

# Depression Ratings, Reported Sexual Risk Behaviors, and Methamphetamine Use: Latent Growth Curve Models of Positive Change Among Gay and Bisexual Men in an Outpatient Treatment Program

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Although the cessation of substance use is the principal concern of drug treatment programs, many individuals in treatment experience co-occurring problems such as mood disruptions and sexual risk behaviors that may complicate their recovery process. This study assessed relationships among dynamic changes tracked over time in methamphetamine use, depression symptoms, and sexual risk behaviors (unprotected anal intercourse) in a sample of 145 methamphetamine-dependent gay and bisexual males enrolled in a 16-week outpatient drug treatment research program. Participants were randomly assigned into 1 of 4 conditions: contingency management (CM), cognitive behavioral therapy (CBT; the control condition), combined CM and CBT, and a tailored gay-specific version of the CBT condition. Using latent growth curve models, the authors assessed the relationship of means (intercepts) and the slopes of the 3 measures of interest over time to test whether changes in methamphetamine use predicted declining rates of depression and risky sexual behavior in tandem. Participants with the greatest downward trajectory in methamphetamine use (urine verified) reported the greatest and quickest decreases in reported depressive symptoms and sexual risk behaviors. The control group reported the most methamphetamine use over the 16 weeks; the tailored gay-specific group reported a more rapidly decreasing slope in methamphetamine use than the other participants. Findings indicate that lowering methamphetamine use itself has a concurrent and synergistic effect on depressive symptoms and risky sexual behavior patterns. This suggests that some users who respond well to treatment may show improvement in these co-occurring problems without a need for more intensive targeted interventions.

*Keywords:* methamphetamine treatment, depression, latent growth curve models, sexual risk behavior

The cessation of drug use is the principal objective of most drug abuse treatment programs. Nevertheless, other maladaptive conditions and behaviors associated with drug abuse and dependence are common targets of treatment

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programs, either directly or indirectly. A partial listing of co-morbid conditions includes depressed mood (Peck, Reback, Yang, Rotheram-Fuller, & Shoptaw, 2005; Quello, Brady, & Sonne, 2005), anxiety (Kokkevi & Stefanis, 1995), criminal behavior (Anglin & Hser, 1990), sexual risk behaviors and infections (Fisher, Reynolds, & Jaffe, 2006; Wells, Fisher, Fenaughty, Cagle, & Jaffe, 2006), and poor parenting skills (Knight, Logan, & Simpson, 2001).

The frequent association of drug use with sexual risk behaviors such as unprotected sexual intercourse has been reported among heterosexual, gay, and bisexual drug users (Ashley, Marsden, & Brady, 2003; Chiasson et al., 1991; Mausbach, Semple, Strathdee, Zians, & Patterson, 2007; Williams et al., 2003), whether they engage in sex trade or not (De Graaf, Vanwesenbeeck, Van Zessen, Straver, & Visser, 1995; Molitor et al., 1999; Wechsberg et al., 2003). Depression and related symptoms are also common among users of methamphetamine (Peck et al., 2005; Semple, Patterson, & Rant, 2005), cocaine (Brown et al., 1998), heroin (Darke & Ross, 2002), alcohol (Sher, 2004), and marijuana (Degenhardt, Hall, & Lynskey, 2003) and may

occur after cessation of use or between use episodes (Davidson, Gow, Lee, & Ellinwood, 2001; Peck et al., 2005). Yet symptoms of depression can be particularly severe during abstinence from methamphetamine. Past findings are divergent on whether treatment for substance use is efficacious in alleviating depressive symptoms, with some findings supporting this claim (Ashley et al., 2003; Peck et al., 2005) and others finding no sustained effects of treatment on depression (Huber, Shoptaw, Roll, Rawson, & Ling, 2002).

The present work assessed the change in depression ratings and reported sexual risk behaviors as a function of change in methamphetamine use in a group of treatment-seeking, methamphetamine-dependent, gay and bisexual males who participated in an outpatient methamphetamine abuse treatment program. Using latent growth curve modeling, we examined the relationships between the rates of change of the variables of interest and associations among mean levels for each of the above variables. Latent growth curve models are useful in the study of change especially when measures at several time points are available and the shape of the trajectory is of particular interest (Duncan, Duncan, Strycker, Li, & Alpert, 1999). Latent growth curve models are a variant of structural equation modeling in that they treat the two major characteristics of a growth profile, initial status (referred to as the *intercept*) and trajectory of growth (referred to as the *slope*), as latent factors (Chou, Bentler, & Pentz, 1998). Latent growth curve modeling has been useful in explaining the dynamic relationship between illicit drug use and a number of related behaviors, such as smoking among methadone-maintained participants in a smoking cessation program (Frosh, Stein, & Shoptaw, 2002); aggression, drug use, and delinquency in adolescents (Farrell, Sullivan, Esposito, & Meyer, 2005); and response to an enhanced HIV intervention program (Wang, Siegal, Falck, Carlson, & Rahman, 1999).

In the current study, it was hypothesized that those participants displaying the most rapid decreases in drug use during the treatment would simultaneously show correspondingly higher rates of improvement in their depression symptoms and fewer reported high-risk sexual behaviors. Moreover, it was expected that these changes would happen simultaneously rather than sequentially. In addition, we included participation in the control versus experimental therapies in the model in order to account for improvements that have already been reported elsewhere, in which those in the experimental conditions showed the most improvement during the treatment period (Peck et al., 2005; Shoptaw et al., 2005). Specifically, Shoptaw et al. (2005) reported that participation in the three experimental conditions resulted in greater retention, higher rates of negative (i.e., metabolite free) methamphetamine urines, and longer lasting reductions in depressive symptoms.

## Method

### Participants

One hundred sixty-two self-identified gay and bisexual male methamphetamine users between the ages of 19 and 57

who were seeking treatment for their methamphetamine use problem and were diagnosed with methamphetamine dependence (verified by *Diagnostic and Statistical Manual of Mental Disorders* [4th ed.; *DSM-IV*; American Psychiatric Association, 1994] criteria during a clinical interview) were randomly assigned to one of four treatment conditions in an outpatient treatment research clinic in Los Angeles, California. Participants were excluded on the basis of preexisting medical or psychiatric conditions that could interfere with the study, inability to comply with protocol requirements, or methamphetamine dependence requiring a more intensive intervention than the outpatient clinic was able to provide.

### Procedures

The procedures and findings from the study are reported elsewhere (Shoptaw et al., 2005), though a brief synopsis is provided. Participants were required to attend the clinic three times per week for 16 weeks during active treatment to provide urine samples, complete research measures, and receive sessions of their respective behavior therapy. Participants were assigned to one of four behavior therapy conditions. Follow-up evaluations were conducted at treatment completion (16 weeks) and at 26 and 52 weeks after randomization.

### Interventions

*Cognitive behavioral therapy* (CBT;  $n = 33$ ) was delivered as a manual-driven, 90-min group intervention (Rawson, Shoptaw, & Obert, 1995) that taught participants how to achieve abstinence from methamphetamine and to prevent relapse. This intervention did not directly address any comorbid conditions or behaviors related to methamphetamine use (including those addressed here). On average, participants attended 40.8% of the 48 available sessions. This was considered the control condition.

*Contingency management* (CM;  $n = 38$ ) provided increasingly valuable reinforcers in exchange for successive, scheduled urine samples that documented abstinence from methamphetamine (Higgins et al., 1993). Participants attended an average of 62.7% of clinic visits and could earn a maximum of \$1,277.50 in vouchers, though the average amount earned per participant in this condition was \$415. No attendance of CBT sessions was included in this condition.

*CBT + CM* ( $n = 36$ ) provided all elements of both above-mentioned conditions. On average, participants in this condition attended 73.8% of the total CBT sessions available and earned \$662 in vouchers.

*Gay-specific CBT* (GCBT;  $n = 38$ ), which also involved 90-min group sessions three times per week, was a culturally tailored approach that integrated gay concepts and referents to the standard CBT approach. This condition also targeted HIV sexual risk reduction behaviors. Participants in this condition attended 55.8% of available sessions on average.

## Measures

*Admission form.* An 8-page measure included participant demographics, drug use behaviors, drug and alcohol treatment history, sexual risk behaviors, HIV serostatus, and medical and psychiatric histories.

*Beck Depression Inventory.* Depression was assessed with the Beck Depression Inventory (BDI; Beck, Steer, & Garbin, 1988), a widely used 21-item self-report scale that assesses symptoms of depression. The BDI was administered on a weekly basis, and monthly averages were used in analysis.

*Assessment of methamphetamine use.* Recent methamphetamine use was assessed at each clinic visit by analysis of observed urine samples for methamphetamine metabolites with an on-site SYVA EMIT Dade-Behring (Newark, DE) radioimmunoassay machine. Urine metabolite results were dichotomized as positive (i.e., “dirty,” or containing metabolites) or negative (i.e., “clean,” or metabolite free), and monthly indices indicating the proportion of metabolic-positive samples to total possible (i.e., 12) urines provided were used in all analyses. Individual missing urines were not counted as either positive or negative and were therefore not included in the computation of the indices, though each index was still computed as a proportion of the 12 possible monthly urines.

*Behavioral Questionnaire—Amphetamine.* The primary measure used to assess sexual risk behaviors was the BQ-A (Chesney, Chambers, & Kahn, 1997). This instrument, administered in an interview format, has been validated for use with methamphetamine-dependent individuals (Twitchell, Huber, Reback, & Shoptaw, 2002) and has been shown to have a reliability of .92 (Veniegas et al., 2002). Sexual risk behaviors performed in the past month were assessed. Reports of unprotected receptive and insertive anal intercourse with both primary and other sexual partners were summed in the current analysis as the sexual risk behaviors outcome variable.

## Data Analysis

Only participants who completed at least 4 weeks of treatment were included in the present analyses. This reduced the sample size from the original 162 randomized individuals to the final sample size of 145. This criterion ensured that the participants had sufficient exposure to study conditions and enough data points to conduct latent growth curve modeling. Past findings from this study showed that most of the reductions in methamphetamine use, depression symptoms, and sexual risk behaviors occurred within the 1st month of treatment (Peck et al., 2005; Shoptaw et al., 2005).

The latent growth curve models were assessed with the EQS structural equation program (Bentler, 2006). Five time points were used for each variable, including baseline, and then mean scores every 4 weeks until Week 16. A linear model was assumed, with negative half-steps for the slope portions. In the initial model, the slope and intercept latent growth variables of methamphetamine use indicated by measured variables at each of the five time points predicted

the slopes and intercepts of depression, and risky sexual behavior, also measured at the five time points. The intercepts represented individual levels of methamphetamine use, depression, and risky sexual behavior at the five time points. The slopes represented the trend of each individual's growth curve. A covariance was included between the slope and intercept latent variables for methamphetamine use and between the slope and intercepts of the outcome latent variables of depression and risky sexual behavior. Nonsignificant predictive paths and covariances were gradually dropped until only significant paths and covariances remained.

It was hypothesized that a decrease in the methamphetamine use intercept and slope parameters would affect a corresponding decrease in the intercepts and slopes of the depression scores (BDI) and sexual risk behaviors. Moreover, we accounted for the effect of intervention group membership by including dummy variables representing participation in each group. We hypothesized that the control group (i.e., the CBT-only group) would demonstrate the least improvement (i.e., less of a decline in means [intercepts] over time) on all measures. As reported below, two of the intervention groups did not impact the latent growth variables and were deleted from the final model in the interest of parsimony.

Goodness-of-fit of the models was assessed with the maximum-likelihood chi-square statistic, the comparative fit index (CFI), and the root mean squared error of approximation (RMSEA; Bentler, 2006; Bentler & Dudgeon, 1996; Hu & Bentler, 1999). The CFI ranges from 0 to 1 and reflects the improvement in fit of a hypothesized model over a model of complete independence among the measured variables (Bentler, 2006). Values approaching 0.95 or greater are desirable for the CFI. The RMSEA is a measure of fit per degrees of freedom, controlling for sample size; values less than .06 indicate a relatively good fit (Hu & Bentler, 1999). Suggestions for model modifications to improve the fit were obtained from the LaGrange Multiplier (LM) test (Bentler, 2006). Missing data were handled with the maximum likelihood (ML) missing data procedures available in the EQS structural modeling program. Using ML, rather than listwise deletion, allows for maximal use of available data, even from participants for whom information at certain time points is missing. EM imputation was utilized, in which parameter estimates are obtained by cycling iteratively between an expectation (E) step and a maximization (M) step (Bentler, 2006). This is the recommended data imputation method in the EQS program. Most of the participants who were retained for analysis had complete data (i.e., none missing; for details regarding retention, see Shoptaw et al., 2005), and fewer than 20% of data points were missing for all of the variables used in the model (range = 16%–19%). Many of the subjects with missing data attended at various points along the treatment time and missed only sporadically. Diagnostics testing whether data could be assumed to be missing completely at random indicated that use of the data was reasonable and included the GLS (generalized least squares) test of homogeneity of

means, GLS test of homogeneity of covariance matrices, and the combined test (Bentler, 2006).

## Results

### Demographics

Participants' mean age was 37 years, mean income level was \$2,422 in the past 30 days, and the average level of education was approximately 15 years (i.e., some college). The sample was mostly White (80%; 116/145), followed by Mexican Hispanic (12%; 18/145), with small numbers of African American (3%; 4/145), American Indian (1%; 2/145), and Asian/Pacific Islander (3%; 5/145) participants. Ethnicity and level of methamphetamine use were used as factors during treatment assignment with an urn randomization procedure. This computerized method of randomization assures that important covariates are balanced across conditions to reduce bias (Wei & Lachin, 1988). Multivariate analysis revealed that the only difference between conditions on any of the demographic variables was a difference in age between the GCBT condition ( $M = 35.00$  years,  $SD = 5.82$ ) and the CBT + CM condition ( $M = 38.94$  years,  $SD = 6.21$ ),  $F(3, 139) = 3.09$ ,  $p < .05$ . The participants who were dropped from the analysis due to their short length of participation were not found to vary significantly from the final sample on any of the demographic variables.

### Mean Values Over Time

The average number of urine samples containing methamphetamine metabolite, average BDI depression scores, and average frequency of participants' reported episodes of unprotected receptive anal sex are reported in Table 1. Marked reductions from baseline values are clear for all three variables.

### Latent Growth Curve Models

The initial model assessed the relationships among all intercept and slope factors as well as the group membership variables. The intercept and slope of methamphetamine use predicted both the intercepts and slopes of depression and risky sexual behavior. This initial model had a good fit:  $ML \chi^2(97, N = 145) = 162.67$ ,  $p < .001$ ,  $CFI = .98$ ,  $RMSEA = .069$ . The RMSEA was slightly over the criterion for good fit, but addition of one correlated error residual described below reduced it further. In a trimmed path model in which the nonsignificant regression paths were deleted

and control group and gay-specific CBT membership were retained, the intercepts of both the depression and sexual risk behavior latent growth factors were predicted by the intercept of methamphetamine use and the negative slopes of depression and sexual risk behavior were predicted by the negative slope of methamphetamine use (see Figure 1). This model also had a good fit:  $\chi^2(115, N = 145) = 177.82$ ,  $p < .001$ ,  $CFI = .98$ ,  $RMSEA = .06$ .

Moreover, membership in the control group directly predicted higher mean positive urines across the duration of the study (the least improvement) but was not a significant direct predictor of the outcome factors. Nevertheless, the indirect effect of the control condition mediated through methamphetamine use was found to be significant for the depression intercept ( $p < .05$ , two-tailed test) and more weakly for sexual risk behavior ( $p < .05$ , one-tailed test), indicating that participants in that condition also reported higher depression scores throughout treatment and more sexual risk behavior than those participating in the other intervention conditions but that these were related to their greater use of methamphetamine.

Participation in the gay-specific intervention directly predicted a more rapid decline in methamphetamine use (an accelerating negative slope). This relationship in turn had a weak but significant indirect effect on the slope of depression ( $p < .05$ , one-tailed test), indicating that participation in the gay-specific intervention tended to have the effect of more quickly lowering depression through its effect on methamphetamine use.

We used the LM test to identify further significant relationships in the data not accounted for in the model, and its use resulted in the addition of one correlated error residual between two different time points of a similar measure (an autocorrelation; methamphetamine use between Months 2 and 3). This theoretically acceptable addition resulted in a better fitting final model and a concomitant reduction in the RMSEA:  $\chi^2(114, N = 145) = 164.39$ ,  $p < .001$ , with  $CFI = .99$  and  $RMSEA = .055$ .

## Discussion

Outcomes from these analyses are among the first to describe the dynamic process by which behavioral drug abuse treatment produces simultaneous, real-time changes in methamphetamine use and reported ratings of depression and sexual risk activities. Evaluation of the intercepts (means) showed significant reductions in these variables, which is consistent with the main findings of the project as

Table 1  
Means (and Standard Deviations) for Methamphetamine Use, Depression, and Unprotected Anal Sex by Time in Treatment

	Intake	Month 1	Month 2	Month 3	Month 4
Positive methamphetamine urines (proportion of total possible)	.69 (.46)	.30 (.29)	.31 (.29)	.27 (.30)	.23 (.29)
Beck Depression Inventory score	14.98 (8.40)	7.76 (5.88)	5.43 (5.28)	5.29 (5.37)	5.09 (4.96)
Risky sex (no. of times in past month)	5.86 (9.02)	1.59 (3.99)	2.20 (5.55)	1.76 (4.52)	2.07 (4.69)

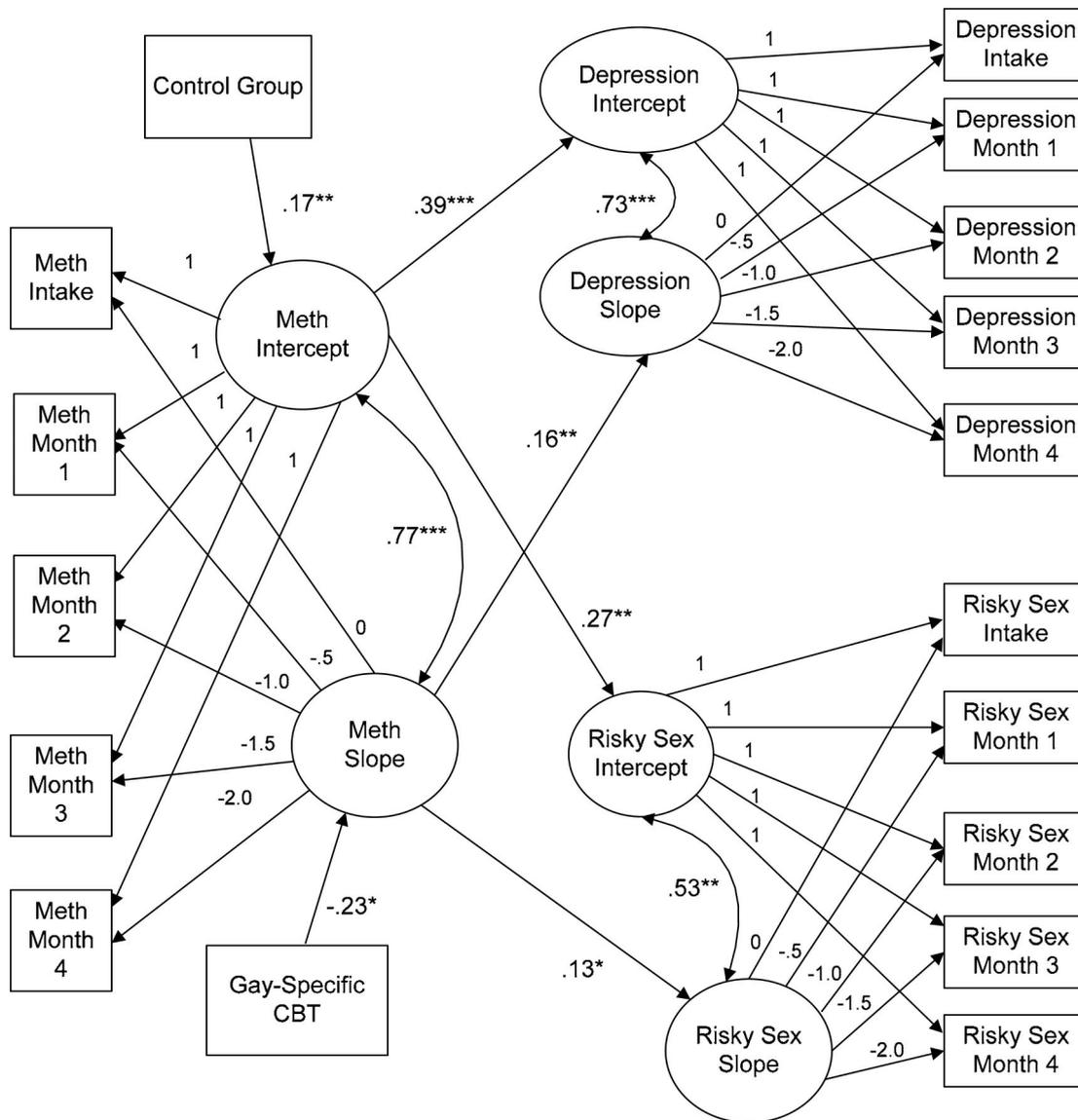


Figure 1. Final latent growth curve model. All estimated parameters are standardized, intercepts are fixed at 1, and slope parameters are fixed at 0,  $-0.5$ ,  $-1.0$ ,  $-1.5$ , and  $-2$ . The large circles designate latent growth variables; the rectangles represent measured variables. One-headed arrows represent regression paths; two-headed arrows represent correlations. Meth = methamphetamine; CBT = cognitive behavioral therapy.  $^*p < .05$ ;  $^{**}p < .01$ ;  $^{***}p < .001$ .

reported elsewhere (Peck et al., 2005; Shoptaw et al., 2005). Testing the slopes as well, however, provided new information and demonstrated that those individuals who reported the most rapid decreases in methamphetamine use also correspondingly demonstrated the quickest decreases in depression symptoms and sexual risk behaviors. Growth curves represent individual rates of change, and these analyses demonstrated that participants in the gay-specific CBT condition reported the most rapidly decreasing slopes, an outcome that was not apparent in the original Shoptaw et al. (2005) study. These findings are novel and demonstrate that modeling approaches using clinical trials data can yield

important additional information that may direct development and evaluation of ever more potent behavioral interventions.

As expected, the process of change in the measures of interest appears to be synchronized and concurrent. Greater reductions in methamphetamine use presaged greater reductions in other maladaptive behaviors in a linear fashion. This finding supports the idea that although depression and high rates of sexual risk behaviors are correlated with methamphetamine use, individuals are likely to experience the greatest relief simply by focusing on sustaining methamphetamine abstinence. One implication of these results

would be that methamphetamine-abusing individuals seeking care should initially be provided interventions to reduce methamphetamine use, in order for the caregiver to observe the extent to which co-morbid disorders are reduced before starting treatment regimens that address depression or that target risk behavior reductions. The minority of individuals who continue to have problems with depression and sexual risk behaviors in the absence of methamphetamine use may be the ideal group who benefits maximally from additional intensive interventions. Findings from this modeling investigation suggest using this type of evidence-based approach in selecting appropriate and tailored interventions with methamphetamine-dependent men who have sex with men.

These findings are encouraging in showing robust reductions in methamphetamine use, ratings of depressive symptoms, and sexual risk behaviors that correspond to the application of evidence-based treatments for methamphetamine dependence. A significant advantage to participation in the gay-specific intervention was also demonstrated, as those that participated in that intervention showed the most rapid decline in methamphetamine use. Moreover, participants assigned to the comparison condition considered the control group (cognitive behavioral therapy) showed the least improvement as measured by methamphetamine abstinence, and indirectly, depression relief, although all groups demonstrated improvement. As in other trials of behavioral therapies for methamphetamine dependence (Rawson et al., 2004, 2006) longer term follow-up evaluations consistently demonstrate dramatic improvements for all participants who receive high-quality treatments.

The present study is limited by factors commonly found when conducting intervention research in the area of drug abuse. Though this project featured random assignment of participants, use of a less intensive or no-treatment control condition was not possible, as all participants were seeking treatment, making it more difficult to interpret relatively small differences between the comparison condition and the other treatments. Also, missing data were a problem, and the attrition rate was relatively high. High rates of missing data values create potential sources of biases and may complicate complex analyses such as the one reported here. Nevertheless, the current study's retention lengths (8.9–13.3 weeks) were in no way abnormal. A larger sample size might have allowed us to discern more significant relationships, especially the indirect effects of membership in the various intervention groups.

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