Published in final edited form as:

J Child Fam Stud. 2020 February ; 29(2): 403–412. doi:10.1007/s10826-019-01629-9.

Adolescent risk and protective factors predicting triple trajectories of substance use from adolescence into adulthood

Jung Yeon Lee¹, Wonkuk Kim^{2,*}, Judith S. Brook¹, Stephen J. Finch³, David W. Brook¹

¹New York University School of Medicine, Department of Psychiatry, New York, NY 10016, USA

²Chung-Ang University, Department of Applied Statistics, Seoul 06974, Republic of Korea

³Stony Brook University, Department of Applied Mathematics and Statistics, Stony Brook, NY 11794, USA

Abstract

Objectives: Since the number of individuals who use substances in the United States has markedly increased every year, substance use is a significant public health concern. The current study examines the possible risk and protective factors associated with triple comorbid trajectories of longitudinal alcohol, tobacco, and cannabis use from age 14 to 36.

Methods: A community sample of 674 participants (53% African Americans and 47% Puerto Ricans; 60% females) were recruited from the Harlem Longitudinal Development Study. Multinomial logistic regression analyses were conducted to examine the associations between the risk (low self-control, peer drug use) and protective (parent-child attachment, family church attendance) factors at age 14 and membership in the triple trajectory groups derived from a multivariate growth mixture model.

Results: Low self-control and peer drug use were associated with an increased likelihood of being a member in the triple comorbid trajectory groups compared to the reference group (i.e., low alcohol, no tobacco, and no cannabis use). On the other hand, parent-child attachment and family church attendance were associated with a decreased likelihood of being a member in the triple comorbid trajectory groups compared to the reference group.

*Corresponding author: Dr. Wonkuk Kim, Assistant Professor, Department of Applied Statistics, Chung-Ang University, 84 Heukseok-ro, Dongjak-gu, Seoul 06974, Republic of Korea. Tel: +82-2-820-6688, Fax: +82-2-814-5498, wkim@cau.ac.kr.

Author Contributions

JYL: designed and executed the study, analyzed the data, and wrote the manuscript. WK: collaborated with the data analyses, interpretation of the results, and preparation of the manuscript. JSB: collaborated with design and writing of the manuscript. SJF: collaborated in interpretation of the results and in reviewing the manuscript. DWB: collaborated in editing the manuscript.

Conflict of Interest

None of the authors has any conflict of interest to declare.

Ethical Approval

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

Informed consent was obtained from all participants at each time wave.

Conclusions: Treatment programs for adolescents who use substances may be more helpful if their parents and/or friends could also participate together with the adolescent, rather than only the adolescent participates in the treatment programs. Further research is needed to gain a greater understanding of the conceptual nature of the relationship between earlier risk and protective factors and later substance use patterns.

Keywords

Family church attendance; Low self-control; Parent-child attachment; Substance use; Triple trajectory analysis

Excessive consumption of alcohol is a major issue in the United States (US) and has adverse social, legal, occupational, psychological, and medical consequences (Friedmann, 2013; Rehm, Gmel, Sempo, & Trevisan, 2003). There are currently 136.9 million alcohol users (12 years of age or older) in the US based on a 2013 survey from the Substance Abuse and Mental Health Services Administration (SAMHSA, 2014). Furthermore, alcohol contributes to 79,000 deaths and \$223.5 billion in societal costs annually in the US (Bouchery, Harwood, Sacks, Simon, & Brewer, 2011; CDC, 2008).

Approximately, 16.8% of adults in the US were regular cigarette smokers in 2014 (Jamal et al., 2015). Adverse consequences of tobacco use include several kinds of cancer, respiratory illnesses, cardiovascular disease, diabetes mellitus, teratogenic effects (Agrawal et al., 2010; Gray et al., 2010) and greater overall mortality (Yankey, Strasser, & Okosun, 2016). Moreover, the estimated annual healthcare expenditures in the US attributable to smoking are approximately \$170 billion (Xu, Bishop, Kennedy, Simpson, & Pechacek, 2015).

According to the National Institute on Drug Abuse, 53% of individuals have used cannabis by age 25 in the US (NIDA, 2014). Furthermore, 20.2 million adults (8.4%) had a substance use disorder during the past year (SAMHSA, 2015). Although cannabis use may seem to be increasingly accepted as safe recreational drug use (e.g., indicated by its legalization in certain states), there are a number of negative effects from the use of cannabis, such as impaired coordination and performance, anxiety, suicidal ideation or tendencies, psychotic symptoms (Karila et al., 2014), motor vehicle crashes, and fatal automobile collisions (Asbridge, Hayden, & Cartwright, 2012).

Co-occurrence of alcohol use, tobacco use, and cannabis use is well-documented (Brook, Lee, Rubenstone, Brook, & Finch, 2014), indicating that some individuals who use one of these substances are at risk for use of the others. For example, membership in both the chronic and abstainer cannabis use groups, respectively, predicted the highest and lowest rates of both binge drinking and tobacco use among young adults (Schulenberg et al., 2005). Moreover, several studies (Brook, Lee, Brown, & Finch, 2012; Jackson, Sher, & Schulenberg, 2008) using trajectory analysis have examined the use of two or more substances simultaneously. Patterns of tobacco, alcohol or cannabis use from late adolescence to young adulthood were similar to the patterns of other substance use; for example, chronic cannabis use was more frequent among chronic tobacco smokers (Jackson et al., 2008).

Due to the increasing prevalence of substance use (alcohol, tobacco, and cannabis use) and its societal costs, the impact of substance use on public health is significant. The present study seeks to examine the possible precursors of substance use in order to reduce the potential adverse consequences of substance use listed above. While most studies exploring the predictors of substance use have focused on psychopathology at one or two points in time (Farmer et al., 2015; Wills, Knight, Williams, Pagano, & Sargent, 2015), the present study investigates earlier risk (i.e., low self-control and peer drug use) and protective (i.e., parent-child attachment and family church attendance) factors at age 14 which may be associated with the subsequent triple trajectory of substance use at four points in time from age 14 to age 36.

Self-Control Theory (SCT) (Gottfredson & Hirschi, 1990) is used as a framework to understand the relationship between the risk factors and substance use. SCT maintains that the commission of crimes and showing self-destructive behaviors, such as smoking cigarettes, drinking alcohol, and using cannabis, are caused by the lack of individual self-control. A number of research papers have shown relationships between low self-control and substance use (Brook, Lee, Brown, et al., 2012; de Ridder, Lensvelt-Mulders, Finkenauer, Stok, & Baumeister, 2012). The correlation between self-control and substance use has been found to be both positive and negative. More specifically, the Social Network Analysis of Risk Behavior in Early Adolescence Study, using a sample of 1,144 adolescents, found that personal low self-control predicts increasing early adolescent externalizing behaviors such as alcohol use and tobacco use (Franken et al., 2016). Beaver et al. (2016), however, found that low self-control was negatively related to illegal drug use.

Another theoretical framework, Family Interactional Theory (FIT) (Brook, Brook, Gordon, Whiteman, & Cohen, 1990), is a possible explanation for the linkage between protective factors and substance use. FIT posits that children raised in a supportive family environment, characterized by less conflict and greater parental affection, are significantly less likely to develop externalizing behaviors such as substance use. A number of published studies established that parent/family factors are key contributors to substance use (Newman, Harrison, Dashiff, & Davies, 2008). For example, greater parent-child attachment has been shown to be associated with less alcohol, tobacco, and cannabis use (Brook, Lee, Finch, & Brown, 2012). Better parent-child communication, one of the parent-child attachment measures, is also related to less substance use (Pokhrel, Unger, Wagner, Ritt-Olson, & Sussman, 2008). This influence remains important as the youth progress through adolescence and into early adulthood. In a related vein, family church attendance has also been found to be a protective factor against substance use (Khavari & Harmon, 1982). A review article by Hawkins et al. (1992) emphasized the importance of research on protective factors for prevention policy.

As compared to females, males tend to use more substances (McCabe et al., 2007). The prevalence of binge drinking, cigarette smoking, and cannabis use is somewhat different from one race to another; In 2013, the rate of binge alcohol use in 2013 was 20.1% for African Americans, 24.1% for Hispanics, 24.0% for whites, 12.4% for Asians, and 24.7% for native Hawaiians or other Pacific Islanders; The prevalence of current use of a tobacco product was 27.1% among African Americans, 18.8% among Hispanics, 27.7% among

whites, 10.1% among Asians, and 25.8% for Hawaiians or other Pacific Islanders; The rate of current illicit drug use was 10.5% among African Americans, 8.8% among Hispanics, 9.5% among whites, 3.1% among Asians, and 14.0% among Hawaiians and other Pacific Islanders (SAMHSA, 2014).

The present study focuses on the developmental course of the comorbid use of alcohol, tobacco, and cannabis, spanning several developmental periods from adolescence to adulthood, among urban African Americans and Puerto Ricans. In other words, we consider the timing and intensity of changes in the use of three substances (alcohol, tobacco, and cannabis) across individuals. Some individuals may begin using cannabis at an early age and escalate rapidly. Some individuals may be moderate users across several developmental stages. The aim of the present study is to understand the relationships between the risk as well as protective factors in mid adolescence and the use of three substances from mid adolescence to adulthood. Based on the two theoretical frameworks (SCT and FIT) and previous research (Brook, Lee, Brown, et al., 2012; Brook, Lee, Finch, et al., 2012), we hypothesize that the increased risk factors (i.e., lower self-control, higher peer drug use) and decreased protective factors (i.e., less parent-child attachment, less family church attendance) in mid adolescence will be associated with a greater likelihood of membership in the triple comorbid substance use trajectory group (alcohol, tobacco, and cannabis use) than of membership in the double comorbid substance use trajectory groups (e.g., alcohol and tobacco use) or than of membership in the single substance use trajectory groups (e.g., alcohol use).

Method

Participants

The present study (N=674; 53% African Americans, 47% Puerto Ricans) is based on time waves 1, 2, 3, 4, and 5 of the Harlem Longitudinal Development Study (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. At T1, the mean age of the participants 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), due to budgetary constraint, 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 participants was 24.4 years (SD=1.3 years). 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 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). A sampling flow chart including mean age, the number of participants, and retention rates at each point in time is shown in Figure 1.

Procedure

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).

We compared the demographic variables for the 674 adults who participated at both T1 and T5 with the 516 who participated at T1 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 were no differences in race/ethnicity at T1 ($\chi^2 = 0.1, p = 0.8, df = 1$), low self-control at T1 ($t = 0.2, p = 0.8$), peer drug use at T1 ($t = -0.1, p = 0.7$), parent-child attachment at T1 ($t = 1.5, p = 0.1$), and family church attendance at T1 ($t = 0.7, p = 0.5$).

Measures

Alcohol use, tobacco use, and cannabis use were measured at T1, T2, T3, T4, and T5 (mean ages 14 to 36 years). The control variables for the analyses consisted of gender at T1 and race/ethnicity at T1. Table 1 lists the scales, time wave(s), response ranges, scale items, and Cronbach's alpha for the independent variables, the control variables, and the dependent variables. (See Table 1.)

Data Analyses

We used Mplus (Muthén & Muthén, 2010) to obtain the triple trajectories of alcohol, tobacco, and cannabis use. Alcohol, tobacco, and cannabis use at each time point were treated as censored normal variables in a multivariate growth mixture model. We used the Bayesian Information Criterion (BIC) to determine the number of trajectory groups. The observed triple trajectories for each of the groups consisted of the averages of alcohol, tobacco, and cannabis use, respectively, at each point in time when the participants were assigned to the trajectory group with the largest Bayesian posterior probability (BPP).

We applied the full information maximum likelihood approach for missing data (Muthén & Muthén, 2010). We had no missing values for gender, race/ethnicity, low self-control at T1, peer drug use at T1, parent-child attachment at T1, family church attendance at T1, alcohol use at T2, tobacco use at T1, T2 and T5, and cannabis use at T2. The percentages of missing values for the other variables are 0.01% (alcohol use at T1), 0.3% (cannabis use at T5), 1% (cannabis use at T1, alcohol use at T5), 6% (alcohol use at T4, tobacco use at T4, cannabis use at T4), and 28% (alcohol use at T3, tobacco use at T3, cannabis use at T3).

Multinomial logistic regression analysis was then conducted to examine whether the risk and protective factors were associated with membership in each of the other substance use trajectory groups, compared to membership in the low or no substance use trajectory group from T1 to T5 controlling for gender and race/ethnicity at T1. The specific model used was

$$\log \frac{\pi_j(x)}{\pi_J(x)} = \alpha_j + \beta_{j,LSC} LSC + \beta_{j,PDU} PDU + \beta_{j,PCA} PCA + \beta_{j,FCA} FCA + \beta_{j,GG} GG + \beta_{j,EE} EE,$$

where $\pi_j(x)$ is the probability that an individual with the covariate $x = (LSC, PDU, PCA, FCA, G, E)^T$ belongs to the j th trajectory group for $j = 1, \dots, J-1$, and $\pi_J(x)$ is the probability that an individual with the covariate x belongs to the reference trajectory group, denoted by J th group. The variable names *LSC*, *PDU*, *PCA*, *FCA*, *G*, *E* denote Low self-control at T1, Peer drug use at T1, Parent-child attachment at T1, Family church attendance at T1, Gender, and Ethnicity, respectively.

Results

A six-group triple trajectory model was selected, based on the BIC and a group size of at least 5% in each group. The BICs were 23893, 23675, 23463, 23384, 23348 and 23337 for a 2, 3, 4, 5, 6, and 7-group model, respectively. Since the 7-group model had the smallest BIC score but one of the 7 groups had a prevalence less than 5%, we selected the 6-group model. Figure 2 presents the observed trajectories and the percentages of the participants who were members in each of the six trajectory groups. The mean BPP in each of the trajectory groups ranged from 81% to 93%, which indicated a good classification.

The six trajectory groups were named: 1) increasing alcohol use, increasing tobacco use, and moderate cannabis use (IAITMC; prevalence 19%, mean BPP=87%); 2) moderate alcohol use, low tobacco use, and low cannabis use (MALTLC; prevalence 14%, mean BPP=81%); 3) moderate alcohol use, high tobacco use, and high cannabis use (MAHTHC; prevalence 7%, mean BPP=93%); 4) increasing alcohol use, increasing tobacco use, and increasing cannabis use (IAITIC; prevalence 17%, mean BPP=90%); 5) increasing alcohol use, low tobacco use, and increasing cannabis use (IALTIC; prevalence 9%, mean BPP=89%); and 6) low alcohol use, no tobacco use, and no cannabis use (LANTNC; prevalence 34%, mean BPP=90%). Table 3 presents the adjusted odds ratios (AOR) for triple trajectory groups in the multinomial logistic regression analysis with the reference group of LANTNC.

Lower self-control was associated with an increased likelihood of being a member in the IAITMC (AOR=1.56, $p<.05$), MAHTHC (AOR=2.66, $p<.001$), and IAITIC (AOR=1.51, $p<.05$) groups as compared to the LANTNC group. Greater peer drug use was also associated with an increased likelihood of being a member of the IAITMC (AOR=2.51, $p<.001$), MALTLC (AOR=3.10, $p<.001$), MAHTHC (AOR=6.49, $p<.001$), and IAITIC (AOR=1.74, $p<.05$) groups as compared to the LANTNC group. On the other hand, greater parent-child attachment was associated with a decreased likelihood of being a member in the MALTLC (AOR=0.69, $p<.05$) and MAHTHC (AOR=0.52, $p<.01$) groups compared to the LANTNC group. Family church attendance was also associated with a decreased likelihood of being a member of the IAITIC group as compared to the LANTNC group (AOR=0.75, $p<.01$). (See Table 3.)

Discussion

The prevalence rates of the use of alcohol (41%), tobacco (33%), and cannabis (36%) in late adolescence from the current study are also consistent with the findings from the Monitoring the Future study (Johnston, O'Malley, Bachman, & Schulenberg, 2011), which indicated that about 44% and 28% of youth have consumed alcohol and used tobacco, respectively, and about 37% of youth have used illicit drugs at least once during the past year.

Overall, the findings support our hypotheses. The results showed that the risk factors (low self-control, peer drug use) and the protective factors (parent-child attachment, family church attendance) were positively and negatively associated with memberships in the heavier use of substances (e.g., MAHTHC) group as compared to membership in the reference (i.e., LANTNC) group.

Low self-control, peer drug use, and parent-child attachment were the significant risk and protective factors in predicting membership of the MAHTHC group as compared with membership of the LANTNC group. Also, family church attendance showed a trend at the 10% significance level. Among these four variables, peer drug use in mid adolescence is the strongest predictor of membership in the MAHTHC group as compared to membership in the LANTNC group. As shown in Table 2, one noticeable characteristic of the MAHTHC group is the high frequencies of alcohol (i.e., average 1 use), tobacco (i.e., average 1.5 use), and cannabis (i.e., average 1.8 use) use at age 14 in contrast to the low frequencies of the use of those substances in the other groups. This implies that affiliating with peers who use substances may play an important role in one's substance use in mid adolescence. This seems to be reasonable because adolescents who use substances tend to select friends who also use substances (Hoffmann & Bahr, 2014).

Our findings are in accord with two theories (SCT and FIT) (Brook et al., 1990; Gottfredson & Hirschi, 1990) that have served as the framework for the present study. More specifically, SCT confirms that individuals with low self-control are more likely to engage in problem behavior because they have trouble anticipating the long-term consequences of their behavior. FIT explains the linkage between the parent-child mutual attachment relationship and substance use. Hence, a positive parent-child mutual attachment relationship is likely to translate into higher self-esteem, prosocial orientation, and academic achievement during adolescence, which are all negatively related to substance use (Brook et al., 1990). From a theoretical perspective, however, the SCT and FIT models are focused primarily on adolescence and young adulthood; the present study leads us to the future research testing if these models would provide support regarding one's substance use into the 4th decade of life.

The other protective factor, family church attendance, was also negatively associated with alcohol, tobacco, and cannabis use. In many religious beliefs, the use of alcohol, tobacco, and other drugs for intoxication, as opposed to medical prescription, is prohibited (Khavari & Harmon, 1982). Therefore, family church attendance may act as a protective factor against deviance such as substance use in adolescence. Here, the interesting point is that family church attendance in mid adolescence predicts individual's alcohol, tobacco, and

cannabis use in the future (i.e., in the 20s and 30s), since only the IAITIC group showed a significant association as compared with the LANTNC group (the MAHTHC group showed a trend at 10% level). In other words, family church attendance did not have an impact on the use of alcohol, tobacco, and cannabis among adolescents who already used these substances at age 14.

The results have implications for public health. Information based on our findings may be used as a guide to form and/or to alter treatment and prevention programs for individuals who are struggling with problematic substance use. Health professionals may consider the findings of the present study to improve existing treatment and prevention programs. Treatment programs that included participation of parents and/or friends along with an adolescent in treatment programs for substance cessation would be more beneficial than treatment programs only focused on adolescents. Treatment programs to quit or reduce substance use in adolescence may also help decrease the continued use of substances in adulthood. Also, prevention programs could be modified by adding the geological/environmental factors such as neighborhood and school. Future research would be advantageous if these associations could be tested.

Further research is needed to gain a greater understanding of the conceptual nature of the relationship between earlier risk and protective factors and concurrent as well as later substance use. This line of research could lead to improvements in individualized treatments for adolescents and adults who use substances.

Strengths and Limitations

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). Also, we did not assess genetic variables that may have an effect on substance use (Dick & Agrawal, 2008; Goldman, Oroszi, & Ducci, 2006; Sanchez-Roige et al., 2019). In a statistical point of view, the uncertainty of group measurement still remains unsolved (Warren, Luo, Halpern-Manners, Raymo, & Palloni, 2015).

Despite these limitations, the study has a number of strengths. First, the present study is unique in examination of not only the risk factors (e.g., low self-control) but also the protective factors (e.g., parent-child attachment) in adolescence as predictors of trajectories of the use of three substances (alcohol, tobacco, and cannabis) beginning in adolescence and extending into adulthood. 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. Fourth, racial/ethnic diversity is also a strength, since our sample is consisting of African American and Puerto Rican participants residing in an urban area of New York City.

Acknowledgement

This research was supported in part by Career Development Award (5 K01 DA041609) granted to Dr. Lee from the National Institute on Drug Abuse.

References

- Agrawal A, Scherrer JF, Grant JD, Sartor CE, Pergadia ML, Duncan AE, . . . Bucholz KK (2010). The effects of maternal smoking during pregnancy on offspring outcomes. *Preventive Medicine*, 50(1), 13–18. doi:10.1016/j.ypmed.2009.12.009 [PubMed: 20026103]
- Asbridge M, Hayden JA, & Cartwright JL (2012). Acute cannabis consumption and motor vehicle collision risk: systematic review of observational studies and meta-analysis. *BMJ*, 344, e536. doi:10.1136/bmj.e536 [PubMed: 22323502]
- Beaver KM, Al-Ghamdi MS, Kobeisy AN, Alqurashi FH, Schwartz JA, Connolly EJ, & Gajos JM (2016). The effects of low self-control and delinquent peers on alcohol, tobacco, and drug use in a sample of Saudi Arabian youth. *International Journal of Offender Therapy and Comparative Criminology*, 60(13), 1569–1587. doi:10.1177/0306624X15583670 [PubMed: 25906778]
- Bouchery EE, Harwood HJ, Sacks JJ, Simon CJ, & Brewer RD (2011). Economic costs of excessive alcohol consumption in the US, 2006. *American Journal of Preventive Medicine*, 41(5), 516–524. doi:10.1016/j.amepre.2011.06.045 [PubMed: 22011424]
- Brook JS, Brook DW, Gordon AS, Whiteman M, & Cohen P (1990). The psychological etiology of adolescent drug use: a family interactional approach. *Genetic, Social, and General Psychology Monographs*, 116, 111–267.
- Brook JS, Lee JY, Brown EN, & Finch SJ (2012). Comorbid trajectories of tobacco and marijuana use as related to psychological outcomes. *Substance Abuse*, 33(2), 156–167. doi:10.1080/08897077.2011.640202 [PubMed: 22489588]
- Brook JS, Lee JY, Finch SJ, & Brown EN (2012). The association of externalizing behavior and parent–child relationships: an intergenerational study. *Journal of Child and Family Studies*, 21(3), 418–427. [PubMed: 23667304]
- Brook JS, Lee JY, Rubenstone E, Brook DW, & Finch SJ (2014). Triple comorbid trajectories of tobacco, alcohol, and marijuana use as predictors of antisocial personality disorder and generalized anxiety disorder among urban adults. *American Journal of Public Health*, 104(8), 1413–1420. doi:10.2105/AJPH.2014.301880 [PubMed: 24922120]
- CDC. (2008). Alcohol-related disease impact (ARDI).
- deRidder DT, Lensvelt-Mulders G, Finkenauer C, Stok FM, & Baumeister RF (2012). Taking stock of self-control: A meta-analysis of how trait self-control relates to a wide range of behaviors. *Personality and Social Psychology Review*, 16(1), 76–99. doi:10.1177/1088868311418749 [PubMed: 21878607]
- Dick DM, & Agrawal A (2008). The genetics of alcohol and other drug dependence. *Alcohol Research & Health*, 31(2), 111. [PubMed: 23584813]
- Farmer RF, Seeley JR, Kosty DB, Gau JM, Duncan SC, Lynskey MT, & Lewinsohn PM (2015). Internalizing and externalizing psychopathology as predictors of cannabis use disorder onset during adolescence and early adulthood. *Psychology of Addictive Behaviors*, 29(3), 541–551. doi:10.1037/adb0000059 [PubMed: 25799438]
- Franken A, Moffitt TE, Steglich CE, Dijkstra JK, Harakeh Z, & Vollebergh WA (2016). The role of self-control and early adolescents' friendships in the development of externalizing behavior: The SNARE study. *Journal of Youth and Adolescence*, 45(9), 1800–1811. doi:10.1007/s10964-015-0287-z [PubMed: 25922116]
- Friedmann PD (2013). Alcohol use in adults. *New England Journal of Medicine*, 368(4), 365–373. doi:10.1056/NEJMc1204714
- Goldman D, Oroszi G, & Ducci F (2006). The genetics of addictions: uncovering the genes. *Focus*, 6(3), 521–415.
- Gottfredson MR, & Hirschi T (1990). *A general theory of crime*. Palo Alto, CA: Stanford University Press.
- Gray TR, Eiden RD, Leonard KE, Connors GJ, Shisler S, & Huestis MA (2010). Identifying prenatal cannabis exposure and effects of concurrent tobacco exposure on neonatal growth. *Clinical Chemistry*, 56(9), 1442–1450. doi:10.1373/clinchem.2010.147876 [PubMed: 20628142]

- Harrison L, Martin S, Enev T, & Harrington D (2007). Comparing drug testing and self-report of drug use among youths and young adults in the general population. Rockville, MD: Substance Abuse and Mental Health Services Administration, Office of Applied Studies
- Hawkins JD, Catalano RF, & Miller JY (1992). Risk and protective factors for alcohol and other drug problems in adolescence and early adulthood: implications for substance abuse prevention. *Psychological bulletin*, 112(1), 64. [PubMed: 1529040]
- Hoffmann JP, & Bahr SJ (2014). Parenting style, religiosity, peer alcohol use, and adolescent heavy drinking. *Journal of Studies on Alcohol and Drugs*, 75(2), 222–227. [PubMed: 24650815]
- Jackson KM, Sher KJ, & Schulenberg JE (2008). Conjoint developmental trajectories of young adult substance use. *Alcoholism: clinical and experimental research*, 32(5), 723–737. doi:10.1111/j.1530-0277.2008.00643.x
- Jamal A, Homa DM, O'Connor E, Babb SD, Caraballo RS, Singh T, . . . King BA (2015). Current cigarette smoking among adults—United States, 2005–2014. *MMWR Morbidity Mortality Weekly Report*, 64(44), 1233–1240. doi:10.15585/mmwr.mm6444a2
- Johnston LD, O'Malley PM, Bachman JG, & Schulenberg JE (2011). Monitoring the Future national results on adolescent drug use: Overview of key findings, 2011.
- Karila L, Roux P, Rolland B, Benyamina A, Reynaud M, Aubin H-J, & Lançon C (2014). Acute and long-term effects of cannabis use: a review. *Current Pharmaceutical Design*, 20(25), 4112–4118. doi:10.2174/13816128113199990620 [PubMed: 24001294]
- Khavari KA, & Harmon TM (1982). The relationship between the degree of professed religious belief and use of drugs. *International Journal of the Addictions*, 17(5), 847–857. doi:10.3109/10826088209056331
- Lee JY, Brook JS, De La Rosa M, Kim Y, & Brook DW (2017). The association between alcohol use trajectories from adolescence to adulthood and cannabis use disorder in adulthood: a 22-year longitudinal study. *The American Journal of Drug and Alcohol Abuse*, 1–7. doi:10.1080/00952990.2017.1288734
- McCabe SE, Morales M, Cranford JA, Delva J, McPherson MD, & Boyd CJ (2007). Race/ethnicity and gender differences in drug use and abuse among college students. *Journal of Ethnicity in Substance Abuse*, 6(2), 75–95. doi:10.1300/J233v06n02_06 [PubMed: 18192205]
- Muthén L, & Muthén B (2010). *Mplus user's guide*. 6th ed. In. Los Angeles, CA: Muthén & Muthén.
- Newman K, Harrison L, Dashiff C, & Davies S (2008). Relationships between parenting styles and risk behaviors in adolescent health: an integrative literature review. *Revista Latino-Americana De Enfermagem*, 16(1), 142–150. doi:10.1590/S0104-11692008000100022 [PubMed: 18392544]
- NIDA. (2014). NIH: National Institute on Drug Abuse. Research Report Series Marijuana. Available at <https://www.drugabuse.gov/drugs-abuse/marijuana>. Accessed on May 26, 2016. (Accession No. 15-3859)
- Pokhrel P, Unger JB, Wagner KD, Ritt-Olson A, & Sussman S (2008). Effects of parental monitoring, parent–child communication, and parents' expectation of the child's acculturation on the substance use behaviors of urban, Hispanic adolescents. *Journal of Ethnicity in Substance Abuse*, 7(2), 200–213. doi:10.1080/15332640802055665 [PubMed: 19042806]
- Rehm J, Gmel G, Sempos CT, & Trevisan M (2003). Alcohol-related morbidity and mortality. *Alcohol Research & Health*, 27(1), 39–51. [PubMed: 15301399]
- SAMHSA. (2014). Results from the 2013 national survey on drug use and health: Summary of national findings (Vol. NSDUH series H-49, HHS publication no. (SMA) 14–4887). Rockville, MD: Substance Abuse and Mental Health Services Administration.
- SAMHSA. (2015). Behavioral Health Trends in the United States: Results from the 2014 national survey on drug use and health. Retrieved from <https://www.samhsa.gov/data/sites/default/files/NSDUH-FRR1-2014/NSDUH-FRR1-2014.pdf>
- Sanchez-Roige S, Fontanillas P, Elson SL, andMe Research T, Gray JC, de Wit H, . . . Palmer AA (2019). Genome- wide association study of alcohol use disorder identification test (AUDIT) scores in 20 328 research participants of European ancestry. *Addiction biology*, 24(1), 121–131. [PubMed: 29058377]

- Schulenberg JE, Merline AC, Johnston LD, O'Malley PM, Bachman JG, & Laetz VB (2005). Trajectories of marijuana use during the transition to adulthood: The big picture based on national panel data. *Journal of Drug Issues*, 35(2), 255–280. [PubMed: 16534532]
- Warren JR, Luo L, Halpern-Manners A, Raymo JM, & Palloni A (2015). Do different methods for modeling age-graded trajectories yield consistent and valid results? *American Journal of Sociology*, 120(6), 1809–1856. doi:10.1086/681962
- Wills TA, Knight R, Williams RJ, Pagano I, & Sargent JD (2015). Risk factors for exclusive e-cigarette use and dual e-cigarette use and tobacco use in adolescents. *Pediatrics*, 135(1), e43–e51. doi:10.1542/peds.2014-0760 [PubMed: 25511118]
- Xu X, Bishop EE, Kennedy SM, Simpson SA, & Pechacek TF (2015). Annual healthcare spending attributable to cigarette smoking: an update. *American Journal of Preventive Medicine*, 48(3), 326–333. doi:10.1016/j.amepre.2014.10.012 [PubMed: 25498551]
- Yankey BN, Strasser S, & Okosun IS (2016). A cross-sectional analysis of the association between marijuana and cigarette smoking with metabolic syndrome among adults in the United States. *Diabetes & Metabolic Syndrome: Clinical Research & Reviews*, 10(2), S89–S95. doi:10.1016/j.dsx.2016.03.001

Figure 1. Sampling process including mean age T_i ($i = 1, \dots, 5$), number of samples N , and retention rate R .

Figure 2.

Triple trajectory groups of alcohol, tobacco, and cannabis use from mid adolescence to the mid thirties

Notes. 1. IAITMC = Increasing Alcohol use, Increasing Tobacco use, and Moderate Cannabis use; MALTLC = Moderate Alcohol use, Low Tobacco use, and Low Cannabis use; MAHTHC = Moderate Alcohol use, High Tobacco use, and High Cannabis use; IAITIC = Increasing Alcohol use, Increasing Tobacco use, and Increasing Cannabis use; IALTIC = Increasing Alcohol use, Low Tobacco use, and Increasing Cannabis use 2. X-axis represents age in years; Y-axis represents the frequency of alcohol, tobacco, and cannabis use 3.

Answer options for alcohol use: none at all (0), less than once a week (1), once a week to several times a week (2), 1 or 2 drinks a day (3), 3 or 4 drinks a day or more (4); for tobacco use: none at all (0), a few cigarettes or less a week (1), 1-5 cigarettes a day (2), about half pack a day (3), about a pack a day (4), about one and half packs a day or more (5); for cannabis use: 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)

Author Manuscript

Author Manuscript

Author Manuscript

Author Manuscript

Table 1.

Independent and Control Variables: Scales, Time Wave(s), Author(s), Number of Items, Response Range, Items, and Cronbach's Alpha.

Scale (number of items)	Response Range	Item(s)	Cronbach's Alpha
<i>Independent variables</i>			
Low self-control at T1 (3)	(1) completely false – (4) completely true	Does each of the following describe you: a) feel like losing your temper at people; b) feel like swearing; c) very often, you do not attend to things because you are thinking about the opposite sex.	0.61
Peer drug use at T1 (4)	(1) none – (4) most	How many of your friends: a) smoke cigarettes on a regular basis?; b) drink alcohol at least once a week?; c) ever used marijuana?; d) ever used other illegal drugs?	0.78
Parent-child attachment at T1 (6)	(1) not at all – (4) very much	How well does each of the following describe how you act with your mother: a) sometimes you break your mother's rule; b) you try to see what you can get away with; c) sometimes you do not obey your mother unless she keeps after you. How well does each of the following describe how you act with your father: d) sometimes you break your father's rule; e) you try to see what you can get away with; f) sometimes you do not obey your father unless she keeps after you.	0.83
Family church attendance at T1 (3)	(1) never – (5) once a week or more	How often do: a) you attend religious services?; b) mother attend religious services?; c) father attend religious services?	0.73
<i>Control variables</i>			
Gender at T1 (1)	Female=1; Male=2	Not applicable	Not applicable (Single Item)
Race/Ethnicity at T1 (1)	African American=1; Puerto Rican=2	Not applicable	Not applicable (Single Item)
<i>Dependent variables</i>			
Alcohol use at T1-T5 (1)	(0) none at all - (4) 3 or 4 drinks a day or more	How much alcohol (beer, wine, or hard liquor) did you drink in the past year?	Not applicable (Single Item)
Tobacco use at T1-T5 (1)	(0) none at all - (4) about one and a half packs a day or more	How many cigarettes a day did you smoke in the past year?	Not applicable (Single Item)
Cannabis use at T1-T5 (1)	(0) never - (4) once a week or more	How often have you used cannabis in the past year?	Not applicable (Single Item)

Table 2.

Summary statistics (fractions, means, and standard deviations)

	1. IAITMC (19%, n=125)	2. MALTLC (14%, n=97)	3. MAHTHC (7%, n=49)	4. IAITC (17%, n=113)	5. IALITC (9%, n=64)	6. LANTNC (34%, n=226)	Entire Sample (N= 674)
Low self-control T1 (age 14)	2.57 (0.70)	2.53 (0.69)	3.02 (0.63)	2.56 (0.66)	2.54 (0.68)	2.24 (0.77)	2.48 (0.74)
Peer drug use T1 (age 14)	1.64 (0.72)	1.70 (0.69)	2.32 (0.72)	1.45 (0.58)	1.42 (0.62)	1.28 (0.47)	1.52 (0.66)
Parent-child attachment T1 (age 14)	2.67 (0.81)	2.57 (0.69)	2.18 (0.83)	2.69 (0.75)	2.69 (0.73)	2.93 (0.75)	2.71 (0.78)
Family church attendance T1 (age 14)	2.60 (1.19)	2.73 (1.23)	2.29 (1.06)	2.47 (1.07)	2.86 (1.24)	2.92 (1.19)	2.71 (1.19)
African Americans	41%, n=51	62%, n=60	39%, n=19	56%, n=63	55%, n=35	57%, n=128	53%, n=256
Females	62%, n=78	74%, n=72	65%, n=32	29%, n=33	45%, n=29	71%, n=161	60%, n=405
Alcohol use	0.23 (0.32)	0.45 (0.45)	0.88 (0.64)	0.17 (0.26)	0.13 (0.32)	0.08 (0.18)	0.23 (0.39)
T1 (age 14)	0.76 (0.71)	0.96 (0.80)	1.13 (0.80)	0.84 (0.81)	0.58 (0.53)	0.35 (0.46)	0.67 (0.71)
T2 (age 19)	1.21 (0.94)	1.32 (0.88)	1.49 (0.99)	1.72 (0.90)	1.33 (0.70)	0.65 (0.56)	1.20 (0.89)
T3 (age 24)	1.24 (1.17)	0.99 (0.65)	1.02 (0.79)	1.49 (1.10)	1.32 (1.10)	0.63 (0.58)	1.03 (0.94)
T4 (age 29)	1.45 (1.14)	1.25 (0.84)	1.43 (1.04)	1.95 (1.41)	1.63 (1.08)	0.89 (0.83)	1.33 (1.11)
T5 (age 36)	0.22 (0.49)	0.24 (0.45)	1.47 (1.40)	0.08 (0.27)	0.07 (0.22)	0.00 (0.02)	0.20 (0.60)
Tobacco use	1.51 (1.62)	0.46 (1.05)	2.29 (1.57)	1.27 (1.45)	0.13 (0.42)	0.05 (0.29)	0.76 (1.32)
T1 (age 14)	2.19 (1.54)	0.14 (0.50)	2.82 (1.74)	2.50 (1.54)	0.15 (0.53)	0.02 (0.19)	1.20 (1.63)
T2 (age 19)	2.57 (1.65)	0.05 (0.21)	2.81 (1.75)	2.88 (1.50)	0.18 (0.43)	0.02 (0.18)	1.19 (1.70)
T3 (age 24)	2.48 (1.77)	0.04 (0.20)	2.77 (1.72)	3.07 (1.88)	0.27 (0.58)	0.03 (0.17)	1.24 (1.81)
T4 (age 29)	0.07 (0.36)	0.23 (0.74)	1.75 (1.44)	0.03 (0.16)	0.02 (0.13)	0.00 (0.07)	0.18 (0.68)
T5 (age 36)	0.89 (1.27)	0.73 (1.19)	2.71 (1.51)	1.85 (1.63)	0.75 (1.27)	0.05 (0.34)	0.87 (1.39)
Cannabis use	0.59 (1.04)	0.40 (0.75)	2.43 (1.52)	3.09 (1.13)	1.93 (1.55)	0.02 (0.15)	1.17 (1.55)
T1 (age 14)	0.26 (0.53)	0.25 (0.59)	2.21 (1.63)	2.86 (1.29)	2.34 (1.40)	0.01 (0.12)	0.96 (1.47)
T2 (age 19)	0.31 (0.78)	0.13 (0.34)	1.59 (1.62)	2.80 (1.52)	1.89 (1.63)	0.05 (0.27)	0.86 (1.45)
T3 (age 24)							
T4 (age 29)							
T5 (age 36)							

Note. IAITMC = Increasing Alcohol use, Increasing Tobacco use, and Moderate Cannabis use; MALTLC = Moderate Cannabis use; MAHTHC = Moderate Alcohol use, High Tobacco use, and High Cannabis use; IAITC = Increasing Alcohol use, Increasing Tobacco use, and Increasing Cannabis use; IALITC = Increasing Alcohol use, Low Tobacco use, and Increasing Cannabis use; LANTNC = Increasing Alcohol use, Low Tobacco use, and Low Cannabis use; MAHTHC = Moderate Alcohol use, High Tobacco use, and High Cannabis use; IAITC = Increasing Alcohol use, Increasing Tobacco use, and Increasing Cannabis use; IALITC = Increasing Alcohol use, Low Tobacco use, and Increasing Cannabis use.

Table 3.

Adjusted odds ratios (AOR) with 95% confidence interval (CI) of the risk (low self-control, peer drug use) and protective (parent-child attachment, family church attendance) factors in mid adolescence as predictors of triple trajectories of tobacco, alcohol, and cannabis use beginning in mid adolescence to the mid thirties

AOR (95% CI) of triple trajectories (age 14 – age 36)					
	IAITMC vs. LANTNC	MALTLC vs. LANTNC	MAHTHC vs. LANTNC	IAITIC vs. LANTNC	IAITIC vs. LANTNC
<i>Risk factors at age 14</i>					
Low self-control	1.56 (1.10, 2.22) *	1.27 (0.87, 1.86)	2.66 (1.53, 4.65) ***	1.51 (1.03, 2.19) *	1.49 (0.97, 2.31) †
Peer drug use	2.51 (1.65, 3.81) ***	3.10 (2.01, 4.79) ***	6.49 (3.85, 10.91) ***	1.74 (1.07, 2.81) *	1.58 (0.91, 2.76)
<i>Protective factors at age 14</i>					
Parent-child attachment	0.85 (0.61, 1.18)	0.69 (0.49, 0.99) *	0.52 (0.32, 0.84) **	0.83 (0.59, 1.18)	0.79 (0.52, 1.19)
Family church attendance	0.86 (0.71, 1.04)	0.92 (0.75, 1.04)	0.72 (0.52, 1.00) †	0.75 (0.60, 0.92) **	1.01 (0.79, 1.28)
<i>Control variables at age 14</i>					
Gender	1.52 (0.94, 2.47) †	0.91 (0.52, 1.59)	1.84 (0.87, 3.85)	5.99 (3.50, 9.97) ***	2.94 (1.65, 5.24) ***
Race/ethnicity	1.66 (1.04, 2.64) *	0.67 (0.40, 1.12)	1.43 (0.69, 2.95)	0.93 (0.57, 1.53)	1.02 (0.57, 1.81)

Notes. 1. † $p < 0.1$, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

2. Gender and race/ethnicity at age 14 were statistically controlled.

3. IAITMC = Increasing Alcohol use, Increasing Tobacco use, and Moderate Cannabis use; MALTLC = Moderate Cannabis use, Low Tobacco use, and Low Cannabis use; MAHTHC = Moderate Alcohol use, High Tobacco use, and High Cannabis use; IAITIC = Increasing Alcohol use, Increasing Tobacco use, and Increasing Cannabis use; IALTIC = Increasing Alcohol use, Low Tobacco use, and Increasing Cannabis use