Drislane Laura E. (Orcid ID: 0000-0002-5816-9074)
Bonar Erin E. (Orcid ID: 0000-0001-8849-4196)

RUNNING HEAD: TBI AND CBI EFFECTS ON ALCOHOL, CANNABIS, AND ANXIETY

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Therapist and Computer-Based Brief Interventions for Drug Use within a Randomized Controlled Trial: Effects on Parallel Trajectories of Alcohol Use, Cannabis Use, and Anxiety Symptoms

Laura E. Drislane[1], Rebecca Waller[1, 2], Meghan E. Martz[1], Erin E. Bonar[1], Maureen A. Walton[1], Stephen T. Chermack[1,3,4], Frederic C. Blow[1,3]

[1] University of Michigan, Addiction Center, Department of Psychiatry, Rachel Upjohn Building, 4250 Plymouth Rd, Ann Arbor, MI, 48109

[2] University of Pennsylvania, Department of Psychology, Stephen A. Levin Building, 425 S University Ave, Philadelphia, PA 19104

[3] Veterans Health Administration, Center for Clinical Management Research, Health Services Research & Development, North Campus Research Complex, 2800 Plymouth Rd Bldg 16, Ann Arbor, MI 48109-2800

[4] Veterans Affairs Ann Arbor Healthcare System, Mental Health Service, 2215 Fuller Rd, Ann Arbor, MI 48105

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Correspondence to: Laura E. Drislane, Department of Psychiatry, University of Michigan Medical School, Rachel Upjohn Building Room 2434, 4250 Plymouth Rd, Ann Arbor, MI, 48109, USA. E-mail: lauradrislane@gmail.com

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Abstract

Background and Aims: Despite their high comorbidity, the effects of brief interventions (BI) to reduce cannabis use, alcohol use, and anxiety symptoms have received little empirical attention. The aims of this study were to examine whether a therapist-delivered BI (TBI) or computer-guided BI (CBI) to address drug use, alcohol consumption (when relevant) and HIV risk behaviors, relative to enhanced usual care (EUC), was associated with reductions in parallel trajectories of alcohol use, cannabis use, and anxiety symptoms, and whether demographic characteristics moderated reductions over time.

Design: Latent growth curve modeling was used to examine joint trajectories of alcohol use, cannabis use, and anxiety symptoms assessed at 3-, 6-, and 12-months after baseline enrollment.

Setting: Hurley Medical Center Emergency Department (ED) in Flint, Michigan, USA.

Participants: The sample was 780 drug-using adults (18-60 years old; 56% female; 44% White) randomly assigned to receive either a TBI, CBI, or EUC through the *Healthi*ER *You* study.

Interventions and comparator: ED-delivered TBI and CBIs involved touchscreen-delivered and audio-assisted content. The TBI was administered by a Master's-level therapist, whereas the CBI was self-administered using a virtual health counselor. EUC included a review of health resources brochures in the ED.

Measurements: Assessments of alcohol use (10-item Alcohol Use Disorders Identification Test), cannabis use (past 30-day frequency) and anxiety symptoms (Brief Symptom Inventory-18) occurred at baseline, and 3-, 6-, and 12-month follow-up.

Findings: TBI, relative to EUC, was associated with significant reductions in cannabis use (B=-.49, SE=.20, $p<.05$), and anxiety (B=-.04, SE=.02, $p<.05$), but no main effect for alcohol use. Two of 18 moderation tests were significant: TBI significantly reduced alcohol use among males (B=-.60, SE=.19, $p<.01$) and patients aged 18-25 in the TBI condition showed significantly greater reductions in cannabis use relative to older patients (B=-.78, SE=.31, $p<.05$). Results for CBI were non-significant.

Conclusions: Emergency department-based therapist-delivered brief interventions to address drug use, alcohol consumption (when relevant) and HIV risk behaviors may also reduce alcohol use, cannabis use, and anxiety over time, accounting for the overlap of these processes.

Keywords: Cannabis, alcohol, anxiety, brief intervention, emergency department, latent growth curve modeling

Alcohol and drug misuse quadruple the risk of emergency department (ED) injury-related admissions worldwide (1,2). Thus, the ED provides an invaluable setting for screening, brief intervention, and referral to treatment (SBIRT) for substance use. The efficacy of SBIRT in healthcare settings including the ED, however, has been mixed. Prior studies have supported the efficacy of alcohol brief interventions (BI) (3-5), although BIs targeting drug use have yielded inconsistent results (6-11) and the inclusion of boosters has shown no effect (12,13). Further, the impact of alcohol and drug BIs on comorbid mental health problems (e.g., anxiety) is largely unknown.

More recently, *Healthi*ER *You* (14) tested the efficacy of a computer-guided BI (CBI) and a therapist-delivered BI (TBI) relative to enhanced usual care (EUC) for drug-using adults presenting to an ED in a predominately low-income, urban community. The BIs were based on motivational interviewing (MI) and focused on reducing drug use, with HIV risk behaviors as a secondary behavioral target (15). At 3-month follow-up, participants were re-randomized to receive either an adapted motivational enhancement therapy (AMET) booster or EUC. At 12-month follow-up, the therapist-delivered BI was associated with reduced number of days using any drug and reduced weighted drug days (the number of days using any drug, weighted by the number of drugs used each day). Both TBI and CBI contributed to fewer cannabis use days compared with EUC. The effects of boosters were non-significant (14).

Despite the promising findings of *Healthi*ER *You*, the effectiveness of BIs for reducing substance use (8,16) in diverse healthcare settings remains equivocal. Most previous drug-

focused BIs were delivered in primary care settings where the severity of substance use problems tends to be low (17), which may account for a failure to detect significant intervention effects in some studies. One notable exception is Project QUIT (6), which was also effective in reducing drug use. By contrast, utilizing an urban ED provided *Health*iER *You* opportunities to reach at-risk populations (18) that may be more likely to benefit from brief interventions (8). To address these inconsistencies, studies are needed to explore potential moderators of BI effectiveness to establish for whom BIs might be most effective, including critical demographic factors such as age, race, and sex. For example, alcohol and cannabis use both typically peak during the early to mid-20s and are most common in males and White individuals (19). Within urban, under-resourced communities, however, cannabis is highly prevalent (20).

In addition to alcohol and cannabis use being highly comorbid (21), anxiety symptoms also commonly co-occur with both alcohol and cannabis use and are associated with greater impairment than substance use alone (21); as such, it is important to disentangle the processes that are shared versus unique among co-occurring problems. Competing perspectives have been used to account for the comorbidity between anxiety and substance use disorders (SUD): (1) anxiety symptomology promotes SUDs, (2) SUDs promote anxiety problems, (3) a third, common factor promotes both anxiety and problematic substance use, and (4) there are bidirectional effects of anxiety and substance use on one another (22). Given these complexities, longitudinal studies are necessary to clarify how these processes "travel together" over time. While there is some evidence that anxiety can moderate the effectiveness of cannabis treatment

(22) no studies have tested whether BIs designed to reduce drug use can have positive collateral effects by simultaneously reducing parallel trajectories of alcohol use and symptoms of anxiety. This information would shed light on the extent to which efficacious drug-focused BIs contribute to positive mental health outcomes broadly or have specific effects only on drug use, which would imply the need for tailoring of BIs towards alcohol versus cannabis use versus mental health coping skills more specifically.

To address these gaps in the literature, we used data from *Healthi*ER *You* (14) to examine trajectories of alcohol use, cannabis use, and anxiety across a 12-month period among drug-using adults presenting to an ED located in a predominately low-income, urban community who were randomly assigned to receive CBI, TBI, or EUC. Next, we investigated whether TBI or CBI (relative to EUC) was related to greater reductions in alcohol use, cannabis use, or anxiety symptoms within a parallel process latent growth curve modeling (LGCM) framework that accounted for overlap of these outcomes. The use of LGCM enabled us to explore the unique variation in rates of alcohol use, cannabis use, and anxiety symptoms over three follow-up periods (baseline, and 3-, 6-, and 12-month) while simultaneously accounting for overlap of these processes (24). Finally, we tested whether the effectiveness of TBI or CBI (relative to EUC) was moderated by sex, race, or age. While prior work using data from *Healthi*ER *You* (14) reported main outcomes, it did not account for the overlap in cannabis use, alcohol use, and anxiety symptoms and did not explore moderators of treatment effectiveness. We hypothesized that both BIs (i.e., TBI and CBI) relative to EUC would be related to greater rates of reduction in

all three processes – alcohol use, cannabis use, and anxiety symptoms, given previous findings that *Healthi*ER *You* BIs reduced cannabis use (14) and that cannabis use, alcohol use, and anxiety tend to co-occur such that improvements in one outcome may contribute to improvements in the others. Because no prior studies have explored potential moderation of parallel trajectories of these processes, we did not have *a priori* hypotheses about how sex, age, or race might moderate the effectiveness of TBI and CBI on intervention outcomes.

Methods

Study Design

The design, procedures, sample, and primary and secondary outcomes of the *Healthi*ER *You* trial are described in detail in prior publications (14,15,25). Briefly, the trial involved a 3 x 2 factorial design where participants were initially randomized to one of three conditions delivered at the baseline ED visit: 1) 30-minute CBI, 2) 30-minute TBI, or 3) EUC (review of health resources brochures in the ED, exceeding the standard of care) (see Bonar et al., 2014, Table 1, for detailed description of the interventions). After a 3-month follow-up assessment, participants were then randomized to receive an adapted motivational enhancement therapy (AMET) booster EUC-B (B: Booster review of health brochures) (see Blow et al., 2018, for further description of AMET procedures). Follow-up staff and 3-month therapists were blinded to baseline condition assignment. Outcomes were measured at 3-, 6-, and 12-months after baseline enrollment. Procedures were approved by the University of Michigan and Hurley Medical Center Institutional Review Boards and a Certificate of Confidentiality was provided by the National

Institutes Health.

Study Setting and Recruitment

Recruitment and baseline intervention delivery took place at the Hurley Medical Center Emergency Department (ED) in urban, Flint, Michigan from February 2011- August 2012. Research assistants screened patients ages 18-60 that were identified through the electronic medical record in the ED. After providing informed consent, patients completed screening measures to determine RCT eligibility (exclusions included psychosis, medical instability, in police custody, seeking care for suicidal ideation or acute sexual assault, non-English-speaking or illiterate, severe hearing or visual impairment). Compensation for the 15-minute screening survey was a $1.00 gift (e.g., puzzle books, lotion). To be eligible for inclusion in the study, participants were required to have a Specific Substance Involvement score ≥ 4 for *any* illicit or misused prescription drug (i.e., stimulants, sedatives, narcotics) within the past three months on the Alcohol, Smoking, and Substance Involvement Screening Test (ASSIST; 25). Those agreeing to participate provided a second-stage informed consent and completed additional baseline survey measures and a Timeline Follow-Back (27) interview plus a urine drug test (see 14,25 for more details).

Interventions

The interventions and EUC are previously described in detail (14,15,25). Briefly, the interventions were grounded in motivational interviewing (28) with parallel content in the CBI and TBI. Interventions used MI strategies to address participants' drug use, as well as alcohol

consumption when relevant, and HIV risk behaviors. The interventions included identifying participants' strengths and goals while addressing drug use via tailored exercises and feedback. After each baseline BI, participants received a summary "change plan" that was based on elements selected during the intervention (e.g., strengths, tools for change, etc.), as well as resource pamphlets (e.g., housing, food, etc.).

In the CBI, participants used a touchscreen tablet with audio via headphones that included still and moving images and interactive vignettes and exercises and led by a virtual counselor, using tailored reflections. The TBI was delivered by Master's-level therapists, trained in MI by study investigators, using a touchscreen tablet to guide the session and maintain intervention fidelity in the chaotic ED environment where interruptions for medical care are common. The TBI covered similar content as the CBI, including focusing on goals, benefits of change, etc.

At 3-months, a 40-minute AMET session was also delivered by Master's-level therapists. This session involved a review of participants' substance use from the past 3 months, which assisted with tailoring the session that was also computer-guided to support therapists in moving through the intervention components. Therapists delivering the TBI and AMET passed proficiency thresholds determined using the Motivational Interviewing Treatment Integrity Code (MITI; 29 [Motivational Interview Adherent summary score of 99% and 97% for AMET]) 14).

At both time-points, the EUC condition involved reviewing a local health resource brochure and HIV prevention information. This information was also given to participants in the

other conditions at both baseline and follow-up visits to control for information receipt. Response rates were greater than 80% for all follow-up periods (3 months: 81%, 6 months :85%, 12 months: 87%) and were similar in all three intervention groups (CBI, TBI, EUC) (14,25).

Measures

Outcome measures included past 3-month alcohol use severity as measured by a) the 10-item Alcohol Use Disorders Identification Test (AUDIT; 30), which includes frequency of use, average consumption, and binge drinking along with seven consequence items (baseline α=0.89, 3-month α=0.90, 6-month α=0.87, 12-month α=0.88), b) past 30-day cannabis use frequency as measured by the National Survey on Drug Use and Health (NSDUH) CAI Specifications for Programming (31), and c) past-week anxiety symptoms as measured by a 3-item anxiety subscale of the Brief Symptom Inventory-18 (BSI-18; 32) (baseline α=0.79, 3-month α=0.83, 6-month α=0.82, 12-month α=0.81). These measures have well-established validity (33-35).

Analytic plan

Aim 1: Explore trajectories of alcohol use, cannabis use, and anxiety across a 12-month period. We used parallel process latent growth curve modeling (LGCM) in Mplus version 7.2 with full information maximum likelihood estimation with robust standard errors based on a covariance matrix generated from multiple covariates (i.e., age, sex, race) to account for any missing data (36). Scores for alcohol use, cannabis use, and anxiety symptoms at baseline, 3-, 6- and 12-month assessments were used as indicators for the intercept (starting values) and slope (linear change) factors for each process, with baseline set as the intercept. The

slope and intercept factors for each process (i.e., alcohol use, cannabis use, and anxiety) were allowed to co-vary, to take into account the "parallel" or "joint" nature of the processes unfolding over time at the latent level (but not at the observed indicator level), and each slope factor was regressed onto each of the three intercept factors. All models also accounted for subsequent AMET randomization (14). Comparative Fit Index (CFI: cut-off value .95), and Root Mean Square Error of Approximation (RMSEA: cut-off value .06) were used to assess model fit (37).

Aim 2: Impact of intervention on reductions in alcohol use, cannabis use, and anxiety and potential moderation by sex, age, and race. To explore the main effects of the interventions and potential moderation by sex, age, and race, we tested a single path model in Mplus where we regressed slope and intercept factors onto intervention conditions (TBI relative to EUD and CBI relative to EUD) and interaction terms between intervention condition (i.e., TBI or CBI relative to EUD) with sex, race, and age. An intent-to-treat approach was used to include all available data for all participants who were randomized. We probed significant interactions by separately exploring slopes for males versus females, White versus non-White participants, and different ages.

Results

Descriptives. Participants were 31 years old on average (range = 18-60; SD = 10.9), 44% (n = 347) were males, and 52% (n = 407) were Black (see [14] for further details). At baseline, 66% of the sample (n = 513) reported cannabis use problems (ASSIST score ≥ 4), 23% (n = 179)

displayed harmful alcohol use (AUDIT score ≥ 8), and 25% (n = 196) displayed significant symptoms of anxiety (BSI Anxiety score > 1.33, equivalent to a T-score > 63 among both men and women). There were no statistical differences in baseline demographic, drug use, or anxiety characteristics across intervention groups (CBI, TBI, EUC). Table 1 presents descriptive statistics for alcohol use, cannabis use, and anxiety symptoms across all four assessment points.

Aim 1: Trajectories of alcohol use, cannabis use, and anxiety across a 12-month period. Figure 1 displays the longitudinal trajectories of alcohol use, cannabis use, and anxiety after accounting for their shared overlap across the whole sample from baseline to 12-month follow-up (CFI = .94; TLI = .92, RMSEA = .06, SRMR = .05). Alcohol use, cannabis use, and anxiety symptoms all showed significant reductions over the one-year follow-up. In support of these processes as being overlapping or "joint processes," higher starting levels (i.e., intercept factors) of anxiety and alcohol use were correlated, and there were significant correlations between slope factors (i.e., correlation in rates of linear change) for all three variables. That is, the rate of reduction for all three processes was correlated (see Figure 1).

Aim 2: Impact of intervention on reductions in alcohol use, cannabis use, and anxiety symptoms and potential moderation. Table 2 presents results from the single model regressing slope factors from the parallel process growth model onto the main and moderating effects of intervention condition (TBI or CBI relative to EUC), sex, age, and race on linear change. The model also controlled for main effects of sex, age, and race on starting levels of substance use and anxiety (i.e., intercept factors) (CFI = .93, TLI = .91, RMSEA = .04, SRMR =

.03). First, we found a main effect of TBI on cannabis use slope. Specifically, there was a significant reduction in cannabis use over time in the TBI group, but not the EUC group (Figure 2). Similarly, there was a main effect of TBI relative to EUC on reduction in anxiety levels from baseline to 12-months (Table 2; Figure 3). There were no unique main effects of CBI relative to EUC on the rate of change in any of the three parallel processes of alcohol use, cannabis use, and anxiety symptoms, taking into account the overlap of these processes.

In the same model, we included interaction terms between intervention condition and sex, age, and race. First, we found that sex moderated the effectiveness of TBI on the rate of reduction in alcohol use (Table 2). We probed this interaction by exploring rates in reduction in alcohol use among males and females separately. Relative to the EUC condition, we found a significant linear reduction in the rate of alcohol use over time among males, but not females, in the TBI group (see Figure 4). Second, the effect of TBI on the slope of cannabis use was moderated by age. We explored this interaction among four different age groups. We found that only participants aged 18-25 years who received TBI, but not aged 26-35, 36-46, or 46 and older, showed significant reductions in cannabis use relative to EUD. We found no significant moderation of the effects for the CBI, or of either TBI or CBI by race.

Discussion

Alcohol use, cannabis use, and anxiety symptoms often co-occur and it is critical to study how they "travel together" and the extent to which BIs aimed at reducing drug use that can be implemented with high fidelity and accessibility might exert collateral effects on alcohol use and

anxiety. In this novel study that incorporated sophisticated quantitative modeling techniques using data from a large sample of low-income, urban adults who presented to an ED, we examined 12-month trajectories of alcohol use, cannabis use, and anxiety following completion of drug-focused TBI or CBI intervention modalities compared to EUC. We showed that TBI was effective in reducing cannabis use and anxiety symptomatology. Moreover, we found that TBI was effective in reducing alcohol use specifically among males and that younger participants benefited the most from the effects of TBI in reducing cannabis use. We highlight three main implications from these findings.

First, we found that TBI was an effective intervention for reducing harmful drug and alcohol use, as well as co-occurring anxiety symptoms, among ED patients. These results indicate that successfully intervening on drug use can positively impact comorbid alcohol use and anxiety symptoms, suggesting that concurrent or integrated treatments for anxiety-related problems may not be necessary for some individuals (38). Although CBI reduced cannabis use days when examined as a sole outcome (14), CBI relative to EUC did not result in significant reductions in severity of alcohol use, cannabis use, and anxiety when examined as simultaneous outcomes. While CBI offers many advantages, such as convenience and low costs, aspects of communicating in-person with a therapist during a single session may facilitate enhanced change processes in multiple co-occurring outcomes beyond the scope of a self-directed, single session computer program. Additional research is needed to compare effectiveness of therapist versus computer-based BIs directly and among more representative samples.

Second, reductions in alcohol use after TBI were found among men, but not women. Although females showed decreasing alcohol use over the 12 months following TBI, the extent of their declines in alcohol use were much smaller than males. By the 12-month follow-up, frequency of alcohol use remained higher among males compared to females, but the sex gap significantly narrowed as a result of TBI. This is consistent with findings from a systematic review of brief alcohol interventions in primary care settings (39), which reported evidence for clear reductions in alcohol use following BI for men but not women. The mechanism driving this sex difference is likely lower rates of consumption resulting in floor effects, however more research is needed to examine ways to enhance interventions for women (e.g., greater inclusion of sex-specific consequences) (40). In contrast to sex differences in intervention effects, race did not impact linear reductions in cannabis use, alcohol use, or anxiety. This is notable given the racial diversity of the present sample. Many previous BI RCTs have utilized primarily White samples (however see 41), which has limited the ability to examine systematic differences in intervention effectiveness as a function of race or ethnicity (39).

Third, significant reductions in cannabis use in the TBI condition were specifically found among young adults between the ages of 18 and 25. This finding is critical from a developmental perspective, because substance use tends to peak during the transition to adulthood (i.e., ages 18 to 25 years old; 19). This developmental period also coincides with the typical onset of symptoms of substance use disorder (SUD; 20). Approximately 5.3 million—or 1 in 7—young adults in the US ages 18-25 years old have a SUD, which represents the largest proportion of

individuals with problematic substance use (2,42). Thus, findings from the present study highlight the potential impact of the *Healthi*ER *You* TBI on reducing cannabis use among young adults at a critical juncture in development. The ED may be an especially important venue for SBIRT with drug-using emerging adults who may not otherwise receive interventions, because the ED is a frequent source of care to uninsured and under-insured populations (43,44) and emerging adults often lack connection to healthcare providers when transitioning out of pediatric medicine (44–47).

Strengths and Limitations

A major strength of the present study was its methodological approach. Given the high co-occurrence of alcohol use, cannabis use, and anxiety, examining their parallel trajectories provides valuable information pertaining to the utility of TBI and CBI for drug use in impacting not only substance use, but also mental health outcomes. We also were able to examine potential moderators of the effectiveness of BIs, providing more information about what interventions are effective in reducing alcohol use, cannabis use, and anxiety and for whom. Although a strength of the study is the ED sample of racially diverse, low-income adults, findings, including moderation effects, require replication prior to generalization to other populations. Further, this study was conducted among adults screening positive for drug use (primarily cannabis), and findings may not generalize to samples screening positive for alcohol use or other mental health concerns. In addition, dismantling studies may provide insights into which components of BIs

contribute to improvements across mental health outcomes, including anxiety and substance use, versus those that are specific to reducing drug and alcohol use.

Conclusions

In summary, findings from the present study not only highlight the potential utility of a motivational interviewing-based TBI focused on reducing drug use for also reducing alcohol use, cannabis use, and anxiety symptoms through 12-months following the intervention, but also demonstrate the importance of examining subgroup differences, such as sex and age, in relation to intervention outcomes. TBIs implemented through the *Healthi*ER *You* study offer a relatively time-efficient way to reduce substance use and improve anxiety symptoms.

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Table 1. Descriptive statistics for main outcome variables of cannabis use, alcohol use, and anxiety symptoms in the whole sample and across each of the intervention conditions

	Whole Sample			Therapist-Delivered Brief Intervention			Computer-Guided Brief Intervention			Control		
	N	*M*	*SD*	N	*M*	*SD*	N	*M*	*SD*	N	*M*	*SD*
Alcohol use (baseline)	780	5.08	7.22	266	4.94	7.04	257	4.75	6.62	257	5.56	7.94
Alcohol use (3 month follow-up)	628	5.49	7.69	223	5.35	6.96	199	5.21	8.01	206	5.92	8.13
Alcohol use (6 month follow-up)	659	4.25	6.13	234	4.63	6.24	208	3.95	5.99	217	4.14	6.14
Alcohol use (12 month follow-up	679	4.12	6.43	233	4.46	6.53	221	3.61	6.15	225	4.27	6.57
Cannabis use (baseline)	780	13.06	11.70	266	13.69	11.76	257	11.94	11.65	257	13.53	11.65
Cannabis use (3 month follow-up)	628	13.25	12.06	223	14.39	12.14	199	11.63	11.73	206	13.57	12.16
Cannabis use (6 month follow-up)	659	12.28	12.17	234	13.80	12.53	208	10.44	11.73	217	12.40	12.02
Cannabis use (12 month follow-up)	679	12.46	12.32	233	14.06	12.54	221	9.98	11.42	225	13.23	12.61
Anxiety symptoms (baseline)	778	0.93	1.03	264	0.88	1.01	257	0.95	1.02	257	0.95	1.07
Anxiety symptoms (3 month follow-up)	628	1.00	1.05	223	1.03	1.02	199	0.98	1.10	206	0.99	1.04

Anxiety symptoms (6 month follow-up)	659	0.86	0.96	234	0.92	0.97	208	0.83	1.04	217	0.81	0.88
Anxiety symptoms (12 month follow-up)	679	0.81	0.95	233	0.85	0.97	221	0.82	0.97	225	0.75	0.91

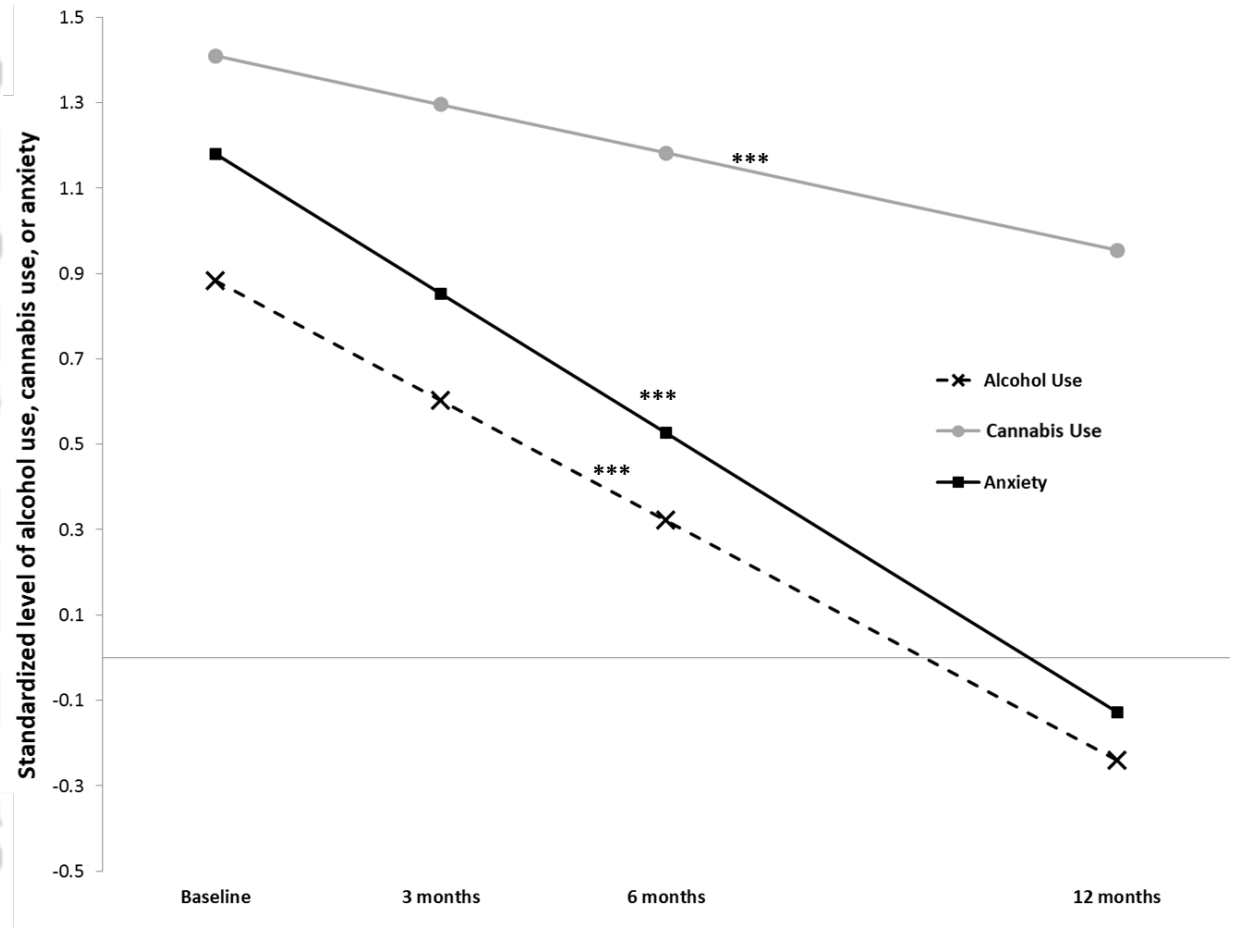
Table 2. Main and moderating effects of intervention condition and sex, age, and race on linear reduction in concomitant cannabis use, alcohol use, and anxiety

	Slope factors								
	Cannabis			**Alcohol**			**Anxiety**		
	B (SE)	β	*p*	B (SE)	β	*p*	B (SE)	β	*p*
Main effects									
Male	.07 (.40)	.02	.871	.34 (.19)	.16	.070	-.06 (.03)	-.20*	.023
Age	.001 (.02)	.001	.998	.01 (.01)	.15	.065	.003 (.001)	.18*	.023
White	-.01 (.38)	-.003	.981	-.17 (.17)	-.08	.307	-.03 (.03)	-.10	.233
TBI	-1.01 (.38)	-.29*	.007	.02 (.19)	.01	.929	-.06 (.03)	-.17*	.039
CBI	-.38 (.37)	-.11	.304	-.10 (.18)	-.05	.569	-.04 (.03)	-.13	.157
Effects of starting levels									
Cannabis Intercept	-.03 (.02)	-.16	.164	.004 (.007)	.03	.586	-.001 (.001)	-.09	.203
Alcohol Intercept	-.004 (.03)	-.01	.883	-.09 (.03)	-.47***	.001	.001 (.002)	.05	.564
Anxiety Intercept	-.68 (.35)	-.35	.052	-.49 (.18)	-.39**	.006	-.03 (.04)	-.14	.518
Interaction effects									
TBI x Male	-.13 (.52)	-.03	.808	-.66 (.26)	-.22*	.010	.05 (.04)	.10	.217
CBI x Male	.37 (.53)	.08	.485	-.02 (.27)	-.01	.947	.04 (.04)	.09	.272
TBI x Age	.04 (.02)	.16*	.039	.02 (.01)	.09	.202	.001 (.002)	.01	.947
CBI x Age	.001 (.02)	-.002	.985	-.02 (.01)	-.12	.084	.001 (.002)	.91	.928
TBI x White	.45 (.51)	.13	.268	.24 (.14)	.08	.326	.07 (.04)	.16	.069
CBI x White	-.27 (.43)	-.06	.606	-.05 (.25)	-.02	.842	.003 (.04)	.01	.937
$\mathbf{R^2}$		.15**			.33***			.29***	

Note. ***p < .001 **p< .01 *p< .05. TBI = therapist-based intervention; CBI = computer-based intervention. Model fit statistics: CFI = .93, TLI = .91, RMSEA = .04, SRMR = .03. Effects of interventions are relative to a no-intervention control group within an RCT design. Income was not a significant predictor in the model and its inclusion did not change the findings presented. Thus, consistent with the original publication using this intervention sample, it was not included in the final model (Blow et al., 2017). All models also accounted for subsequent AMET randomization (Blow et al., 2017). Because depression and anxiety are often comorbid, we controlled for the effects of depression symptoms at baseline on all intercept and slope factors. Higher levels

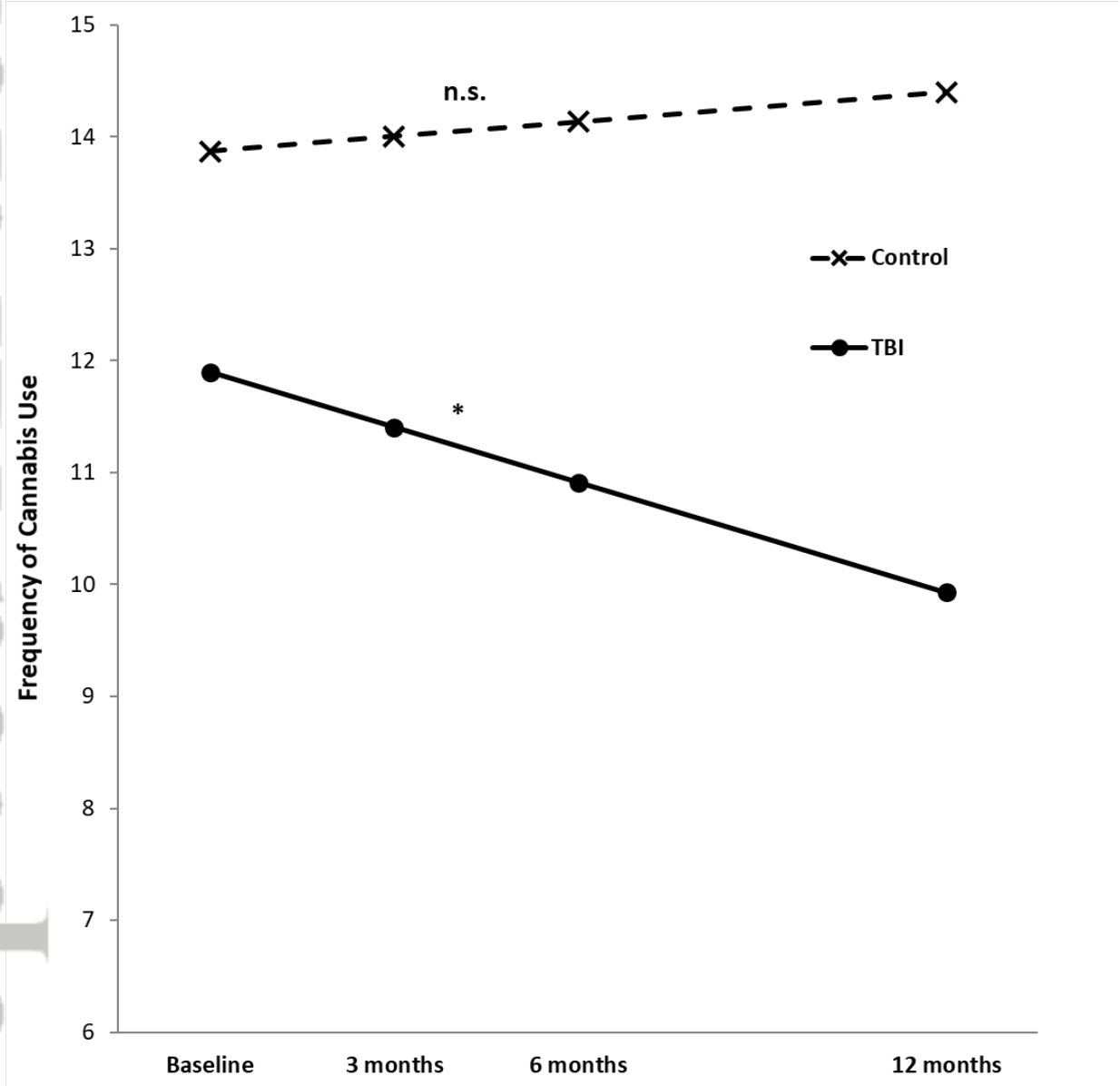
of depression were related to higher starting levels (i.e., intercept factor scores) of anxiety and alcohol use and significant increases (i.e., slope factor) in alcohol use over time (results available on request). Finally, each intercept factor was also simultaneously regressed onto sex, age, and race. Starting levels of cannabis use and alcohol use were higher in males, starting levels of alcohol use were lower in White participants, starting levels of cannabis were higher in younger participants, and starting levels of anxiety were higher in older participants (results available on request).

Figure 1. Joint process model showing that alcohol use, cannabis use, and anxiety levels decreased significantly across the whole sample from baseline to 12-month follow-up.



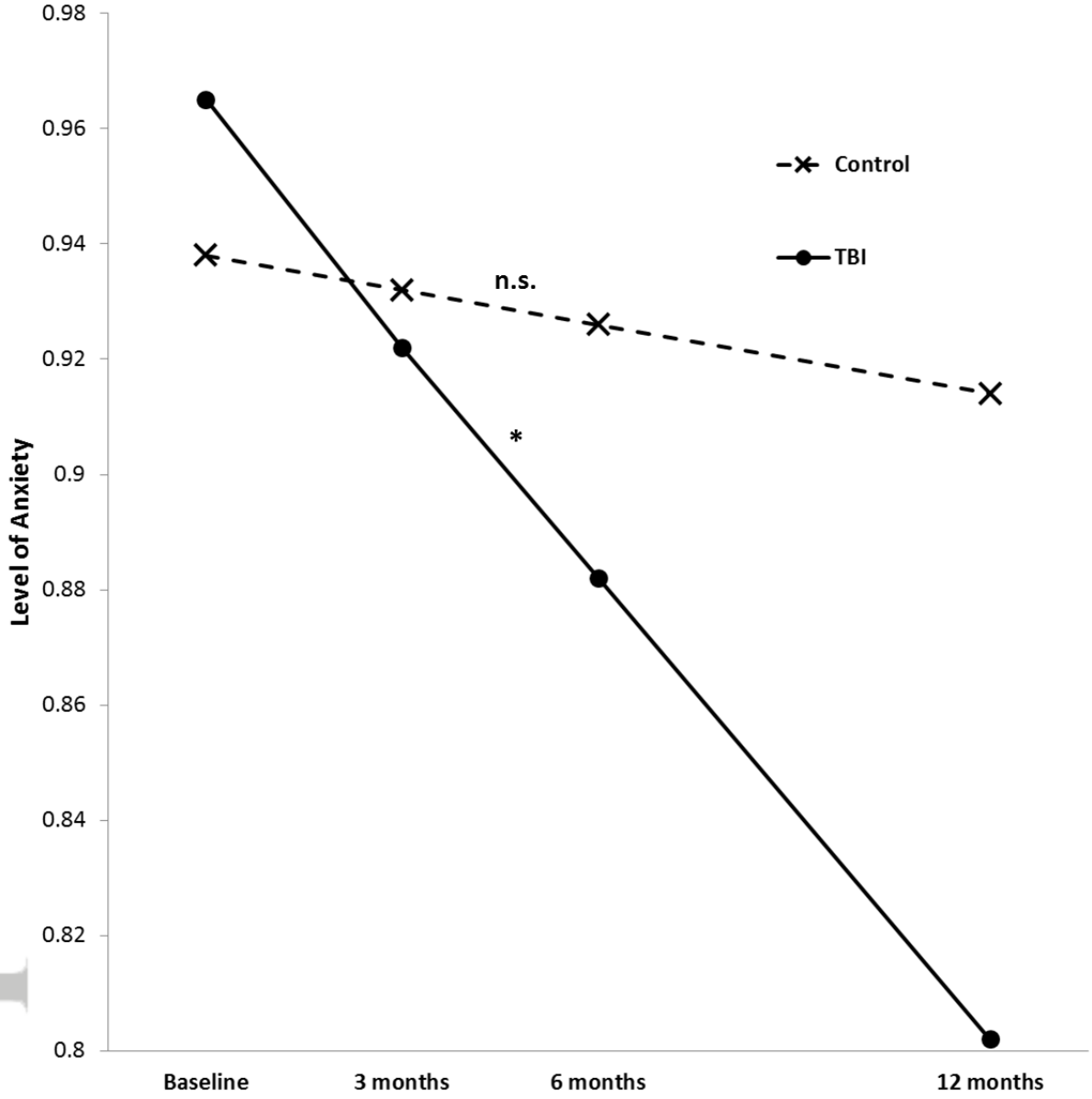
Note. ***p < .001. Model fit statistics: CFI = .94; TLI = .92, RMSEA = .06, SRMR = .05. Standardized values reflect z-scores. Overall, across the whole sample, there was a reduction in alcohol use across the four time points, with significant variance in both starting levels (intercept) and linear change (slope): Means: Slope, B = -.04, SE = .01, p < .001, Intercept, B = .96, SE = .04, p < .001; variances: Slope, B = .01, SE = .006, p < .05. Intercept, B = .66, SE = .06, p < .001. There was also a reduction in cannabis use across time, with significant variance in both starting levels (intercept) and linear change (slope): Means: Slope, B = -.18, SE = .11, p = .11, Intercept, B = 13.08, SE = .40, p < .001; variances: Slope, B = [illegible], SE = .93, p < .01. Intercept, B = 86.07, SE = 5.20, p < .001. There was a significant correlation between the starting levels of anxiety and alcohol use (r = .31, p < .001), but not between anxiety and cannabis use or between alcohol and cannabis use. Finally, there were correlations between slope factors (i.e., correlation in linear change): alcohol and cannabis use, r =.35, p <.05; alcohol use and anxiety: r = .47, p < .05; cannabis and anxiety: r = .42, p < .05.

Figure 2. Cannabis use showed a significant reduction over time from baseline to 12 months in the TBI group but not the control group.



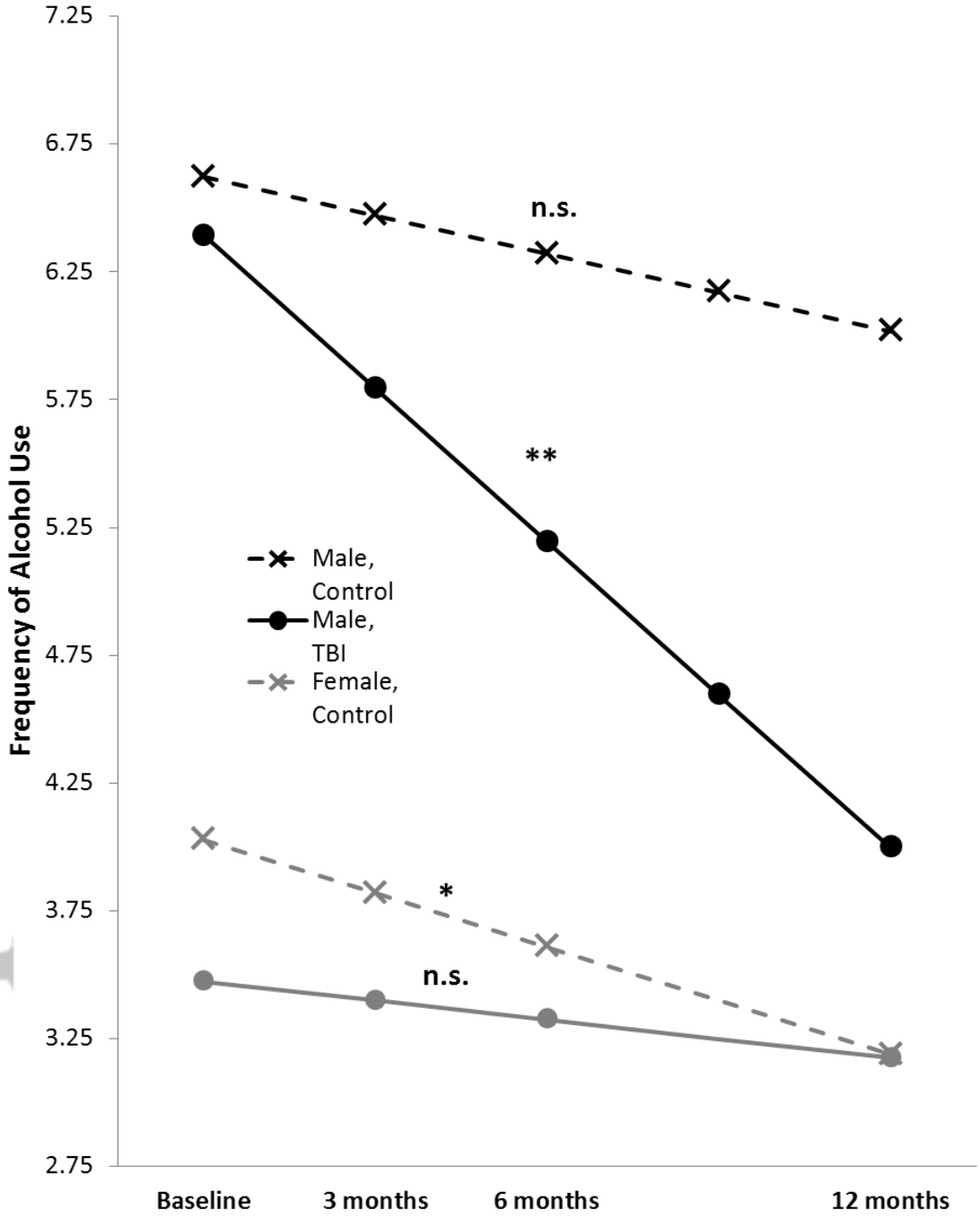
Note. *$p < .05$, n.s. = non-significant. There was a significant linear reduction in cannabis use over time in the TBI group (B = -.49, SE = .20, $p < .05$) but not the control group (B = .13, SE = .20, $p = .50$).

Figure 3. Anxiety level showed a significant reduction over time from baseline to 12 months in the TBI group but not the control group.



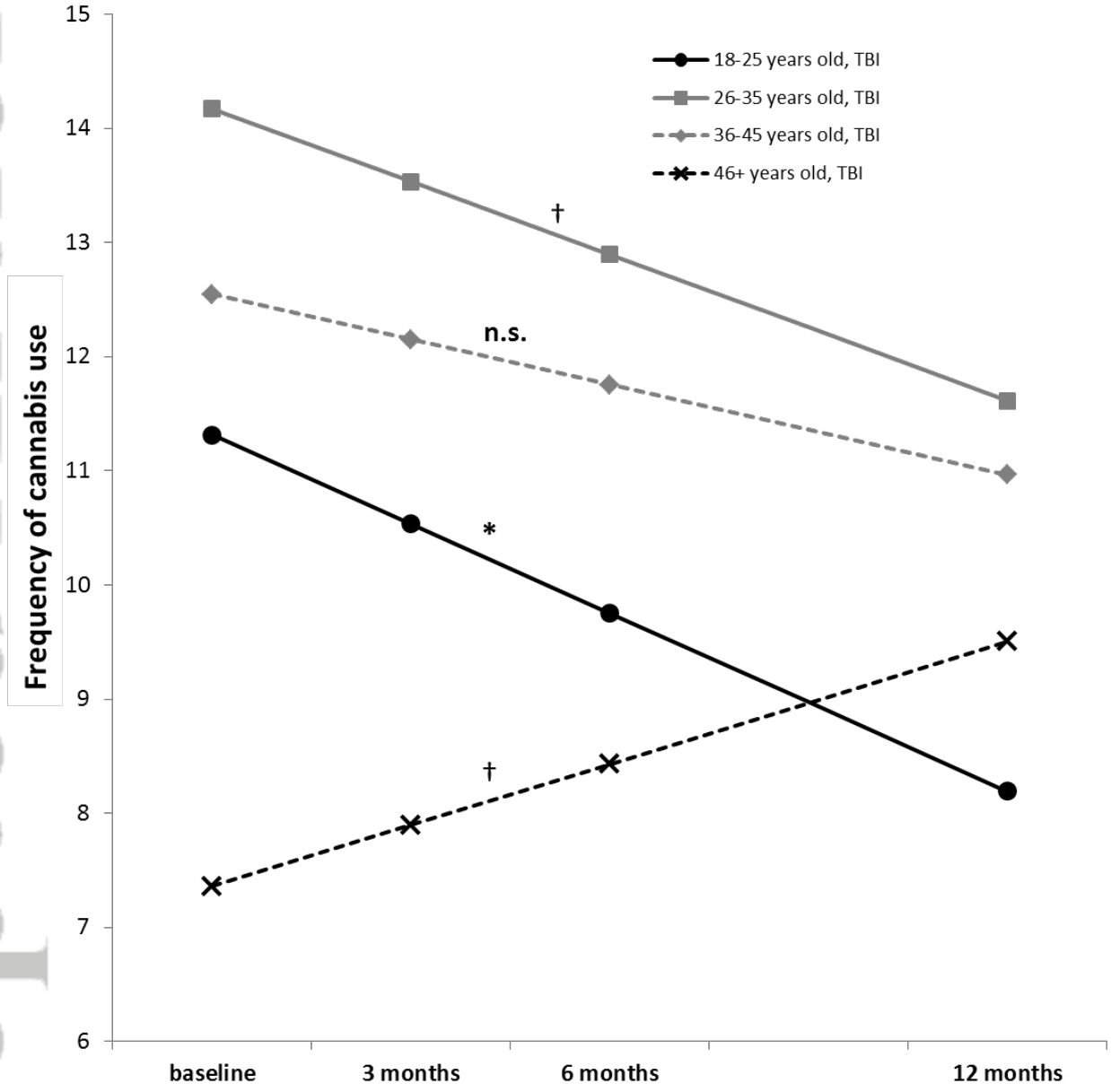
Note. *$p < .05$, n.s. = non-significant. There was a significant linear reduction in level of anxiety over time in the TBI group (B = -.04, SE = .02, $p < .05$) but not the control group (B = -.006, SE = .02, $p = .74$).

Figure 4. Alcohol use showed a significant reduction over time from baseline to 12 months among males in the TBI group but not the control group.



Note. **$p < .01$, *$p < .05$, n.s. = non-significant. There was a significant linear reduction in level of alcohol use over time among males in the TBI group (B = -.60, SE = .19, $p < .01$) but not the control group (B = -.15, SE = .18, $p = .40$) Among females, there was a slight decrease in alcohol use in the control group (B = -.21, SE = .11, $p < .05$) but the rate of alcohol use among females in the TBI group did not change significantly (B = -.08, SE = .12, $p = .52$).

Figure 5. Participants aged 18-25 years old benefited most from the TBI relative to other age groups



Note. *$p < .05$, †$p < .10$. The figure shows linear change in cannabis usage among individuals within the TBI group divided into four age categories: ages 18-25 (n = 101, ages 25-35 (n = 76), ages 36-45 (n = 45), and 46 years and older (n = 35). Individuals ages 18-25 years old who received TBI showed a significant reduction in cannabis usage (B = -.78, SE = .31, $p < .05$); individuals aged 26-35 within the TBI group also showed a modest reduction in cannabis use but was not significant (B = -.64, SE = .38, p = .09; individuals aged 36-45 years old within the TBI

group did not show a significant change in usage (B = -.40, SE = .50, p = .43); finally, individuals aged 46 years or older within the TBI group actually showed a slight increase in cannabis use but was not significant (B = .54, SE = .31, p = .09).