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Triple comorbid trajectories of alcohol, cigarette, and marijuana use from adolescence to adulthood predict insomnia in adulthood

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Abstract

Approximately 9% of adults report the symptoms of insomnia, and there are a number of adverse consequences of insomnia. This could be a public health concern. The current study seeks plausible longitudinal predictors of insomnia for prevention purposes. A community sample of 674 participants (53% African Americans and 47% Puerto Ricans; 60% were females) were recruited from the Harlem Longitudinal Development Study. We applied a growth mixture model to obtain the triple trajectories of alcohol, cigarette, and marijuana use. Logistic regression analyses were then conducted to examine the associations between the triple trajectory groups from mean age 14 to 36 and insomnia at age 36. The estimated prevalence of insomnia is 7.1%. A five-group triple trajectory model was selected: A) Increasing use of all three substances (18%); B) Moderate use of alcohol and marijuana, and high use of cigarette (11%); C) Moderate use of alcohol and cigarette, and experimental use of marijuana (3%); D) Moderate use of all three substances (5%); and E) No or low use of all three substances (63%). Among the five trajectory groups, the increasing use of all three substances group (AOR=2.71, *p*-value=0.011) was associated with an increased likelihood of having insomnia as compared to the no or low use of all three substances group. Treatment programs to quit or reduce the use of alcohol, cigarette, and marijuana may help decrease the prevalence of insomnia. This could lead to improvements in individualized treatments for patients who have symptoms of insomnia and who also use substances.

Keywords

Triple comorbid trajectories; Alcohol use; Cigarette use; Marijuana use; Insomnia; Harlem Longitudinal Development Study

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Introduction

Insomnia is defined by the presence of an individual's report of difficulty in sleeping. Insomnia impairs cognitive and physical functioning and is associated with a wide range of impaired daytime functions across a number of emotional, social, and physical domains. Compared with good sleepers, people with persistent sleep disturbances are more prone to accidents, have higher rates of work absenteeism, diminished job performance, decreased quality of life, and increased health care utilization (Diaz et al., 2014; Jurado-Gámez, Guglielmi, Gude, & Buela-Casal, 2015; M. Lee et al., 2009; Leger et al., 2014). A general consensus has developed from population-based studies that approximately 9% of adult samples drawn from different countries are dissatisfied with their sleep quality (Ancoli-Israel & Roth, 1999). Furthermore, the annual direct cost of insomnia has been estimated to be in the billions of US dollars (Reynolds & Ebben, 2017).

Insomnia has a strong effect on patients' health-related quality of life (Kyle, Morgan, & Espie, 2010), and has a substantial economic impact on society (Daley, Morin, LeBlanc, Grégoire, & Savard, 2009; Léger & Bayon, 2010; Rosekind & Gregory, 2010). Thus, insomnia is recognized as a major public health issue. Based on the literature indicating the association between substance use and insomnia (Bonn-Miller, Boden, Bucossi, & Babson, 2014; J. Y. Lee, Brook, Finch, & Brook, 2016; Schuckit, 2009), the current study seeks to identify the longitudinal predictors of insomnia. Substance use is a well known factor relating to insomnia; however, there is dearth of research examining the long-term patterns of simultaneous drinking alcohol, smoking cigarettes, and using marijuana as predictors of insomnia. Therefore, the current study uses a longitudinal design to examine the long term consequences of triple comorbid trajectories of alcohol, cigarette, and marijuana use beginning in adolescence and entering to the mid thirties on symptoms of insomnia in the mid thirties.

Alcohol drinking is associated with insomnia (Schuckit, 2009). Alcohol is commonly used as a way of self-medication among individuals who suffer from initiating sleep (Stein & Friedmann, 2006). A review paper reported that the use of alcohol can exacerbate the adverse consequences of insomnia (e.g. mood changes and performance decrements); moreover, insomnia among patients entering treatment for alcoholism has been significantly associated with subsequent alcoholic relapse (Brower, 2003).

Smoking is also associated with difficulty in initiating sleep (Wetter & Young, 1994). More recently, Lee and her colleagues found that individuals in the chronic smoking trajectory group were associated with an increased likelihood of experiencing insomnia compared to those in the low smoking trajectory group (J. Y. Lee et al., 2016). Research carried out by Sabanayagam & Shankar found that current cigarette smokers were nearly twice as likely to report insufficient sleep and rest as compared to non-smokers (Sabanayagam & Shankar, 2011).

In a related vein, insomnia was found to be associated with more problematic marijuana use in a cross-sectional study (Bonn-Miller et al., 2014). A review paper suggested that longterm use of marijuana could have a negative impact on sleep (Babson, Sottile, & Morabito, 2017).

There is also recognition of a bona fide marijuana withdrawal syndrome with symptoms of insomnia or sleep difficulties, which make cessation difficult and contributes to relapse (Gorelick et al., 2012).

In addition, the co-occurrence of alcohol, cigarette, and marijuana use has been reported (Degenhardt, Hall, & Lynskey, 2001; Duhig, Cavallo, McKee, George, & Krishnan-Sarin, 2005; Iglesias, Cavada, Silva, & Cáceres, 2007; Schulenberg et al., 2005); however, only a few studies (Brook, Lee, Rubenstone, Brook, & Finch, 2014; Jackson, Sher, & Schulenberg, 2008) assess concurrent trajectories of the use of two or more substances. For instance, Jackson et al. (Jackson et al., 2008) showed that patterns of alcohol, cigarette, or marijuana use from late adolescence to young adulthood were related to an increased likelihood of similar patterns of other substance use, e.g., chronic marijuana use was more frequent among chronic cigarette smokers.

Women report more frequent symptoms of insomnia than men (Jaussent et al., 2011; Yoshioka et al., 2012). In clinical samples, about three quarters of all depressed patients complain of difficulty either in initiation or in maintaining sleep (Tsuno, Besset, & Ritchie, 2005; Yates et al., 2007). Studies have also suggested a bidirectional relationship between insomnia and depression (Jansson-Fröjmark & Lindblom, 2008; Sivertsen et al., 2012).

A few studies reported the associations between substance use and insomnia among college students (Taylor, Bramoweth, Grieser, Tatum, & Roane, 2013) and among adolescents (Johnson & Breslau, 2001). However, these studies examined the associations of alcohol, cigarette, and marijuana use with insomnia separately. The present study focuses on the developmental course of the use of alcohol, cigarette, and marijuana simultaneously, spanning several developmental periods from adolescence to adulthood. This is the first investigation of triple comorbid trajectories of substance use and of their longitudinal associations with insomnia using a community sample of African Americans and Hispanics.

We hypothesize that membership in the heavy/increasing use of all three substances trajectory group (e.g., alcohol, cigarette, and marijuana use) is associated with a greater likelihood of having symptoms of insomnia in adulthood than membership in the moderate use of two or less substances trajectory groups (e.g., alcohol and cigarette use, alcohol use only, no use of any substances).

Methods

Participants

The present study (N=674; 53% African Americans, 47% Puerto Ricans) is based on time waves 1, 2, 4, and 5 of the Harlem Longitudinal Development Study (J. Y. Lee, Brook, De La Rosa, Kim, & Brook, 2017), a psychosocial investigation of urban African Americans and Puerto Ricans. Data were first collected in 1990 (time 1; T1, N=1,332) when the participants were students attending schools in the East Harlem area of New York City. Their mean age at T1 was 14.1 years with a standard deviation (SD) of 1.4 years. Data were collected by the National Opinion Research Center at time 2 (T2; 1994-1996; N= 1,190) in person or by phone. The mean age of the participants at this wave was 19.2 years (SD=1.5

years). At time 3 (T3), we randomly selected 662 participants from the T2 sample. The Survey Research Center of the University of Michigan collected the data at T3 (2000-2001; N=662), when the mean age of the participants was 24.4 years (SD=1.3 years). The current study excluded the T3 data due to the low retention rate. The data were collected by our research group at time 4 (T4) and time 5 (T5). At T4 (2004-2006; N=838), the mean age of the participants was 29.2 years (SD=1.4 years). At T5 (2011-2013; N=674), the mean age was 35.9 years (SD= 1.4 years).

The Institutional Review Board (IRB) of the New York University School of Medicine approved the study for T4 and T5, and the IRBs of the Mount Sinai School of Medicine and New York Medical College (our former affiliations) approved the study's procedures for earlier waves of data collection. A Certificate of Confidentiality was obtained from the National Institutes of Health for each wave of data collection. Informed consent was obtained from all participants at each time wave. At T2, passive consent was obtained from the parents of participants who were minors (< 18 years old). Additional information regarding the study methodology is available from a previous report (J. Y. Lee et al., 2016).

We compared the demographic variables for the 674 adults who participated at both T1 (for gender)/T2 (for depressive symptoms) and T5 with the 516 who participated at T1/T2 but not at T5. The percentage of males among T5 non-participants (52%) was significantly higher than the percentage of males who participated at T5 (40%) ($\chi^2 = 16.5$, $p < 0.001$, $df=1$). However, there are no difference in depressive symptoms at T2 ($t=-1.9$, $p=0.1$).

Measures

Alcohol use, cigarette use, and marijuana use were measured at T1, T2, T4, and T5 (mean ages 14 to 36 years).

Alcohol use (T1-T5)—Participants were asked “How often do you drink beer, wine, or hard liquor?” with a 5-point ordinal scale that ranged: none (0), less than once a week (1), once a week to several times a week (2), 1 or 2 drinks everyday (3), and three or more drinks every day (4) at T1 and “On average, how many drinks (beer, wine, or hard liquor) did you have in the past 5 years?” with a 6-point ordinal scale that ranged: none (0), less than once a week (1), once a week to several times a week (2), one or two drinks a day (3), three or four drinks a day (4), and five or more drinks every day (5) at T2, T4, and T5.

Cigarette use (T1-T5)—Participants were asked “How many cigarettes do you smoke?” at T1 and “How many cigarettes did you smoke in the past 5 years?” at T2, T4, and T5. The answer options were none (0), a few cigarettes or less a week (1), 1-5 cigarettes a day (2), about half a pack a day (3), about 1 pack a day (4), about 1 and half packs a day (5), and more than 1 and half packs a day (6).

Marijuana use (T1-T5)—Participants were asked “How often have you ever used marijuana?” at T1 and “How often have you used marijuana in the past 5 years?” at T2, T4, and T5. The answer options were never (0), a few times a year or less (1), about once a month (2), several times a month (3), once a week or more (4).

The control variables included gender (female=1; male=2) and depressive symptoms at T2 as a proxy for earlier insomnia. *Depressive symptoms* (Derogatis, Lipman, Rickels, Uhlenhuth, & Covi, 1974) at T2 were assessed with a 2 item scale, i.e. “Do you sometimes feel unhappy, sad, or depressed?” and “Do you sometimes feel hopeless about the future?” using a 4-point Likert scale that ranged from “not at all” to “extremely.” The inter-correlation between the 2 items was 0.47 ($p < .001$).

Insomnia at T5—A proxy insomnia diagnosis was given in accordance with DSM-5 (DSM-5, 2013). It was diagnosed if the participant answered extremely severe to one or more of the following 3 questions: In the past 12 months, to what extent, if any, have you experienced each of the following problems for a period of a month or more: 1) Difficulty falling asleep?; 2) Difficulty staying asleep?; and 3) Early-morning awakening with inability to return to sleep? The internal reliability of this measure was satisfactory ($\alpha = .91$).

Analytic procedure

We used Mplus (Muthén & Muthén, 2010) to obtain the triple trajectories of alcohol, cigarette, and marijuana use. Alcohol, cigarette, and marijuana use at each time point were treated as normal variables. For subject i , the tri-variate trajectory $y_i = (y_{i1t}, \dots, y_{ijt}, \dots, y_{i34})^T$ of the three substances use in a latent group g is given by

$$y_{ijt} = \beta_{0jg} + \beta_{1jg}x_{ijt} + \beta_{2jg}x_{ijt}^2 + \epsilon_{ijt}$$

where $x_{ijt} = (Age_{ijt} - 14)/(36 - 14)$ is a normalized age.

$$\begin{aligned} \epsilon_{ijt} &\sim MN_{12}(0, V), \\ (\beta_{01g}, \dots, \beta_{23g}) &\sim MN_9(\mu_{01g}, \dots, \mu_{23g}, \Sigma), \end{aligned}$$

where Σ is a 9×9 covariance matrix to include the correlations of the three substances and the within-subjects correlations, and the residual covariance matrix $V = \text{diag}(\sigma_1^2, \dots, \sigma_{12}^2)$ is a diagonal matrix. We assume the residual errors are independent of the random effects $\beta_{01g}, \dots, \beta_{23g}$. The density of a trajectory of subject i is given by

$$f(y_i) = \sum_{g=1}^G \pi_g f_g(y_i | C_i = g) = \sum_{g=1}^G \pi_g \frac{1}{(2\pi)^6 |\Sigma_i|^{1/2}} \exp\left(-\frac{(y_i - \mu_g)^T \Sigma_i^{-1} (y_i - \mu_g)}{2}\right),$$

where $\Sigma_i = x_i \Sigma x_i^T + V$, $x_i = (x_{i1t}, \dots, x_{i34})^T$, C_i is the latent group membership variable, $j = 1$ for cigarette, $j = 2$ for alcohol, and $j = 3$ for marijuana, and $\pi_g = P(C_i = g)$ denotes a mixing proportion of the trajectory group g .

The likelihood function can be written as

$$L = \prod_{i=1}^N \left[\sum_{g=1}^G \pi_g f_g(y_i; \mu_g, \Sigma, V) \right].$$

We used the Bayesian Information Criterion (BIC) to determine the number of trajectory groups. The participants were assigned to the triple trajectory groups with the largest Bayesian posterior probability (BPP). The Bayesian posterior probability for subject i that belongs to the trajectory group k is defined as

$$\tau_k(y_i) = P(C_i = k | Y_i = y_i) = \frac{\pi_k f_k(y_i | C_i = k)}{\sum_{g=1}^G \pi_g f_g(y_i | C_i = g)}.$$

We applied the full information maximum likelihood approach for missing data (Muthén & Muthén, 2010). We had no missing values for insomnia, gender, alcohol use at T2, cigarette use at T2 and T5, and marijuana use at T2. The percentages of missing values for the other measurements (e.g., alcohol use at T1, T4, and T5) ranged from 0.01% to 6%.

After the triple trajectory groups were identified using Growth Mixture Modeling, logistic regression analyses were then conducted to examine whether the BPP of the triple trajectory group of increasing use of all three substances, compared with the BPPs of each of the other substance use trajectory groups from T1 to T5, were associated with insomnia at T5, controlling for gender, and depressive symptoms at T2 as a proxy for insomnia. We use the BPP in the logistic regression model to better reflect the uncertainty of class membership instead of the inferred class membership. The model for the multiple logistic regression analysis can be written as

$$\begin{aligned} \log \left(\frac{P(\text{Insomnia at T5} | y, \text{Gender}, \text{Depressive Symptoms at T2})}{1 - P(\text{Insomnia at T5} | y, \text{Gender}, \text{Depressive Symptoms at T2})} \right) \\ = \beta_0 + \beta_1 \tau_1(y) + \beta_2 \tau_2(y) + \beta_3 \tau_3(y) + \beta_4 \tau_4(y) \\ + \beta_6 \times \text{Gender} + \beta_7 \times \text{Depressive Symptoms at T2}. \end{aligned}$$

Results

Among the 674 participants, 48 individuals (7.1%) reported that they experienced insomnia. A five-group triple trajectory model was selected, based on the BIC. The BICs were 20061, 19640, 19516, 19161, and 19248 for a 2, 3, 4, 5, and 6-group model, respectively (See Figure 1). We selected the five trajectory group model, since the 5-group model had the smallest BIC score. Figure 2 presents the observed trajectories and the percentages of participants who were members in each of the five trajectory groups. The mean BPP in each trajectory group ranged from 87.0% to 99.9%, which indicated a good classification. (See Figure 2.)

The five trajectory groups were named: A) Increasing use of all three substances (prevalence=18%, mean BPP=99.8%); B) Moderate use of alcohol and marijuana, and high use of cigarette (prevalence=11%, mean BPP=87.0%); C) Moderate use of alcohol and

cigarette, and experimental use of marijuana (prevalence=3%, mean BPP=99.9%); D) Moderate use of all three substances (prevalence=5%, mean BPP=99.9%); and E) No or low use of all three substances (prevalence=63%, mean BPP=97.3%). Table 1 presents summary statistics for each of the five trajectory groups.

Table 2 shows the odds ratios (OR) and the adjusted odds ratios (AOR) for insomnia in the logistic regression analyses. Females are more likely to have insomnia than males (OR=0.48, $p<0.05$; AOR=0.44, $p<0.05$). Higher depressive symptoms at T2 was associated with a greater likelihood of having insomnia (OR=1.92, $p<0.001$; AOR=1.76, $p<0.01$). The BPP of the increasing use of all three substances trajectory group (OR=2.13, $p<0.05$; AOR=2.71, $p<0.05$) were associated with an increased likelihood of having insomnia as compared to the BPP of the no or low use of all three substances trajectory group. (See Table 2.)

Discussion

Overall, the results support our hypothesis since the findings indicated that membership in the increasing use of all three substances trajectory groups were associated with an increased likelihood of having insomnia as compared to membership in the no or low use of all three substances trajectory group. Also, the estimated prevalence of insomnia (7.1%) is consistent with findings based on the criteria in DSM-IV (5-10%) (Mai & Buysse, 2008) as well as from DSM-5 (7%) (Uhlir, Sand, Ødegård, & Hagen, 2014).

Our findings indicated that women are about twice as likely to have insomnia as men. Women are more prone to mood disorders (Miller et al., 2016; Schuch, Roest, Nolen, Penninx, & de Jonge, 2014) such as depression leaving them more vulnerable to sleep problems. Many of the same chemicals in the brain that can be disrupted in mood disorders are also involved in regulating sleep (Li, Romans, De Souza, Murray, & Einstein, 2015). It is also possible that variations in estrogen levels contribute to differences in the expression of insomnia (Polo-Kantola, Erkkola, Helenius, Irjala, & Polo, 1998).

The positive association between depressive symptoms and insomnia is consistent with the results from other studies among adolescents (Roberts & Duong, 2013) as well as among adults (Suh et al., 2013). Since insomnia is very common among depressed patients (Steiger & Kimura, 2010; Stewart et al., 2006), sleep problems and depressive symptoms may share similar risk factors and their biological features.

As compared to individuals in the no or low use trajectory group, individuals in the increasing use of all three substances group were associated with greater likelihood of having insomnia. However, there were no statistically significant differences between the no or low use trajectory group and the moderate use trajectory group (i.e., moderate use of all three substances; moderate use of alcohol and cigarette and experimental use of marijuana; and moderate use of alcohol and marijuana and high use of cigarette). These findings emphasize an adverse effect of the simultaneous and increasing use of alcohol, cigarette, and marijuana on insomnia.

Alcohol is one of the most commonly used substances for insomnia because of its depressant qualities (Stein & Friedmann, 2006). Although it may initially produce

sleepiness, it actually disrupts natural, healthy sleep patterns (Brower, 2003). Also, heavy smoking during the day may cause nicotine withdrawal at night time, leading to sleep disturbances and awakening (Jaehne et al., 2015). In addition, cannabinoid, a major component of marijuana, may disrupt sleep by producing a feeling of wakefulness and increasing energy levels (Babson et al., 2017).

Regardless of the type of substance as a way of self-medication for insomnia, it will generate a cycle. As a result, one may consume even more alcohol in the hopes of finding relief, and may use stimulant drugs such as marijuana to reduce one's need for sleep. However, the body still needs to rest, so it will start to slow down. When that occurs, one might likely reach for more drugs in order to stay alert or awake. In other words, individuals may find themselves in a vicious cycle of using marijuana to manage sleep, habituating to the effects of marijuana, and using more marijuana in order to obtain the desired impact, resulting in problematic patterns of use.

Strengths and Limitations

There are limitations in this research. Our data are based on self-reports rather than official records. However, studies have shown that self-report data yield reliable results (Harrison, Martin, Enev, & Harrington, 2007). Another limitation is that our sample did not represent the full range of ethnic diversity which exists in the United States. Our sample only focused on African American and Hispanic participants from an urban area of New York City. Also, the measurement of insomnia is limited, since it is assessed with three items. There is relatively a long gap between the time points 2 and 4 because the present study excludes T3 data due to the low retention rate. Lastly, we did not assess whether insomnia is attributable to the physiological effects of a substance, or to coexisting mental disorders.

Despite these limitations, the study has a number of strengths. First, the present study is unique in its simultaneous examination of trajectories of the use of three substances (alcohol, cigarette, and marijuana) as well as their relationship to insomnia. Second, unlike most research that focuses on only one or two points in time, we assessed substance use over a span of almost 22 years covering important developmental stages from age 14 to 36. Third, the prospective nature of the data enabled us to go beyond a cross-sectional analysis and to take into consideration the temporal sequencing of variables.

Conclusions and Clinical Implications

The results have implications for public health. From a prevention point of view, treatment programs designed to quit or reduce substance use may help decrease the prevalence of insomnia. Relaxation therapy (RT) using biofeedback could be an appropriate approach as an effective way to relax the individuals' body, which allows individuals to have greater control over sleep problems (Arnedt, Conroy, & Brower, 2007). In conjunction with RT, cognitive behavioral therapy (Boland, Tansey, & Brooks, 2015), focused on the reasons of difficulties in sleep, is another approach for both substance use and insomnia. This line of research could lead to improvements in individualized treatments for patients who have insomnia and who also use substances.

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Highlights

- The estimated prevalence of insomnia is 7.1% in the present study.
- Heavy use of alcohol, tobacco, and marijuana group is associated with insomnia.
- Increasing use of alcohol, tobacco, and marijuana group is related to insomnia.
- The findings may inform treatment programs for insomnia as well as substance use.

Figure 1. Bayesian Information Criterion (BIC) scores for a 2-group trajectory model through a 6-group trajectory model

Figure 2.

Triple trajectory groups of alcohol, cigarette, and marijuana use from mid adolescence to the mid thirties

Table 1.

Summary statistics (fractions, means, and standard deviations)

		A. Increasing use of all three substances (18%, n=118)	B. Moderate use of alcohol and marijuana use, and high use of cigarette (11%, n=76)	C. Moderate use of alcohol and cigarette, and experimental use of marijuana (3%, n=20)	D. Moderate use of all three substances (5%, n=35)	E. No or low use of all three substances (63%, n=425)	Entire Sample (N=674)
Insomnia		11%, n=13	8%, n=6	5%, n=1	11%, n=4	6%, n=24	7%, n=48
Females		33%, n=39	53%, n=40	55%, n=11	69%, n=24	68%, n=291	60%, n=405
African American		56%, n=66	50%, n=38	40%, n=8	46%, n=16	54%, n=228	53%, n=256
Depressive symptoms at T2		2.42 (0.88)	2.49 (0.94)	2.53 (0.80)	2.73 (0.87)	2.34 (0.85)	2.40 (0.87)
Alcohol use	T1	0.12 (0.37)	0.11 (0.32)	1.22 (0.83)	0.60 (0.52)	0.09 (0.31)	0.13 (0.38)
	T2	0.73 (0.70)	0.80 (0.80)	1.17 (1.19)	0.90 (0.62)	0.48 (0.70)	0.60 (0.74)
	T4	1.32 (1.00)	1.54 (1.42)	0.94 (0.73)	0.97 (0.85)	0.89 (0.80)	1.03 (0.95)
	T5	1.90 (1.41)	1.51 (1.28)	1.60 (0.94)	1.34 (0.94)	1.13 (0.93)	1.33 (1.11)
Cigarette use	T1	0.08 (0.27)	0.21 (0.44)	1.68 (1.67)	1.32 (1.33)	0.06 (0.27)	0.19 (0.63)
	T2	1.08 (1.42)	2.17 (1.75)	1.75 (1.77)	1.60 (1.61)	0.30 (0.77)	0.76 (1.32)
	T4	2.16 (1.71)	3.60 (1.58)	2.37 (2.06)	1.97 (1.94)	0.39 (0.91)	1.19 (1.70)
	T5	2.50 (1.91)	3.85 (1.70)	2.32 (1.77)	1.94 (1.91)	0.30 (0.74)	1.24 (1.81)
Marijuana use	T1	0.05 (0.22)	0.00 (0.00)	3.63 (0.50)	1.31 (0.47)	0.00 (0.00)	0.18 (0.68)
	T2	1.78 (1.65)	1.28 (1.49)	2.10 (1.71)	2.09 (1.67)	0.38 (0.93)	0.87 (1.39)
	T4	2.94 (1.34)	0.87 (1.27)	2.11 (1.97)	1.27 (1.51)	0.35 (0.86)	0.96 (1.47)
	T5	3.71 (0.47)	0.26 (0.47)	1.65 (1.73)	0.74 (1.09)	0.14 (0.35)	0.86 (1.45)

Table 2.

Odds ratios (OR) from simple logistic regression analyses and adjusted odds ratios (AOR) from multiple logistic regression analysis with 95% confidence interval (CI) of triple trajectories of alcohol, tobacco, and marijuana use beginning in adolescence as predictors of insomnia at age 36

	Insomnia at age 36	
	OR (95% CI)	AOR (95% CI)
<i>Control variables</i>		
Gender-Males	0.48 (0.23, 0.91) *	0.44 (0.20, 0.88) *
Depressive symptoms at age 19	1.92 (1.36, 2.71) ***	1.76 (1.23, 2.53) **
<i>Substance use at age 14 – age 36</i>		
Increasing use of all three substances vs. No or low use of all three substances	2.13 (1.02, 4.31) *	2.71 (1.23, 5.80) *
Moderate use of alcohol and marijuana, and high use of cigarette vs. No or low use of all three substances	1.65 (0.54, 4.38)	1.58 (0.50, 4.30)
Moderate use of alcohol and cigarette, and experimental use of marijuana vs. No or low use of all three substances	0.90 (0.05, 4.68)	0.90 (0.05, 4.30)
Moderate use of all three substances vs. No or low use of all three substances	2.22 (0.62, 6.23)	1.76 (0.48, 5.11)

Note.

*
 $p < .05$

**
 $p < .01$

 $p < .001$