

Determining the relative importance of the mechanisms of behavior change within Alcoholics Anonymous: a multiple mediator analysis

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ABSTRACT

Aims Evidence indicates that Alcoholics Anonymous (AA) participation reduces relapse risk but less is known about the mechanisms through which AA confers this benefit. Initial studies indicate self-efficacy, negative affect, adaptive social networks and spiritual practices are mediators of this effect, but because these have been tested in isolation, their relative importance remains elusive. This study tested multiple mediators simultaneously to help determine the most influential pathways. **Design** Prospective, statistically controlled, naturalistic investigation examined the extent to which these previously identified mechanisms mediated AA attendance effects on alcohol outcomes controlling for baseline outcome values, mediators, treatment, and other confounders. **Setting** Nine clinical sites within the United States. **Participants** Adults ($n = 1726$) suffering from alcohol use disorder (AUD) initially enrolled in a randomized study with two arms: aftercare ($n = 774$); and out-patient ($n = 952$) comparing three out-patient treatments (Project MATCH). **Measurements** AA attendance during treatment; mediators at 9 months; and outcomes [percentage of days abstinent (PDA) and drinks per drinking day (DDD)] at 15 months. **Findings** Among out-patients the effect of AA attendance on alcohol outcomes was explained primarily by adaptive social network changes and increases in social abstinence self-efficacy. Among more impaired aftercare patients, in addition to mediation through adaptive network changes and increases in social self-efficacy, AA lead to better outcomes through increasing spirituality/religiosity and by reducing negative affect. The degree to which mediators explained the relationship between AA and outcomes ranged from 43% to 67%. **Conclusion** While Alcoholics Anonymous facilitates recovery by mobilizing several processes simultaneously, it is changes in social factors which appear to be of primary importance.

Keywords Addiction, alcohol dependence, alcoholics anonymous, alcoholism, depression, self-help groups, social network, spirituality.

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INTRODUCTION

Alcohol is the third leading risk factor for disease and disability globally [1,2]. Also, 4% of all deaths worldwide are attributable to alcohol, greater than those due to human immunodeficiency virus/acquired immune deficiency syndrome (HIV/AIDS), violence or tuberculosis, and alcohol is the leading risk factor for death among males aged 15–59 years [1]. In the United States, alcohol is the third leading actual cause of death

[3], and alcohol misuse and related disorders confer an extraordinary negative social strain and economic impact approaching \$200 billion annually [4]. In partial response, most societies provide some form of professionally delivered treatment to address these problems. However, due to the often chronic nature of alcohol use disorders (AUD) and difficulties in accessing professional services, a network of peer-led mutual-help organizations have emerged and grown providing additional support [5,6].

In 2009, approximately 2.3 million individuals with a substance use disorder attended a formal treatment program, and 5 million attended a peer-led mutual-help group for an alcohol or other drug problem [7]. By far the largest of these groups is Alcoholics Anonymous (AA), with 1.3 million US members meeting in 57 000 groups each week [8]. It is the most commonly sought source of help for alcohol-related problems [9,10]. Given AA's potential public health significance in reducing alcohol-related harm, in 1990 the Institute of Medicine [11] called for more research on AA, specifically on its mechanisms, to help elucidate how it works and for whom. A subsequent scientific monograph summarized the state of the science as well as further research opportunities [12]. The intervening 20-year period has seen a significant increase in scientific interest and rigor focused on the study of AA. This body of work has indicated that AA confers short- and long-term therapeutic benefit on a par with professional interventions [13–16], and there are now numerous empirically supported interventions designed specifically to increase AA participation [17–22]. AA has been shown also to reduce health-care costs while enhancing treatment outcomes [14,23]. It is only recently, however, that research has begun to examine mechanisms through which AA confers these benefits (see [24] for a review).

Initial studies indicate that AA helps individuals recover in several ways. One is by facilitating changes in social networks [25–27], especially by helping individuals drop pro-drinking ties and gain pro-abstinence ties [28]. Further investigations have examined whether AA mobilizes salutary psychological mechanisms. These studies have included coping, abstinence motivation and self-efficacy in the ability to abstain in high-risk situations, such as when exposed to alcohol in social contexts or when experiencing negative affect [29–32]. Given AA's focus on working the 12 Steps to alleviate and/or better tolerate sources of tension and distress [33], another mechanism through which AA may work is by reducing negative affect and increasing psychological wellbeing. While this latter theory has received only limited attention, initial studies indicate that AA leads to improved alcohol outcomes through this path [34]. Finally, AA itself purports to help individuals recover primarily by enhancing spirituality. Specifically, AA states that it helps individuals recover through a broadly defined, 'spiritual awakening' or 'spiritual experience' ([33]; Appendix II). The few formal mediational studies conducted using this construct have shown that AA appears to work in part through this mechanism [35,36].

Many, but not all, of these studies used appropriate prospective statistically controlled designs to enhance causal inference and conducted state-of-the-art mediational analyses [37]. Their combined results suggest that

participation in AA provides a complex and multi-faceted experience that helps individuals to recover through several different mechanisms. While this research has been illuminating, the relative importance of these mechanisms has remained unclear, as the mediators have often been tested in isolation. The goal of this study, therefore, was to determine the most influential pathways by which AA attendance is likely to affect alcohol outcomes. Using a uniquely large, multi-site, clinical AUD sample [20], we fitted a multiple mediator model for two types of patients (i.e. a more severe 'aftercare' sample and a less severe 'out-patient' sample) and for two alcohol outcomes, which capture alcohol use frequency [i.e. percentage of days abstinent (PDA)] and alcohol use intensity [i.e. number of drinks per drinking day (DDD)].

METHODS

Participants

Participants ($n = 1726$) consisted of an 'aftercare' sample ($n = 774$), recruited directly from in-patient treatment, and a less severe 'out-patient' ($n = 952$) sample from Project MATCH [20]. Inclusion criteria were: current DSM-III-R AUD diagnosis; alcohol as primary drug; drinking 3 months prior to study; aged 18 years or older; and minimum sixth grade reading level. Exclusion criteria were: current DSM-III-R diagnosis of dependence on sedative-hypnotics, stimulants, cocaine or opiates; intravenous drug use in prior 6 months; danger to self/others; probation/parole requirements that might interfere with participation; risk of residential instability; inability to identify at least one 'locator' person to assist tracking; psychosis/organic impairment; and involvement in alternative treatment (i.e. >6 hours, except for self-help groups). Out-patients were significantly younger, more residentially stable and less alcohol-dependent than aftercare [38]. In addition, relative to aftercare patients, out-patients reported significantly fewer prior treatments, lower depression symptoms, and lower DDD and higher PDA at intake (see Table 1).

Procedure

Subjects were assigned randomly to one of three psychosocial interventions: cognitive-behavioral therapy (CBT; [39]), motivational enhancement therapy (MET; [15]), and 12-Step facilitation therapy (TSF; [40]) and were re-assessed at 3, 6, 9, 12 and 15 months following study intake, with follow-up rates over 90%. More details can be found elsewhere including psychometric properties of the measures [41]. This study focused on baseline, 3-, 9- and 15-month follow-ups because only these time-points contained the variables needed for our lagged model.

Table 1 Sample description at baseline.

	Aftercare		Out-patient		
	n = 764		n = 942		
	mean/%	SD	mean/%	SD	t/χ ²
Demographics					
Age	41.9	11.1	38.9	10.7	5.76**
Gender (% female)	20.0		27.7		13.79**
Race (%)					77.69**
White	81.5		82.3		
Hispanic	15.0		5.6		
Black	3.5		12.2		
Marital status (% married/cohabiting)	33.7		35.8		0.83
Employment status (% full-time)	47.8		51.0		1.69
Baseline clinical descriptors					
Beck Depression Inventory (BDI) ^a	10.6	8.6	9.8	8.0	1.96
Percentage of days abstinent (PDA)	26.8	29.6	34.3	29.8	−5.92**
Drinks per drinking day (DDD) ^a	20.5	12.1	13.5	8.0	14.38**
No. of prior alcohol treatments (max = 4) ^a	1.2	1.4	0.9	1.2	5.37**

***P* < 0.01. ^aSatterthwaite *t*-test for unequal variances was used. SD: standard deviation.

Measures

Alcohol use

Alcohol consumption was assessed using the Form 90 [42], which combines an interview procedure with calendar-based and drinking pattern estimation methods. Two drinking outcomes were based on past 90 days: PDA and number of DDD.

Alcoholics anonymous attendance

AA attendance was also assessed using the Form 90, which captured the number of AA meetings attended during the past 90 days at intake and 3, 9 and 15 months. The proportion of days attending AA was created by dividing the number of days attended by the total number of days in the period.

Self-efficacy

The Alcohol Abstinence Self-Efficacy Scale [43] is a 20-item scale that assesses self-efficacy using four subscales (negative affect, social/positive, physical and other concerns, withdrawal and urges). Each item is rated on a five-point Likert scale ('not at all confident' to 'extremely confident'). In this study, two subscales were included (negative affect: $\alpha = 0.88$; social/positive: $\alpha = 0.82$), shown to be mediators of the effect of AA attendance on alcohol outcomes [32].

Spiritual/religious practices

Spirituality/religiousness was assessed with the religious background and behavior instrument (RBB; [44]). Total

scores were based on religious status on a five-point scale ['I do not believe in God' (atheist) coded '0'; 'I believe we can't really know about God' (agnostic) coded '1' to 'unsure' coded '2'; 'I believe in God, but I'm not religious (spiritual) coded '3'; 'I believe in God and practice religion (religious), coded '4'], and past 90-day religious and spiritual practices (i.e. 'thought about God', 'prayed', 'meditated', 'attended worship services', 'read or studied scriptures/holy writings' and 'had direct experiences of God'), rated on an eight-point Likert-scale ('never' to 'more than once a day'). As in previous research [45], RBB questions pertaining to life-time religious practices were excluded from the total score, because we examined changes in spirituality/religiousness.

Depression

Depression symptoms were assessed using the Beck Depression Inventory (BDI; [46]). This 21-item measure assesses past-week depression symptom severity. The measure is well established psychometrically, with good internal consistency, test-retest stability and construct validity [47].

Social networks

The Important People and Activities Instrument (IPA; [48]) was used to assess social networks on two dimensions: 'pro-drinking' and 'pro-abstinence'. Patients are asked to name the four most important people of the past 6 months, and asked to rate how each reacted to their abstinence or drinking. A person was coded as 'pro-abstinence' if s/he either encouraged abstinence or

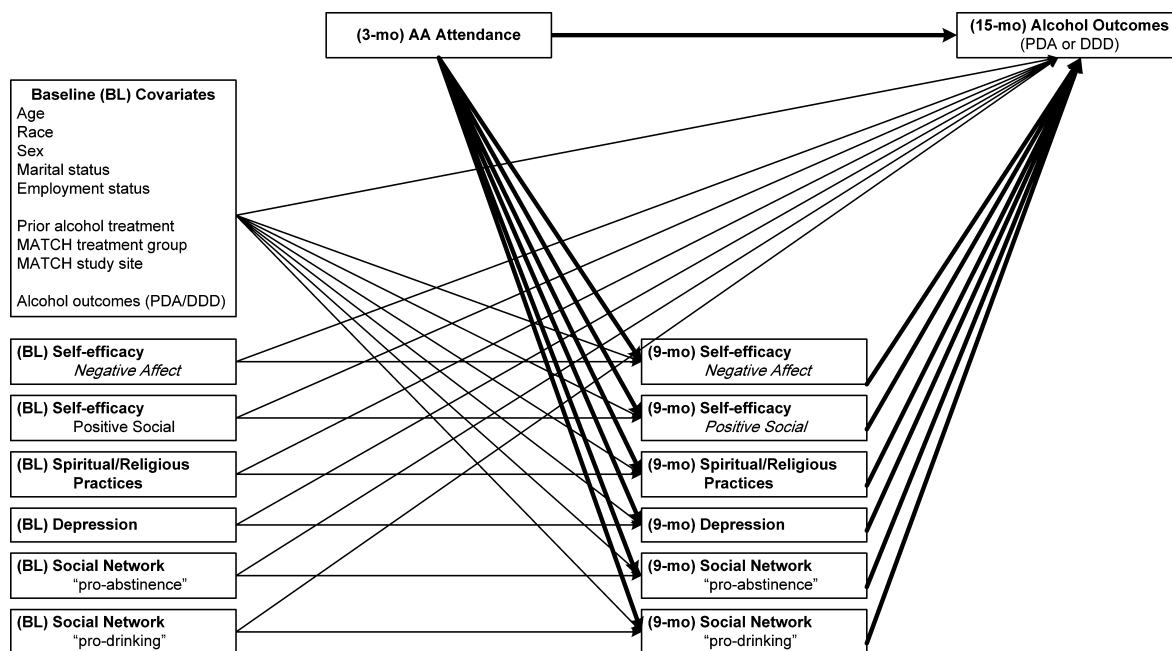


Figure 1 Tested multi-mediator model; PDA: percentage of days abstinent; DDD: drinks per drinking day; mo: months

discouraged drinking, or both. A person was coded as 'pro-drinking' if s/he either encouraged drinking or discouraged abstinence, or both. The number of each type of network members was summed to produce a scale range 0–4. Someone could list four people all neutral about drinking, in which case they would get a count of 0 for both measures. Based on previous research [28], these variables were chosen as the most salient social network descriptor, as they mediated the relationship between AA and alcohol outcomes.

Baseline characteristics

At intake, demographic information and number of prior alcohol treatments were recorded. Gender, marital status and employment status were coded as binary variables; race was coded as a three-level categorical variable, dummy-coded in the structural equation model (SEM) (see Table 1 for details). The number of prior alcohol treatments was capped at four (range 0–4).

Analytical strategy

Data preparation

The dependent variables (i.e. PDA and DDD) and the independent AA attendance variable were transformed (PDA/ arcsine-transformed; DDD/square root-transformed; and AA attendance/log-transformed).

Mediational analyses

To test whether the previously identified mediators of the effect of AA attendance on alcohol outcomes

[28,32,34,35] contributed uniquely to the mediation in combination with the other mediators, a multiple mediator model was fitted. In separate analyses, the same model (Fig. 1) was fitted for both samples (i.e. aftercare and outpatient) and both alcohol outcomes (i.e. PDA and DDD). Baseline values of alcohol outcomes and the mediating variables were included as covariates, as were demographic variables, prior alcohol treatment, treatment assignment and study site. To test mediation, we used the product-of-coefficients approach [49,50]. This approach extends directly to multiple mediator models, where the total indirect effect is simply the sum of mediator-specific indirect effects [51,52]. Instead of fitting four linear regression models per mediator, we used SEM implemented by SAS version 9.2 TCALIS to fit all paths simultaneously (Fig. 1). Then, using equations provided by MacKinnon [51], we calculated the indirect effects, where we constructed 95% confidence intervals using the Monte Carlo method for assessing mediation (MCMAM), as first evaluated by MacKinnon, Lockwood & Williams [53], and implemented using the interactive tool by Selig & Preacher [54].

Missing data

Missing data were 3.6% at 3 months, 9.5% (for social networks) to 13.6% (for self-efficacy) at 9 months and 9.1% at 15 months. To address missing data, we used the maximum likelihood estimation approach [55], where we first estimated the variance–covariance matrix using all available data points [using the iterative expectation–maximization (EM) algorithm (SAS 9.2 Proc MI)], and

Table 2 Partitioning of the standardized effect of Alcoholics Anonymous on drinking outcome: total, direct and indirect effects.

<i>Drinking outcome</i>				
<i>Sample</i>	<i>Total</i>	<i>Direct</i>	<i>Indirect</i>	<i>% Mediated</i>
Percentage of days abstinent				
Aftercare	0.22**	0.11**	0.11**	50.8%
Out-patient	0.25**	0.14**	0.11**	42.9%
Drinks per drinking day				
Aftercare	-0.18**	-0.08*	-0.10**	55.0%
Out-patient	-0.12**	-0.04	-0.08**	66.6%

* $P < 0.05$; ** $P < 0.01$.

then used this matrix as the input data for fitting the SEM (Fig. 1).

RESULTS

SEM: total, direct and indirect effects on alcohol outcomes

Taken together, mediation through the six variables was statistically significant (Z range = -4.24 to 5.77, $P < 0.001$) and explained a substantial proportion of the relationship between AA and outcomes (i.e. the ratio of the indirect/total effect). This ranged from 43% for PDA in the out-patient sample to 67% for DDD in the out-patient sample (Table 2). The standardized parameters in Table 2 also indicate that AA attendance had a larger influence on PDA (0.22 and 0.25 for aftercare and out-patient, respectively) than on DDD (-0.18 and -0.12 for aftercare and out-patient, respectively), but that a greater proportion of this smaller effect on DDD was explained by the mediators, especially among the out-patients (e.g. 42.91% for PDA versus 66.58% for DDD).

Individual paths of the multi-mediator models

AA attendance predicting mediators

AA attendance predicted changes (i.e. statistically significant above and beyond variance accounted for by baseline values, MATCH treatment and other control variables) in all the mediating variables, although not consistently so across samples (Table 3). In the aftercare sample, standardized parameter estimates were largest for increases in spirituality/religiousness followed by increases in the number of pro-abstinence network members. In the out-patient sample, standardized estimates were largest for increases in number of pro-abstinence network members, followed by decreases in number of pro-drinking network members, followed by increases in spirituality/religiousness.

Mediators predicting alcohol outcomes

Not all mediating variables predicted alcohol outcomes, given the simultaneous presence of the other mediators in the model. Furthermore, significant predictors varied by sample. Consistently across both samples and both alcohol outcomes, however, higher self-efficacy in social situations and a lower number of pro-drinking social network members, at 9 months, predicted better outcomes, measured at 15 months. In general, the standardized parameter estimates for both these mediating variables were of comparable magnitude across samples and outcomes, suggesting that both variables are related strongly and uniquely to subsequent alcohol use. Of note, the number of pro-abstinent network members predicted alcohol outcomes in the aftercare sample for PDA only, but in the out-patient sample for both PDA and DDD, above and beyond the effect of the number of pro-drinking network members.

More sample-specific were the results for spirituality/religiousness, self-efficacy in negative affect situations and depression. Spirituality/religiousness, which was predicted strongly by AA attendance in both samples, was related significantly only to alcohol outcomes in the aftercare sample. Similarly, self-efficacy for negative affect situations was significantly predicted by AA attendance in the aftercare sample only, and was the best predictor of DDD in the aftercare sample. In the out-patient sample, greater depression was significantly associated with lower PDA and higher DDD, but was itself not predicted by AA.

Mediation tests and the relative proportion of the mediated (indirect) effect attributable to each mediator

The relative contribution of each of the six mediating variables to the overall mediated effect along with their significance tests is shown in Table 4; Fig. 2 illustrates these relative proportions. Among aftercare patients there were significant effects for all mediators except negative affect-related self-efficacy and depression for

Table 3 Standardized path parameter estimates of the multiple mediator model.

Type of path	Percentage of days abstinent (PDA)						Drinks per drinking day (DDA)					
	Aftercare			Out-patient			Aftercare			Out-patient		
	EST	SE	t	EST	SE	t	EST	SE	t	EST	SE	t
Direct effect: AA attendance predicting alcohol outcomes												
AA attendance → PDA/DDD	0.11	0.04	2.92*	0.14	0.04	3.77*	-0.08	0.04	-2.07*	-0.04	0.04	-0.93
Mediational path: AA attendance predicting mediators												
AA attendance → Self-efficacy (NA)	0.10	0.04	2.75*	0.01	0.04	0.38	0.11	0.04	2.86*	0.02	0.04	0.56
AA attendance → Self-efficacy (Soc)	0.16	0.04	4.30*	0.12	0.04	2.94*	0.16	0.04	4.43*	0.12	0.04	2.86*
AA attendance → Spirituality/relig	0.19	0.03	6.72*	0.14	0.03	5.55*	0.18	0.03	6.69*	0.14	0.03	5.34*
AA attendance → Depression	-0.10	0.04	-2.73*	-0.02	0.04	-0.51	-0.10	0.04	-2.87*	-0.02	0.04	-0.64
AA attendance → SocNet: pro-abst.	0.16	0.04	4.37*	0.20	0.04	5.14*	0.17	0.04	4.51*	0.20	0.04	5.10*
AA attendance → SocNet: pro-drk.	-0.12	0.04	-3.12*	-0.15	0.04	-3.82*	-0.13	0.04	-3.32*	-0.14	0.04	-3.57*
Mediational path: mediators predicting alcohol outcomes												
Self-efficacy (NA) → PDA/DDD	0.06	0.04	1.67	0.07	0.03	2.43*	-0.18	0.04	-5.13*	-0.05	0.03	-1.48
Self-efficacy (Soc) → PDA/DDD	0.24	0.03	6.92*	0.24	0.03	8.28*	-0.13	0.04	-3.45*	-0.26	0.03	-8.04*
Spirituality/relig → PDA/DDD	0.14	0.05	2.95*	0.04	0.05	0.86	-0.11	0.05	-2.20*	-0.05	0.05	-0.99
Depression → PDA/DDD	0.03	0.04	0.85	-0.12	0.03	-3.71*	0.11	0.04	2.84*	0.16	0.04	4.37*
SocNet: pro-abst. → PDA/DDD	0.11	0.04	3.24*	0.17	0.03	5.40*	-0.07	0.04	-1.83	-0.07	0.03	-1.98*
SocNet: pro-drk. → PDA/DDD	-0.23	0.03	-6.76*	-0.23	0.03	-7.85*	0.12	0.03	3.49*	0.15	0.03	4.72*

'Adj. n' refers to the average number of participants who had data for the eight structural variables; not shown but included in model are baseline covariates (see Fig. 1). * $P < 0.05$. Self-efficacy (NA): abstinence self-efficacy in situations involving experiencing negative affect; self-efficacy (Soc): abstinence self-efficacy in situations involving coping with high risk social situations. SocNet: pro-abst: number of pro-abstainers in the social network; SocNet: pro-drk: number of pro-drinkers in the social network. AA: Alcoholics Anonymous; EST: estimated; SE: standard error.

Table 4 Test of mediation for specific indirect (i.e. mediated) effects using the product of coefficients approach.

<i>Drinking outcome</i>	<i>Aftercare</i>				<i>Out-patient</i>			
	<i>(adj. n = 688)</i>				<i>(adj. n = 856)</i>			
<i>Mediator</i>	<i>EST</i>	<i>SE</i>	<i>95% CI†</i>	<i>%‡</i>	<i>EST</i>	<i>SE</i>	<i>95% CI†</i>	<i>%‡</i>
Percentage of days abstinent (PDA)								
Self-efficacy (NA)	0.001	0.00	−0.0001–0.0024	5.3%	0.000	0.00	−0.0006–0.0010	1.0%
Self-efficacy (Soc)	0.006	0.00	0.0028–0.0091*	33.7%	0.004	0.00	0.0011–0.0062*	27.0%
Spirituality/relig	0.004	0.05	0.0013–0.0070*	23.3%	0.001	0.03	−0.0009–0.0025	5.5%
Depression	0.000	0.03	−0.0018–0.0006	2.7%	0.000	0.00	−0.0008–0.0015	2.1%
SocNet: pro-abst.	0.003	0.00	0.0009–0.0051*	16.3%	0.004	0.00	0.0021–0.0064*	30.9%
SocNet: pro-drk.	0.004	0.00	0.0014–0.0071*	24.0%	0.004	0.00	0.0020–0.0070*	33.1%
Drinks per drinking day (DDD)								
Self-efficacy (NA)	−0.012	0.01	−0.0216–0.0032*	20.1%	0.000	0.00	−0.0027–0.0013	1.4%
Self-efficacy (Soc)	−0.012	0.01	−0.0222–0.0042*	20.9%	−0.012	0.01	−0.0208–0.0035*	38.6%
Spirituality/relig	−0.012	0.05	−0.0239–0.0012*	20.6%	−0.003	0.03	−0.0089–0.0029	9.2%
Depression	−0.006	0.03	−0.0139–0.0012*	11.2%	−0.001	0.00	−0.0064–0.0031	4.8%
SocNet: pro-abst.	−0.007	0.01	−0.0151–0.0004	11.3%	−0.005	0.00	−0.0114–0.0000*	17.3%
SocNet: pro-drk.	−0.009	0.01	−0.0177–0.0027*	15.9%	−0.009	0.01	−0.0155–0.0032*	28.6%

Adj. *n* refers to the average number of participants who had data for the eight structural variables; †MCMAM estimates; ‡percentage of total indirect effects attributable to specific mediators, which add to more than 100%, if specific indirect effects were in opposite directions. **P* < 0.05. Self-efficacy (NA): abstinence self-efficacy in situations involving experiencing negative affect; self-efficacy (Soc): abstinence self-efficacy in situations involving coping with high-risk social situations. SocNet: Pro-abst: number of Pro-abstainers in the network; SocNet: pro-drk: number of pro-drinkers in the network. EST: estimated; SE: standard error; CI: confidence interval.

PDA and pro-abstinence social network for DDD. Of the significant mediators of AA on PDA, the social constructs explained 70% of the mediational effect (pro-drinking network = 23%, pro-abstinent network = 15% and social self-efficacy = 32%); and spirituality/religiosity explained a further 22%. As shown in Fig. 2, for DDD among aftercare patients, the significant mediational effects were distributed more evenly among the variables with a more prominent mediational effect for the negative affect constructs (negative affect self-efficacy = 20%; depression = 11%). In contrast, in the out-patient sample the only significant mediators between AA and outcomes were those related to the social domains, which in combination explained 91% of the total mediated effect of AA on PDA (pro-drinking network = 33%; pro-abstinent network = 31%; and social self-efficacy = 27%); and 85% of total mediated effect of AA on DDD (pro-drinking network 29%; pro-abstinent network = 17%; and social self-efficacy = 39%). Unlike the aftercare sample, neither the spiritual/religious nor the negative affect-related variables were significant mediators between AA and outcomes.

DISCUSSION

Using a uniquely large clinical multi-site sample of alcohol dependent adults, this investigation found that AA attendance during the first 3 months was associated

with recovery-related benefits 1 year later over and above the effects attributable to the study's professionally delivered out-patient treatments and a variety of other predictor confounds. Furthermore, 43–67% of these AA-related benefits were found to be explained by the six mediating variables examined.

The strongest mediational pathways through which AA was related to outcomes across both samples were observed for social variables; namely, through reductions in pro-drinking network members and enhancements in self-efficacy in high risk social situations. Notably, positive changes in pro-abstinent network members was an additional, non-redundant pathway through which AA attendance was related to outcomes, with the exception of DDD among aftercare patients. Thus, the most consistent pathway overall through which AA confers its recovery benefits is by facilitating changes in the social networks of its members and by simultaneously enhancing abstinence self-efficacy in high-risk social contexts. These findings are consistent with recent research that has highlighted the importance of social networks on health (e.g. obesity, [56]) and substance use (e.g. smoking, [57]). Notably, these effects can be both positive (e.g. decreasing smoking/drinking) and negative (e.g. increasing obesity/drinking). Consistent with such findings, we observed an independent and additive effect of social networks, where both decreasing the number of pro-drinking social network members and increasing the

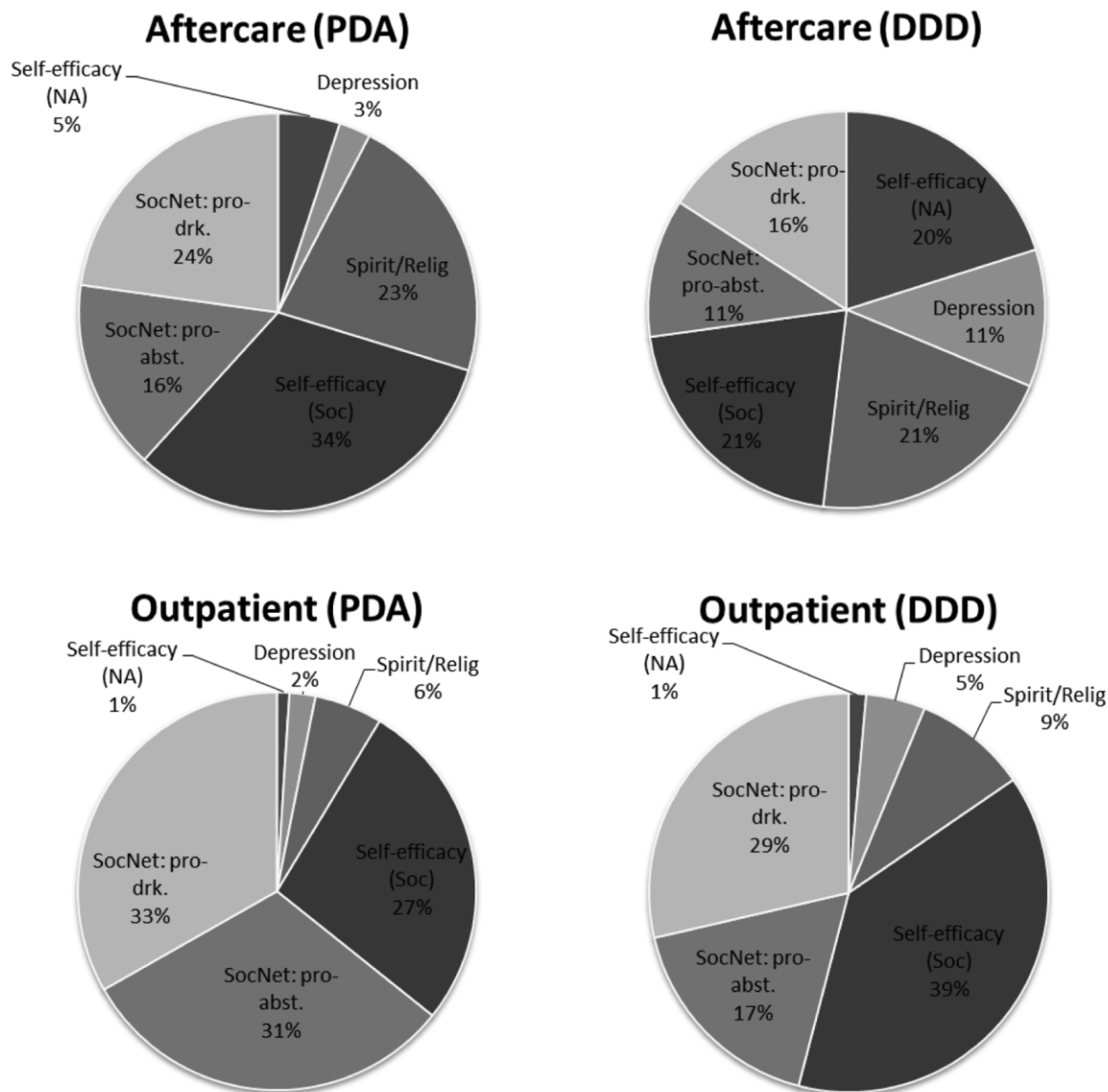


Figure 2 The specific contribution of each mediator in explaining the overall mediated effect between Alcoholics Anonymous attendance and alcohol outcomes; PDA: percentage of days abstinent; DDD: drinks per drinking day; NA: negative affect

number of pro-abstinence social network members positively impacted outcomes. When one considers the common precursors to relapse (i.e. cue-induced; stress-induced; and drug-induced—through a priming dose of the substance), it may be that the downstream mechanisms by which these adaptive social network changes attenuate relapse risk is by helping AA attendees to avoid alcohol-related environmental cues, gain social support to cope with stress and maintain greater abstinence, further reducing the potential for priming doses to kindle craving and lead to more intensive use and relapse/reinstatement. Alterations in individuals' social environments also may produce influential changes at the biological level. Extrapolating from addiction-focused social neuroscience research with primates, for example,

it is plausible that the rich social integration that occurs in AA may accelerate up-regulation of dopamine D2 receptors, a higher density of which has been shown to protect against relapse [58]. The dominance of these social pathways highlights the importance of the group and fellowship dimensions of AA in facilitating recovery from AUD.

As noted previously, spirituality/religiosity is AA's own stated chief mechanism by which recovery is purported to occur. In line with this notion, we found that the beneficial effect of AA attendance on alcohol outcomes was indeed mediated by spiritual/religious practices, while controlling for the other mediational paths. Unlike the mediation through social variables, however, this was only evident in the aftercare sample, which consisted of more severely

alcohol-impaired patients. Changing spiritual beliefs and shifting one's world-view are not trivial matters. The motivation to embrace such a change would have to be compelling, and we speculate that the toll that AUD may have had on the lives of more severe patients may be so much graver as to stimulate a new openness and motivation to embrace a new outlook. Furthermore, the disinhibiting effects of alcohol on behavior can lead many individuals to behave in ways inconsistent with their own values or moral code. Frequent deviations of this sort, along with functional decline over years, can lead to self-criticism and suicidal tendencies. The spiritual framework of AA may provide a compassionate structure that facilitates self-forgiveness [35].

In the context of the other mediators in the model, while greater AA attendance was shown to attenuate depression, a complete mediational pathway was observed only among aftercare patients and only in reducing intensity of alcohol use. Thus, among more severe alcohol-impaired individuals, an additional way in which AA appeared to help was by decreasing depression symptoms which, in turn, decreased DDD. Assuming that at least some of the alcohol consumption may have been an attempt by patients to mitigate negative affect through self-medication, the AA-associated decrease in depression may have thus required less intense 'medication'. It is possible that this effect as well was caused by changes in social networks, which can influence depression [59] and happiness [60]. Similar to reductions in depression, a complete independent pathway was observed for negative affect self-efficacy only among the aftercare patients and only on reducing DDD. This finding suggests that, for the more severe patients, attending AA reduces DDD by simultaneously reducing depression symptoms and increasing confidence in individuals' ability to resist alcohol when experiencing negative affect.

In summary, AA appears to lead to greater rates of abstinence and less intensive alcohol consumption through multiple mechanisms simultaneously. Most consistently and strongly, this beneficial effect occurs through mobilizing adaptive changes in the social networks of attendees and enhancing socially relevant abstinence self-efficacy. Among the more severely alcohol-impaired patients, AA additionally increases alcohol abstinence by enhancing individuals' spiritual/religious practices and decreases alcohol use intensity by reducing depression and increasing negative affect-relevant abstinence self-efficacy. The clinical implications of these mediational findings are that providers wishing to facilitate patients' involvement in AA could emphasize the multiple recovery-related benefits that might be obtained from attending, including finding supportive friends, increasing a sense of mastery and competence in coping with sobriety, increasing meaning and purpose in life and

enhancing psychological wellbeing and the ability to cope with negative affect.

Limitations

While there are several strengths of the current study, some limitations should be noted. First, patients self-select into AA and we cannot rule out 'third' variables that may be responsible for at least some of the observed effects. There were also limitations in the availability of certain measures at certain time-points limiting control of constructs that might have strengthened conclusions, and there were long time lags between measures. Future research should examine relationships using finer temporal resolutions. Also, mechanisms were examined concurrently and it is likely that some mechanisms may act as precursors to changes in others. Additionally, the measure of spirituality/religiosity used may not be consistent with AA's own idea of 'spirituality', which may be a more subtle phenomenon captured in its later publications (e.g. [61]). Finally, only a handful of simply measured constructs were examined here as mediators and it is likely that, even among examined constructs, influential nuances across areas of the construct domain may further relate to AA and outcome.

CONCLUSIONS

In a 1961 letter to AA's co-founder, Bill W., the renowned psychoanalyst, Carl Jung, described two main ways in which individuals with severe alcohol addiction might recover. One was through 'real religious insight'; the other was through 'the protective wall of human community' characterized by a 'personal and honest contact with friends' (AA, 1963) [62]. Although AA has more earnestly expressed the former as being the principal pathway to recovery in its main texts [33,63] perhaps inadvertently, stemming from its social orientation and structure, it has also tapped into the curative facets of the latter—protective and positive social influence. While other factors are certainly involved to varying degrees, this AA-facilitated combination, in particular, appears to help individuals suffering from alcohol addiction to find and sustain recovery.

Declarations of interest

None.

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