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Single and dual diagnoses of major depressive disorder and posttraumatic stress disorder predicted by triple comorbid trajectories of tobacco, alcohol, and marijuana use among urban adults

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Abstract

Background: The adverse consequences of major depressive disorder (MDD) and posttraumatic stress disorder (PTSD) affect a significant portion of the US population every year (i.e., 15 million for MDD; 8 million for PTSD) and are of public health concern. The current study examines tobacco, alcohol, and marijuana use as possible longitudinal predictors of MDD and/or PTSD.

Methods: A community sample of 674 participants (53% African Americans and 47% Puerto Ricans; 405 females and 269 males) were recruited from the Harlem Longitudinal Development Study. We used *Mplus* software to obtain the triple trajectories of tobacco, alcohol, and marijuana use from mean age 14 to 36. Logistic regression analyses were then conducted to examine the associations between those triple trajectory groups and a single diagnosis of MDD or PTSD as well as a dual diagnosis of MDD with PTSD at age 36.

Results: The observed percentages of MDD, PTSD, and the comorbidity of MDD and PTSD were 17%, 8%, and 5%, respectively. The heavy use of all 3 substances group was associated with an increased likelihood of having MDD (adjusted odds ratio [AOR] = 3.14, $P < .01$), PTSD (AOR

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Author contributions

Each of the authors certifies that the article represents valid work to which they substantially contributed. J. Y. Lee conducted the statistical analysis, created the tables, and contributed to the writing of the article and interpretation of results. J. S. Brook involved in the research design. S. J. Finch provided interpretation of the statistical analysis and review of the article. W. Kim performed the statistical analysis, created the figure, and contributed to the writing of the article. D. W. Brook was involved in the editing and review of the article. All authors were involved in article preparation and approved the final draft.

= 3.91, $P < .05$), and MDD with PTSD (AOR = 6.64, $P < .01$), as compared with the tobacco and alcohol use group.

Conclusions: Treatment programs to quit or reduce the use of tobacco, alcohol, and marijuana may help decrease the prevalence of MDD and PTSD. This could lead to improvements in individualized treatments for patients who use tobacco, alcohol, and marijuana and who have both MDD and PTSD.

Keywords

Longitudinal study; major depressive disorder; posttraumatic stress disorder; triple comorbid substance use trajectories

Introduction

The World Health Organization has ranked depression as the fourth leading cause of disability worldwide and projects that by 2020, it will be the second leading cause.¹ In the US, major depressive disorder (MDD) affects about 15 million (6.7%) adults every year.² A number of sociodemographic correlates of major depression are found consistently across countries, and cross-national data also document the association of MDD with numerous adverse outcomes, including difficulties in role transitions (e.g., low education, high teen childbearing, marital disruption, unstable employment), reduced role functioning (e.g., low marital quality, low work performance, low earnings), elevated risk of onset, persistence and severity of a wide range of secondary disorders, and increased risk of early mortality due to physical disorders and suicide.³

Posttraumatic stress disorder (PTSD) affects about 8 million (3.5%) adults every year in the US.² Numerous studies have shown the impact of PTSD on aspects of mental health such as suicide, depression, substance use, violence, and the inability to maintain relationships,⁴ as well as on aspects of physical health-related quality of life, general health symptoms, and general medical conditions.⁵ In a community-based sample of the elderly population in The Netherlands, individuals with PTSD were less satisfied with life in general, used health care for predominantly somatic care, and evaluated the care they received to be inadequate.⁶

Studies of PTSD have found high levels of comorbid MDD using a population of veterans,⁷ as well as in the general population,⁸ because depression often occurs after trauma. For example, a survey of survivors from the Oklahoma City bombing showed that 23% had depression after the bombing as compared with 13% who had depression before the bombing.⁹ More recently, approximately half of people with PTSD also had a diagnosis of MDD across diverse epidemiological samples.¹⁰ Indeed, individuals with PTSD seldom used prescribed antidepressants.⁶ Furthermore, comorbidity of MDD and PTSD was associated with greater symptoms, reduced quality of life, and increased health care utilization than PTSD alone.^{11,12}

Greater understanding of the precursors of MDD and PTSD is valuable for public health policy given the adverse consequences of MDD and PTSD that affect such a huge portion of the US population every year (i.e., 15 million for MDD and 8 million for PTSD). Prevention

programs that use insights from the precursors are needed. The earlier use of alcohol,¹³ cigarettes,¹⁴ and cannabis¹⁵ are associated with an increased risk for developing later MDD. Furthermore, the high prevalence of MDD among individuals with a history of trauma and PTSD is well established in the literature.¹⁶

Tobacco use, alcohol use, and marijuana use often co-occur,^{17–19} so that some individuals who use one of these substances are at risk for use of the others. Schulenberg et al.²⁰ for instance, showed that membership in the chronic and abstainer marijuana use groups, respectively, predicted the highest and lowest rates of both binge drinking and tobacco use among emerging adults. Only a few studies^{21,22} assess concurrent trajectories of the use of 2 or more substances. For example, Jackson et al.²¹ showed that patterns of tobacco, alcohol, 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 tobacco smokers.

Our previous research²² identified 5 groups of tobacco, alcohol, and marijuana use trajectories: the use of all 3 substances (23%), marijuana and alcohol use (14%), tobacco and alcohol use (16%), alcohol use only (38%), and nonuse (9%) extending from late adolescence (mean age 19) to the early 30s (mean age 32). In the present study, we extend previous research that assessed MDD and PTSD as outcomes of triple trajectories of tobacco, alcohol, and marijuana use. The current analysis makes a substantial contribution over our previous research that assessed individuals during ages 19–32. We have now added measures of tobacco, alcohol, and marijuana use at 2 additional points in time (mean ages of 14 and 36) to examine the changes in the patterns of the trajectories of tobacco, alcohol, and marijuana use.

The present study focuses on the developmental course of the comorbid use of tobacco, alcohol, and marijuana, spanning several developmental periods from adolescence to adulthood, among urban African Americans and Puerto Ricans. This is the first investigation of triple comorbid trajectories of substance use and their longitudinal associations with a single diagnosis of MDD or PTSD as well as a dual diagnosis of MDD with PTSD.

We hypothesize that (1) membership in the triple comorbid trajectory group (tobacco, alcohol, and marijuana use) will be associated with a greater likelihood of having MDD and/or PTSD in adulthood than membership in any double comorbid trajectory groups (e.g., tobacco and alcohol use); (2) membership in the triple comorbid trajectory group of tobacco, alcohol, and marijuana use will be associated with a greater likelihood of MDD and/or PTSD than membership in any single trajectory group (e.g., alcohol use only); (3) membership in any double comorbid trajectory group will be related to a greater likelihood of MDD and/or PTSD in adulthood than membership in any single trajectory group; (4) the comparisons listed above will have stronger associations with a dual diagnosis of MDD with PTSD than a single diagnosis of either MDD or PTSD.

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,²³ a psychosocial investigation of urban African Americans and Puerto Ricans. Data were first collected in 1990 (time 1; T1, $N = 1332$) when the participants (mean age: 14.1 years, standard deviation [SD] = 1.4 years) were students attending schools in the East Harlem area of New York City. Data were collected by the National Opinion Research Center at time 2 (T2; 1994–1996; $N = 1190$) 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), because of budgetary constraints, 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 T3 data were not used in this paper. 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).

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 T1 and 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.²⁴

We compared the demographic variables for the 674 adults who participated at both T1 (for gender and race/ethnicity)/T2 (for depressive symptoms and victimization) and T5 with the 516 who participated at T1/T2 but not at T5. The percentage of males among T5 nonparticipants (52%) was significantly higher than the percentage of males who participated at T5 (40%) ($\chi^2 = 16.5$, $P < .001$, $df = 1$). However, there are no differences in race/ethnicity at T1 ($\chi^2 = 0.1$, $P = .8$, $df = 1$), depressive symptoms at T2 ($t = -1.9$, $P = .1$), and victimization at T2 ($t = 1.5$, $P = .1$).

Measures

Tobacco use, alcohol use, and marijuana use were measured at T1, T2, T4, and T5 (mean ages 14–36 years). The control variables for the analyses consisted of gender at T1, ethnicity at T1, depressive symptoms at T2 as a proxy for earlier MDD, and victimization at T2 as a proxy for earlier PTSD. Table 1 lists the scales, time wave(s), response range, sample items, and Cronbach's alphas (or interitem correlation) for the independent and control variables (see Table 1).

MDD at T5

Major depressive disorder²⁵ was diagnosed if the participant answered yes (1) to either of the first 2 questions (a and b below), (2) to 5 or more on the next 7 questions (c, d, e, f, g, h, and i below), and (3) to the last question (j below): In the past 5 years, (a) were you depressed or down most of the day, nearly every day, for 2 weeks in a row?; (b) were you much less interested in most things, or much less able to enjoy the things you used to enjoy, most of the time, for 2 weeks?; Over this 2-week period when you felt depressed or uninterested, (c) was your appetite decreased or increased nearly every day or did you weight decrease or increase without intentionally trying?; (d) did you have trouble sleeping nearly every night (difficulty falling asleep, waking up in the middle of the night, early morning wakening) or did you sleep excessively?; (e) did you talk or move more slowly than normal or were fidgety, restless or having trouble sitting still almost everyday?; (f) did you feel tired or without energy almost everyday?; (g) did you feel worthless or guilty almost everyday?; (h) did you have difficulty in concentrating or making decisions almost everyday?; (i) did you repeatedly consider hurting yourself, feel suicidal, or wish that you were dead?; (j) did these experiences cause significant problems at home, at work, socially, at school, or in some other important way? The internal reliability of this measure was satisfactory ($\alpha = .81$).

PTSD at T5

PTSD was assessed by use of the PCL-S (PTSD Checklist for DSM-IV [*Diagnostic and Statistical Manual of Mental Disorders, Fourth Edition*])—Specific) measure.²⁶ First, participants were asked: “Have you ever experienced or witnessed or had to deal with an extremely stressful or traumatic event that bothered you for at least a month. The event included actual or threatened death or serious injury to you or someone else? (yes or no).” If the participant answered yes to the above question, s/he was asked about each of 17 experiences, with its minimum score for PTSD symptoms in parenthesis: (a) Repeated, disturbing memories, thoughts, or images of the stressful experience? (4); (b) Repeated, disturbing dreams of the stressful experience? (4); (c) Suddenly acting or feeling as if the experience were happening again (reliving it)? (3); (d) Feeling very upset when something reminded you of the stressful experience? (3); (e) Having physical reactions when something reminded you of the stressful experience? (3); (f) Avoiding thinking about or talking about the stressful experience or avoiding having feelings related to it? (3); (g) Avoiding activities or situations because they remind you of the stressful experience? (3); (h) Having trouble remembering important parts of the stressful experience? (3); (i) Loss of interest in things you used to enjoy? (4); (j) Feeling distant or cut off from other people? (4); (k) Feeling emotionally numb or being unable to have loving feelings for those close to you? (3); (l) Feeling as if your future will somehow be cut short? (4); (m) Trouble falling or staying asleep? (3); (n) Feeling irritable or having angry outbursts? (3); (o) Having difficulty concentrating? (4); (p) Being “super alert”—watchful, or on guard (3); (q) Feeling jumpy or easily startled? (3).²⁷ The participant rated each experience on a 5-point Likert scale: no = 1, a little bothered = 2, moderately bothered = 3, quite a bit bothered = 4, and extremely bothered = 5. A participant was scored as having PTSD symptoms when the following 4 criteria were met: (1) at least 1 question from (a) through (e) met or exceeded the minimum score; (2) at least 3 questions from (f) through (l) met or exceeded the minimum score; (3) at

least 2 questions from (m) through (q) met or exceeded the minimum score; and (4) the summed score of all 17 questions was greater than or equal to 44. The internal reliability of this measure was satisfactory ($\alpha = .95$). All variables in the present study were based on participant self-report.

Analytic procedure

We used *Mplus* software²⁸ to obtain the triple trajectories of tobacco, alcohol, and marijuana use. Tobacco, alcohol, and marijuana use at each time point were treated as censored normal variables. 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 tobacco, alcohol, and marijuana use, respectively, at each point in time when the each participant was assigned to the group with the largest Bayesian posterior probability (BPP).

We applied the full information maximum likelihood approach for missing data.²⁸ We had no missing values for MDD, PTSD, gender, ethnicity, alcohol use at T2, tobacco 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%.

Logistic regression analyses were then conducted to examine whether the BPPs of the triple trajectory group of heavy use of all 3 substances, compared with the BPPs of each of the other substance use trajectory groups from T1 to T5, were associated with MDD and PTSD at T5, controlling for gender, ethnicity, and 2 proxies of the outcome variables: depressive symptoms at T2 and victimization at T2.

Results

Among the 674 participants, 114 individuals (17%) reported having MDD and 53 individuals (8%) reported having PTSD. In addition, 34 out of 674 participants (5%) had comorbidity of MDD with PTSD. A 5-group triple trajectory model was selected, based on the BIC and a group size of at least 5% in each group. The BIC scores were 20128, 19972, 19882, 19821, and 19872 for a 2-, 3-, 4-, 5-, and 6-group model, respectively. The 5-group model had the smallest BIC score, and none of the 5 groups had prevalence less than 5%. Figure 1 presents the observed trajectories and the percentages of the participants who were members in each of the 5 trajectory groups. The mean BPP in each trajectory group ranged from 85% to 92%, which indicated a good classification (see Figure 1).

The 5 trajectory groups were named: (A) heavy use of all 3 substances (prevalence 7%, mean BPP = 92%); (B) increasing use of all 3 substances (prevalence 17%, mean BPP = 91%); (C) tobacco and alcohol use (prevalence 19%, mean BPP = 87%); (D) alcohol and marijuana use (prevalence 17%, mean BPP = 85%); and (E) moderate alcohol use only (prevalence 40%, mean BPP = 92%). Table 2 presents summary statistics for each of the 5 trajectory groups.

Table 3 shows the adjusted odds ratios (AORs) for MDD, PTSD, and MDD with PTSD in the logistic regression analyses. The BPP of the heavy use of all 3 substances group was

associated with an increased likelihood of having MDD (AOR = 3.14, $P < .01$), PTSD (AOR = 3.91, $P < .05$), and MDD with PTSD (AOR = 6.64, $P < .01$), as compared with the BPP of the tobacco and alcohol use group. Also, the BPP of the heavy use of all 3 substances use group was associated with an increased likelihood of having MDD with PTSD (AOR = 3.70, $P < .05$), as compared with the BPP of the alcohol and marijuana use group. When the comparison group was the moderate alcohol use only group, the BPP of the heavy use of all 3 substances use group was associated with an increased likelihood of having MDD (AOR = 4.75, $P < .001$), PTSD (AOR = 6.84, $P < .001$), and MDD with PTSD (AOR = 35.90, $P < .001$). The BPP of the increasing use of all 3 substances group was associated with an increased likelihood of having MDD (AOR = 3.10, $P < .01$), PTSD (AOR = 3.49, $P < .05$), and MDD with PTSD (AOR = 14.89, $P < .001$), as compared with the BPP of the moderate alcohol use only group. The BPP of the alcohol and marijuana use group was associated with an increased likelihood of PTSD (AOR = 3.02, $P < .05$) and MDD with PTSD (AOR = 8.50, $P < .05$), compared with the BPP of the moderate alcohol use only group (see Table 3).

Discussion

The present study examined the longitudinal patterns of the comorbid use of tobacco, alcohol, and marijuana, spanning several developmental periods from adolescence (mean age 14) to adulthood (mean age 36), among urban African Americans and Puerto Ricans. The results, therefore, add to the literature, since the other research teams have investigated the patterns of more than 1 substance use using a sample of primarily whites.²¹ Furthermore, there are no other studies, to our knowledge, examining the association of the earlier comorbid use of tobacco, alcohol, and marijuana with later MDD, PTSD, and MDD with PTSD among urban African Americans and Puerto Ricans.

Overall, our findings support our hypotheses, since the results showed that the triple comorbid trajectory groups were associated with an increased likelihood of having MDD, PTSD, and MDD with PTSD as compared with either the double comorbid substance use trajectory groups or the single substance use trajectory groups. Also, a dual diagnosis of MDD with PTSD had stronger associations with the substance use trajectory groups than a single diagnosis of either MDD or PTSD alone.

The first comparison (heavy use of all 3 substances vs. increasing use of all 3 substances) in Table 3 presents no statistical differences in terms of being related to a single diagnosis of MDD or PTSD, and a dual diagnosis of MDD with PTSD. Although memberships in the increasing use of all 3 substances group indicated no or very little substance use in adolescence, the frequency of substance use increased over time; therefore, the amount of substance use in the increasing use of all 3 substances group reached the amount of substance use in the heavy use of all 3 substances group in young adulthood and even exceeded the amount of substance use in the heavy use of all 3 substances group in adulthood. The use of substances during adulthood rather than its use during adolescence may play an important role as a risk factor for MDD, PTSD, and MDD with PTSD in adulthood.

The heavy use of all 3 substances group compared with the tobacco and alcohol use group was significantly associated with MDD and PTSD alone, whereas the association was not significant when we compared the heavy use of all 3 substances group with the alcohol and marijuana use group. Similarly, the alcohol and marijuana use only group compared with the moderate alcohol use group showed a significant association with PTSD, whereas the tobacco and alcohol use only group compared with the moderate alcohol use group had no apparent association with PTSD. The use of marijuana rather than tobacco seems to have some impact on MDD and/or PTSD.

Although the heavy use of all 3 substances group and the alcohol and marijuana use group were not statistically different in terms of having either MDD or PTSD, the heavy use of all 3 substances group had a 3.7-fold increased likelihood of having a dual diagnosis of MDD with PTSD as compared with the alcohol and marijuana use group. Also, the alcohol and marijuana use only group compared with the moderate alcohol use group had increased odds of 8.5 for having a dual diagnosis of MDD with PTSD, whereas there was no such association with MDD alone. These findings may give guidance to clinicians to form or to alter screening tools for MDD and/or PTSD. Although a patient, who uses at least 2 substances, is free for the screening on either MDD or PTSD, that patient may be at greater risk for a dual diagnosis of MDD with PTSD.

Many symptoms of MDD overlap with the symptoms of PTSD, such as anhedonia, irritability, difficulty with concentration, and sleep problems.²⁹ If the overlapped symptoms are responsible for the comorbidity of MDD and PTSD, then it would occur more frequently occurred in PTSD patients with MDD than without MDD. For example, with both MDD and PTSD, individuals may have trouble sleeping or keeping their mind focused and may not feel pleasure or interest in things they used to enjoy. Both PTSD and MDD may involve greater irritability. Indeed, a number of research papers have documented that individuals with both MDD and PTSD report high levels of distress and role impairment^{30–33} and are at greater risk for suicide³⁴ than individuals with PTSD only.

From a theoretical perspective, a dual diagnosis of MDD with PTSD in the current study might lead to a question about the validity of MDD and PTSD as distinct disorders among trauma-exposed individuals. It is important to consider these results in light of the current diagnostic system. Also, research is needed to understand the unique and shared features of MDD and PTSD. Ultimately, greater understanding of MDD and PTSD comorbidity could improve the reliability of these diagnoses, and enable the creation of more targeted treatments.

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.³⁵ Another limitation is that our sample did not represent the full range of ethnic diversity that exists in the US but focused on African American and Puerto Rican participants from an urban area of New York City. Also, we did not assess some factors that may underlie the relationships of the trajectories of substance use and MDD and/or PTSD, such as genetic variables. However, our findings are consistent

with the results from other studies with different samples that suggested that substance use has an effect on MDD^{13–15} and PTSD.³⁶

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 all 3 substances (tobacco, alcohol, and marijuana) as well as their relationship to a single diagnosis of either MDD or PTSD and a dual diagnosis of MDD with PTSD. Second, unlike most research that focuses on only 1 or 2 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

Single and dual diagnoses of MDD and PTSD were predicted by triple comorbid trajectories of tobacco use, alcohol use, and marijuana use from adolescence to adulthood. As the prevalence of substance use increases, it is significant to examine the associations between earlier use of all 3 substances simultaneously and later MDD and/or PTSD. The findings of the present study could lead to improvements in individualized treatments for African American and Puerto Rican patients who have both MDD and PTSD and who also use tobacco, alcohol, and marijuana.

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References

- [1]. Lopez AD, Murray CJ. The Global Burden of Disease: A Comprehensive Assessment of Mortality and Disability from Diseases, Injuries, and Risk Factors in 1990 and Projected to 2020; Summary. Cambridge, MA: Harvard School of Public Health; 1996.
- [2]. ADAA. Facts & Statistics | Anxiety and Depression Association of America. Available at <https://www.adaa.org/about-adaa/pressroom/facts-statistics> Accessed in April 2017 2017.
- [3]. Kessler RC, Bromet EJ. The epidemiology of depression across cultures. *Annu Rev Public Health*. 2013;34:119–138. [PubMed: 23514317]
- [4]. Tanielian T, Jaycox LH. The Invisible Wounds of War: Psychological and Cognitive Injuries, Their Consequences, and Services to Assist Recovery. Santa Monica, CA: RAND Corporation, MG-720-CCF; 2008 (Post-Traumatic Stress Disorder Among Adults. 2008).
- [5]. Pacella ML, Hruska B, Delahanty DL. The physical health consequences of PTSD and PTSD symptoms: a meta-analytic review. *J Anxiety Disord*. 2013;27(1):33–46. [PubMed: 23247200]
- [6]. van Zelst WH, de Beurs E, Beekman AT, van Dyck R, Deeg DD. Well-being, physical functioning, and use of health services in the elderly with PTSD and subthreshold PTSD. *Int J Geriatr Psychiatry*. 2006;21(2):180–188.
- [7]. Andrews B, Brewin CR, Stewart L, Philpott R, Hejdenberg J. Comparison of immediate-onset and delayed-onset posttraumatic stress disorder in military veterans. *J Abnorm Psychol*. 2009;118(4):767. [PubMed: 19899846]

- [8]. Caramanica K, Brackbill RM, Liao T, Stellman SD. Comorbidity of 9/11-related PTSD and depression in the World Trade Center Health Registry 10–11 years postdisaster. *J Trauma Stress*. 2014;27(6):680–688. [PubMed: 25470556]
- [9]. North CS, Nixon SJ, Shariat S, et al. Psychiatric disorders among survivors of the Oklahoma City bombing. *JAMA* 1999; 282(8):755–762. [PubMed: 10463711]
- [10]. Rytwinski NK, Scur MD, Feeny NC, Youngstrom EA. The cooccurrence of major depressive disorder among individuals with posttraumatic stress disorder: a meta-analysis. *J Trauma Stress*. 2013;26(3):299–309. [PubMed: 23696449]
- [11]. Post LM, Zoellner LA, Youngstrom E, Feeny NC. Understanding the relationship between co-occurring PTSD and MDD: symptom severity and affect. *J Anxiety Disord*. 2011; 25(8):1123–1130. [PubMed: 21899984]
- [12]. Ikin JF, Creamer MC, Sim MR, McKenzie DP. Comorbidity of PTSD and depression in Korean War veterans: prevalence, predictors, and impairment. *J Affect Disord*. 2010;125(1–3): 279–286. [PubMed: 20071032]
- [13]. Nault-Brière F, Rohde P, Seeley JR, Klein D, Lewinsohn PM. Comorbidity between major depression and alcohol use disorder from adolescence to adulthood. *Compr Psychiatry*. 2014; 55(3):526–33. [PubMed: 24246605]
- [14]. Bakhshaie J, Zvolensky MJ, Goodwin RD. Cigarette smoking and the onset and persistence of depression among adults in the United States: 1994–2005. *Compr Psychiatry*. 2015;60: 142–148. [PubMed: 25882595]
- [15]. Lev-Ran S, Roerecke M, Le Foll B, George T, McKenzie K, Rehm J. The association between cannabis use and depression: a systematic review and meta-analysis of longitudinal studies. *Psychol Med*. 2014;44(04):797–810. [PubMed: 23795762]
- [16]. Elhai JD, Grubaugh AL, Kashdan TB, Frueh BC. Empirical examination of a proposed refinement to DSM-IV posttraumatic stress disorder symptom criteria using the National Comorbidity Survey Replication data. *J Clin Psychiatry*. 2008; 69(4):597. [PubMed: 18294026]
- [17]. Degenhardt L, Hall W, Lynskey M. The relationship between cannabis use and other substance use in the general population. *Drug Alcohol Depend*. 2001;64(3):319–327. [PubMed: 11672946]
- [18]. Duhig AM, Cavallo DA, McKee SA, George TP, Krishnan-Sarin S. Daily patterns of alcohol, cigarette, and marijuana use in adolescent smokers and nonsmokers. *Addict Behav*. 2005;30(2): 271–283. [PubMed: 15621398]
- [19]. Iglesias V, Cava G, Silva C, Cáceres D. Early tobacco and alcohol consumption as modifying risk factors on marijuana use. *Rev Saúde Pública*. 2007;41(4):517–522. [PubMed: 17589748]
- [20]. Schulenberg JE, Merline AC, Johnston LD, O'Malley PM, Bachman JG, Laetz VB. Trajectories of marijuana use during the transition to adulthood: The big picture based on national panel data. *J Drug Issues*. 2005;35(2):255–280. [PubMed: 16534532]
- [21]. Jackson KM, Sher KJ, Schulenberg JE. Conjoint developmental trajectories of young adult substance use. *Alcohol Clin Exp Res*. 2008;32(5):723–737. [PubMed: 18331376]
- [22]. Brook JS, Lee JY, Rubenstein E, Brook DW, Finch SJ. Triple comorbid trajectories of tobacco, alcohol, and marijuana use as predictors of antisocial personality disorder and generalized anxiety disorder among urban adults. *Am J Public Health*. 2014; 104(8):1413–1420. [PubMed: 24922120]
- [23]. Lee JY, Brook JS, De La Rosa M, Kim Y, Brook DW. The association between alcohol use trajectories from adolescence to adulthood and cannabis use disorder in adulthood: a 22-year longitudinal study. *Am J Drug Alcohol Abuse* 2017;43(6): 727–733. [PubMed: 28635349]
- [24]. Lee JY, Brook JS, Finch SJ, Brook DW. Trajectories of cigarette smoking beginning in adolescence predict insomnia in the mid thirties. *Subst Use Misuse*. 2016;51(5):616–624. [PubMed: 27008539]
- [25]. DSM-5. Diagnostic and Statistical Manual of Mental Disorders. 5th ed. Arlington, VA: American Psychiatric Association; 2013.
- [26]. Ruggiero KJ, Del Ben K, Scotti JR, Rabalais AE. Psychometric properties of the PTSD Checklist-Civilian Version. *J Trauma Stress*. 2003;16(5):495–502. [PubMed: 14584634]
- [27]. Lee JY, Brook JS, Finch SJ, Brook DW. Pathways from victimization to substance use: post traumatic stress disorder as a mediator. *Psychiatry Res*. 2016;237:153–158. [PubMed: 26832837]

- [28]. Muthén L, Muthén B. Mplus User's Guide. 6th ed. Los Angeles, CA: Muthén & Muthén; 2010.
- [29]. Afzali MH, Sunderland M, Teesson M, Carragher N, Mills K, Slade T. A network approach to the comorbidity between posttraumatic stress disorder and major depressive disorder: the role of overlapping symptoms. *J Affect Disord.* 2017;208: 490–496. [PubMed: 27810269]
- [30]. Blanchard EB, Buckley TC, Hickling EJ, Taylor AE. Posttraumatic stress disorder and comorbid major depression: is the correlation an illusion? *J Anxiety Disord.* 1998;12(1): 21–37. [PubMed: 9549607]
- [31]. Campbell DG, Felker BL, Liu C-F, et al. Prevalence of depression–PTSD comorbidity: implications for clinical practice guidelines and primary care-based interventions. *J Gen Intern Med.* 2007;22(6):711–718. [PubMed: 17503104]
- [32]. Yehuda R, Flory JD, Bierer LM, et al. Lower methylation of glucocorticoid receptor gene promoter 1F in peripheral blood of veterans with posttraumatic stress disorder. *Biol Psychiatry.* 2015;77(4):356–364. [PubMed: 24661442]
- [33]. Nijdam MJ, Gersons BP, Olff M. The role of major depression in neurocognitive functioning in patients with posttraumatic stress disorder. *Eur J Psychotraumatol.* 2013;4(1):19979.
- [34]. Ramsawh HJ, Fullerton CS, Mash HBH, et al. Risk for suicidal behaviors associated with PTSD, depression, and their comorbidity in the US Army. *J Affect Disord.* 2014;161: 116–122. [PubMed: 24751318]
- [35]. Harrison L, Martin S, Enev T, Harrington D. 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; 2007.
- [36]. Walsh K, Elliott JC, Shmulewitz D, et al. Trauma exposure, posttraumatic stress disorder and risk for alcohol, nicotine, and marijuana dependence in Israel. *Compr Psychiatry.* 2014;55(3): 621–630. [PubMed: 24387979]

Figure 1.

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

Table 1.

Independent and control variables: scales, time wave(s), number of items, response range, sample item, and Cronbach's alpha.

Scale	Number of items	Response range	Sample item	Cronbach's alpha
<i>Independent variables</i>				
Tobacco use at T1–T5	1	0 = none at all to 4 = about one and a half packs a day or more	“How many cigarettes a day did you smoke in the past year?”	N/A (single item)
Alcohol use at T1–T5	1	0 = none at all to 4 = 3 or 4 drinks a day or more	“How often did you drink beer, wine, or hard liquor in the past year?”	N/A (single item)
Marijuana use at T1–T5	1	0 = never to 4 = once a week or more	“How often have you used marijuana in the past year?”	N/A (single item)
<i>Control variables</i>				
Gender at T1	1	1 = female; 2 = male	NA	N/A (single item)
Ethnicity at T1	1	1 = African American 2 = Puerto Rican	NA	N/A (single item)
Victimization at T2	5	1 = never to 5 = 5 or more times	“During the past 5 years, how often has someone held a weapon (gun, club, or knife) to you?”	.70
Depressive symptoms at T2	2	1 = not at all to 4 = extremely	“Do you sometimes feel unhappy, sad, or depressed?”	.47* ($P < .0001$)

* Interitem correlation.

Table 2.

Summary statistics (percentages, means, and standard deviations).

Measure	A. Heavy use of all 3 substances (7%, <i>n</i> = 53)	B. Increasing use of all 3 substances (17%, <i>n</i> = 114)	C. Tobacco and alcohol (19%, <i>n</i> = 126)	D. Alcohol and marijuana (17%, <i>n</i> = 113)	E. Moderate alcohol only (40%, <i>n</i> = 268)	Entire sample (<i>N</i> = 674)
MDD	36%, <i>n</i> = 19	24%, <i>n</i> = 27	16%, <i>n</i> = 20	19%, <i>n</i> = 21	10%, <i>n</i> = 27	17%, <i>n</i> = 114
PTSD	21%, <i>n</i> = 11	10%, <i>n</i> = 11	7%, <i>n</i> = 9	9%, <i>n</i> = 10	4%, <i>n</i> = 12	8%, <i>n</i> = 53
Females	66%, <i>n</i> = 35	31%, <i>n</i> = 35	60%, <i>n</i> = 75	60%, <i>n</i> = 67	72%, <i>n</i> = 193	60%, <i>n</i> = 405
AA	36%, <i>n</i> = 19	60%, <i>n</i> = 68	40%, <i>n</i> = 51	55%, <i>n</i> = 62	58%, <i>n</i> = 156	53%, <i>n</i> = 256
Depressive symptoms at T2	2.69 (0.90)	2.44 (0.86)	2.56 (0.88)	2.42 (0.89)	2.24 (0.82)	2.40 (0.87)
Victimization at T2	1.62 (0.64)	1.59 (0.63)	1.48 (0.66)	1.37 (0.48)	1.27 (0.39)	1.41 (0.54)
Alcohol use						
T1	0.93 (0.63)	0.15 (0.25)	0.23 (0.32)	0.23 (0.38)	0.14 (0.27)	0.23 (0.39)
T2	1.20 (0.88)	0.77 (0.77)	0.83 (0.81)	0.71 (0.57)	0.43 (0.55)	0.67 (0.71)
T4	1.02 (0.77)	1.46 (1.16)	1.32 (1.19)	1.17 (0.84)	0.66 (0.59)	1.03 (0.94)
T5	1.55 (1.36)	2.00 (1.40)	1.38 (1.13)	1.49 (0.95)	0.91 (0.81)	1.33 (1.11)
Tobacco use						
T1	1.45 (1.36)	0.10 (0.30)	0.20 (0.47)	0.11 (0.29)	0.04 (0.20)	0.20 (0.60)
T2	2.15 (1.62)	1.14 (1.41)	1.67 (1.61)	0.27 (0.72)	0.09 (0.42)	0.76 (1.32)
T4	2.64 (1.84)	2.56 (1.55)	2.82 (1.64)	0.16 (0.44)	0.02 (0.15)	1.19 (1.70)
T5	2.48 (1.73)	3.04 (1.84)	2.57 (1.79)	0.10 (0.33)	0.02 (0.15)	1.24 (1.81)
Marijuana use						
T1	1.82 (1.41)	0.02 (0.13)	0.02 (0.15)	0.12 (0.50)	0.03 (0.24)	0.18 (0.68)
T2	2.66 (1.57)	1.68 (1.61)	1.02 (1.41)	0.84 (1.23)	0.10 (0.45)	0.87 (1.39)
T4	2.16 (1.66)	2.81 (1.34)	0.51 (0.98)	1.32 (1.42)	0.004 (0.06)	0.96 (1.47)
T5	1.62 (1.65)	3.18 (1.19)	0.13 (0.34)	0.97 (1.28)	0.01 (0.08)	0.86 (1.45)

Note. AA = African American; MDD = major depressive disorder; PTSD = posttraumatic stress disorder.

Adjusted odds ratios (95% confidence intervals) of triple trajectories of tobacco, alcohol, and marijuana use beginning in adolescence as predictors of a single diagnosis of major depressive disorder (MDD) or posttraumatic stress disorder (PTSD) and a dual diagnosis of MDD with PTSD at age 36.

Table 3.

Substance use at age 14-age 36	Psychiatric disorders at age 36		
	Single diagnosis		Dual diagnosis
	MDD	PTSD	MDD with PTSD
Heavy use of all 3 substances vs. Increasing use of all 3 substances	1.50 (0.66, 3.37)	1.77 (0.65, 4.87)	1.83 (0.62, 5.37)
Heavy use of all 3 substances vs. Tobacco and alcohol use	3.14 (1.14, 7.25)**	3.91 (1.30, 11.75)*	6.64 (1.80, 24.47)**
Heavy use of all 3 substances vs. Alcohol and marijuana use	2.22 (0.96, 5.14)	2.55 (0.88, 7.38)	3.70 (1.08, 12.65)*
Heavy use of all 3 substances vs. Moderate alcohol use only	4.75 (2.18, 10.34)***	6.84 (2.46, 19.02)***	35.90 (6.48, 199.08)***
Increasing use of all 3 substances vs. Moderate alcohol use only	3.10 (1.48, 6.49)**	3.49 (1.24, 9.83)*	14.89 (3.26, 67.94)***
Tobacco and alcohol use vs. Moderate alcohol use only	1.29 (0.61, 2.72)	1.34 (0.45, 4.04)	1.80 (0.33, 9.94)
Alcohol and marijuana use vs. Moderate alcohol use only	2.09 (0.93, 4.67)	3.02 (1.00, 9.07)*	8.50 (1.50, 48.22)*

Note. Gender, ethnicity, depressive symptoms, and victimization at age 19 were statistically controlled.

* $P < .05$;
** $P < .01$;
*** $P < .001$.