



One-year sobriety improves satisfaction with life, executive functions and psychological distress among patients with polysubstance use disorder



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ABSTRACT

Introduction: Polysubstance use disorder is prevalent in treatment-seeking patients with substance use disorder (SUD), with a higher risk of developing comorbid psychiatric symptoms, more pervasive deficits in cognitive functions, and inferior treatment results. The present study investigates if individuals with polysubstance use disorder who achieve at least one year of abstinence show greater improvements in satisfaction with life, executive functions, and psychological distress, compared to relapsers and controls. The prospective recovery from polysubstance use disorder assessed with broad output indicators remains understudied. A better understanding of the pattern of recovery of the chosen output indicators could shed light on the recovery process for this group of patients.

Material and methods: We investigated changes in satisfaction with life, executive functions and psychological distress over a period of 12 months in patients who remained abstinent and in those who relapsed. Subjects with polysubstance use disorder (N = 115) were recruited from outpatient and residential treatment facilities; healthy controls (N = 34) were recruited by posters exhibited at social welfare and GP offices. Executive functions were assessed by the Behaviour Rating Inventory of Executive Function-Adult self-report version (BRIEF-A), psychological distress by the Symptom Checklist-90-R (SCL-90-R), and satisfaction with life by the Satisfaction With Life Scale (SWLS). Substance use was assessed by self-reports on the Alcohol Use Disorders Identification Test (AUDIT) and the Drug Use Disorders Identification Test (DUDIT). Participants were categorized as “relapsers” if they had AUDIT score ≥ 8 , or DUDIT score ≥ 2 for women and ≥ 6 for men.

Results: Results indicated that the abstinent group had the greatest improvement on all the indicators compared with relapsers and controls. Participants who successfully quit substance use for one year showed improved satisfaction with life, executive functions, and psychological distress compared to participants who relapsed and controls.

Conclusions: Our study provides support for the view that there is a clinically and statistically significant recovery of satisfaction with life, executive functions, and psychological distress for SUD patients following one-year of abstinence. This knowledge highlights the importance of time and continued abstinence.

Our findings suggest that a gradual and careful step-up of learning requirement should be adopted, and SUD treatment should initially focus on stabilizing the patient and achieving abstinence, while interventions for comorbid problems and more cognitively demanding treatment components are more likely to succeed later in the treatment sequence.

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Abbreviations: SUD, substance use disorder; EF, executive function; BRIEF-A, Behaviour Rating Inventory of Executive Function-Adult version; SWLS, Satisfaction With Life Scale; SCL-90-R, Symptom Checklist-90-R; AUDIT, Alcohol Use Disorders Identification Test; DUDIT, Drug Use Disorders Identification Test; WASI, Wechsler Abbreviated Scale of Intelligence; MI, Metacognition Index; BRI, Behavioral Regulation Index; GEC, Global Executive Composite.

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1. Introduction

Polysubstance use disorder is the most common diagnosis among patients seeking treatment for substance use, and polysubstance use is also associated with several challenges (Andrade, Carroll, & Petry, 2013). Compared with single-drug users, polydrug users have an earlier onset of drug use and a higher rate of dropout (King & Canada, 2004; Preti, Prunas, Ravera, & Madeddu, 2011), and they report higher levels of general psychological distress (Andreas, Lauritzen, & Nordfjærn, 2015; Quek et al., 2013; White et al., 2013). This group reports more symptoms of anxiety and depression (Booth et al., 2010; G. W. Smith, Farrell, Bunting, Houston, & Shevlin, 2011), which is clinically relevant because psychiatric comorbidity increases risk of relapse (Flynn & Brown, 2008). Furthermore, polysubstance use disorder is associated with pervasive deficits in cognitive functions, and significant impairments have been reported on neuropsychological tests of working memory, inhibition, cognitive flexibility, self-regulation, and decision-making (Moreno-López et al., 2012). Cognitive impairments and psychological distress thus place users with polysubstance use disorder at preeminent risk of impaired recovery and more treatment dropout (Preti et al., 2011). Consequently, treatment approaches for polysubstance use disorder are less effective compared with treatments for use of single substances (Connor, Gullo, White, & Kelly, 2014; Williamson, Darke, Ross, & Teesson, 2006).

A number of studies have found a co-occurrence between mental distress and dose-related polydrug use, and also a reduction of mental distress among abstinent patients (Andreas et al., 2015). However, efforts that focus on a broad spectrum of output indicators are needed to shed light on the recovery process for this important and highly vulnerable subgroup of SUD patients. Polydrug users constitute a high risk group compared with other SUD patients, with more distinct depressive and suicidal symptomatology at treatment admission (Riehm, Iguchi, & Anglin, 2002), and also more social anxiety (Bakken, Landheim, & Vaglum, 2005). Studies have shown that impaired psychiatric and cognitive functions greatly diminish satisfaction with life (Burgess et al., 2000). Satisfaction with life is also reduced among SUD patients, although it has not been thoroughly investigated in patients with polysubstance use disorder. (Donovan, Mattson, Cisler, Longabaugh, & Zweben, 2005; K. Smith & Larson, 2003). As satisfaction with life is described as a core motivator for and predictor of successful treatment, it should be included as a key outcome indicator when evaluating the success of SUD treatment (De Maeyer, Vanderplasschen, & Broekaert, 2010).

Previous treatment studies of impaired executive functions in SUD patients have several limitations. They have primarily dealt with the acute and subacute effects of chronic alcohol and drug use (Fernandez-Serrano, Perez-Garcia, & Verdejo-Garcia, 2011; Vik, Cellucci, Jarchow, & Hedt, 2004; Yucel, Lubman, Solowij, & Brewer, 2007), and studies of long-term recovery do not always require a 14-day drug-free period prior to baseline testing (Fernandez-Serrano et al., 2011). Other studies have small sample sizes, often with a focus on patients with one primary addiction (Badiani, Belin, Epstein, Calu, & Shaham, 2011; Buelow & Suhr, 2009; Stavro, Pelletier, & Potvin, 2013). In addition, many studies have used cross-sectional designs and are therefore unable to track changes in individual patients over time (van Holst & Schilt, 2011). There is also considerable variability in the follow-up rates, ranging from 40% to 98% (Cottler, Compton, Ben-Abdallah, Horne, & Claverie, 1996; Desmond, Maddux, Johnson, & Confer, 1995; Stinchfield, Niforopulos, & Feder, 1994), and some studies have not included a follow-up procedure for a control group (Schulte et al., 2014).

We have not been able to find other studies that have focused on satisfaction with life, executive functions, and psychological distress during the course of recovery for people with polysubstance use disorder, even though a consideration of all these variables could prove important to understand the course of recovery for these patients. The present study features a prospective design and a control group, and was used

to address the following question: Will individuals with polysubstance use disorder who achieve at least one year of abstinence show greater improvements in satisfaction with life, executive functions, and psychological distress, compared to relapsers and controls?

2. Material and methods

2.1. Participants

One hundred fifty SUD patients were recruited from 10 outpatient and residential treatment facilities within the Stavanger University Hospital catchment area (Norway) between March 2012 and May 2013. We employed broad inclusion criteria focusing on polysubstance use disorder because polysubstance use disorder is common in a clinical setting (Badiani et al., 2011; Stavro et al., 2013). The main inclusion criteria at baseline were: (a) evidence of SUD polysubstance use, operationalized as the use of more than one drug on a single occasion, or a history of abusing multiple drugs; (b) enrolled in a new treatment sequence by the substance use treatment service; and (c) at least 16 years of age.

The control group (N = 38) was a convenience sample recruited by posters exhibited at social welfare and GP offices. Controls and SUD patients were compensated with NOK 400 (~\$US 50) for the baseline testing. During the one-year follow-up period, 13 SUD patients and four in the control group withdrew or dropped out of the study. The final group included 115 SUD patients and 34 controls. This study was reviewed and approved by the Regional Ethical Committee (REK 2011/1877) and conducted according to its guidelines and those of the Helsinki Declaration (1975). Signed informed consent was obtained from all the participants.

2.2. Procedures

The study is part of a prospective cohort study of a sample of SUD patients in the Stavanger University Hospital catchment area. To minimize contamination from drug withdrawal and acute neurotoxic effects from psychoactive substances, baseline assessment was performed after two weeks of abstinence (Miller, 1985) by experienced and trained staff. Information on substance use was assessed using the Alcohol Use Disorders Identification Test (AUDIT) (Bohn, Babor, & Kranzler, 1995) and the Drug Use Disorders Identification Test (DUDIT) (Voluse et al., 2012). At the one-year follow up, patients were defined as relapsing to a significant level of use if they had an AUDIT score ≥ 8 or DUDIT score ≥ 2 for women and ≥ 6 for men (Bohn et al., 1995; Voluse et al., 2012).

2.3. Satisfaction with life

Satisfaction with life was assessed baseline and one year later with the Satisfaction With Life Scale (SWLS) (Diener, Emmons, Larsen, & Griffin, 1985). This is a self-report questionnaire including five items measuring the global life satisfaction experienced by the respondent. The SWLS has demonstrated good psychometric characteristics (Pavot & Diener, 2008). The five items are all set in a positive direction, and the total SWLS score (range = 5–35) was included in the present study. A score of 20 represents a neutral point on the scale; scores between 5 and 9 indicate that the respondent is very dissatisfied with life, while scores ranging between 31 and 35 indicate that the respondent is very satisfied with life (Pavot & Diener, 2008). In this study two patients did not complete the SWLS at the 1-year follow up, yielding a response rate was 98.2% for patients and 100% for controls.

2.4. Executive functions

This study assessed executive functions by asking the participants to complete the Behaviour Rating Inventory of Executive Function- Adult version (BRIEF-A) (Gioia, Isquith, Guy, Kenworthy, & Baron, 2000; Roth, Isquith, & Gioia, 2005) at baseline and one year later. The BRIEF-

A has been shown to have high ecological validity (Gioia et al., 2000; Roth et al., 2005), and to be associated with substance use status as well as several social adjustment indicators in patients with a history of polysubstance use disorder (Hagen et al., 2016). The BRIEF-A includes three composite scores including sets of subscales. A Behavioural Regulation Index (BRI-index) is calculated from the Inhibit, Shift, Self-Monitor and Emotional Control subscales. The BRIEF-A Metacognition Index (MI) is calculated from the Initiate, Plan/Organize, Working Memory, Organization of Materials, and Task Monitor subscales. In this study one patient and one control did not complete the BRIEF-A at the 1-year follow up, yielding a response rate was 99.1% for patients and 97.1% for controls. Validity scales of the BRIEF-A were examined, using the cut-off scores proposed by the original authors (Gioia et al., 2000). Invalid response style led to exclusion of one control and nine SUD participants at baseline, and three controls and five SUD participants at the one-year follow up. The final sample included the 30 controls and 101 SUD patients with valid BRIEF-A protocols.

The Wechsler Abbreviated Scale of Intelligence (WASI) (Wechsler, 1999) was used to estimate intellectual function (IQ) by including two tests of verbal crystallized abilities (Vocabulary and Similarities) and two tests of nonverbal fluid-visual abilities (Block Design and Matrices) (Canivez, Konold, Collins, & Wilson, 2009).

2.5. Psychological distress

Psychological distress was measured at baseline and one year later using the Symptom Checklist-90-R (SCL-90-R) (Derogatis, 1994). This is a 90-item self-report symptom inventory that yields measures of nine symptom domains of psychological distress: (1) Somatization; (2) Obsessive compulsion; (3) Interpersonal sensitivity; (4) Depression; (5) Anxiety; (6) Hostility; (7) Phobic anxiety; (8) Paranoid ideation, and (9) Psychoticism. This study includes the nine subscales and the summary score; Global Severity Index (GSI) (Derogatis, 1994). In this study three patients did not complete the SCL-90-R at the 1-year follow-up, yielding a response rate was 97.4% for patients and 100% for controls.

2.6. Statistical analyses

Data were analyzed using IBM SPSS v22 for Mac. Statistical significance was interpreted at $p < 0.05$ (two-tailed). Group differences were analyzed using t -tests, Mann–Whitney U tests, and Pearson's chi square-tests when appropriate. Levene's test was used to select the appropriate p -values based on whether the assumption of equal variances within groups was met. Histograms, Q–Q plots, Kolmogorov–Smirnov tests, and Shapiro–Wilk tests were used to investigate normality.

The research question was analyzed using mixed between–within subjects' ANOVA to compare changes in abstainers, relapsers and controls from the baseline to the one-year follow-up. Variables where the three groups have similar patterns of change from baseline to one year will not have a statistically significant interaction effect (the null hypothesis). Variables where one group has a different pattern of change from the other two groups are expected to show an interaction. To determine the cause of interaction effects, Wilcoxon signed rank tests were used to evaluate median change from baseline to one year within each group. Effect sizes were calculated as Cohen's r for nonparametric data, where 0.3 is considered a medium and 0.5 is considered a large effect (Cohen, 1988). Main effects were not interpreted in the presence of a statistically significant interaction (Bordens & Abbott, 2002).

3. Results

3.1. Group characteristics

At baseline, patients and controls were similar according to age, but controls were more often female (chi square = 5.8, $p = 0.016$), had higher level of education ($Z = 4.1$, $p < 0.001$), and higher IQ score at

Table 1

Baseline demographic and clinical variables for participants, grouped according to drug use status after one year.

	Abstinent (N = 51)	Relapsers (N = 64)	Controls (N = 34)
Age	28.7 (7.5)	27.1 (8.1)	30.9 (12.9)
Male gender, n (%)	35 (68.6%)	42 (65.6%)	15 (55.9%)
Years of education	11.9 (1.8)	11.6 (1.7)	14.2 (3.1)
AUDIT score at baseline	12.3 (9.8)	15.2 (10.5)	5.4 (3.8)
DUDIT score at baseline	36.6 (9.6)	35.3 (8.7)	0.3 (1.2)
WASI IQ	100.7 (11.5)	95.8 (12.1)	105.5 (13.6)

AUDIT = Alcohol Use Disorder Identification Test; DUDIT = Drug Use Disorder Identification Test; WASI = Wechsler Abbreviated Scale of Intelligence. All data are means (SD), unless otherwise indicated.

baseline ($t = 3.2$, $p < 0.001$). Clinical and demographic variables after one year for patients who remained abstinent (N = 51), relapsers (N = 64), and controls (N = 34) are summarized in Table 1. Although there were no differences in baseline demographic variables between the two SUD groups, the abstinent group obtained a higher score on WASI IQ ($t = 2.2$, $p = 0.030$). Baseline levels of substance abuse, as measured by mean AUDIT/DUDIT score, did not differ between the two SUD groups.

3.2. Satisfaction with Life Scale (SWLS)

Analysis of SWLS showed a significant main effect of group [$F(2,144) = 59.8$, $p < 0.001$] and time [$F(1,144) = 16.9$, $p < 0.001$], and a significant group \times time interaction [$F(2,144) = 9.84$, $p < 0.001$]. Follow-up analyses showed that the interaction could be attributed to the significant improvement in the abstinent group ($Z = -4.86$, $P < 0.001$), with a medium to large effect size ($r = 0.49$). The relapse and control group did not have statistically significant improvement. See Fig. 1 and Table 2.

3.3. Executive functions in everyday life (BRIEF-A)

Analysis of the BRIEF-A Global Executive Composite (GEC) showed a significant main effect of group [$F(2,125) = 20.4$, $p < 0.001$] and time

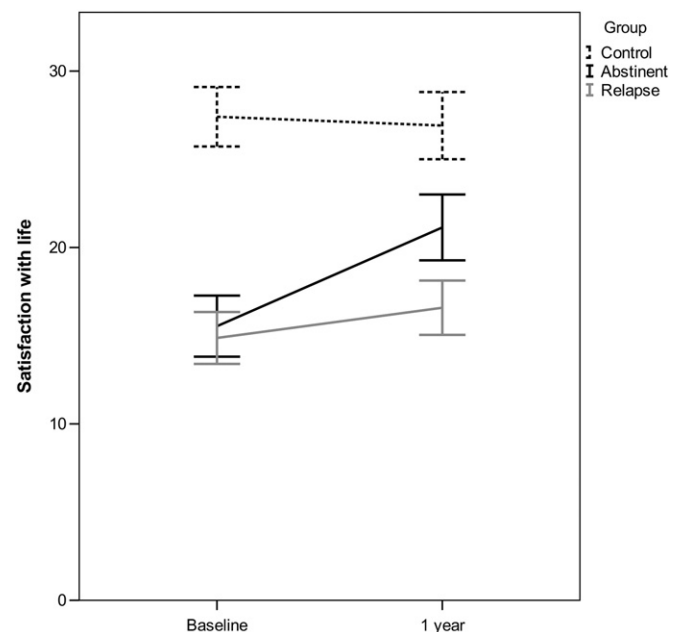


Fig. 1. Satisfaction with life “Satisfaction with life baseline and one year later measured with the Satisfaction With Life Scale (SWLS). Mean value for the control group, the participants that remained abstinent and the participants that relapsed to drug use. Error bars: 95% Confidence interval.”

Table 2
Self-reported executive functioning, psychological distress and life quality during the 1 year follow up period.

	Abstinent group (N = 51)			Relapse group (N = 64)			Control group (N = 32)		
	Baseline	1 year	Z value ^a	Baseline	1 year	Z value ^a	Baseline	1 year	Z value ^a
SWLS sum	15.7 (6.1)	21.1 (6.6)	-4.9**	14.9 (5.8)	16.6 (6.1)	-1.9	27.4 (4.8)	26.9 (5.5)	-0.4
BRIEF-A GEC	64.8 (11.8)	55.0 (12.3)	-4.5**	66.4 (9.4)	64.7 (10.2)	-1.5	52.3 (10.4)	48.7 (12.7)	-2.0*
BRIEF-A BRI	63.3 (11.2)	53.5 (11.5)	-4.4**	64.0 (12.5)	63.3 (10.2)	-0.2	51.0 (9.3)	49.3 (11.0)	-1.9
BRIEF-A MI	64.0 (11.6)	55.3 (11.9)	-4.5**	63.7 (13.1)	63.9 (11.0)	-1.5	53.1 (10.7)	50.1 (10.3)	-1.1
SCL-90-R GSI	1.0 (0.7)	0.5 (0.6)	-4.5**	1.3 (0.6)	1.1 (0.6)	-2.4*	0.4 (0.4)	0.4 (0.5)	-0.1
Somatization	0.87 (0.8)	0.43 (0.5)	-3.8**	1.10 (0.7)	1.09 (0.8)	-0.1	0.41 (0.5)	0.49 (0.5)	-1.4
Obsessive compulsive	1.44 (0.8)	0.85 (0.8)	-4.9**	1.61 (0.7)	1.43 (0.8)	-2.1*	0.58 (0.6)	0.52 (0.6)	-1.0
Interpersonal sensitivity	1.22 (0.9)	0.59 (0.8)	-4.5**	1.30 (0.7)	1.01 (0.7)	-3.2**	0.38 (0.4)	0.41 (0.6)	-0.6
Depression	1.23 (0.8)	0.66 (0.7)	-4.5**	1.49 (0.7)	1.26 (0.8)	-0.4*	0.43 (0.5)	0.45 (0.5)	-0.8
Anxiety	1.13 (0.9)	0.47 (0.6)	-5.2**	1.42 (0.8)	1.26 (0.8)	-2.1*	0.32 (0.4)	0.35 (0.5)	-0.7
Hostility	0.64 (0.8)	0.30 (0.5)	-3.7**	0.91 (0.8)	0.81 (0.9)	-1.2	0.20 (0.2)	0.23 (0.5)	-0.8
Phobic anxiety	0.79 (0.9)	0.35 (0.6)	-3.9**	1.10 (0.9)	0.84 (0.8)	-2.1*	0.17 (0.4)	0.19 (0.4)	-0.2
Paranoid ideation	0.97 (0.9)	0.48 (0.7)	-3.9**	1.21 (0.9)	1.10 (0.9)	-1.2	0.35 (0.4)	0.35 (0.6)	-0.7
Psychoticism	0.63 (0.7)	0.24 (0.4)	-4.7**	0.71 (0.6)	0.52 (0.5)	-2.55*	0.14 (0.3)	0.24 (0.5)	-1.8

All data are means (SD), unless otherwise indicated.

BRIEF-A GEC = Behaviour Rating Inventory of Executive Function-Adult Version Global Executive Composite; SCL-90-R GSI = Symptom Checklist-90-Revised Global Severity Index; SWLS = Satisfaction With Life Scale; AG = Abstinent group; RG = Relapse group; CG = Control group.

* $P < 0.05$.

** $P < 0.001$.

^a Results of Wilcoxon signed rank test. This measures improvement in median score in this group from baseline until one year later.

[$F(1125) = 17.5, p < 0.001$], in addition to a significant group \times time interaction [$F(2125) = 4.4, p = 0.015$]. The interaction is mainly attributed to the improvement in the abstinent group ($Z = -4.52, P < 0.001$), with a medium to large effect size ($r = 0.45$), but some of the interaction-effect could also be carried by an improvement in the control group ($Z = -2.04, P < 0.05$), but this effect was small ($r = 0.2$). The relapse group did not show a statistically significant improvement. See Fig. 2 and Table 2.

The BRIEF-A Behavioral Regulation Index (BRI) showed a significant group \times time interaction [$F(2126) = 4.9, p = 0.009$]. The interaction could be attributed to the improvement in the abstinent group ($Z = -4.5, P < 0.001$), with a large effect size ($r = 0.6$). Relapsers and controls did not show a statistically significant improvement from baseline to one year. BRIEF-A Metacognition Index (MI) showed a significant group \times time interaction [$F(2126) = 4.0, p = 0.020$]. The interaction

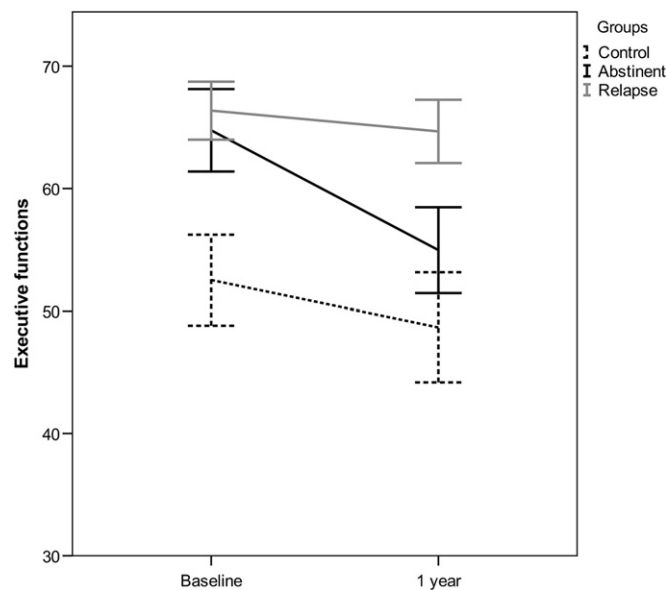


Fig. 2. Executive functions "Executive functions at baseline and one year later measured with the Global Executive Composite (GEC) from the Behavior Rating Inventory of Executive Function - Adult Version (BRIEF-A). Mean value for the control group, the participants that remained abstinent and the participants that relapsed to drug use. Error bars: 95% Confidence interval."

could be attributed to the improvement in the abstainers ($Z = -4.5, P < 0.001$), with a large effect size ($r = 0.6$). Relapsers and controls did not have statistically significant improvement. See Table 2.

3.4. Symptom Checklist-90-R (SCL-90-R)

Analysis of psychological distress as measured by SCL-90-R Global Severity Index (GSI) showed a significant main effect of group [$F(2143) = 24.7, p < 0.001$] and time [$F(1143) = 23.8, p < 0.001$], in addition to a significant group \times time interaction [$F(2143) = 11.0, p < 0.001$]. The interaction is mainly attributed to the improvement in the abstinent group ($Z = -4.50, P < 0.001$), with a medium to large effect size ($r = 0.45$), but some of the interaction-effect could also be carried by an improvement in the relapse group ($Z = -2.44, P < 0.05$), but this effect was small ($r = 0.2$). The control group did not have statistically significant improvement. See Fig. 3 and Table 2.

All nine SCL-90 subscales showed significant interactions at $p < 0.05$. The abstinent group improved from baseline to one-year on all nine subscales ($p < 0.001$). The relapse group improved on the subscales; Obsessive compulsive, interpersonal sensitivity, depression, anxiety, phobic anxiety and psychoticism at a $p < 0.05$ level, but showed no significant change on the subscales somatization, hostility, paranoid ideation. The control group had no change from baseline to one year on any of the SCL-90 subscales. See Table 2.

3.5. 3.4 abstinent vs. controls at baseline and one year

At baseline the abstinent group had significantly worse SWLS score ($Z = -6.6, p < 0.001$), BRIEF-A GEC score ($Z = -4.6, p < 0.001$) and SCL-90-R GSI score ($Z = -5.0, p < 0.001$) compared to the control group. Comparing the scores at the 1-year follow-up between the abstinent and control group demonstrated a significant difference in scores on SWLS score ($Z = -3.91, P < 0.001$) and BRIEF-A GEC score ($Z = -2.21, P < 0.05$), but no evident difference between these groups on SCL-90-R GSI score. Although the abstinent group performed slightly worse compared to the control group (see Fig. 3), this difference was insignificant and indicates a normalization of psychological distress following one year of abstinence.

3.6. Summary

Significant interactions with group and time were shown for all outcome variables, with the abstainers showing the highest improvement

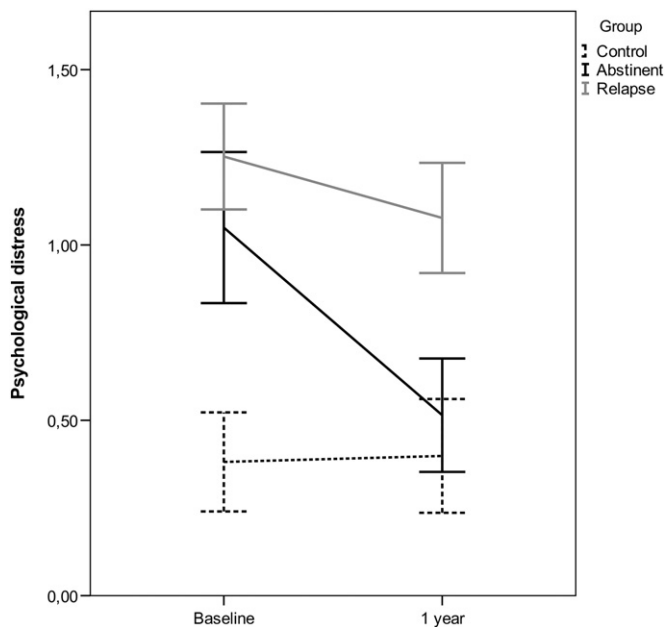


Fig. 3. Psychological distress “Psychological distress at baseline and one year later measured with the Global Severity Index (GSI) from the Symptom Checklist 90 – Revised (SCL-90-R). Mean value for the control group, the participants that remained abstinent and the participants that relapsed to drug use. Error bars: 95% Confidence interval.”

on all variables (see Table 2). Overall, participants that successfully quit substance use for one year show improved satisfaction with life, executive functions and psychological distress compared to participants that relapse and controls.

4. Discussion

This study compared the change from baseline to follow-up one year later on self-reported satisfaction with life, executive functions and psychological distress. The participants were patients with polysubstance use disorder who remained abstinent during the course of one year, patients who relapsed to substance use, and healthy controls. The abstinent group showed a significant improvement in perceived life quality, executive functions, and psychological distress compared with the relapsers and controls.

4.1. Improvement of satisfaction with life, executive functions and, psychological distress.

Executive functions (EF) improved in the group of abstinent patients between baseline and one-year, but this was not the case with the patients that relapsed. Improvement of EF is very promising, considering that maladaptive, impulse-driven behaviour is strongly associated with a substance using lifestyle (Crews & Boettiger, 2009). Impulsivity and impaired EF have been associated with almost all stages of the SUD life cycle (Stevens et al., 2014): with increased probability of initiating use, more aggressive escalation of use, failure to reduce consumption and higher numbers of relapses after treatment (Jentsch, 2009; Robbins, Gillan, Smith, de Wit, & Ersche, 2012; Winstanley, Olausson, Taylor, & Jentsch, 2010). Notably, despite the improvement in EF in the abstainers, they still had somewhat impaired function compared with controls, which indicates that they still had some degree of vulnerability related to impaired EF, even after a year of abstinence.

Psychological distress decreased in the abstinent group. At the one-year follow up, the disparity between the abstinent group and the controls almost disappeared, suggesting a normalization of psychological distress following one year of abstinence. Together with the differences

between the relapsers and abstinent patients on almost all SCL-90 subscales, these results offer a promising view regarding initial recovery from psychological distress in SUD patients. This finding is in line with previous research that have found a reduction of psychological distress among patients who stopped using multiple drugs (Andreas et al., 2015), however it should be emphasized that the present study focused on a broader spectrum of output indicators than previously reported.

There was a significant difference in perceived satisfaction with life as measured by SWLS between the abstinent and relapse groups after one year. The importance of this finding is substantiated by previous studies showing an association between satisfaction with life and subsequent symptoms in recovery, where satisfaction with life increases through early recovery to stable abstinence (Laudet, Morgen, & White, 2006). Furthermore, a longer period of sobriety is shown to predict higher levels of satisfaction with life one year later, and satisfaction with life at the end of SUD treatment predicts commitment to sobriety (Laudet et al., 2006).

The multimodal improvement of satisfaction with life and executive functions with a decrease of psychological distress following one year of abstinence is compelling. Most therapeutic interventions for SUD, including, cognitive behavioral therapy, motivational interviewing, and 12-step programs, are verbally based interventions requiring extensive cognitive processing to facilitate cognitive, motivational, and behavioral change (Roehrich & Goldman, 1993). For instance, a common feature of most treatment initiatives involves learning the harmful effects of various drugs, as well as teaching of programme rules and overarching treatment philosophy (Grohman & Fals-Stewart, 2003), thus representing a distinct learning requirement at the onset of therapy. Our findings suggest that a gradual and careful step-up of learning requirements should be adopted, and emphasize that SUD treatment should initially focus on stabilizing the patient and achieving abstinence, while interventions for co-morbid problems and more cognitively demanding treatment components are more likely to succeed later in the treatment sequence, as cognitive functioning improves. Moreover, these results raise possibility that interventions specifically designed to improve cognitive function, such as memory training (Bickel, Yi, Landes, Hill, & Baxter, 2011), might facilitate somewhat more rapid recovery of cognitive function in this population.

4.2. Strengths and limitations

Many studies in this field have used cross-sectional designs (van Holst & Schilt, 2011), and thus cannot track changes over time. We have used a prospective design for the patient and control groups to enable control of training effects by repeated testing and reports on the same questionnaires (Schulte et al., 2014). The mean IQ score of the control group (104) was within the normal range for the population. However, there was a significant difference in years of education, gender distribution and work experience between the patient groups and the controls (Table 1). These disparities are anticipated when comparing a healthy control group and a clinical sample of patients with polysubstance use disorder with a vast number of risk factors. With regard to education, all Norwegian citizens have compulsory education from five to 16 years old. It was difficult to recruit age-matched participants with fewer than 10 years of education who did not use drugs. The skewed gender distribution, with the SUD group being 67% male and the control group 55.9% male, may be explained by a factual gender difference in the prevalence of SUD between men and women; males are more likely to suffer from lifetime and 12-month use and dependence on drugs (Warner, Kessler, Hughes, Anthony, & Nelson, 1995). There was no significant age difference between patients and controls, which was a strength of the study as age is known to significantly impact neurocognitive functions.

To ensure a diverse picture of the dimensions underlying recovery, we broadened the scope of interest to satisfaction with life, executive functions and psychological distress. By testing participants after

14 days of detoxification, we aimed to exclude the possible subacute effects of the drug use (Fernandez-Serrano et al., 2011).

However, the present study has a number of limitations. First, it did not incorporate a randomized design. Relapsers and abstainers self-selected into their groups based on self-reports, and baseline or time-varying variables that were not assessed may have influenced our outcome variables. Thus, we cannot conclude that the differences in these outcomes observed at 12 months were caused only by changes in substance use status. Furthermore, in this study we only addressed a follow-up period of 12 months with only one follow-up wave, and the control group was relatively small. It is possible that a larger control group would have shown statistically significant improvements on EF. It is however, unlikely that a large control group would change the overall impression that participants achieving one year of abstinence show greater improvements compared to the other groups.

Finally, we were not able to determine the patterns of polydrug use in our sample; that is, whether different substances were used concurrently, or before or after another drug. This information would be beneficial to understand better the issues of polydrug use.

5. Conclusions

To date, few studies have investigated the natural progression of recovery in terms of this particular combination of outcome indicators in patients with polysubstance use disorder. Our study provides support for the view that there is a clinically significant recovery in satisfaction with life, executive functions and psychological distress for polysubstance using SUD patients following one-year of abstinence. This improvement from admission to one-year, suggests that a gradual progression of treatment should be adopted to ensure that the patients have the prerequisites for receiving treatment in a broad array of dimensions. By this, our findings could shed light on the recovery process for this group of patients. It highlights the necessity of an ongoing diagnostic approach as the clinical picture at the admission of treatment could be dramatically improved for patients suffering for polysubstance use disorder. This knowledge could provide hope for patients, as well as therapist, simply by highlighting the importance of time and continued abstinence. This might subsequently reduce dropout numbers and improve the recovery process for these patients. Future research should consider the timing and sequence of interventions in SUD treatment.

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Competing interests

The authors declare that they have no competing interests. We certify that there is no conflict of interest with any financial organization or nonfinancial competing interests regarding the material discussed in the manuscript.

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EH initiated the project, wrote the manuscript, and contributed to project design, analysis, and interpretation; AHE contributed to statistical analyses, interpretation, and manuscript revision; KPH contributed to the writing and revision of the manuscript and interpretation of the analyses; SMN, JRM, and AJL contributed to the revision of the manuscript; and EW contributed to manuscript revision and overall supervision of this research. All authors read and approved the final manuscript.

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