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Twelve-step Affiliation and Three-year Substance Use Outcomes among Adolescents: Social Support and Religious Service Attendance as Potential Mediators

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Abstract

Aims—Twelve-step affiliation among adolescents is little understood. We examined twelve-step affiliation and its association with substance use outcomes 3 years post-treatment intake among adolescents seeking chemical dependency (CD) treatment in a private, managed care health plan. We also examined the effects of social support and religious service attendance on the relationship.

Design—We analyzed data for 357 adolescents, aged 13–18, who entered treatment at four Kaiser Permanente Northern California CD Programs between March 2000 and May 2002 and completed both baseline and 3-year follow-up interviews.

Measures—Measures at follow-up included alcohol and drug use, twelve-step affiliation, social support and frequency of religious service attendance.

Findings—At 3 years, 68 adolescents (19%) reported attending any twelve-step meetings, and 49 (14%) reported involvement in at least one of seven twelve-step activities, in the prior 6 months. Multivariate logistic regression analyses indicated that after controlling individual and treatment factors, twelve-step attendance at 1 year was marginally significant, while twelve-step attendance at 3 years was associated with both alcohol and drug abstinence at 3 years [odds ratio (OR) 2.58, $P < 0.05$ and OR 2.53, $P < 0.05$, respectively]. Similarly, twelve-step activity involvement was significantly associated with 30-day alcohol and drug abstinence. There are possible mediating effects of social support and religious service attendance on the relationship between post-treatment twelve-step affiliation and 3-year outcomes.

Conclusions—The findings suggest the importance of twelve-step affiliation in maintaining long-term recovery, and help understand the mechanism through which it works among adolescents.

Keywords

long-term outcomes; adolescents; twelve-step affiliation; social support; religious service attendance

INTRODUCTION

Youth substance use (SU) is one of the most challenging public health problems in the United States [1,2]. Although evidence is accumulating that successful chemical dependency (CD) treatment leads to positive SU and psychosocial outcomes for adolescents [3,4], most studies examine short-term outcomes. Adolescent studies of outcomes longer than 1 year are uncommon.

Adults often participate in twelve-step groups as CD treatment aftercare, and studies support their beneficial effects on outcomes [5-12]. However, we know little about the patterns and effectiveness of twelve-step affiliation (TSA) among adolescents [13-15]. As noted by Kelly and colleagues [16], some studies have found positive associations between twelve-step attendance (as treatment itself or as aftercare for formal treatment) and short-term outcomes [14,17-21], but few have examined effects of twelve-step on long-term outcomes, and none study adolescent outpatients [22].

Particularly among adolescents, we have yet to understand how and why TSA leads to positive SU outcomes. The adult literature has suggested mediating factors such as self-efficacy and motivation, increased active coping efforts, spirituality/religiosity, and improved social networks [23-27]. A study of 99 adolescent inpatients found modest beneficial effects of twelve-step attendance at 3 and 6 months post-discharge, which were mediated by motivation but not by coping or self-efficacy [14]. No adolescent studies, however, have examined social support and religiosity as mediators for longer periods, despite their importance as protective factors [28-31], or potential mediators of TSA, in long-term SU recovery among adolescents and young adults.

By conducting secondary analyses of longitudinal data of adolescents entering CD treatment, this paper examines: (1) the patterns of post-CD treatment TSA for adolescents; (2) the associations between post-treatment TSA and SU outcomes at 3 years, adjusting for individual characteristics, twelve-step attendance at 1 year, and treatment characteristics; and (3) the extent that social support and religious service attendance affect the associations between post-treatment TSA and 3-year SU outcomes.

METHODS

Study sites and treatment programs

The study sites were four Chemical Dependency Recovery Programs (CDRPs) of Kaiser Permanente (KP) Northern California, a large, group-model, integrated health care delivery system with approximately 3.4 million members. Eighty-eight percent of members are commercially insured, 10% insured through Medicare, and 2% through Medicaid. The membership is generally employed, middle-class, and well educated, with 78% having some college education [32].

Both CD and mental health (MH) treatment are provided within KP. The Adolescent CD programs offer intensive outpatient treatment, with referral to contracted residential programs when needed. Services include supportive group therapy, education, relapse prevention, and family therapy, with individual counseling and pharmacotherapy available. Programs are abstinence-based and random drug testing is conducted. Regular twelve-step attendance is expected.

Program length is approximately 1 year, with actual length based on individual needs. It includes three treatment phases. Phase 1 begins with intake/assessment and orientation, followed by group treatment sessions three times/week for 6 to 8 weeks. Phase 2 focuses on

continuing recovery and relapse prevention, with two group sessions/week for 3 to 6 months. The final phase is aftercare, which may last for months and entails one group session per week [33].

Study subjects

Study subjects were 419 adolescents, aged 13-18, seeking treatment at the four CDRPs between March 2000 and May 2002. The treatment programs and staff were similar across sites. We recruited 64% of all patients with an intake appointment, and 83% of those who started treatment [33]. There were 276 (66%) boys and 143 (34%) girls; 16% were African American, 9% Native American, 19% Hispanic, 6% Asian, and 50% White. Thirty-three percent reported “legal systems” as one of the referral sources, and almost half (46%) reported receiving an ultimatum to enter treatment, including court mandates.

Procedure

Consent for study participation was obtained from both the adolescent and accompanying parent. The Institutional Review Boards of Kaiser Foundation Research Institute and the University of California, San Francisco approved the study. A detailed description of recruitment and the study sample has been published [33]. At baseline, all 419 adolescents completed a computerized self-report and a paper-and-pencil questionnaire. We conducted phone interviews at 6 months and 1 and 3 years after intake, with response rates of 92%, 92%, and 85%, respectively.

This study analyzed data of those completing the 3-year follow-up ($N=357$). Compared to those not followed, we found a trend of more girls (35.8% versus 24.6%, $P<0.10$) and longer index treatment stays (77.8 days versus 48.4 days, $P<0.05$), but no differences between them in racial/ethnic distribution, age, motivation level at treatment entry, and baseline SU and MH severity.

Measures

Substance use (SU) outcomes—We measured quantity/frequency of SU at baseline and each follow-up, including days of use of alcohol and 11 other substances in the prior 30 days. Many questions were drawn from the Comprehensive Addiction Severity Index for Adolescents (CASI-A), a widely used semi-structured self-report questionnaire measuring adolescent health and functioning in domains of substance use and problems, education, legal issues, and family relationships. The CASI-A has been shown to have concurrent validity with Diagnostic and Statistical Manual of Mental Disorders and American Society of Addiction Medicine dependence and abuse criteria [34-37].

A validity test of self-report 1-year SU data was conducted on a subsample ($n=41$) of respondents at one site, who were asked at the completion of the telephone interview to come in for an in-person visit. The urinalysis (using Hitachi microparticle immuno assay) tested for alcohol, heroin, methadone, pain killers, cocaine, stimulants, marijuana, barbiturates, tranquilizers, inhalants, hallucinogens and PCP. Of those who reported abstinence, 92% had negative urine tests ($\kappa=0.79$) [38]. We also found no differences between this sub-sample and the other sites' survey respondents in age, gender, or SU at 1 year.

Consistent with treatment goals, this study used two dichotomous outcome measures, 30-day abstinence from alcohol and 30-day abstinence from drugs (excluding tobacco) at 3 years. Misuse of prescription medications was measured as drug use.

Twelve-step attendance at 1 year post-treatment intake—A dichotomous measure in the 1-year follow-up interview measured whether participants attended 10 or more meetings in the prior 6 months.

Post-treatment twelve-step affiliation (TSA)—We assessed prior 6-month TSA at 3 years using questions adapted from the Alcoholics Anonymous (AA) Affiliation Scale, a brief instrument developed to measure AA affiliation across a variety of AA experiences with robust validity across diverse populations and settings [39]. The eight questions ask about meeting attendance and involvement in various activities: considering oneself a member, having a sponsor, having sponsored anyone, calling other members for help, reading literature for guidance, performing service activities (e.g., cleaning up after a meeting), and having a spiritual awakening or a conversion experience. We modified the questions to include AA, Narcotics Anonymous (NA), Cocaine Anonymous, or any other twelve-step meetings. For those reporting any twelve-step meeting attendance, we asked, “In general, what is the typical age of those attending your twelve-step meetings?”

As the literature suggests [16], we examined “*meeting attendance*” and “*activity involvement*” separately for the construct of post-treatment TSA at 3 years: “meeting attendance” was measured by numbers of meetings attended in the past 6 months; “activity involvement” was measured by summing up positive responses to the twelve-step activities.

Social support—We assessed social support at 3 years by asking, “How many of your family or friends have been actively supporting your efforts to reduce your drinking and/or drug use?” and examined it as a potential mediator between TSA and abstinence.

Religious service attendance—We used frequency of religious service attendance in the past 6 months at 3 years as a proxy for religiosity [40-42], and examined it as another potential mediator of TSA and abstinence.

Individual characteristics—*Demographic variables* included age, gender, and race/ethnicity. Baseline SU severity was measured by summing the number of ‘yes’ answers to alcohol and drug dependence and abuse symptom questions from CASI-A, including symptoms of withdrawal, consequences of use, loss of control, and physical dependence in the prior 6 months. It ranged from 0 to 14, with a higher number indicating greater severity [43,44]. Baseline *MH problem severity* was measured by the internalizing and externalizing scales of the Youth Self-Report (YSR), a structured questionnaire measuring MH problem domains with solid psychometric properties across a variety of adolescent populations [4,45-48]. Higher scores indicate greater severity. *Motivation* was measured by the Circumstances, Motivation, and Readiness (CMR) total score, an instrument developed to assess client perceptions across four interrelated domains: circumstances (external pressures), motivation (internal pressures), readiness and suitability for CD treatment, which has been shown to possess strong reliability and validity [49].

Treatment utilization—We examined length of stay for the index CD treatment (up to 1 year), MH services received for 1 year, and CD and MH services received during the second and the third years, both inside and outside KP. Data were collected from the survey and KP databases.

Statistical analyses

According to the model proposed by Baron and Kenny [50], we conducted analyses in three steps. First, to demonstrate significant relationships between the independent and dependent variables, we conducted chi-square tests of twelve-step attendance at 1 year, TSA at 3 years,

and alcohol and drug abstinence at 3 years. For TSA at 3 years, we examined each of the seven activities and number of meetings attended, then created two summary measures - *meeting attendance* and *activity involvement*.

Second, to establish the possible mediating effects of social support and religious service attendance on the relationship between TSA and abstinence at 3 years, we examined the associations between the potential mediators and both the independent variables (*meeting attendance* and *activity involvement*) and the dependent variables (alcohol and drug abstinence), using chi-square tests for categorical variables, and Wilcoxon rank-sum tests for continuous variables due to violation of normality.

Third, to examine whether the mediators significantly reduce the strength of the relationships between the independent and dependent variables in multivariate models, for each summary measure of TSA (*meeting attendance* and *activity involvement*), we ran a series of up to four multivariate logistic regression models predicting 3-year abstinence. We first examined TSA alone as the main independent variable. Next, each mediator was added in addition to TSA; then finally, TSA and both mediators were included. Based on health services and treatment outcomes literature, and on findings from our empirical studies [14,18,43,51-57], each model controlled for individual characteristics (age, gender, race/ethnicity, baseline SU and MH severity, motivation at treatment entry), twelve-step attendance at 1 year, and treatment utilization (length of stay for the index CD treatment, CD readmission in second and third years within and outside KP, MH services in each follow-up year within and outside KP). Program site was not significantly associated with SU outcomes and thus not included in the models. We examined both alcohol and drug abstinence. We also estimated the extent of possible mediation effects for social support and religious service attendance by calculating the percent change in the effect of TSA measures on the outcome [58]. Analyses were performed using SAS version 9.1 (SAS Institute Inc., Cary, NC).

RESULTS

Sample characteristics

A total of 357 adolescents (35.9% girls) completed baseline and 3-year interviews; 176 (49.4%) were white, and of mean age of 16.1 years (SD 1.3). The length of index treatment stay ranged from 0 to 366, with mean of 77.6 days (SD 87.9). During the 2 years following the index treatment year, 64 (17.9%) adolescents received additional outpatient CD treatment with mean of 5.51 visits (SD 19.69) per member year; among them, 48 (75.0%) received all their CD treatment through KP. Another 42 (11.8%) reported receiving CD treatment only outside KP in years 2 to 3. At 3 years, 137 (38.4%) reported abstinence from alcohol and 203 (56.9%) from drugs in the prior 30 days, with 107 (30.0%) reporting abstinence from both alcohol and drugs (excluding tobacco).

Twelve-step affiliation: meeting attendance and activity involvement

At 1 year post-intake, 93 adolescents (26%) reported having attended 10 or more meetings in the prior 6 months. Bivariate analyses found that attending 10 or more meetings in the prior 6 months at 1 year was associated with higher alcohol, but not drug, abstinence at 3 years (50.5% versus 34.5%, $P < 0.01$ and 62.4% versus 56.4%, $P > 0.05$, respectively) (results not shown). At 3 years, we examined twelve-step *meeting attendance* and *activity involvement* in greater depth. Sixty-eight (19%) adolescents attended at least one meeting in the prior 6 months, among whom 42 attended 10 or more meetings. Forty-nine (14%) reported involvement in one or more of the seven activities. Two activities - having had a spiritual awakening/conversion experience, and having sponsored anyone - were not

associated with alcohol or drug abstinence (not shown); the other five - considering themselves a member, having called a member for help, having a sponsor, reading literature, or performing service activities - were associated with alcohol and drug abstinence (all $P < 0.05$) (Table 1).

Because the literature suggests no clear relationship between level of TSA and positive SU outcomes among adolescents, we conducted exploratory analyses to examine alcohol and drug abstinence by various groupings of *attendance* and *activity involvement*. Findings in the bottom of Table 1 indicate that adolescents involved in three or more activities had significantly higher abstinence rates from alcohol and drugs than those reporting fewer; while those involved in one to two activities had abstinence rates no different from those with none. Similarly, adolescents who attended 10 to 19, or 20 or more meetings had alcohol and drug abstinence rates significantly higher than those reporting fewer. Those who attended one to nine meetings had alcohol and drug abstinence rates that were lower or not different from non-attendants, respectively (Table 1). Guided by these results, we created two dichotomized summary measures of TSA: attending 10 or more meetings and participating in three or more activities.

Associations among TSA, SU outcomes, social support, and religious service attendance

Table 2 presents bivariate associations between the two hypothesized mediators (social support and religious service attendance) and the independent variables (the two measures of TSA at 3 years) and the dependent variables (alcohol and drug abstinence). Social support was positively associated with both TSA measures. Similarly, attending weekly religious services was related to participating in three or more twelve-step activities, as well as attending 10 or more twelve-step meetings. Social support was positively associated with both alcohol and drug abstinence (both $P < 0.0001$). However, frequency of religious service attendance was associated with drug ($P < 0.001$), but not alcohol, abstinence. Thus, we examined the mediating effects of **both religious service attendance and social support** on the associations between TSA and **drug** abstinence, and of **only social support** on the associations between TSA and **alcohol** abstinence.

Interrelationships among twelve-step meeting attendance, alcohol abstinence, and social support

Multivariate logistic regression analyses controlling for individual characteristics and treatment utilization across time found that twelve-step attendance at 1 year predicted 3-year alcohol [odds ratio (OR) 1.81, 95% confidence interval (CI) 1.01, 3.22], but not drug (OR 1.41, 95% CI 0.79, 2.53), abstinence (results not shown). We next added *meeting attendance* for the 3-year time point into the multivariate models. When twelve-step measures at both time points were included, 1-year attendance was marginally related to 3-year alcohol, but not drug, abstinence, while 3-year *attendance* predicted higher alcohol and drug abstinence at 3 years (Model 1 in Table 3 and Model 1 in Table 4).

Table 3 also presents the mediating effect of social support between twelve-step *meeting attendance* and alcohol abstinence at 3 years. Model 1 shows that after controlling for other covariates, adolescents attending 10 or more twelve-step meetings in the prior 6 months at the 3-year interview had 2.58 times the odds (95% CI 1.18, 5.64) of reporting 30-day abstinence from alcohol as those attending fewer or none ($P < 0.05$). However, including social support in model 2 reduced the effect of *meeting attendance* by 30.4%, and social support itself was positively associated with alcohol abstinence (OR 1.09, 95% CI 1.04, 1.13).

Interrelationships among twelve-step meeting attendance, drug abstinence, and religious service attendance and social support

Table 4 presents multivariate logistic regression analysis predicting drug abstinence. In all four models, 1-year twelve-step attendance was not associated with drug abstinence at 3 years. Model 1 indicates that after controlling for other covariates, adolescents attending 10 or more meetings had 2.53 times the odds (95% CI 1.08, 5.92) of being abstinent from drugs as those attending fewer or none ($P<0.05$). Model 2 shows that the odds of being abstinent from drugs for those who never attended religious services were only one-third of those who attended weekly ($P<0.01$); including religious service attendance reduced the effect of *meeting attendance* by 35.9%. Model 3 shows that social support was associated with drug abstinence (OR 1.09, 95% CI 1.04, 1.13) and reduced the effect of *meeting attendance* on drug abstinence by 22.2%. In model 4, the inclusion of both religious service attendance and social support accounted for almost 44.4% of the effect of *meeting attendance*.

Interrelationships among twelve-step activity involvement, SU outcomes, and religious service attendance and social support

We also examined the relationships between twelve-step *activity involvement* at 3 years and alcohol and drug abstinence, and the potential mediating effects of religious service attendance and social support on the relationships (not shown). Involvement in three or more activities was associated with alcohol (OR 4.94, 95% CI 1.74, 14.05, $P<0.01$) and drug (OR 7.54, 95% CI 1.98, 28.74, $P<0.01$) abstinence. Frequency of religious service attendance was associated with drug, but not alcohol, abstinence, and reduced the effects of *activity involvement* on drug abstinence by 7.2%. Number of family members and friends supporting less SU was associated with both alcohol and drug abstinence (OR 1.08, 95% CI 1.04, 1.13, $P<0.0001$ and OR 1.08, 95% CI 1.03, 1.13, $P<0.001$, respectively), and accounted for the effects of *activity involvement* on alcohol and drug abstinence by 27.4% and 21.4%, respectively. Together, religious service attendance and social support accounted for 30.0% of the effects of *activity involvement* on drug abstinence.

Potential mediating effects between TSA and SU outcomes

Figure 1 summarizes the results of examining potential mediating effects of social support and religious service attendance on the relationships between TSA and SU outcomes at 3 years. Results suggest social support as a potential mediator for the relationships between TSA and abstinence from both alcohol and drugs. However, we found possible mediating effects of religious service attendance for relationship between TSA and abstinence from only drugs but not alcohol.

Factors associated with post-treatment TSA

We conducted additional analyses to examine factors associated with post-treatment TSA at 3 years. Higher baseline and 1-year SU severity was associated with a higher likelihood of TSA at 3 years (all $p<0.05$). We also found significant associations between numbers of CD visits within KP during years 2 to 3 and attending 10 or more twelve-step meetings or involving three or more twelve-step activities at 3 years (both $P<0.05$). Similarly, having CD treatment outside the health plan during years 2 to 3, or receiving any MH treatment within or outside the health plan during years 2 to 3, were significantly associated with TSA at 3 years (all $p<0.05$) (not shown). We found no associations between TSA and baseline characteristics of age, gender, race/ethnicity, or having family members with SU problems. At baseline, adolescents who attended 10 or more meetings or were involved in three or more activities reported more peers using drugs in the prior 6 months (18.9 versus 11.8, $P<0.05$ and 20.2 versus 12.0, $P<0.05$, respectively). At 3 years, however, we found no differences in numbers of peers using drugs in prior 30 days by levels of meeting attendance

or activity involvement (5.7 versus 7.2, $P>0.05$ and 3.2 versus 7.3, $P>0.05$, respectively) (not shown).

DISCUSSION

This study found that 1-year twelve-step attendance predicted 3-year alcohol abstinence, and even remained marginally significant when including the proximal measure of 3-year TSA. This has implications for clinical approaches, because CD programs have the option of facilitating twelve-step attendance. It also suggests that early twelve-step attendance might help maintain better long-term alcohol abstinence for adolescents. Although early twelve-step attendance did not predict 3-year drug abstinence, the proximal 6-month measure of twelve-step meeting attendance and activity involvement at 3 years predicted both alcohol and drug abstinence at 3 years while controlling for individual characteristics, treatment services across time, and 1-year twelve-step attendance. Though level of TSA among adolescents was low at 3 years, those who attended more meetings or were involved in more activities had better SU outcomes than their counterparts.

Several factors may contribute to post-treatment TSA among adolescents. Consistent with Kelly et al. [16], we found that higher baseline and 1-year SU severity was associated with a higher likelihood of 3-year TSA. Those with higher severity may be more willing to utilize such resources; they may also more likely be in controlled environments that restrict substance use and require twelve-step attendance. The availability of teen-focused twelve-step groups may also be a determinant. Post hoc analyses found that among those who attended any meetings at 3 years, 90% reported that the typical age in their group was “18 years or older”, and only 10% reported ages more similar to their own ages, “16-18 years old.” As greater age similarity is positively associated with twelve-step attendance among adolescents [59], the relative dearth of adolescent twelve-step groups may pose a challenge.

Instead of a dose-response relationship, our findings suggest that minimum threshold levels of TSA were associated with improved outcomes. Adolescents attending 10 or more meetings in the prior 6 months were twice, and those involved in three or more activities were more than five times, as likely to be abstinent from alcohol and drugs compared to their counterparts. Interestingly, those who attended fewer than 10 meetings or were involved in fewer than two activities had abstinence rates similar to those who reported no attendance or activities. This is similar to adult findings that weekly or more frequent twelve-step attendance is associated with abstinence [60]. Our findings also echo adult studies in that TSA in short- and long-term follow-ups post-treatment are both independent significant contributors to long-term abstinence [27,61,62], thus highlighting the importance of TSA in long-term continuing care after an initial CD treatment episode [63-65]. Additional research is needed to more extensively examine whether a minimum threshold of frequency and intensity is associated with the benefits of TSA among adolescents, whether affiliation levels increase as adolescents move into adulthood, how the relationship between TSA and outcomes changes over time, and whether the relationship varies for alcohol versus drugs.

Consistent with other studies [53,54,66-68], we found that at 3 years girls had higher alcohol and drug abstinence rates. This may be an artifact of the gender differences in problem characteristics [4], response to treatment [54], and SU development over time [69]. Numbers of CD visits received within KP during years 2 to 3 were negatively associated with alcohol, but not drug, abstinence. In addition, no associations were found between receiving CD treatments outside KP, or receiving MH services within or outside KP, and abstinence at 3 years. The lack of unique predictive ability for the treatment measures may be partially

explained by the significant associations between receiving additional CD and MH treatments and TSA.

Our findings suggest that social support mediates the relationship between TSA and both alcohol and drug abstinence. This is consistent with the adult literature [24,25,27]. Participation in twelve-step programs may alter members' social networks by increasing the number of acquaintances who support quitting (development of a “dry” social network), or inoculate members from the negative influence of a “wet” social network encouraging SU [70].

A recent 1-year study of adult CD patients found that spiritual change partially mediated the relationship between increased twelve-step involvement and abstinence [71]. This study found that frequent religious service attendance only mediated the relationships between TSA and drug, but not alcohol, abstinence. Our measure, frequency of attendance at religious services, is only a narrow operationalization of the religiosity construct. Religiosity and spirituality are closely related constructs [72,73], yet there is little agreement among researchers about the theoretical and operational definitions of religiosity and spirituality [42,72,74,75], especially among adolescents. While twelve-step groups described themselves as “spiritual and not religious”, some argue that “the distinction is debatable” [76], and the religious overtones have been recognized in court decisions [77]. For some individuals, religious participation may be a mean of cultivating a spiritual connection or change [73], resulting from TSA. Whether there is a causal role for spiritual or religious change in the beneficial effects of twelve-step participation warrants research to understand the constructs and interrelationships between TSA, religiosity and spirituality within different subgroups.

A main limitation of this study is the lack of proper temporality among post-treatment TSA at 3 years, the dependent variables (alcohol and drug abstinence), and the potential mediators (social support and religious service attendance). The time window for both measures of post-treatment TSA, and for frequency of religious service attendance, was the 6 months prior to the 3-year interview; and was open-ended for the social support measure. Alcohol and drug abstinence rates were measured for the 30 days prior to the 3-year interview. However, we found robust predictive power of religious service attendance and social support when comparing multivariate models including and not including TSA at 3 years (results not shown), suggesting the associations between TSA and abstinence being explained by the mediators, versus the other way around. Future studies with more precise sequencing of measures are needed.

There are other limitations. First, the study was conducted in a private managed care health plan, and may not be generalizable to other health plans or public populations. Managed care is, however, a major model for private and public health care. The follow-up sample had marginally more girls and longer index CD treatment stays. Though we controlled for both variables in our multivariate analyses, caution should be used when interpreting and generalizing the results. Second, as with other observational studies, our results cannot be interpreted as causal. A randomized comparison of TSA to a no-TSA condition on SU outcomes would more properly control for possible confounding factors, but this would be difficult to conduct given the availability of AA/NA. Although observational, our data highlight the potential of TSA in positive outcomes, and may help explain the mechanisms through which TSA works among adolescents. (For a review of the evidence of effects of TSA, see Kaskutas [78]).

Third, because only a small proportion attended twelve-step meetings and was involved in twelve-step activities, it is possible that some, but not all, adolescents may benefit from

TSA. For example, our findings that those with TSA were more severe at baseline and 1 year suggest that the effects of TSA on outcomes might be moderated by severity. Other potential self-selection effects include motivation. Better understanding of who is more or less likely to benefit from twelve-step affiliation, and why, will help tailor treatment and continuing care accordingly in long-term recovery [79].

Fourth, our measures of TSA referred to any type twelve-step meetings without distinguishing among them. We also did not have detailed information on discharge type and reasons for CD treatments that might be related to twelve-step attendance. Finally, our social support measure generates an absolute total number rather than a proportion of the social support for the respondent's effort to reduce SU, and the use of a single-item measure as a proxy for religiosity may have limitations [80].

The current findings are encouraging for adolescents, their families, and treatment providers, as they suggest that a free, widely available informal resource may help long-term recovery efforts. Nevertheless, there is much to learn about how policies and clinical interventions can facilitate TSA during and after treatment for this population. Research is warranted to better understand barriers to, and effectiveness of, TSA among adolescents, particularly as they transition to adulthood.

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Figure 1.
Potential Mediating Effects of the Relationship between Twelve-step Affiliation (TSA) and Substance Use (SU) Outcomes at 3 Years
Note: a) TSA = twelve-step meeting attendance; b) TSA = twelve-step activity involvement. P values from the likelihood ratio tests of model comparisons.

Table 1
Post-treatment Twelve-step Affiliation and Substance Use Outcomes at 3 Years (N=357)

Involvement of twelve-step activities							
Have considered yourself a member of a twelve- step program in the prior 6 months							
No	(n=329)	35.3	<0.0001 ^a	54.4	0.0013 ^a		
Yes	(n=28)	75.0		85.7			
Have called a twelve-step member for help in the prior 6 months							
No	(n=333)	36.0	0.0007 ^a	54.7	0.0017 ^a		
Yes	(n=24)	70.8		87.5			
Have a twelve-step program sponsor							
No	(n=342)	36.8	0.0044 ^a	55.6	0.0173 ^a		
Yes	(n=15)	73.3		86.7			
Have read twelve-step meeting literature in the prior 6 months							
No	(n=311)	35.4	0.0024 ^a	55.0	0.0624 ^a		
Yes	(n=46)	58.7		69.6			
Have done services in the prior 6 months							
No	(n=330)	35.5	<0.0001 ^a	55.2	0.0225 ^a		
Yes	(n=27)	74.1		77.8			
Number of twelve-activities involved (range 0-5)							
0	(n=309)	35.3	0.0006 ^b	54.7	0.0212 ^b		
1	(n=10)	40.0		50.0			
2	(n=11)	27.3		45.5			
3	(n=8)	62.5		87.5			
4	(n=11)	81.8		90.9			
5	(n=8)	87.5		87.5			
Attendance of twelve-step meetings							
Number of meetings attended in the prior 6 months:							
0	(n=289)	36.7	0.0125 ^a	54.7	NS ^a		
1-9	(n=26)	23.1		57.7			

	Alcohol Abstinence Rate (%)	P	Drug Abstinence Rate (%)	P
10-19	(n=10) 60.0		70.0	
≥20	(n=32) 59.4		71.9	

Note:
NS = Non-significant.
^a = P values from Chi-square tests.
^b = P values from Fisher Exact Tests.

Table 2

Associations between Post-treatment Twelve-step Affiliation, Substance Use Outcomes, and Social Support and Religiosity at 3 Years (N=357)

Number of family members and friends who support reducing or quitting substance use				Frequency of religious services attended (%)				
		mean (SD)	median	p value	never	<=1~2/month	weekly	p value
Twelve-step affiliation measures								
Number of twelve-step activities involved in the prior 6 months								
0-2	(n=330)	5.2 (6.9)	2.0	<0.0001 ^a	47.0	45.8	7.3	0.0217 ^b
3-5	(n=27)	9.4 (6.0)	9.5		33.3	44.4	22.2	
Number of twelve-step meetings attended in the prior 6 months								
0-9	(n=315)	5.2 (6.8)	2.0	0.0003 ^a	48.6	44.4	7.0	0.0035 ^b
≥10	(n=42)	8.3 (6.8)	7.0		26.2	54.8	19.1	
Substance use outcomes								
Abstinence from alcohol in the prior 30 days								
No	(n=220)	4.0 (5.9)	2.0	<0.0001 ^a	49.1	44.6	6.4	NS ^b
Yes	(n=137)	8.0 (7.7)	5.0		40.9	47.5	11.7	
Abstinence from drugs in the prior 30 days								
No	(n=154)	3.6 (5.6)	2.0	<0.0001 ^a	57.1	38.3	4.6	0.0005 ^b
Yes	(n=203)	7.0 (7.5)	4.0		37.4	51.2	11.3	

Note:

NS = Non-significant.

^a = P values from Wilcoxon rank-sum tests.^b = P values from Chi-square tests.

Table 3**Multivariate Logistic Regression Analyses Predicting Alcohol Abstinence Status at 3-year Follow-up**

		Model 1	Model 2
		OR (95% CI)	OR (95% CI)
Age	(as continuous)	NS	NS
Gender	(boy vs. girl)	0.59** (0.34, 1.00)	0.61* (0.35, 1.07)
Race/ethnicity	(white vs. non-white)	NS	NS
Baseline mental health (MH) severity			
YSR Internalizing score	(as continuous)	NS	NS
YSR Externalizing score	(as continuous)	NS	NS
Baseline substance use (SU) severity			
No. of abuse/dependent symptoms	(as continuous)	NS	NS
Baseline CMR total score	(as continuous)	NS	NS
Treatment characteristics			
Index chemical dependency treatment (CD) LOS in days	(as continuous)	NS	NS
No. of CD visits in years 2-3 within the health plan	(as continuous)	0.98** (0.96, 1.00)	0.98** (0.96, 1.00)
Receiving any CD treatment in years 2-3 outside the health plan	(yes vs. no)	NS	NS
No. of MH visits in year 1 within the health plan	(as continuous)	NS	NS
No. of MH visits in years 2-3 within the health plan	(as continuous)	NS	NS
Receiving any MH treatment in years 2-3 outside the health plan	(yes vs. no)	NS	NS
Twelve-step meeting attendance at 1 year			
Attended 10+ meetings in the prior 6 months	(yes vs. no)	1.68* (0.93, 3.03)	1.77* (0.94, 3.32)
Post-treatment twelve-step meeting attendance at 3 years			
Attended 10+ meetings in the prior 6 months	(yes vs. no)	2.58** (1.18, 5.64)	2.10** (0.92, 4.78)
Social support			
No. of families/friends who support reduce/quit substance use	(as continuous)	-	1.09 [‡] (1.04, 1.13)
Percent change in the estimated effect of twelve-step meeting attendance		-	30.4
Significance of likelihood ratio test		-	P<0.05

Note: Percent change in the estimated effect of twelve-step = $100 \times [(OR_{m-} - OR_{m+}) / (OR_{m-} - 1)]$, where OR_{m-} = odds ratio for twelve-step meeting attendance obtained from the regression model that does not consider the potential mediator (i.e. social support), and OR_{m+} = odds ratio for twelve-step meeting attendance obtained from the regression model that does include the potential mediator (i.e. social support). YSR = Youth self-report. CMR = Circumstances, motivation, and readiness. LOS = Length of stay. NS = Non-significant;

* P<0.10

** P<0.05

[†] P<0.01

[‡] P<0.001

Table 4
Multivariate Logistic Regression Analyses Predicting Drug Abstinence Status at 3-year Follow-up

		Model 1	Model 2	Model 3	Model 4
		OR (95% CI)	OR (95% CI)	OR (95% CI)	OR (95% CI)
Age	(as continuous)	NS	NS	NS	NS
Gender	(boy vs. girl)	0.54** (0.32, 0.92)	0.58** (0.33, 1.00)	0.56** (0.32, 0.97)	0.59* (0.34, 1.04)
Race/ethnicity	(white vs. non-white)	NS	NS	NS	NS
Baseline mental health (MH) severity					
YSR Internalizing score	(as continuous)	NS	NS	NS	NS
YSR Externalizing score	(as continuous)	NS	NS	NS	NS
Baseline substance use (SU) severity					
No. of abuse/dependent symptoms	(as continuous)	NS	NS	NS	NS
Baseline CMR total score	(as continuous)	1.04 [†] (1.01, 1.07)	1.04** (1.01, 1.07)	1.04** (1.01, 1.07)	1.04** (1.01, 1.07)
Treatment characteristics					
Index chemical dependency treatment (CD) LOS in days	(as continuous)	NS	NS	NS	NS
No. of CD visits in years 2-3 within the health plan	(as continuous)	0.99* (0.97, 1.00)	0.99* (0.97, 1.00)	0.99* (0.97, 1.00)	0.99* (0.97, 1.00)
Receiving any CD treatment in years 2-3 outside the health plan	(yes vs. no)	NS	NS	NS	NS
No. of MH visits in year 1 within the health plan	(as continuous)	NS	NS	NS	NS
No. of MH visits in years 2-3 within the health plan	(as continuous)	NS	NS	NS	NS
Receiving any MH treatment in years 2-3 outside the health plan	(yes vs. no)	NS	NS	NS	NS
Twelve-step meeting attendance at 1 year					
Attended 10+ meetings in the prior 6 months	(yes vs. no)	1.32 (0.73, 2.40)	1.38 (0.75, 2.54)	1.42 (0.76, 2.64)	1.46 (0.78, 2.75)
Post-treatment twelve-step meeting attendance at 3 years					
Attended 10+ meetings in the prior 6 months	(yes vs. no)	2.53** (1.08, 5.92)	1.98 (0.83, 4.72)	2.19* (0.91, 5.29)	1.73 (0.70, 4.24)
Religiosity					
Frequency of service attendance	(never vs. weekly)	-	0.33 [†] (0.13, 0.87)	-	0.34** (0.12, 0.90)
	(<=1-1-2/months vs. weekly)	-	0.69 (0.26, 1.81)	-	0.65 (0.24, 1.75)
Social support					
No. of families/friends who support reduce/quit substance use	(as continuous)	-	-	1.09 [†] (1.04, 1.13)	1.08 [†] (1.03, 1.13)
Percent change in the estimated effect of twelve-step meeting attendance		-	35.9	22.2	44.4

	Model 1	Model 2	Model 3	Model 4
	OR (95% CI)	OR (95% CI)	OR (95% CI)	OR (95% CI)
Significance of likelihood ratio test	-	P<0.05	P<0.05	P<0.05

Note: Percent change in the estimated effect of twelve-step = $100 \times [(OR_{m-} - OR_{m+}) / (OR_{m+} - 1)]$, where OR_{m-} = odds ratio for twelve-step meeting attendance obtained from the regression model that does not consider the potential mediator (i.e. social support, religiosity), and OR_{m+} = odds ratio for twelve-step meeting attendance obtained from the regression model that does include the potential mediator (i.e. social support, religiosity). YSR = Youth self-report. CMR = Circumstances, motivation, and readiness. LOS = Length of stay. NS = Non-significant;

* P<0.10
** P<0.05
† P<0.01
‡ P<0.001.