

Brief report

Attenuated Positive Psychotic Symptoms in Relation to Cigarette Smoking in a Nonclinical Population

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Abstract

Introduction: This study explored the association between cigarette smoking and attenuated positive psychotic symptoms in a young adult nonclinical sample.

Methods: Undergraduates ($N = 930$), aged 18–35 years (26.3% male), completed a battery of self-report measures assessing subthreshold psychotic symptoms, cigarette smoking behavior/dependence, and drug use.

Results: Individuals endorsing a greater number of attenuated positive psychotic symptoms were more likely to be smokers. Exploratory analyses indicated that the odds of being a smoker were two times greater for those at potential higher risk for psychosis compared with individuals at lower risk. Results were consistent after adjusting for sex and other drug use.

Conclusions: In line with findings from psychotic populations, results suggest that attenuated positive psychotic symptoms, particularly those endorsed as distressing in a nonclinical, undergraduate population, are related to cigarette smoking.

Implications: Even in nonclinical, undergraduate populations, subthreshold psychotic symptoms are related to cigarette smoking, and cigarette smokers are twice as likely to be considered at potentially higher risk for psychosis compared with noncigarette smokers. In summary, there may be a threshold whereby psychotic symptoms confer increased risk for nicotine consumption, with endorsement of a greater number of distressing subthreshold psychotic symptoms increasing the likelihood of cigarette use.

Introduction

Substantial evidence supports an association between cigarette smoking and psychosis, including higher rates of smoking for individuals with schizophrenia relative to individuals with other mental disorders, and the general population.^{1–13} Individuals with schizophrenia smoke cigarettes containing higher levels of nicotine,^{7,14} experience stronger cigarette cravings, more severe nicotine withdrawal symptoms, higher reinforcing effects of nicotine, they return to smoking sooner compared with smokers without a psychiatric diagnosis (though see reference 15), and they extract more nicotine from cigarettes than

smokers in the general population that have a similar smoking history.^{14,16,17} This association may be because smoking is a risk factor for psychosis, smoking is a form of self-medication from psychosis symptoms, or an unknown third variable leads to both schizophrenia and smoking.¹⁸ It remains unclear whether the entire spectrum of psychotic experiences also is related to cigarette smoking.

To assess the relationship between cigarette smoking and psychotic symptomatology, research investigating the period prior to the onset of psychosis is necessary. Few studies have examined smoking behavior in at-risk for psychosis samples, and no studies

have examined smoking behavior in nonclinical populations that endorse attenuated positive psychotic symptoms (APPS). APPS are subthreshold levels of positive psychotic phenomena (e.g., hallucinatory experiences, unusual thinking, and perceptual abnormalities) that are commonly experienced, generally transitory, and occur in the absence of current substance or alcohol use (e.g., hearing one's name being called when there is no one around) (for further reading see 19,20). Studies suggest that individuals who are later diagnosed with schizophrenia begin smoking cigarettes during their teenage years, prior to the emergence of psychotic symptoms.^{18,21} Further, evidence suggests a positive relationship between number of cigarettes smoked and schizophrenia outcomes (e.g., later hospitalizations for schizophrenia²² and percentage of individuals with a schizophrenia spectrum disorder²³). Further, general population studies have indicated that cigarette smokers have a greater risk of experiencing psychotic symptoms,^{24,25} psychotic-like experiences,^{26,27} and delusional-like experiences²⁸ compared with nonsmokers; however, none of these studies examined nicotine dependence and other characteristics of smoking, or examined differences between distressing and nondistressing symptoms (the former being more indicative of clinical relevance²⁹).

The aim of the current study was to further explore the connection between cigarette smoking and APPS in a young adult, nonclinical sample. To the best of our knowledge, the relationship between smoking status, nicotine dependence, cigarette consumption, and APPS has yet to be studied in this population. We recruited an undergraduate sample, and we predicted (1) that the greater the number of APPS endorsed by an individual, the more likely they are to be a cigarette smoker, and that among cigarette smokers, a greater number of APPS would be associated with (2) greater levels of nicotine dependence and (3) heavier nicotine consumption. An exploratory aim was to determine whether these predictions remained consistent in those at potentially higher risk for psychosis compared with individuals at lower risk. However, these findings are preliminary, as our clinical high-risk measure has only been associated with increased risk for psychosis in clinical samples.¹⁹

Methods

Participants

The study, approved by Temple University's Institutional Review Board, included 930 undergraduate students (all of whom provided written informed consent) recruited from a variety of academic disciplines through the university's online research study listing. For inclusion in the study, individuals were between the ages of 18 and 35 years, and all received course credit for their participation. Participants completed a set of self-report measures administered via laboratory computers.

Measures

Positive symptoms from the Prodromal Questionnaire were used to evaluate APPS.¹⁹ Participants were asked whether they experienced various symptoms within the past month, while not under the influence of drugs, alcohol, or other medications (e.g., "I have noticed strange feelings on or just beneath my skin, like bugs crawling"; "I have smelled or tasted things that other people didn't notice"), and for those items endorsed, participants were then asked whether the symptom was distressing. Individuals were dichotomized into potential higher risk (high-D-APPS; endorsing eight or more distressing APPS) and low risk (low-D-APPS; endorsing three or

fewer distressing APPS, the mean number of distressing APPS in our sample) for psychosis. This dichotomous variable allows for examination of a more clinically meaningful measure, the cutoffs were based on previous protocol,^{30,31} and comparison of potential higher/lower risk groups mirrors literature on individuals at clinical high risk for psychosis, with first episode psychosis, and schizophrenia, which typically focus on comparing these clinical groups with healthy control groups.¹⁵⁻¹⁷ Endorsing eight or more distressing APPS has achieved high sensitivity and specificity in classifying high risk for psychosis cases identified using the Structured Interview for Psychosis-Risk Syndromes²⁰ in clinical samples,¹⁹ and 2% of an undergraduate sample met this criterion in a previous study (corresponding to approximate rates of those at risk for psychosis in the general population).^{32,33}

The Cigarette Dependence Scale (CDS-12)³⁴ assessed nicotine dependence and has established reliability and validity³⁵ (alpha for the current sample was .93). Smoking status (i.e., smoker or nonsmoker), nicotine dependence (total score, ranging from the lowest score/low dependence [12] to highest score/high dependence [60]), and nicotine consumption (average number of cigarettes smoked per day) were used in the present study.

The Drug Use Frequency measure (DUF)³⁶ was used to assess substance use within the past 3 months and demonstrates adequate concurrent validity.³⁷ Drugs related to the independent or dependent variables were dichotomized into one variable that represented no use (defined as never used, categorized as "0") and any use (defined as once or twice, several times a month, several times a week, or daily use, categorized as "1") and served as potential covariates in analyses. Drug categories that were explored as potential covariates included tranquilizers, amphetamines, barbiturates, marijuana, heroin, synthetic narcotics, and other narcotics.

Statistical Analyses

Sex, age, and other drug use were explored as potential covariates. Statistical analyses addressed the following predictions:

1. The greater the number of APPS, the more likely an individual is to be cigarette smoker, tested via logistic regression.
2. APPS scores will be positively associated with higher nicotine dependence, tested via linear regression.
3. APPS scores will be positively associated with total number of cigarettes consumed, tested via linear regression.
4. Exploratory analyses will test whether the results from predictions 1–3 persist when analyzing the D-APPS dichotomous variable, tested via linear/logistic regression.

Results

See Table 1 for demographics of the sample, as well as for smokers and nonsmokers. Sex was included as a covariate in analyses with the APPS and/or smoking status variable, as males were significantly more likely to be smokers ($p = .001$) and reported a greater number of APPS ($p < .05$), compared with females. Drugs included in the overall drug use variable were tranquilizers, amphetamines, barbiturates, marijuana, synthetic, and other narcotics. Analyses were run with and without covariates.

As Table 2 indicates, individuals who endorsed a greater number of APPS were more likely to be smokers, and this held after adjusting for sex and other drug use (OR = 1.04, $p = .003$). However, APPS were not related to higher nicotine dependence or average number of

Table 1. Demographics and Questionnaire Scores for Overall Sample

| | Overall sample | Smokers | Nonsmokers |
|---|--------------------|---------------------|--------------------|
| | (N = 930) | (n = 102) | (n = 828) |
| Demographics | | | |
| Male, n (%) | 245 (26.3) | 41 (40.2) | 204 (24.6) |
| Age (years), mean (SD) [range] | 20.5 (2.5) [18–35] | 21.0 (2.2) [18–30] | 20.5 (2.5) [18–35] |
| Race, n (%) | | | |
| Non-Hispanic White | 556 (59.7) | 76 (74.5) | 480 (58.0) |
| African-American | 114 (12.2) | 6 (5.9) | 108 (13.0) |
| Asian/Pacific Islander | 121 (13.1) | 8 (7.8) | 113 (13.6) |
| Hispanic/Latino | 35 (3.8) | 4 (3.9) | 31 (3.7) |
| Other | 104 (11.3) | 8 (7.8) | 96 (11.6) |
| Cigarette dependence score, mean (SD) [range] | — | 30.5 (12.0) [12–56] | — |
| Cigarettes smoked per day, ^a mean (SD) [range] | — | 5.8 (4.7) [0–20] | — |
| APPS, mean (SD) [range] | 8.9 (7.1) [0–37] | 11.6 (8.8) [0–34] | 8.5 (6.8) [0–37] |
| D-APPS status, ^b n (%) | | | |
| Low-D-APPS | 496 (53.3) | 42 (41.2) | 454 (54.8) |
| High-D-APPS | 120 (12.9) | 24 (23.5) | 96 (11.6) |

APPS = attenuated positive psychotic symptoms.

Percentages in each column represent total sample size of that column.

^aCigarettes smoked per day reflects raw number, analyses reflect categorization in which 0–5 cigarettes = 1; 6–10 cigarettes = 2; 11–20 cigarettes = 3; 21–29 cigarettes = 4; and 30+ cigarettes = 5.

^bn = 616 for individuals in both high- and low-D-APPS groups, excluding individuals scoring in the middle; low-D-APPS represents individuals who endorsed three or fewer distressing APPS and high-D-APPS represents individuals who endorsed eight or more distressing APPS; cutoffs based on previous literature.^{29,30,32,33}

Table 2. Unadjusted and Adjusted Regression and Logistic Regression Models Examining the Relation Between Cigarette Smoking Variables and APPS/D-APPS

| | APPS | | | | | D-APPS status ^a | | | | |
|--------------------------------------|---------|--------|-------|---------|-----------------------------|----------------------------|--------|-------|---------|-----------------------------|
| | β | B | SE | p | OR [CI] | β | B | SE | p | OR ^c [CI] |
| Unadjusted models | | | | | | | | | | |
| Prediction 1: Smokers vs. Nonsmokers | — | — | — | <.001** | 1.055 [1.027, 1.081] | — | — | — | <.001** | 2.702 [1.564, 4.669] |
| Prediction 2: Nicotine dependence | 0.026 | 0.036 | 0.137 | .795 | — | 0.008 | 0.202 | 3.224 | .95 | — |
| Prediction 3: Number of cigarettes | –0.052 | –0.004 | 0.008 | .602 | — | –0.149 | –0.202 | 0.168 | .234 | — |
| Adjusted models ^b | | | | | | | | | | |
| Prediction 1: Smokers vs. Nonsmokers | — | — | — | .003* | 1.042 [1.013, 1.071] | — | — | — | .004* | 2.313 [1.313, 4.077] |
| Prediction 2: Nicotine dependence | 0.047 | 0.064 | 0.145 | .660 | — | 0.024 | 0.607 | 3.471 | .917 | — |
| Prediction 3: Number of cigarettes | –0.040 | –0.003 | 0.008 | .704 | — | –0.167 | –0.227 | 0.181 | .214 | — |

β = standardized coefficient; APPS = attenuated positive psychotic symptoms; B = unstandardized coefficient; CI = confidence interval for the unstandardized (B) coefficients; OR = odds ratio; SE = standard error. Values in bold represent statistical significance.

^aD-APPS status represents low-D-APPS (individuals who endorsed three or fewer distressing APPS) and high-D-APPS (individuals who endorsed eight or more distressing APPS); cutoffs based on previous literature.^{20,30,31,33}

^bModel adjusted for sex and other drug use.

^cOdds of being classified at high-D-APPS status in the context of being a smoker.

* $p < .05$. ** $p < .001$.

cigarettes smoked. For exploratory analyses, logistic regression indicated that the odds of being high-D-APPS among smokers were two times as great as the odds of being high-D-APPS among nonsmokers (see Table 2), and this held when controlling for sex and other drug use (OR = 2.31, $p = .004$). D-APPS status was not related to nicotine dependence or average number of cigarettes smoked.

Discussion

This is the first study to examine whether cigarette smoking and nicotine dependence are related to endorsement of APPS in a nonclinical, undergraduate population. Similar to studies evaluating individuals diagnosed with psychotic disorders,³⁸ our sample showed evidence

of a relationship between cigarette smoking status and subthreshold psychotic symptoms. However, our sample did not support a relationship between increased cigarette consumption (i.e., number of cigarettes smoked daily) or nicotine dependence as a function of psychotic symptoms. Exploratory analyses indicated that smokers were twice as likely to be classified as high-D-APPS (potential higher risk for psychosis) compared with nonsmokers, even when accounting for sex and drug use. Findings suggest that cigarette smoking may be associated with experiencing APPS, as well as with experiencing distressing APPS, a potentially more clinically meaningful variable. Indeed, while approximately 12% of nonsmokers were considered to be at a potential higher risk for psychosis, almost 24% of smokers were at potentially higher risk for psychosis. Although we are unable

to determine explanations for these findings or the temporal nature of this relationship, it is a possibility that individuals experiencing a higher number of APPS, or who may be at higher risk for psychosis, either smoke cigarettes as a method of coping with their symptoms or smoking could be related to worsening of psychotic symptoms.

There are several potential explanations for our findings and some differing results between our nonclinical sample and clinical populations. First, individuals diagnosed with psychotic disorders may have higher rates of cigarette smoking due to the pharmacological effects of antipsychotic medications.^{39,40} Specifically, certain antipsychotics work by blocking dopamine D2 receptors, thereby reducing the level of dopamine in the brain. Individuals with schizophrenia may be more likely to use cigarettes to replenish dopamine levels that were previously reduced by antipsychotic use.^{41,42} Therefore, nonclinical populations, such as ours, may not have as strong an incentive to smoke cigarettes. Second, increased cigarette consumption by clinical psychosis populations may be to alleviate extrapyramidal side effects from antipsychotic medications.^{11,41,43,44}

Third, there is substantial evidence to suggest that the high percentage of cigarette smoking found in individuals with schizophrenia may be an attempt to alleviate sensory processing deficits, cognitive deficits, and negative symptoms associated with the disorder.^{41,45-52} Although cognitive deficits may precede the onset of schizophrenia,^{53,54} the current sample may just have begun experiencing symptoms of psychopathology, or may not yet be experiencing notable cognitive difficulties or negative symptoms, and very few are currently prescribed an antipsychotic medication. Thus, there is a possibility that as severity of symptoms and cognitive difficulties progress, risk of smoking increases. Study limitations include the exploratory nature of the dichotomized D-APPS variable and the nonspecific measurement of individuals' level of nicotine consumption (i.e., no specific metric measurement of participant nicotine intake). Although it is important that our study found evidence of a relationship between cigarette smoking status and APPS in an undergraduate sample, who traditionally smoke fewer cigarettes compared with their noncollege peers,⁵⁵ the results should be replicated in other nonclinical populations that are not isolated to undergraduates in order to improve generalizability. It is also possible that limited power reduced our ability to detect findings between smokers and nonsmokers, as there were only 42 and 24 smokers identified as low- and high-D-APPS status, respectively. Further, our cross-sectional data cannot determine causality, and there is the potential that nicotine consumption may be operating in inverse order or simultaneously with APPS/D-APPS status. Future research should utilize a longitudinal design, as well as a more accurate measure of nicotine consumption, potentially by measuring cotinine levels via plasma nicotine concentration, and/or collecting data on cigarette brand.⁵⁶ An additional limitation is the possibility that some study participants did not identify as a smoker because they were light or nondaily smokers. Finally, approximately 13% of our sample met criteria for high-D-APPS, whereas it isolated 2% of an undergraduate sample in another study.³³ This discrepancy may be attributed to differences in the demographic characteristics between the two undergraduate samples, in addition to the possibility that our rate includes false positives. In subsequent undergraduate studies, high-D-APPS rates have been closer to what is reported in our study,^{30,31} and some have higher rates.⁵⁷ Further, while the prevalence rate of those at risk for psychosis in the general population is presently unknown, it may be closer to 13% than 2%, given that 5%–7% of the population has received a lifetime diagnosis of a psychotic disorder.

Strengths of the current study include the dimensional measure of psychotic symptoms and use of a nonclinical sample. Measuring psychotic symptoms on a continuum may provide new insights into risk factors. Further, there are shared mechanisms between clinical and nonclinical psychosis,⁵⁸ which highlight the importance of continuing to examine nonclinical populations.

Findings suggest a relationship between cigarette smoking status and psychotic symptoms and that endorsement of a greater number of distressing APPS is associated with increased odds of being a cigarette smoker.

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Declaration of Interests

None declared.

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References

- Lasser K, Boyd JW, Woolhandler S, Himmelstein DU, McCormick D, Bor DH. Smoking and mental illness: a population-based prevalence study. *JAMA*. 2000;284(20):2606–2610.
- de Leon J, Tracy J, McCann E, McGrory A, Diaz FJ. Schizophrenia and tobacco smoking: a replication study in another US psychiatric hospital. *Schizophr Res*. 2002;56(1-2):55–65.
- McCreddie RG, Scottish Schizophrenia Lifestyle Group. Diet, smoking and cardiovascular risk in people with schizophrenia. *Br J Psychiatry*. 2003;183(6):534–539.
- Ziedonis D, Hitsman B, Beckham JC, et al. Tobacco use and cessation in psychiatric disorders: National Institute of Mental Health report. *Nicotine Tob Res*. 2008;10(12):1691–1715.
- Glassman AH. Cigarette smoking: implications for psychiatric illness. *Am J Psychiatry*. 1993;150(4):546–553.
- de Leon J, Dadvand M, Canuso C, White AO, Stanilla JK, Simpson GM. Schizophrenia and smoking: an epidemiological survey in a state hospital. *Am J Psychiatry*. 1995;152(3):453–455.
- Uçok A, Polat A, Bozkurt O, Meteris H. Cigarette smoking among patients with schizophrenia and bipolar disorders. *Psychiatry Clin Neurosci*. 2004;58(4):434–437.
- Dalack GW, Becks L, Hill E, Pomerleau OF, Meador-Woodruff JH. Nicotine withdrawal and psychiatric symptoms in cigarette smokers with schizophrenia. *Neuropsychopharmacology*. 1999;21(2):195–202.
- Hughes JR, Hatsukami DK, Mitchell JE, Dahlgren LA. Prevalence of smoking among psychiatric outpatients. *Am J Psychiatry*. 1986;143(8):993–997.
- Strassnig M, Brar JS, Ganguli R. Increased caffeine and nicotine consumption in community-dwelling patients with schizophrenia. *Schizophr Res*. 2006;86(1-3):269–275.
- Goff DC, Henderson DC, Amico E. Cigarette smoking in schizophrenia: relationship to psychopathology and medication side effects. *Am J Psychiatry*. 1992;149(9):1189–1194.
- de Leon J, Diaz FJ, Rogers T, Browne D, Dinsmore L. Initiation of daily smoking and nicotine dependence in schizophrenia and mood disorders. *Schizophr Res*. 2002;56(1-2):47–54.
- Kelly C, McCreddie RG. Smoking habits, current symptoms, and premorbid characteristics of schizophrenic patients in Nithsdale, Scotland. *Am J Psychiatry*. 1999;156(11):1751–1757.

14. Olincy A, Young DA, Freedman R. Increased levels of the nicotine metabolite cotinine in schizophrenic smokers compared to other smokers. *Biol Psychiatry*. 1997;42(1):1–5.
15. Tidey JW, Colby SM, Xavier EM. Effects of smoking abstinence on cigarette craving, nicotine withdrawal, and nicotine reinforcement in smokers with and without schizophrenia. *Nicotine Tob Res*. 2014;16(3):326–334.
16. Williams JM, Gandhi KK, Lu S, et al. Nicotine levels in schizophrenia compared with controls after smoking a single cigarette. *Nicotine Tob Res*. 2010;12(8):855–859.
17. Strand JE, Nybäck H. Tobacco use in schizophrenia: a study of cotinine concentrations in the saliva of patients and controls. *Eur Psychiatry*. 2005;20(1):50–54.
18. Kelly C, McCreadie R. Cigarette smoking and schizophrenia. *Adv Psychiatric Treat*. 2000;6(5):327–331.
19. Loewy RL, Bearden CE, Johnson JK, Raine A, Cannon TD. The prodromal questionnaire (PQ): preliminary validation of a self-report screening measure for prodromal and psychotic syndromes. *Schizophr Res*. 2005;79(1):117–125.
20. Loewy RL, Therman S, Manninen M, Huttunen MO, Cannon TD. Prodromal psychosis screening in adolescent psychiatry clinics. *Early Interv Psychiatry*. 2012;6(1):69–75.
21. Corvin A, O'Mahony E, O'Regan M, et al. Cigarette smoking and psychotic symptoms in bipolar affective disorder. *Br J Psychiatry*. 2001;179:35–38.
22. Weiser M, Reichenberg A, Grotto I, et al. Higher rates of cigarette smoking in male adolescents before the onset of schizophrenia: a historical-prospective cohort study. *Am J Psychiatry*. 2004;161(7):1219–1223.
23. Sorensen HJ, Mortensen EL, Reinisch JM, Mednick SA. A prospective study of smoking in young women and risk of later psychiatric hospitalization. *Nord J Psychiatry*. 2011;65(1):3–8.
24. Wiles NJ, Zammit S, Bebbington P, Singleton N, Meltzer H, Lewis G. Self-reported psychotic symptoms in the general population: results from the longitudinal study of the British National Psychiatric Morbidity Survey. *Br J Psychiatry*. 2006;188:519–526.
25. Degenhardt L, Hall W. The association between psychosis and problematic drug use among Australian adults: findings from the National Survey of Mental Health and Well-Being. *Psychol Med*. 2001;31(4):659–668.
26. Mackie CJ, Castellanos-Ryan N, Conrod PJ. Developmental trajectories of psychotic-like experiences across adolescence: impact of victimization and substance use. *Psychol Med*. 2011;41(1):47–58.
27. van Gastel WA, MacCabe JH, Schubart CD, et al. Cigarette smoking and cannabis use are equally strongly associated with psychotic-like experiences: a cross-sectional study in 1929 young adults. *Psychol Med*. 2013;43(11):2393–2401.
28. Saha S, Scott JG, Varghese D, Degenhardt L, Slade T, McGrath JJ. The association between delusional-like experiences, and tobacco, alcohol or cannabis use: a nationwide population-based survey. *BMC Psychiatry*. 2011;11:202.
29. van Os J, Linscott RJ, Myin-Germeys I, Delespaul P, Krabbendam L. A systematic review and meta-analysis of the psychosis continuum: evidence for a psychosis proneness-persistence-impairment model of psychotic disorder. *Psychol Med*. 2009;39(2):179–195.
30. Gibson LE, Anglin DM, Klugman JT, et al. Stress sensitivity mediates the relationship between traumatic life events and attenuated positive psychotic symptoms differentially by gender in a college population sample. *J Psychiat Res*. 2014;53:111–118.
31. Reeves LE, Anglin DM, Heimberg RG, et al. Anxiety mediates the association between cannabis use and attenuated positive psychotic symptoms. *Psychiat Res*. 2014;218:180–186.
32. Miller TJ, McGlashan TH, Rosen JL, et al. Prospective diagnosis of the initial prodrome for schizophrenia based on the Structured Interview for Prodromal Syndromes: preliminary evidence of interrater reliability and predictive validity. *Am J Psychiatry*. 2002;159(5):863–865.
33. Loewy RL, Johnson JK, Cannon TD. Self-report of attenuated psychotic experiences in a college population. *Schizophr Res*. 2007;93(1-3):144–151.
34. Stavem K, Røgeberg OJ, Olsen JA, Boe J. Properties of the Cigarette Dependence Scale and the Fagerström Test of Nicotine Dependence in a representative sample of smokers in Norway. *Addiction*. 2008;103(9):1441–1449.
35. Etter JF, Le Houezec J, Perneger TV. A self-administered questionnaire to measure dependence on cigarettes: the cigarette dependence scale. *Neuropsychopharmacology*. 2003;28(2):359–370.
36. O'Farrell TJ, Fals-Stewart W, Murphy M. Concurrent validity of a brief self-report Drug Use Frequency measure. *Addict Behav*. 2003;28(2):327–337.
37. Sobell LC, Sobell MB. Timeline Followback user's guide: a calendar method for assessing alcohol and drug use. Toronto, ON: Ontario Addiction Research Foundation; 1996.
38. Compton MT, Kelley ME, Ramsay CE, et al. Association of pre-onset cannabis, alcohol, and tobacco use with age at onset of prodrome and age at onset of psychosis in first-episode patients. *Am J Psychiatry*. 2009;166(11):1251–1257.
39. Schilström B, Rawal N, Mamedi-Engvall M, Nomikos GG, Svensson TH. Dual effects of nicotine on dopamine neurons mediated by different nicotinic receptor subtypes. *Int J Neuropsychopharmacol*. 2003;6(1):1–11.
40. de Haan L, Booij J, Lavalaye J, van Amelsvoort T, Linszen D. Occupancy of dopamine D2 receptors by antipsychotic drugs is related to nicotine addiction in young patients with schizophrenia. *Psychopharmacology (Berl)*. 2006;183(4):500–505.
41. Winterer G. Why do patients with schizophrenia smoke? *Curr Opin Psychiatry*. 2010;23(2):112–119.
42. Glynn SM, Sussman S. Why patients smoke. *Psychiatr Serv*. 1990;41(9):1027–1028.
43. Anfang MK, Pope HG. Treatment of neuroleptic-induced akathisia with nicotine patches. *Psychopharmacology*. 1997;134(2):153–156.
44. Yang YK, Nelson L, Kamaraju L, Wilson W, McEvoy JP. Nicotine decreases bradykinesia-rigidity in haloperidol-treated patients with schizophrenia. *Neuropsychopharmacology*. 2002;27(4):684–686.
45. Adler LE, Olincy A, Waldo M, et al. Schizophrenia, sensory gating, and nicotinic receptors. *Schizophr Bull*. 1998;24(2):189–202.
46. Olincy A, Ross RG, Young DA, Roath M, Freedman R. Improvement in smooth pursuit eye movements after cigarette smoking in schizophrenic patients. *Neuropsychopharmacology*. 1998;18(3):175–185.
47. Kumari V, Soni W, Sharma T. Influence of cigarette smoking on pre-pulse inhibition of the acoustic startle response in schizophrenia. *Hum Psychopharmacol Clin Exp*. 2001;16(4):321–326.
48. Smith RC, Singh A, Infante M, Khandat A, Kloos A. Effects of cigarette smoking and nicotine nasal spray on psychiatric symptoms and cognition in schizophrenia. *Neuropsychopharmacology*. 2002;27(3):479–497.
49. Rezvani AH, Levin ED. Cognitive effects of nicotine. *Biol Psychiatry*. 2001;49(3):258–267.
50. Levin ED, Rezvani AH. Nicotinic treatment for cognitive dysfunction. *Curr Drug Targets CNS Neurol Disord*. 2002;1(4):423–431.
51. Gray JA, Mitchell SN, Joseph MH, Grigoryan GA, Dawe A, Hodges H. Neurochemical mechanisms mediating the behavioral and cognitive effects of nicotine. *Drug Develop Res*. 1994;31(1):3–17.
52. Sacco KA, Termine A, Seyal A, et al. Effects of cigarette smoking on spatial working memory and attentional deficits in schizophrenia: involvement of nicotinic receptor mechanisms. *Arch Gen Psychiatry*. 2005;62(6):649–659.
53. Niendam TA, Bearden CE, Johnson JK, et al. Neurocognitive performance and functional disability in the psychosis prodrome. *Schizophr Res*. 2006;84(1):100–111.
54. Lencz T, Smith CW, McLaughlin D, et al. Generalized and specific neurocognitive deficits in prodromal schizophrenia. *Biol Psychiatry*. 2006;59(9):863–871.
55. Johnston LD, O'Malley PM, Bachman JG, Schulenberg JE, Miech RA. *Monitoring the Future National Survey Results on Drug Use, 1975–2014. Vol. 2. College students and adults ages 19–55*. Ann Arbor, MI: Institute for Social Research, The University of Michigan.
56. Jacobsen LK, D'Souza DC, Mencl WE, Pugh KR, Skudlarski P, Krystal JH. Nicotine effects on brain function and functional connectivity in schizophrenia. *Biol Psychiatry*. 2004;55(8):850–858.
57. Anglin DM, Lighty Q, Greenspoon M, Ellman LM. Racial discrimination is associated with distressing subthreshold positive psychotic symptoms among US urban ethnic minority young adults. *Soc Psychiatry Psychiatr Epidemiol*. 2014;49(10):1545–1555.
58. Kelleher I, Cannon M. Psychotic-like experiences in the general population: characterizing a high-risk group for psychosis. *Psychol Med*. 2011;41(1):1–6.