Original Investigation

Course of comorbidity of tobacco and marijuana use: Psychosocial risk factors

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Abstract

Introduction: This longitudinal study examined the psychosocial factors associated with the comorbidity of pairs of tobacco and marijuana use trajectories from adolescence extending into adulthood in two ethnic groups, Blacks and Puerto Ricans.

Methods: Data on psychosocial functioning and tobacco and marijuana use at four points in time were obtained.

Results: The association between the trajectories of tobacco and marijuana use was quite high. Pairs of comorbid trajectories of tobacco and marijuana use may share at least three kinds of influence: (a) a constellation of externalizing personality risk factors, (b) Depressive Mood and low Ego Integration, and (c) identification with certain group values.

Discussion: Knowledge of the risk and protective factors for pairs of comorbid trajectories of use may strengthen the foundation for individual and group targets for prevention and treatment programs.

Introduction

There is a wealth of data supporting the relationship between tobacco and marijuana use (Lai, Lai, Page, & McCoy, 2000; Richter et al., 2004). An estimated 9.5 million Americans (Office of Applied Studies, 2008) currently smoke both substances nationwide. Comorbidity of the two substances is significant in that, in addition to the separate effects of tobacco and marijuana use on psychosocial functioning (Hall, Degenhardt, & Lynskey, 2002; Mathers, Toumbourou, Catalano, Williams, & Patton, 2006), concurrent use of these substances can have a cumulative effect on physical functioning (e.g., chronic pulmonary problems, Taylor et al., 2002). Thus, the adverse consequences of comorbid substance use present significant public health concerns. Accordingly, it is important to identify the psychosocial indicators, which persist over time, of comorbid tobacco and marijuana use.

This is one of the first studies designed to address the important issue of predictors of specific comorbidities in patterns

of use, or trajectories, of these substances. The research is unique in that it covers a wide developmental span from early adolescence to adulthood and studies the comorbidities in the understudied population of Puerto Ricans and Blacks. Furthermore, the psychosocial variables associated with pairs of comorbid trajectories of tobacco and marijuana use are related to five important domains in an individual's life, including the individual's personality attributes and social network. Understanding the relationship of these domains to pairs of comorbid trajectories of use is essential to improve treatment programs.

A small number of studies have focused on the relationship between trajectories of use of different substances (e.g., Flory, Lynam, Milich, Leukefeld, & Clayton, 2004; Orlando, Tucker, Ellickson, & Klein, 2005). Jackson, Sher, and Schulenberg (2008), using a large national sample, followed individuals from late adolescence to adulthood and identified five trajectories of tobacco use and four trajectories of marijuana use. Among 20 possible pairs of trajectories of comorbid tobacco and marijuana use, 7 occurred more frequently than expected. In order to isolate predictors of pairs of such comorbid trajectories of tobacco and marijuana use, Jackson et al. first identified factors that were common to trajectories of use of both substances.

A number of important influences on trajectories of substance use have been described in Family Interactional Theory (FIT). FIT (Brook, Brook, Gordon, Whiteman, & Cohen, 1990) is a multidimensional theory of the developmental pathways to substance use and other problem behaviors. The model incorporates interrelated domains, which function as proximal and distal influences on the individual's behavior, namely components of the individual's personality (e.g., Ego Integration, Depressive Mood, Risk Taking, Rebellion, Delinquency), social influences (e.g., Religious Attendance, Peer Deviance, Peer Substance Use), parent personality and parenting, and ecology. These domains are linked to substance use and other problem behaviors via three primary mechanisms: social modeling, parent-child attachment, and identification with values and behaviors as a result of the attachment relationship between parents and child.

Studies have found that psychosocial variables such as Sensation Seeking, Depressive Symptoms, Delinquency, Religious Attendance, and Peer Substance Use are significantly related to

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trajectories of use of a single substance (Brown, Flory, Lynam, Leukefeld, & Clayton, 2004; Windle & Wiesner, 2004). We add to this line of research by examining the associations of many such factors from the personality and social influence domains of FIT with pairs of comorbid trajectories of tobacco and marijuana use. Though little research has been done on the role of peer factors in predicting comorbid trajectories of use of these substances, the link between peer behavior and the individual's substance use (Hoffman, Monge, Chou, & Valente, 2007) and trajectories of use of a single substance (Windle & Wiesner) is likely to extend to comorbid trajectories of tobacco and marijuana use.

Our research builds on the work of Jackson et al. (2008) in two important ways. First, in addition to examining late adolescent through adult stages of development, we are also examining early adolescence, a critical developmental period. Second, we examine two understudied minority populations, namely Puerto Ricans and Blacks, living in an urban area.

We propose the following hypotheses: (a) There will be comorbidity between the trajectories of tobacco and of marijuana use. (b) The comorbidity of pairs of trajectories of tobacco and marijuana use will be accounted for, in part, by internalizing problems, such as Depressive Mood and low Ego Integration. (c) The comorbidity of pairs of trajectories of tobacco and marijuana use will be accounted for, in part, by externalizing problems, such as Delinquency, Risk Taking, and Rebellion. (d) The comorbidity of pairs of trajectories of tobacco and marijuana use will be accounted for, in part, by peer influences, such as Peer Deviance, Peer Tobacco, and Peer Marijuana Use.

Methods

Sample and procedure

Data are from a four-wave longitudinal study of Black and Puerto Rican adolescents and adults. The time 1 (T1) data were collected in 1990 and the majority of the time 2 (T2), time 3 (T3), and time 4 (T4) data were collected in 1994, 2000, and 2002, respectively. The study's procedures for data collection were Institutional Review Board approved. Participants at T1 ($N = 1,331$) came from Grades 7–10 in 11 schools serving the East Harlem area of New York City. The T1 data collection took place in classrooms, while the T2, T3, and T4 data were collected primarily via in-person home interviews. The T2 response rate was 89% of those who participated at T1. Because of budget limitations, the T3 data collection was a subsample of the T2 sample (T3 $N = 660$). To ensure sufficient N s on our dependent variables, we oversampled respondents who reported using marijuana and/or having a child at T2. At T4, again due to budget restrictions, we took a subsample of the T3 participants (T4 $N = 475$). As the T4 data collection emphasized tobacco use, smokers were oversampled. The 475 participants present at T4 were used in the trajectory analyses in this paper.

We ran three sets of comparisons: those interviewed at T1 only compared with those participating at both T1 and T4, those interviewed at T2 but not T4 compared with those participating at T2 and T4, and those interviewed at T3 but not T4 compared with those participating at T3 and T4. Participants who took part at T1 and T4, compared with those interviewed at T1 only,

reported less Ego Integration and greater Peer Deviance, Cigarette Use, and Marijuana Use ($p \leq .05$). Participants who took part at T2 and T4, compared with those who participated at T2 but not T4, reported less Ego Integration, greater Peer Deviance, and greater Peer Cigarette Use ($p \leq .05$). Participants who participated at T3 and T4, compared with those who participated at T3 but not T4, demonstrated no statistically significant differences on the demographic or psychosocial variables ($p \leq .05$).

Of the 475 participants, 51% ($n = 243$) were Black and 49% ($n = 232$) were Puerto Rican. Females comprised 50.7% ($n = 241$) of the sample. Mean ages were 13.9 ($SD = 1.3$) at T1, 19.3 ($SD = 1.5$) at T2, 24.4 ($SD = 1.3$) at T3, and 26.1 ($SD = 1.4$) at T4. The median educational level at T4 was having completed at least 1 year of business or technical school. With regard to the occupational level at T4, 17.3% were employed in semiskilled jobs (e.g., factory worker), 11.0% in skilled jobs (e.g., mechanic), 33.4% in clerical positions, 13.9% had professional level jobs, and 24.4% were unemployed. Of those who were unemployed, 17.2% were attending school. At T4, 20.6% of the participants were cohabiting, 16.0% were married and living together, 2.8% were married but separated, and 60.6% were single.

Measures

The respondents were asked about the number of cigarettes currently smoked at each wave (T1–T4). Response options included “none” (coded 1), “a few cigarettes or less a week” (2), “one to five cigarettes a day” (3), “about half a pack a day” (4), “about one pack a day” (5), and “more than one pack a day” (6).

The respondents were asked about the frequency of their marijuana use. The response options included “never” (1), “a few times a year or less” (2), “about once a month” (3), “several times a month” (4), and “once a week or more” (5).

Table 1 presents the demographic variables and the psychosocial variables with their Cronbach's alphas and source (see Table 1). Each psychosocial variable is the sum of all items from T1 to T4. The Cronbach's alphas were adequate. The psychosocial variables have been found in previous research to predict substance use and psychopathology (Brook, Whiteman, Czeisler, Shapiro, & Cohen, 1997; Crawford, Cohen, & Brook, 2001). Externalizing and internalizing personality sets were patterned after the work of Achenbach (1999).

Analytic plan

We applied the SAS Traj procedure (Jones & Nagin, 2007; Jones, Nagin, & Roeder, 2001) to explore the trajectories of the participants' tobacco use and marijuana use using the censored normal distribution (White, Pandina, & Chen, 2002).

Since Brook, Ning, and Brook (2006) and Brook, Balka, Ning, and Brook (2007) reported a four-trajectory group model for tobacco use using this sample, we used four tobacco use trajectory groups. For marijuana use, the model having the maximum value of the Bayesian information criterion (BIC) and Akaike's information criterion (AIC) was selected. We assigned trajectory group membership using modal posterior probabilities.

In line with Jackson et al. (2008), we evaluated comorbidity between tobacco and marijuana use from a cross-tabulation of trajectory group memberships (see Table 2).

Table 1. Psychosocial variables: Sources and Cronbach's alphas

T1–T4 psychosocial variables	Source	No. of items	Sample item	Response range (minimum, maximum)	Cronbach's alpha ^a
Demographics					
Gender ^b	–	1	Are you (female or male)?	Female (1), male (2)	n/a
Race/Ethnicity ^b	–	1	Which (race/ethnicity) best describes you?	Black (1), Puerto Rican (2)	n/a
Religion					
Religious Attendance ^c	–	4	How often do you attend religious services?	Never (1), once a week or more (5)	n/a
Internalizing personality attributes					
Ego Integration	Brook and Pahl (2005)	12	(How well does this describe you?) You feel like swearing	Completely true (1), completely false (4)	.68
Depressive Mood	Derogatis (1994)	20	(How well does this describe you?) You sometimes feel unhappy, sad or depressed	Completely false (1), completely true (4)	.87
Externalizing personality attributes					
Delinquency	Gold (1966); Huizinga, Menard and Elliott (1989)	46	How often have you gotten in trouble with the police for something you did?	Never (1), 5 or more times (5)	.88
Risk Taking	Jackson (1997)	12	(How well does this describe you?) You would do almost anything on a dare	Completely false (1), completely true (4)	.84
Rebellion	Smith and Fogg (1979)	12	(How well does this describe you?) Sometimes you enjoy seeing how much you can get away with	Completely false (1), completely true (4)	.76
Peer factors					
Peer Deviance	Gold (1966); Huizinga, Menard and Elliott (1989)	12	How many of your friends have gotten into a serious fight at school or work?	None (1), most (4)	.85
Peer Tobacco Use ^c	Siqueira and Brook (2003)	4	How many of your friends smoke cigarettes on a regular basis?	None (1), most (4)	n/a
Peer Marijuana Use ^c	Siqueira and Brook (2003)	4	How many of your friends have ever used marijuana or hashish (pot, grass)?	None (1), most (4)	n/a

Note. n/a = not applicable. ^aCronbach's alphas were computed based on responses to each of the items that comprised the psychosocial measures four points in time.

^bItems only asked at T1.

^cVariable used is the sum of a single item asked at four different timepoints.

We tested observed versus expected cell frequencies in the trajectories of tobacco and marijuana use contingency table to determine those trajectory pairs that occur more frequently than expected under independence (Lienert & Krauth, 1975; von Eye, 2002). A pair of trajectories (i, j) was selected when $\frac{O_{ij} - E_{ij} - 0.5}{\sqrt{E_{ij} \left(1 - \frac{E_{ij}}{N}\right)}} \geq 3.72$, where O_{ij} is the observed value of i th row and j th column and E_{ij} is the expected value of i th row and j th column with 3.72 chosen to set $p < .0001$.

For each selected pair of tobacco and marijuana use trajectories, first, we predicted Y_k , the indicator of the selected marijuana use trajectory group for participant k from the indicator of the selected tobacco use trajectory group for participant k , X_k . The logistic regression model is $Y_i = \beta_0 + \beta_1 X_i + \varepsilon_i$, $i = 1, \dots, 475$, where ε_k is the residual error for k th participant under the model. The overall odds ratio (OR) for the selected pair of trajec-

tories is $e^{\hat{\beta}_1}$ (Agresti, 1996). These ORs are reported in the first line of Table 3.

We then conducted further logistic regression analyses to see whether a risk variable, R , reduced the OR in the pair of trajectories. That is, we fit the logistic regression model $Y_k = \gamma_0 + \gamma_1 X_k + \gamma_2 R_k + v_k$, $k = 1, \dots, 475$, where R_k is the value of the risk variable R , Y_k and X_k are defined as above, and v_k is the residual error for k th participant under this model. The value $e^{\hat{\beta}_1}$ is the OR between trajectory groups controlling for risk variable R .

We compare the OR controlling for R with the overall OR using the test statistic $T = \frac{\hat{\gamma}_1 - \hat{\beta}_1}{\sqrt{\{se(\hat{\gamma}_1) - se(\hat{\beta}_1)\} \frac{\hat{\sigma}_v^2}{\hat{\sigma}_\varepsilon^2}}}$ (Clogg, Petkova, & Haritou, 1995). Under the null hypothesis of no change in OR, T is approximately standard normal.

Table 2. Cross-tabulations of frequency (expected frequency, E_{ij}) of group membership in tobacco use trajectories and marijuana use trajectories

Tobacco use	Marijuana use				Marginals
	Non/low user	Maturing out	Late onset	Chronic	
Non/low use	257 (202.9)↑	14 (27.6)	23 (41.7)	11 (32.8)	305 (64.21%)
Maturing out	3 (4.0)	0 (0.0)	2 (0.8)	1 (0.6)	6 (1.26%)
Late onset	44 (73.9)	14 (10.5)	30 (15.2)↑	23 (11.9)	111 (23.37%)
Chronic	12 (35.3)	15 (4.8)↑	10 (7.3)	16 (5.7)↑	53 (11.16%)
Marginals	316 (66.53%)	43 (9.05%)	65 (13.68%)	51 (10.74%)	475

Note. $\chi^2(9, n = 475) = 141.78, p < .0001$; $\Phi = 0.55$; Cramer's $V = 0.32$. Numbers with up arrows (↑) indicate values that are significantly greater than would be expected under independence using the normal approximation to the binomial ($p < .0001$), that is, $\frac{O_{ij} - E_{ij} - 0.5}{\sqrt{E_{ij} \left(1 - \frac{E_{ij}}{N}\right)}} \geq 3.72$ where

O_{ij} is the observed value of i th row and j th column and E_{ij} is the expected value of i th row and j th column.

We then examined the five sets of variables specified in Table 4. The logistic regression of the trajectory of marijuana use was estimated with control on the tobacco use trajectory and all variables in each of the sets (see Table 4). We also estimated the logistic regression of the trajectory of marijuana use with control on the tobacco use trajectory and with control on all the psychosocial variables simultaneously. We then tested whether the OR with a given tobacco use trajectory variable was significantly reduced when a set of predictors was added as a control.

Results

Mixture modeling: Extracting trajectories

There were four tobacco use trajectory groups. The average trajectory for “non/low tobacco users” had means corresponding to not smoking at all or smoking a few cigarettes or less a week at all four times (i.e., 1.29, 1.07, 1.10, and 1.14). The average trajectory for “maturing-out tobacco users” had means corresponding

Table 3. Adjusted odds ratios of selected pairs of tobacco use trajectories and marijuana use trajectories from logistic regression analyses after controlling each specified risk factor

Risk factors controlled for	Non/low tobacco, non/low marijuana	Chronic tobacco, maturing-out marijuana	Late onset tobacco, late onset marijuana	Chronic tobacco, chronic marijuana
None	10.1 (6.5, 15.7) ^a	5.6 (2.7, 11.3) ^a	3.5 (2.0, 6.0) ^a	4.8 (2.4, 9.4) ^a
Gender	9.9 (6.3, 15.4)	5.5 (2.7, 11.2)	3.2 (1.8, 5.5)	5.1 (2.6, 10.2)
Ethnicity	10.2 (6.6, 15.9)	5.5 (2.7, 11.2)	3.5 (2.0, 6.0)	5.2 (2.6, 10.3)
Religious Attendance	10.0 (6.3, 15.7)	5.5 (2.6, 11.4)	3.3 (1.9, 5.8)	3.9 (1.9, 7.8)**
Ego Integration	10.5 (6.6, 16.7)	5.2 (2.5, 10.8)	3.4 (1.9, 5.9)	3.4 (1.7, 7.0)**
Depressive Mood	10.3 (6.5, 12.3)	4.7 (2.2, 9.9)	3.4 (1.9, 5.9)	3.4 (1.7, 7.0)**
Delinquency	7.2 (4.4, 11.7)**	4.4 (2.0, 9.2)	3.1 (1.7, 5.4)	2.4 (1.1, 5.2)***
Risk Taking	9.5 (5.9, 15.2)	4.7 (2.3, 9.8)	3.0 (1.7, 5.3)	3.7 (1.8, 7.6)*
Rebellion	8.2 (5.1, 13.2)*	3.8 (1.8, 8.1)**	3.0 (1.7, 5.3)	2.7 (1.3, 5.7)***
Peer Deviance	9.1 (5.6, 14.6)	4.0 (1.9, 8.4)**	3.2 (1.8, 5.7)	2.9 (1.4, 6.0)***
Peer Tobacco Use	7.8 (4.8, 12.6)*	3.0 (1.4, 6.8)**	3.5 (1.9, 6.2)	1.9 (0.9, 4.1)***
Peer Marijuana Use	7.4 (4.5, 12.2)**	2.9 (1.4, 6.3)***	2.9 (1.6, 5.1)*	2.1 (1.0, 4.4)***

Note. The tobacco and marijuana use trajectory groups are defined in the results section. Stars are used to indicate that the odds ratio (OR) after controlling for risk factor(s) was significantly less than the OR with no risk factors controlled (* $p < .05$, ** $p < .01$, *** $p < .001$). Each column describes a logistic regression on $N = 475$ subjects. The dependent variable is the indicator of membership in the specified marijuana use trajectory, and the independent trajectory variable is membership in the specified tobacco use trajectory. The second independent variable is specified in the row. For example, the second column indicates the OR of membership in the non/low marijuana use trajectory group as predicted by membership in the non/low tobacco use trajectory alone (first row) and with control on each of the specified risk factors (Rows 2–12).

^aOR significant at the level of .0001.

Table 4. Adjusted odds ratios and 95% CI for selected pairs of tobacco use trajectories and marijuana use trajectories from logistic regression analyses with control on each of 5 sets of risk factors, and on a set of all the risk factors

Risk factors controlled for	Non/low tobacco, non/low marijuana	Chronic tobacco, maturing-out marijuana	Late onset tobacco, late onset marijuana	Chronic tobacco, chronic marijuana
None	10.1 (6.5, 15.7)	5.6 (2.7, 11.3)	3.5 (2.0, 6.0)	4.8 (2.4, 9.4)
Demographics	10.0 (6.4, 15.6)	5.4 (2.6, 11.1)	3.2 (1.8, 5.5)	5.5 (2.7, 11.2)
Gender				
Ethnicity				
Religion	10.0 (6.3, 15.7)	5.5 (2.6, 11.4)	3.3 (1.9, 5.8)	3.9 (2.0, 7.8)
Religious Attendance				
Internalizing personality attributes	10.2 (6.4, 16.3)	4.7 (2.2, 9.9)	3.4 (1.9, 5.9)	3.1 (1.5, 6.3)***
Ego Integration				
Depressive Mood				
Externalizing personality attributes	6.6 (4.0, 11.0)***	3.8 (1.7, 8.3)*	2.9 (1.7, 5.2)*	2.1 (1.0, 4.7)***
Delinquency				
Risk taking				
Rebellion				
Peer factor	10.7 (6.0, 18.9)	2.9 (1.3, 6.5)***	3.3 (1.8, 5.9)	1.9 (0.9, 4.2)***
Peer Deviance				
Peer Tobacco Use				
Peer Marijuana Use				
Gender	7.0 (3.8, 12.9)***	3.7 (1.6, 8.5)*	2.4 (1.3, 4.4)**	1.3 (0.5, 3.3)***
Ethnicity				
Religious Attendance				
Ego Integration				
Depressive Mood				
Delinquency				
Risk Taking				
Rebellion				
Peer Deviance				
Peer Tobacco Use				
Peer Marijuana Use				

Note. The tobacco and marijuana use trajectory groups are defined in the results section. Stars are used to indicate that the odds ratio (OR) after controlling for risk factor(s) was significantly less than the OR with no risk factors controlled (* $p < .05$, ** $p < .01$, *** $p < .001$). Each column describes a logistic regression on $N = 475$ subjects. The dependent variable is the indicator of membership in the specified marijuana use trajectory, and the independent trajectory variable is membership in the specified tobacco use trajectory. The additional independent variable(s) is(are) specified in the row. For example, the second column indicates the OR of membership in the non/low marijuana use trajectory group as predicted by membership in the non/low tobacco use trajectory alone (first row) and with control on each of the sets of risk factors (Rows 2–7).

to smoking one pack a day at T1 (5.02), not smoking at all or smoking a few cigarettes or less a week at T2 and T3 (1.05 and 1.17), and smoking more than a few cigarettes per week at T4 (2.23). The average trajectory for “late onset tobacco users” had means corresponding to not smoking at all or smoking a few cigarettes or less a week at T1 and T2 (1.34 and 1.74), smoking one to five cigarettes a day at T3 (2.96), and smoking more than one to five cigarettes a day at T4 (3.24). The average trajectory for “chronic tobacco users” had means corresponding to not smoking at all or smoking a few cigarettes or less a week at T1 (1.62) and smoking a half a pack a day or more at T2, T3, and T4 (3.97, 4.26, and 4.08). Estimated prevalences for the four trajectory groups were 64.2% non/low tobacco users, 1.3% maturing-out tobacco users, 23.4% late onset tobacco users, and 11.1% chronic tobacco users.

For marijuana use, we computed solutions for two through five components. Since both the BIC (–2,409) and the AIC

(–2,359) had the largest value for the four-trajectory group model, we chose a four-component model for marijuana use.

The average trajectory for “non/low marijuana users” had means corresponding to not using marijuana at all or using marijuana a few times a year or less at all four waves of data collection (i.e., 1.08, 1.25, 1.19, and 1.24). The average trajectory for “maturing-out marijuana users” had means corresponding to not using marijuana at all or using marijuana a few times a year or less at T1 (1.48), using more than several times a month at T2 (4.50), using from a few times a year or less to once a month at T3 (2.28), and not using marijuana at all or using marijuana a few times a year or less at T4 (1.73). The average trajectory for “late onset marijuana users” had means corresponding to not using marijuana at all or using marijuana a few times a year or less at T1 and T2 (1.15 and 1.78), using more than once a month at T3 (3.44), and more than several times a month at T4 (4.28). The average trajectory for “chronic marijuana

users” had means corresponding to not using marijuana at all or using marijuana a few times a year or less at T1 (1.72) and using marijuana more than several times a month T2, T3, and T4 (4.45, 4.65, and 4.65). Estimated prevalences of the four trajectory groups were 66.5% non/low marijuana users, 10.7% maturing-out marijuana users, 13.7% late onset marijuana users, and 9.1% chronic marijuana users.

Comorbidity

Table 2 presents the cross-tabulation of trajectory group memberships. The trajectories of tobacco and marijuana use were significantly associated, $\chi^2(9, n = 475) = 141.78, p < .0001; \Phi = 0.55$; Cramer’s $V = 0.32$. There were four trajectory pairs (indicated by up arrows [$\uparrow$]) that had counts significantly greater than would be expected under independence. As noted in Table 3, the n s and the OR s for the groups were as follows: non/low tobacco users and non/low marijuana users ($n = 257, OR = 10.1; p < .001$), chronic tobacco users and maturing-out marijuana users ($n = 15, OR = 5.6; p < .001$), late onset tobacco users and late onset marijuana users ($n = 30, OR = 3.5; p < .001$), and chronic tobacco users and chronic marijuana users ($n = 16, OR = 4.8; p < .01$). More than 66% of participants were in a comorbid trajectory pair with most in the non/low tobacco use and non/low marijuana use trajectory pair.

Correlates of comorbidity

Table 3 shows OR s when a single risk variable was controlled. The OR s of the comorbidity of the pairs of trajectories of tobacco and marijuana use were reduced with control on many of the psychosocial risk variables. For the non/low tobacco use and non/low marijuana use trajectory pair, no single risk factor reduced the OR below 7.2 (OR reduced from 10.1 to 7.2, $t = 3.0, p < .01$). For the non/low tobacco use and non/low marijuana use trajectory pair, the greatest reduction was obtained by controlling for Delinquency. For each of the four comorbid trajectory pairs, controlling for Peer Marijuana Use generated the largest or next largest reduction in OR . The chronic tobacco use and chronic marijuana use trajectory pair controlling for Peer Tobacco use had the largest reduction in OR . For the chronic tobacco use and chronic marijuana use trajectory group, all of the psychosocial risk variables except the demographic variables (i.e., Gender and Ethnicity) significantly reduced the OR s (see Table 3).

Table 4 presents the results of six sets of multivariate logistic regression analyses (one for each row of the table) for the four selected pairs of tobacco and marijuana use trajectory groups (see Table 4). The leftmost column specifies the variables controlled for. As shown in Table 4, for the non/low tobacco use and non/low marijuana use trajectory pair, which included more than 50% of the sample, no set of risk factors reduced the OR below 6.6. Controlling for the set of externalizing personality attributes produced the greatest reduction in OR for the non/low tobacco use and non/low marijuana use trajectory pair and the late onset tobacco use and late onset marijuana use trajectory pair. It also reduced the OR significantly for the other pairs. Controlling for the set of peer variables had the greatest reduction in OR for the chronic tobacco use and maturing-out marijuana use trajectory pair and the chronic tobacco use and chronic marijuana use trajectory pair. Controlling for the internalizing personality attributes significantly reduced the OR only for the chronic tobacco use and chronic marijuana use trajec-

tory pair. Controlling for all the variables at once significantly reduced the OR for each of the four comorbid trajectory pairs.

Discussion

We used the growth mixture model to identify multiple trajectories of tobacco and marijuana use. We explored the developmental course of comorbid tobacco and marijuana use beginning in adolescence and extending into adulthood, and we identified the associated factors that reduced the comorbidity of pairs of tobacco and marijuana use trajectories. This is the first study to examine the psychosocial factors that are common to pairs of comorbid trajectories of tobacco and marijuana use in Blacks and Puerto Ricans.

Comorbidities in substance use

The trajectories of tobacco and marijuana use are strongly related (see Table 2). The following four pairs are more common than expected under independence: non/low tobacco use and non/low marijuana use, chronic tobacco use and maturing-out marijuana use, late onset tobacco use and late onset marijuana use, and chronic tobacco use and chronic marijuana use (see Table 2). All of the pairs of comorbid trajectories were consistent with those reported by Jackson et al. (2008).

The comorbid tobacco and marijuana use trajectories have implications for similar developmental timing in the use of tobacco and marijuana. This may be due to the interaction of these two substances or to common developmental transitions (e.g., living situation, traditional roles associated with a new career and family relations) and personality factors.

Prediction of comorbidity by risk factors

Some of the individual risk factors explained, in part, the comorbidity of the pairs of trajectories of tobacco use and marijuana use (see Table 3). The pattern of risk factors suggests three kinds of influence on comorbidity. The first is identification with certain group values, hence the importance of deviant peer groups and participation in religious groups. The second pattern refers to a personality disposition manifested in impulsivity and ignoring the consequences of one’s behavior. The third draws on the significance of Depressive Mood and possible relief from internal distress.

Table 4 indicates that comorbidity of pairs of trajectories of tobacco and marijuana use may be explained in part by a constellation of externalizing personality risk factors (e.g., Delinquency, Risk Taking, and Rebellion). Thus, those who are more extreme in unconventional personality attributes are more likely to be polydrug users. Our findings are consistent with Problem Behavior Theory (Donovan & Jessor, 1985; Turbin, Jessor, & Costa, 2000), which posits a subset of adolescent behaviors including Delinquency, tobacco use, and illicit drug use that are linked and often co-occur.

Internalizing behavior only reduced the OR for the comorbid pair of trajectories of chronic tobacco and chronic marijuana use. However, our findings that internalizing behavior does not lead to a reduction in the OR s of the other comorbid pairs of trajectories of tobacco and marijuana use may be due to a smaller effect size. The self-medication hypothesis (Khantzian, 1997) suggests

that the abuse of substances may function as a means of relieving or making a “subjective state of distress” (such as Depressive Mood) more tolerable. Our finding that those with internalizing personality problems are more likely to be chronic users of both tobacco and marijuana (data not shown) supports the relationship between “distress” and chronic polysubstance use.

The externalizing factor appears to be more influential than the internalizing factor (Table 4). This is in accord with previous research on the effect of such personality factors on trajectories of use of only one drug (Windle & Wiesner, 2004). The externalizing personality attributes partially reduced the comorbidity of pairs of trajectories of tobacco and marijuana use, despite our small sample size. In future research using larger samples, the relationship of a variety of biopsychosocial factors to pairs of comorbid trajectories of tobacco and marijuana use may be even more apparent.

Peer factors partly reduced the ORs of the comorbidity of pairs of trajectories of tobacco and marijuana use (i.e., chronic tobacco use and maturing-out marijuana use and chronic tobacco use and chronic marijuana use). One possibility for this effect is that deviant peers have an adverse effect on Peer Substance Use through socialization processes (Hoffman et al., 2007). Moreover, substance-using individuals seek out peers with similar behaviors (Ennett & Bauman, 2006). In general, these findings are in accord with FIT, which emphasizes the influence of peers through such processes.

There were no major differences in Ethnicity or Gender in the risk and protective factors related to pairs of comorbid trajectories of use, in accord with Jackson et al. (2008). The results have considerable generalizability for male and female and for Black and Puerto Rican individuals. Clinical programs designed to deal with the comorbidity of tobacco and marijuana use might be similar for both Blacks and Puerto Ricans. Nevertheless, as Compton, Grant, Collier, Glantz, and Stinson (2004) have noted, interventions need to be linguistically appropriate and culturally relevant.

Limitations

First, it remains possible that the associations between the predictors and pairs of comorbid trajectories may arise from genetic risk factors and other environmental variables (e.g., school influences) that were not examined in this study. Second, our data are based on self-reports rather than on external measurements from official records, such as police records, though studies have shown that use of this type of self-report data yields reliable results (Harrison, Martin, Enev, & Harrington, 2007). Third, the sample sizes for some of the comorbid trajectory pairs are limited in size. Given the relatively small *N*, and the restriction of our sample to New York City, the study of additional samples is warranted.

Despite these limitations, the study supports and extends the literature in a number of important ways. We assess psychosocial variables over a span of 12 years. The current study demonstrates the feasibility and substantive importance of this approach to modeling comorbidity. Since comorbidity of tobacco and marijuana use trajectories occurs in many individuals, the presence of additional substance use problems needs to be assessed in treatment programs for the use of one of these substances. Once iden-

tified, treatment for all substance use problems should be coordinated. Without comprehensive treatment, chronic tobacco and chronic marijuana users are at risk for the adverse psychosocial and health consequences associated with concurrent heavy use of tobacco and marijuana over a number of years. Additionally, the study highlights the predictors of the comorbid pair of trajectories of chronic tobacco use and chronic marijuana use: namely dimensions involving identification with group values and behaviors (e.g., Religious Attendance, Peer Substance Use), personality dispositions (e.g., Risk Taking), and Depressive Mood. This knowledge may strengthen the foundation for both prevention and treatment programs that address the development of comorbid use of tobacco and marijuana.

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Declaration of Interests

None declared.

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