Velicer WF, Rossi JS, Redding CA, Greene GW, Rossi SR, et al. Plummer BA. Multiple risk expert systems interventions: Impact of simultaneous stage-matched expert system interventions for smoking, high-fat diet, and sun exposure in a population of parents. Health Psychology. 2004; 23:503–516.10.1037/0278-6133.23.5.503 [PubMed: 15367070]
Pronk NP, Anderson LH, Crain AL, Martinson BC, O’Connor PJ, Sherwood NE, Whitebird RR. Meeting recommendations for multiple healthy lifestyle factors. Prevalence, clustering, and predictors among adolescent, adult, and senior health plan members. American Journal of Preventive Medicine. 2004; 27:25–33.10.1016/j.amepre.2004.04.022 [PubMed: 15275671]

Salsberry PJ, Chips E, Kennedy C. Use of general medical services among Medicaid patients with severe and persistent mental illness. Psychiatric Services. 2005; 56:458–462.10.1176/appi.ps.56.4.458 [PubMed: 15812097]

Schane RE, Ling PM, Glantz SA. Health effects of light and intermittent smoking. Circulation. 2010; 121:1518–1522.10.1161/CIRCULATIONAHA.109.904235 [PubMed: 2036531]

Sokal J, Messiaen E, Dickerson FB, Kreyenbuhl J, Brown CH, Goldberg RW, Dixon LB. Comorbidity of medical illnesses among adults with serious mental illness who are receiving community psychiatric services. Journal of Nervous and Mental Disease. 2004; 192:421–427.10.1097/01.nmd.0000130135.78017.96 [PubMed: 15167405]

Spring B, Pagoto S, Pingitore R, Doran N, Schneider K, Hedeker D. Randomized controlled trial for behavioral smoking and weight control treatment: Effect of concurrent versus sequential intervention. Journal of Consulting and Clinical Psychology. 2004; 72:785–796.10.1037/0022-006X.72.5.785 [PubMed: 15482037]

Stanton, MW. Rockville, MD: Agency for Healthcare Research and Quality; 2006. The high concentration of US health care expenditures. Contract No. 19Retrieved from http://www.ahrq.gov/research/ria19/expendria.htm

Tsoi DT, Porwal M, Webster AC. Interventions for smoking cessation and reduction in individuals with schizophrenia. Cochrane Database of Systematic Reviews. 2010; 2010 Article No. CD007253. 10.1002/14651858.CD007253.pub2

Unger J. Stages of change of smoking cessation: Relationships with other health behaviors. American journal of Preventive Medicine. 1996; 12:134–138. [PubMed: 8777067]

United States Department of Health & Human Services. Healthy People 2020. 2010. Retrieved from http://www.healthypeople.gov/2020/topicsobjectives2020/pdfs/HP2020objectives.pdf

United States Department of Health and Human Services Administration. Report to Congress on the prevention and treatment of co-occurring substance abuse disorders and mental disorders. Washington, DC: U.S. Department of Health and Human Services; 2002.

Ussher MH, Taylor A, Faulkner G. Exercise interventions for smoking cessation. Cochrane Database of Systematic Reviews. 2012; 2012 Article No.CD002295. 10.1002/14651858.CD002295.pub4

Vancampfort D, Knapen J, Probst M, van Winkel R, De Hert M. Considering a frame of reference for physical activity research related to the cardiometabolic risk profile in schizophrenia. Psychiatry Research. 2010; 177:271–279.10.1016/j.psychres.2010.03.011 [PubMed: 20406713]
Velicer WF, Fava JL, Prochaska JO, Abrams DB, Emmons KM, Pierce JP. Distribution of smokers by stage in three representative samples. Preventive Medicine. 1995; 24:401.10.1006/pmed.1995.1065 [PubMed: 7479632]

Ware J Jr, Kosinski M, Keller SD. A 12-Item short-form health survey: Construction of scales and preliminary tests of reliability and validity. Medical Care. 1996; 34:220–233.10.1097/00005650-199603000-00003 [PubMed: 8628042]

Watkins KE, Burnam A, Kung FY, Paddock S. A national survey of care for persons with co-occurring mental and substance use disorders. Psychiatric Services. 2001; 52:1062–1068.10.1176/appi.ps.52.8.1062 [PubMed: 11474052]

Xu WH, Zhang XL, Gao YT, Xiang YB, Gao LF, Zheng W, Shu XO. Joint effect of cigarette smoking and alcohol consumption on mortality. Preventive Medicine. 2007; 45:313–319.10.1016/j.ypmed.2007.05.015 [PubMed: 17628652]
Figure 1.
Conditional response probabilities for 3-class solution (% at risk). \textit{Note}. ALC (alcohol), MJ (marijuana), STIM (stimulants), OPIAT (nonprescribed opiates), HF DIET (high-fat diet), FV (fruit and vegetable consumption), EXERC (inactivity), SLEEP (poor sleep hygiene), STRESS (poor stress management), DEPR (poor depression prevention). See the online article for the color version of this figure.
Table 1
Percent of Sample at Risk and Among Those at Risk, the Percent Prepared to Change, Ordered by Frequency, Most to Least

| Behavior            | % At risk | Behavior               | % Prepared to change |
|---------------------|-----------|------------------------|----------------------|
| 1. Tobacco          | 100%      | 1. Depression prevention | 76%                  |
| 2. High-fat diet    | 68%       | 2. Stimulant use        | 74%                  |
| 3. Fruits and vegetables | 67%      | 3. Stress management    | 69%                  |
| 4. Sleep hygiene    | 53%       | 4. Sleep hygiene        | 69%                  |
| 5. Inactivity       | 52%       | 5. Non-Rx opiate use    | 68%                  |
| 6. Marijuana        | 46%       | 6. Binge drinking       | 57%                  |
| 7. Depression prevention | 43%      | 7. Inactivity           | 51%                  |
| 8. Stress management| 42%       | 8. Fruits and vegetables| 46%                  |
| 9. Binge drinking   | 26%       | 9. High-fat diet        | 43%                  |
| 10. Stimulant use   | 22%       | 10. Marijuana           | 23%                  |
| 11. Non-Rx opiate use | 11%     | 11. Tobacco             | 23%                  |

Note. Though recruited as a smoking sample for a tobacco-treatment trial, tobacco use was the behavior participants were the least prepared to change in the next 30 days.
Table 2
Fit Statistics and Entropy for Latent Class Models of Classes 2–5

| Classes | BIC    | LMR p values | % Smallest class | Entropy |
|---------|--------|--------------|------------------|---------|
| 2       | 7751.5 | < .001       | 49               | .67     |
| 3       | 7729.3 | .001         | 11               | .70     |
| 4       | 7768.1 | .1260        | 3                | .73     |
| 5       | 7811.6 | .6462        | 3                | .67     |

Note. LMR = Lo-Mendell-Rubin Likelihood Ratio; BIC = Bayesian Information Criterion.
Table 3
Sample Characteristics by Latent Class

| Sample characteristics | Class 1 Global higher risk OR, n = 76 | Class 2 Global lower risk OR, n = 343 | Class 3 Mood and metabolic risk OR, n = 274 | Overall group Comparison p value |
|------------------------|--------------------------------------|--------------------------------------|-------------------------------------------|---------------------------------|
| Demographic characteristics |                                       |                                       |                                           |                                 |
| Male (%) | 65% | 48% | 49% | .033 |
| Race/Ethnicity (%) |                                       |                                       |                                           |                                 |
| Non-Hispanic White | 43% | 42% | 48% | .035 |
| African American | 33% | 22% | 26% |                   |
| Multiracial/other | 24% | 36% | 26% |                   |
| Marital status (%) |                                       |                                       |                                           |                                 |
| Never married | 72% | 56% | 55% | .033 |
| Divorced/separated/widowed | 13% | 30% | 30% |                   |
| Married/cohabitating | 15% | 14% | 15% |                   |
| Unemployed (%) | 65% | 55% | 61% | ns |
| Income <$10,000 (%) | 43% | 52% | 51% | ns |
| Age | 34.1 (12.9) | 40.0 (13.4) | 39.6 (13.4) | .002 |
| Years of education | 12.8 (2.8) | 13.6 (2.9) | 13.4 (3.2) | ns |
| BMI | 29 (7.0) | 29 (8.0) | 30 (8.0) | ns |
| Unstably housed | 57% | 34% | 37% | .001 |
| Community social status | 4.7 (2.8) | 5.6 (2.7) | 4.2 (2.6) | .001 |
| U.S. social status | 4.2 (2.9) | 4.8 (2.8) | 3.8 (2.5) | .038 |
| Psychiatric characteristics |                                       |                                       |                                           |                                 |
| BASIS-24 scales |                                       |                                       |                                           |                                 |
| Depression | 2.7 (1.0) | 2.2 (1.0) | 2.9 (.9) | .001 |
| Interpersonal | 2.0 (1.0) | 1.7 (1.1) | 1.9 (1.0) | .002 |
| Self-harm | 2.1 (1.3) | 1.1 (1.3) | 1.8 (1.3) | .001 |
| Emotional lability | 2.6 (1.1) | 1.8 (1.2) | 2.3 (1.1) | .001 |
| Psychosis | 1.7 (1.3) | 1.1 (1.1) | 1.3 (1.3) | .001 |
| Substance abuse | 2.1 (.9) | 1.0 (1.0) | 1.3 (1.2) | .001 |
| Summary score | 2.4 (.8) | 1.8 (.7) | 2.3 (.6) | .001 |
| CESD Depression | 20.4 (6.7) | 15.6 (7.8) | 21.3 (6.3) | .001 |
| SF-12 mental health | 30 (13.0) | 36 (15.0) | 26 (11.0) | .001 |
| SF-12 physical health | 50 (12.0) | 47 (13.0) | 45 (13.0) | ns |
| Treatment Episodes: M (IQR) |                                       |                                       |                                           |                                 |
| Inpatient psychiatry | 4 (2.12) | 4 (2.10) | 4 (2.10) | ns |
| Alcohol/drugs | 4 (1.8) | 0 (0.3) | 1 (0.4) | .001 |
| DSM-IV Diagnoses (%) |                                       |                                       |                                           |                                 |
| Unipolar depression | 22% | 26% | 35% | .015 |
| Bipolar depression | 59% | 35% | 45% | .001 |
| Psychotic disorders | 37% | 26% | 20% | .006 |
| Posttraumatic stress disorder | 45% | 34% | 43% | .041 |
### Sample characteristics

|                        | Class 1 Global higher risk OR, n = 76 | Class 2 Global lower risk OR, n = 343 | Class 3 Mood and metabolic risk OR, n = 274 | Overall group Comparison p value |
|------------------------|---------------------------------------|----------------------------------------|---------------------------------------------|---------------------------------|
| Eating disorders       | 7%                                    | 7%                                     | 8%                                          | ns                              |
| Attention-deficit hyperactivity | 45%                                  | 19%                                    | 29%                                         | .001                            |
| Antisocial personality | 42%                                   | 17%                                    | 17%                                         | .001                            |
| Alcohol-use disorder   | 67%                                   | 36%                                    | 38%                                         | .001                            |
| Illicit drug-use disorder | 84%                                 | 41%                                    | 47%                                         | .001                            |
| Number of assessed disorders | 4.1 (1.5)                     | 2.4 (1.6)                              | 2.8 (1.4)                                   | .001                            |

#### Tobacco characteristics

- Usual cigarettes per day
- FTND
- Age first smoked
- Age regular smoker
- Desire to quit
- Perceived success
- Expected difficulty
- Tobacco goal (%)

**Note.** Sample characteristics are reported as M (SD), unless otherwise noted. Scale ranges: CESD-10 (0-30, > 10 significant depressive symptomatology); BASIS-24 (0–4, higher scores indicate greater symptom/problem severity); SF-12 (0–100, national norm = 50, SD = 10, lower scores indicate worse functioning), FTND (0–10, with 1–4 indicating low and 5 indicating moderate nicotine dependence); IQR = interquartile range.