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## Substance use and depression. Comparative course in adolescents

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■ **Abstract** *Objective* To examine the relation between depression and substance use in adolescents and the concomitant courses of both disorders. *Methods* Four individual interviews were administered to 85 adolescent substance users aged 14–19 years (mean 17.1 years, SD 1.4) over a 3.5 year period using the Adolescent Drug Abuse Interview (ADAD) and the Beck Depression Inventory (BDI-13). *Results* No predictive effect was observed on one dimension over the other, but each dimension was predictive of its own course. A decrease in substance-use severity paralleled a decrease in depressive state. Similarly, stable substance-use rates, either at a low or a high level, tended to be associated with low or high levels of depression,

respectively. However, an increase in substance use was not accompanied by an increase in depressive states. Moreover, depression varied greatly between adolescents, and according to gender and age. *Conclusions* Depressive states and substance use in adolescents can vary considerably overtime, and are closely but rather synchronically related. Since most of the adolescents do not seek help for substance-related problems, substance use should be systematically assessed in adolescents presenting with a depressive state.

■ **Key words** adolescent – substance use – depression – longitudinal design – community study

### Introduction

Adolescence is a key period with regard to substance use. The risk of substance-use onset is highest in this age group [18]. The earlier the onset of substance use, the greater the risk of future dependence [17]. Furthermore, substance use in adolescents may lead to impairments that will interfere with normal development, which might, in turn, reinforce substance use [7, 12, 17, 21]. Although the association between substance-use disorders and depression has been consistently established, little evidence regarding the

underlying mechanisms behind this association is currently available [9–11, 23]. The present study sets out to explore the concurrent natural course of substance use and depressive state in a community-based sample of regular adolescent substance users.

As in other European countries, substance-use trends in Switzerland show a disturbing increase in teenagers. In 2002, lifetime cannabis use was 49.9% in boys and 39.1% in girls aged 15–16 years, which represents a 20% increase since 1994. Daily cannabis use is also increasing, with 6.5% of adolescents reporting daily use in recent years [16]. Moreover, patterns of substance use are changing toward more

frequent, risky behaviours such as binge drinking, daily cannabis use, and multiple substance use on the same occasion [15, 16, 24].

Both community-based and clinical studies show the large co-morbidity between substance-use disorders and other psychiatric disorders, especially anxiety and depression, in adult as well as adolescent populations [2, 5, 18–20]. Prevalence rates of depression of between 20 and 30% are reported in adolescent substance users [2].

Four models have been proposed to explain the relation between substance use and psychiatric disorders [23]. The first model asserts that high rates of co-morbidity are the result of shared underlying factors, such as genetic factors or personality disorders, inducing common vulnerability. The second model postulates that substance use is secondary to psychiatric disorders, and notably that substance use could be a way of alleviating 'feeling bad' (i.e. affect regulation model). In contrast, the third model posits that psychiatric illness is induced by primary substance use. Finally, the fourth model asserts that interacting effects accounting for the increased co-morbidity rates could link both disorders.

The objective of this study was to investigate the relation between depression and substance use in adolescents and the concomitant courses of both disorders. In particular, the study sets out to examine the hypotheses referring to the common factor model, the affect regulation model, the secondary psychiatric disorder model and the bi-directional model.

## Methods

### ■ Population

The sample at baseline included 102 adolescents (66 boys and 36 girls aged 14–19 years, 17.1 years SD 1.4) recruited between January 1999 and March 2000 in the French-speaking part of Switzerland, an area with approximately one million inhabitants. They all fitted the criterion of regular illicit drug or alcohol use (at least one substance once a week during the last 3 months) at the first interview (time 1). All of them were regular cannabis users. Ninety-four per cent fitted the DSM-IV (Diagnostic and Statistical Manual of Mental Disorders version 4) criteria for cannabis abuse or dependence, of which 54% received additional substance-abuse diagnoses, mainly for alcohol (38%). Seventy-five percent were Swiss and 25% came from another country (mainly European), which corresponds to the percentages observed in the general population. Eighty-nine percent of the subjects were native French speakers. None of the subjects was excluded due to language difficulties or because of

psychosis or chronic physical disease, which were exclusion criteria. Regarding family background, 63% of the subjects had lived most of their life with both parents whereas 16% had lived mainly with their mother alone. The remaining 21% had lived either in a mixed family (11%); with adoptive parents, other relatives, or a foster family (6%); or in community homes (4%). They were recruited in outpatient units (26%), residential units (27%), hospitals (15%) and leisure places (32%).

### ■ Procedure

Adolescents were recruited in a variety of contexts, through collaboration with youth-service professionals, through dissemination and direct distribution of flyers in public and leisure places, or through direct contact. They were informed about the conditions of participation before they joined the study, in particular the fact that they were free to leave the study at any time. They were given a SFr. 50.00 incentive for the time spent on each interview. They all gave written consent and Ethical Committee approval was obtained. Three consecutive interviews, hereafter referred to as time 2, time 3 and time 4, were administered after 9, 18 and 42 months. Drop-out rates were 17% at time 3 and 19% at time 4. Most of the drop-outs were due to loss of contact because of moving or telephone number changes. Three adolescents left the study on their own. The time 3 and time 4 samples were comparable to the baseline sample according to age ( $F [1,100] = 1.728$ ,  $P = 0.192$  and  $F [1,100] = 0.002$ ,  $P = 0.961$ , respectively), gender ( $\chi^2 = 0.4$ ,  $P_2 = 0.1$ ,  $P = 0.74$ , respectively) and sociodemographic characteristics.

At each time, trained psychologists administered a standard protocol to adolescents individually. Depression was measured using the BDI-13 (Beck Depression Inventory, short version) [3]. The French translation was used [8], which assesses the current depressive state. This instrument is composed of 13 questions with four statements related to depression symptomatology rated on Likert-type scales from 0 to 3 with the total score ranging from 0 to 39. Total scores ranging from 0 to 4 correspond to "not depressed", those from 5 to 7 to "lightly depressed", those from 8 to 15 to "fairly depressed" and those of 16 and over to "severely depressed". In this study, the total score was used in order to study depressive state changes over time compared to substance-use evolution. The French version of the ADAD (Adolescent Drug Abuse Diagnosis) [4] was used to evaluate illegal drug and alcohol use and associated life problem areas. For each domain, interviewers attribute severity-rating scores ranging from 0 (no real problem) to

9 (extreme problem, treatment absolutely necessary) on the basis of the adolescents' reports and self-perception of their situation. A severity rating score of 4 and over indicates that the problems in this area are important and necessitate treatment. Finally the MINI (Mini International Neuropsychiatric Interview) [25] was used, which provides substance-abuse diagnoses based on DSM-IV criteria.

### ■ Data transformation

Three transformations were performed before analyzing the data. First, BDI mean scores showed a high variability with irregular variations across gender and substance-use evolution subgroups (SUES; see Table 1 in the Results). Therefore BDI individual scores were transformed into natural logarithm scores (hereafter mentioned as BDI ln mean scores), and scores equal to zero were replaced manually. The transformation to BDI ln mean scores made the variation smaller and more constant across levels of data series. BDI ln scores were thus used in the subsequent statistical analyses. Second, age was dichotomised into adolescents aged under 17 years and those aged 17 and over to introduce this variable into the general linear model (GLM) analyses as a between-subjects factor. The younger and older age groups contained 46 and 39 adolescents, respectively. Finally, the grouping analysis of Wills

et al. [27] was used to explore the courses of both depression and substance use simultaneously over time according to gender and age. Therefore, clustering analysis using individual substance-use severity scores at times 1, 2 and 3 was performed to determine empirical patterns of substance-use over time. The depression rate of drop-outs at baseline was significantly higher compared to those who completed the time 4 interview. Moreover, subjects' age at time 4 ranging from 18- to 23-years old made them more comparable to young adults than adolescents, and the time frame between time 4 and time 3 differed from the others. For these reasons, the clustering analysis was conducted on the 85 adolescents who completed the first three interviews. The analysis produced four SUES: one group of 15 adolescents, referred to as increasers (IC), whose substance use increased over time; one group of 22 adolescents, referred to as decreasers (DC), whose substance use decreased over time; and two groups with either low or high stable substance-use severity, one group of 18 low persisters (LP) and one composed of 30 high persisters (HP). Cluster membership was cross-validated by making sure that increasers' and decreasers' substance-use score changes were of 2 points or more. These substance-use evolution patterns were confirmed by substance-use trends in each SUES at time 4, with IC and HP presenting significantly higher substance-use severity scores than DC and LP ( $F [3,74] = 6.98, P = 0.000$ ).

**Table 1** Depression and substance-use mean scores according to substance-use evolution subgroups (SUES), gender and age

		BDI mean scores*				ADAD drug severity mean scores			
		time 1	time 2	time 3	Mean	time 1	time 2	time 3	Mean
<i>SUES</i>									
Increasers ( <i>n</i> = 15)	Mean	7.53	9.10	8.47	8.37	4.47	5.73	6.93	5.71
	SD	5.04	6.82	6.10	5.11	1.51	1.03	0.96	0.93
Decreasers ( <i>n</i> = 22)	Mean	9.05	6.11	3.86	6.28	6.23	4.50	2.55	4.42
	SD	5.18	4.85	4.23	3.89	1.60	2.54	1.34	1.49
Low persisters ( <i>n</i> = 18)	Mean	6.06	5.00	4.78	5.28	3.67	3.39	3.33	3.46
	SD	6.99	7.88	6.98	6.59	1.61	1.75	1.68	1.60
High persisters ( <i>n</i> = 30)	Mean	10.30	8.31	8.62	9.12	6.87	5.86	6.77	6.47
	SD	7.96	6.88	7.91	6.52	1.07	1.43	1.07	1.15
<i>Gender</i>									
Girls ( <i>n</i> = 30)	Mean	10.80	8.97	7.29	9.01	5.90	4.76	4.73	5.18
	SD	8.13	9.19	7.54	7.50	2.34	2.32	2.57	2.14
Boys ( <i>n</i> = 55)	Mean	7.38	6.24	6.15	6.56	5.44	5.05	5.11	5.16
	SD	5.56	4.67	6.48	4.54	1.63	1.87	2.23	1.53
<i>Age</i>									
Youngers ( <i>n</i> = 46)	Mean	7.15	6.15	5.47	6.22	5.28	5.04	4.83	5.05
	SD	5.65	5.39	5.11	4.26	1.60	1.76	2.17	1.35
Olders ( <i>n</i> = 39)	Mean	10.28	8.42	7.82	8.87	5.97	4.84	5.15	5.31
	SD	7.56	7.86	8.35	7.07	2.18	2.33	2.56	2.15
Total ( <i>n</i> = 85)	Mean	8.59	7.20	6.55	7.44	5.60	4.95	4.98	5.17
	SD	6.74	6.70	6.85	5.84	1.91	2.03	2.35	1.76

\*BDI mean scores ranging from 0 to 4 correspond to "not depressed", from 5 to 8 to "lightly depressed", from 9 to 15 to "fairly depressed" and 16 and over to "severely depressed"

## Statistical analyses

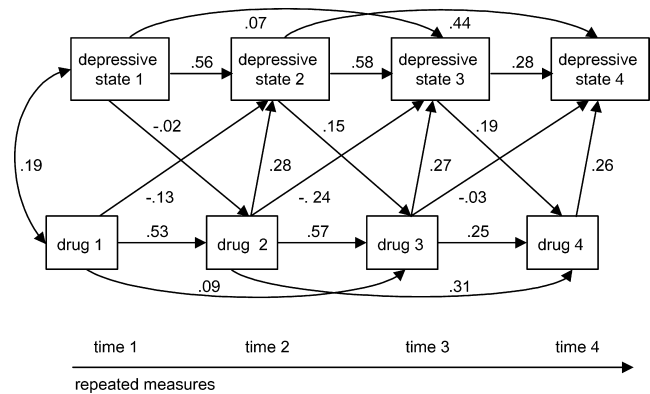
Preliminary analyses are presented that explore depression, substance use and individual factors such as gender, age and substance-use duration. Structural equation modeling, using Amos software [1], was then performed to investigate predictive relations between depression and substance use. Finally, GLM with repeated measures were performed using BDI ln mean scores at each time measure as the dependent variable and SUES, age groups and gender as factors. These analyses allowed the appraisal of the joint evolution of both dimensions.

## Results

Table 1 presents BDI and ADAD substance-use severity rating mean scores according to SUES, gender and age at time 1, 2 and 3.

Drug severity rating total mean scores were relatively high, indicating a need for some treatment, except in the LP group. Older adolescents tended to be rated slightly higher than younger adolescents for drug severity, but only at baseline ( $F [1,83] = 2.83$ ,  $P = 0.096$ ). There was no difference in drug severity according to gender. Concerning depression, BDI total mean scores showed an overall moderate depressive state (between lightly and fairly depressed according to BDI scores grouping). Depressive rates differed at baseline according to gender, girls being significantly more depressed than boys ( $F [1,83] = 5.25$ ,  $P = 0.024$ ). However, this discrepancy diminished over time and was not found in BDI total mean scores. With respect to age groups, older adolescents tended to be globally more depressed than the younger adolescents ( $F [1,83] = 3.54$ ,  $P = 0.063$ ), which was especially the result of depression rates at baseline (2.00 SD 0.94 and 1.64 SD 0.89, respectively). SUES were then compared according to potential influential factors. Substance-use duration varied according to SUES ( $F [3,81] = 2.58$ ,  $P = 0.059$ ). HP had been using substances since a longer period of time compared to LP (2.8 years, SD 1.4 and 2.1 years SD 0.93, respectively). However no difference appeared among SUES according to age.

Structural equation modeling was then performed to investigate predictive relations between depression and substance use. Auto-regressive cross-lagged panel models were performed with BDI ln and substance-use severity rating mean scores at each time point. According to the alternative hypotheses presented in the introduction, two a priori models were tested, one with cross-lagged inter-dimensional paths linking prior substance use with successive depres-



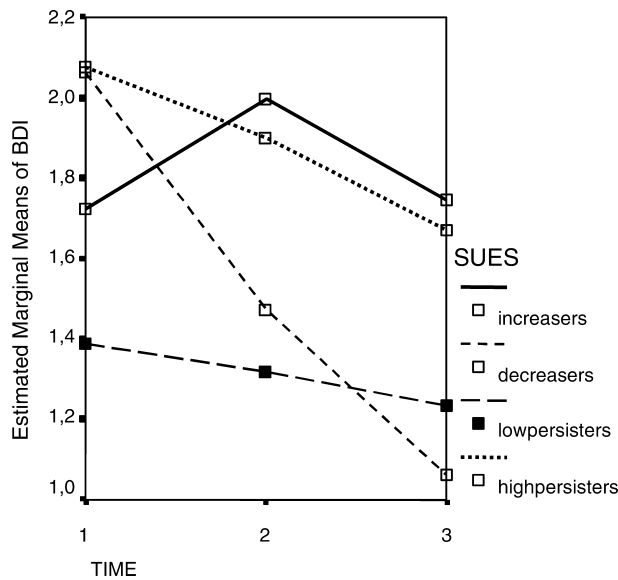
**Fig. 1** Effects of prior depression (BDI ln mean scores) and substance-use severity (ADAD mean scores) on successive measures. One-tailed arrows are path-coefficients and the two-tailed is a correlation

sion—corresponding to the ‘secondary mood disorder model’—and one with paths between prior depression and substance use—according to the ‘affect regulation model’. Both models failed to meet the criteria for adequate fit. However, when both models were combined and 2-lag intra-dimensional paths were added, all criteria indicated a good model fit ( $c2 = 11.97$ ,  $df 8$ ,  $P = 0.153$ ,  $RMSEA 0.07$ ).

Fig. 1 presents this model comprising 1- and 2-lag intra-dimensional paths and 1-lag inter-dimensional paths, showing that both depressive state and substance use were significantly predictive of each future respective course. Globally direct effects within each dimension predominated compared to cross-lagged inter-dimensional path coefficients. Inter-dimensional path coefficients were, overall, relatively low, except for one negative coefficient between substance use at time 2 and depression at time 3. Simple linear regression showed, however, that the residual part of substance use 2 in predicting BDI ln 3 was near zero once BDI ln 2 was controlled for. Finally, coefficients were moderately high between both dimensions within the same time measure.

GLM with repeated measures were performed using time 1 to time 3 BDI ln mean scores as dependent variables and SUES, age groups and gender as factors. These analyses allowed appraisal of the joint evolution of both dimensions.

A time effect appeared in the GLM analysis ( $F [2,134] = 4.64$ ,  $P = 0.011$ ), which indicated that the depressive state tended to decrease over time (see Fig. 2). There was a tendency towards differentiated evolution patterns for depression according to substance-use subgroups ( $F [6,134] = 1.94$ ,  $P = 0.079$ ). The depressive state decreased dramatically in the DC group whereas it remained stable at a high level in the HP and IC groups, and at a low level in the LP group. Two significant effects appeared in triple interactions



**Fig. 2** BDI mean scores at time 1, 2 and 3 by substance-use evolution subgroups (SUES)

with time, SUES and gender ( $F [6,134] = 2.70, P = 0.017$ ), and with time, gender and age ( $F [1,67] = 5.61, P = 0.021$ ). Older girls presented with higher depressive states at baseline, which then tended to show a greater decrease over time compared to the other adolescents. Three between-subjects effects occurred, two tendencies with SUES ( $F [3,67] = 2.49, P = 0.068$ ) and gender ( $F [1,67] = 3.60, P = 0.062$ ), and one significant effect with age ( $F [1,67] = 5.90, P = 0.018$ ). Girls and older subjects appeared to be more depressed than boys and younger subjects, respectively. Furthermore, there was an interaction of gender with age ( $F [1,67] = 4.19, P = 0.045$ ), older girls being more depressed than all other adolescents.

Regarding the difference in depression total mean scores over time according to SUES, post-hoc tests performed in the one-way analysis comparing BDI total mean scores by subgroups showed a significant difference between the LP and HP groups, the former being globally less depressed than the latter (see Table 1). At time 4, the depressive state in the LP group remained significantly lower than that in the HP group, and was also significantly lower than those in the IC and DC groups (1.15 SD 0.99, 6.62 SD 5.13, 7.30 SD 5.12 and 5.70 SD 4.39, respectively,  $F [3,65] = 5.29, P = 0.003$ ).

## Discussion

The different patterns evidenced overtime show that depression and substance use may vary considerably

during adolescence. Regarding changes over time in depression and substance use, there was no predictive relation of one dimension over the other. Instead, prior depressive states and substance-use severity were each predictive of successive measures in the respective dimensions. Moreover, when analysing the substance-use evolution subgroups separately, depression varied over time according to substance-use evolution patterns, gender and age. In every case, a decrease in substance-use severity paralleled a decrease in depressive state. In the same way, stable substance-use subgroups, either with a low or a high level of substance-use severity, tended to present stable low or high levels of depression, respectively. An increase in substance use was not accompanied by an increased depressive state, which can be explained by relatively high depressive states at baseline. The lack of prediction of one dimension over the other argues against both secondary psychiatric disorder—and affect regulation explanation models [23]. Whereas the common factor model cannot be definitely proved false by our results, they give more support to the interacting effects model.

Globally depressive state differed according to gender and age, girls—especially older girls—being significantly more depressed than boys. However, depression rates were rather heterogeneous and varied over time, particularly in those groups where depression was highest at baseline. These results paralleled those found in the literature [6, 10, 11, 28].

Substance misuse was associated with relatively high depressive states. Moreover girls, and especially older ones, presented more severe, but highly heterogeneous, depressive states.

There were no predictive relations for one dimension over the other. Prior depression rates predicted successive depression rates, which was also the case for substance-use severity. Moreover, depressive states and substance-use severity were moderately associated at each time point. The importance of these relations, on the one hand within each dimension across time and on the other hand in cross-dimensional paths at each time point, could induce an artefact accounting for the negative coefficients found in two of the cross-lagged paths. This explanation is supported by the lack of a ‘singular’ predictive residual part of substance-use once prior depression is controlled for.

Depression course was then analysed according to substance-use evolution patterns, gender and age. A general observation was that a decrease in substance-use severity was accompanied by a decrease in depressive symptoms. Moreover, adolescents whose substance-use remained stable either at a low (LP) or a high (HP) level tended to present similarly low and high depressive rates. Depressive states and substance

use in adolescents appear to be closely, but rather synchronically, related. This could be explained by the fact that each problem, and its associated impairments, might contribute to reinforce the other in a reciprocal way. These observations are consistent with those of Kandell et al. [19]; they support the usefulness of detecting substance misuse and depressive states at an early stage to provide adolescents with an integrated-treatment plan that will target both disorders and help prevent mutual relapse [13, 14].

Some limitations should be mentioned regarding the results discussed here. First, depression rates showed an important variability, with some adolescents having extremely high scores, especially at baseline where one-third of the sample was recruited from within health or social services. This could explain the general tendency towards a decrease in depression rates (regression toward the mean), and the fact that an increase in substance use was not accompanied by an increase in depressive state. Second, the respective courses of depression and substance use were evaluated when substance use was already established. Thus depressive traits might be

present prior to substance-use onset and vice versa. Third, the intervals between each time measure were large. Consequently, it might be the case that a causal relation exists between the courses of both disorders, but within a shorter timescale.

Nevertheless these results show that some of the depressive symptoms could be directly associated with substance-use severity, especially in boys [28]. Regarding the treatment of depressive states in adolescents, this observation stresses the importance of carefully assessing substance use and taking it into account in the treatment planning. Moreover, current pharmacological treatments for adolescent depression were not found to be particularly effective, notably in substance-user adolescents [22], and a 6–8 week period was required before any effect was seen [26]. Further research is needed to follow both disorder courses with shorter time intervals between each measure in order to explore in-depth an eventual causal relation.

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