Ecstasy use and psychological distress – where does the association lie? A complementary analysis of Australian data sets

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Ecstasy use and psychological distress – where does the association lie? A complementary analysis of Australian data sets

Short title: Ecstasy use and psychological distress

Abstract

We examine the association between young adult Ecstasy users’ psychological distress and two dimensions of their drug use: age of initiation and frequency of use. Data from two studies conducted in Australian community settings are used to assess whether different sampling methods produce comparable estimates of these associations. The Natural History Study (N=339) conducted in 2009 used population sampling and the 2009 Ecstasy and Related Drug Reporting System (EDRS; N=359) used purposive sampling. Participants, aged 19-23 years, were recurrent Ecstasy users. Psychological distress was assessed using the Kessler 10 in the EDRS and the Hospital Anxiety Depression Scale in the Natural History Study. In both samples psychological distress was associated with daily tobacco use and early drug use initiation, but not frequent Ecstasy use. One-third of Ecstasy users smoked tobacco daily. Study limitations and implications are noted.

Keywords: ecstasy (drug), age of initiation, psychological factors, young adult, adolescence, tobacco
INTRODUCTION

Ecstasy use is common among young adults in many developed countries (United Nations Office on Drugs and Crime, 2010). For young Australian adults, the use of Ecstasy now exceeds that of methamphetamine, and is second only to cannabis in terms of illicit drug use (Australian Institute of Health and Welfare, 2008a). Yet in 2007-08 just 1.7 per cent of drug treatment episodes for Australians aged 20 to 29 years involved Ecstasy as the principal focus of treatment, compared to 15.6 per cent for methamphetamine and 27.6 per cent for cannabis (Australian Institute of Health and Welfare, 2009). On the basis of these treatment data, it appears that relatively few young adult Ecstasy users experience clinically significant levels of psychological distress (PD) associated with their use. Previous research provides inconsistent evidence regarding an association between Ecstasy use and PD (Guillot, 2007; Matthews & Bruno, 2010; Rogers et al., 2009; Sumnall & Cole, 2005).

A possible explanation for this inconsistency is variation in the attributes of Ecstasy users sampled in different studies, including differences in drug use etiology. The age of first drug use is a key etiological factor, and has been given little consideration in previous Ecstasy use studies. Most research concerning the relationship between Ecstasy use and mental health has focused on recent or concurrent patterns of frequent Ecstasy use (Degenhardt, Bruno, & Topp, 2010; Guillot, 2007). PD tends to increase during adolescence (Compas, Orosan, & Grant, 1993; Newcomb, Vargas-Carmona, & Galaif, 1999) and it is plausible that adolescents may use Ecstasy to self-medicate for PD (Newcomb, et al., 1999; Nichols, 1986; Verheyden, Henry, & Curran, 2003). Those commencing Ecstasy use in adolescence could also be more likely to use Ecstasy frequently in early adulthood compared to those who commence use later (Lynskey et al., 2003). Consequently, associations observed between frequent Ecstasy use and PD in previous research could be accounted for by early initiation to Ecstasy use and/or pre-existing PD.
Etiological and other differences between Ecstasy-using samples may arise due to variation in study settings, sampling criteria and sampling methods. In particular, purposive samples (using convenience methods such as advertising to selectively recruit participants) and population samples applied in the same setting are likely to recruit different groups of drug users, although this proposition has been contested in regard to Ecstasy users (Miller, Johnston, Dunn, Fry, & Degenhardt, 2010b; Topp, Barker, & Degenhardt, 2004).

Of those who are identified as Ecstasy users in population surveys, only a small proportion are likely to be frequent or problematic users (Huizink, Ferdinand, van der Ende, & Verhulst, 2006; Lieb, Schuetz, Pfister, von Sydow, & Wittchen, 2002; Soellner, 2005). It follows that greater insight may be gained by the complementary rather than separate examination of different types of studies (Begley, 1996). Population research can enhance interpretation of purposive study findings by replication of relevant associations and by producing estimates of the proportion of the young adult population affected. Purposive studies can add to information furnished by population studies by providing ‘upper bound’ estimates of the strength and magnitude of associations pertaining to problematic drug use; greater extremes of behaviour are sampled using purposive methods (Morral, McCaffrey, & Paddock, 2002; Sumnall & Cole, 2005). Previous comparative research concerning Ecstasy use has attempted to identify similarities in descriptive parameter estimates obtained from different sampling methods rather than assessing the consistency of relevant associations (Miller, Johnston, Dunn, Fry, & Degenhardt, 2010a; Libby Topp, et al., 2004).

Another methodological problem for both population-based and purposive studies of Ecstasy use relates to adequate control for levels of concurrent drug use and the capacity to control for such use (Guillot, 2007; Rogers, et al., 2009; Sumnall & Cole, 2005). Where associations have been found it is unclear whether they are specific to Ecstasy use (Alati et al., 2008; Huizink, et al., 2006; Lieb, et al., 2002); Ecstasy use is associated with the use of a
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variety of drugs, especially cannabis (Huizink, et al., 2006; Scholey et al., 2004; K. von Sydow, R. Lieb, H. Pfister, M. Hofler, & H.-U. Wittchen, 2002). A small number of studies have also noted high levels of alcohol and tobacco use among Ecstasy users (Kinner, George, Johnston, Dunn, & Degenhardt, 2011; Measham, 2004; Mohamed, Hamida, Cassel, de Vasconcelos, & Jones, 2011), but few relevant studies have adjusted for these licit drug use patterns. Two studies which used purposive samples suggest that PD in Ecstasy users could be largely associated with tobacco use (George, Kinner, Bruno, Degenhardt, & Dunn, 2010; Scott, Hides, Allen, Burke, & Lubman, 2010), but these findings have not been replicated in population studies.

In the present study we assess whether there is a consistent pattern of association between Ecstasy use and PD among young adults across two studies using different sampling designs within the same community setting. We compare the Natural History Study (NHS), which screened a random sample of the general population aged 18 to 23 years, and the Ecstasy and Related Drugs Reporting System (EDRS), a drug monitoring system that uses purposive sampling. The two data sets are restricted to matching age groups (19 to 23 years) of recent Ecstasy users. We focus on the relative contributions of age of first Ecstasy use and frequent Ecstasy use to clinically relevant levels of PD in young adult Ecstasy users, while controlling for the use of alcohol, tobacco and cannabis.

METHODS

Participants

Each of the samples comprises recent Ecstasy users (past 12 month) of matching age groups, although the specific frequency of recent Ecstasy use differs due to the selection criteria of each study.

The Natural History Study
The Natural History Study (NHS) is a population based retrospective/prospective longitudinal study of a cohort of young adults, aged 19 to 23 years at first interview, who had used amphetamine or Ecstasy at least three times in the 12 months preceding recruitment into the study (baseline) in 2008-09. This age group was chosen because this is the age at which experimentation with amphetamine-type stimulants tends to commence (Australian Institute of Health and Welfare, 2008a; Chen & Kandel, 1995; K. von Sydow, R. Lieb, H. Pfister, M. Hofler, & H. U. Wittchen, 2002). We used a novel application of population screening, using electoral roll data, to create a population-based probability sample of young drug users and non-users. Voting is compulsory in Australia for all citizens aged 18 years and over. In June 2008 an estimated 82% of eligible 18 to 25 year olds were registered on the Australian electoral roll (Australian Electoral Commission, 2008). A questionnaire was mailed to 12,118 young adults (aged 18-22 years at screening) randomly selected from electoral roll data for Brisbane and the Gold Coast (Australia). The screening response rate was 49.9 per cent, based on 6044 screeners complete for Ecstasy and methamphetamine questions. The present analysis includes only those participants who were selected on the basis of their recent Ecstasy use (i.e. ≥ 3 times in the past year; N=339). The use of a ‘targeted’ screening approach to population sampling enabled the NHS to recruit a relatively large number of recurrent Ecstasy users compared to other population studies (e.g. Australian Institute of Health and Welfare, 2008b).

The 2009 Ecstasy and Related Drugs Reporting System

The Ecstasy and Related Drugs Reporting System (EDRS) is a national annual monitoring study coordinated by the National Drug and Alcohol Research Centre; detailed descriptions of the study are available elsewhere. (Sindicich & Burns, 2010; Topp, Breen, Kaye, & Darke, 2004) The EDRS surveys a ‘sentinel’ population of regular Ecstasy users to identify emerging trends in the Ecstasy and related drugs markets in Australia, and to examine
patterns of use and associated harm (Sindicich & Burns, 2010). In contrast to the NHS, recruitment is restricted to participants who have used Ecstasy on at least six occasions over the past six months. Purposive sampling, in the form of advertising and snowballing, was used to recruit participants. For the present analyses, participants were restricted to the 19 to 23 year age range. In total, 756 Ecstasy users participated in the 2009 EDRS, and there were 359 participants in the age-restricted sample.

**Measures**

**Age of first use**

The age of first drug use (for Ecstasy, alcohol, tobacco and cannabis) was collected as a discrete variable within each study and dichotomous variables were generated to indicate early initiation to each drug, based on the relevant age distributions (approximating the lower quartile). Early initiation to Ecstasy was represented by first use at age < 17 years, for cannabis this was age < 14 years, and for alcohol and tobacco this was age < 13 years.

**Frequency of use**

In the NHS frequency of use was measured as number of days of use in the last month; 30 days or more of use in the last month was interpreted as daily use and 4 days or more as at least weekly use. The EDRS collected number of days of use in the last 6 months. Daily use was interpreted as 180 days or more and weekly use as 24 days or more.

**Psychological distress**

PD was measured using the 10-item Kessler Psychological Distress Scale (K10) in the EDRS and the Hospital Anxiety Depression Scale (HADS) in the NHS. The K10 was developed to screen for non-specific PD (Andrews & Slade, 2001; Kessler et al., 2003a) and has excellent inter-item reliability (Cronbach’s alpha of 0.92-0.93 in Australia and the USA; Kessler et al., 2002). The HADS is a 14-item scale validated in clinical and non-clinical settings (Bjelland, Dahl, Haug, & Neckelmann, 2002; Crawford, Henry, Crombie, & Taylor, 2001; Zigmond &
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Snaith, 1983). The HADS comprises subscales for anxiety and depression and the total scale provides a valid and reliable screen for PD (Cronbach’s alpha of 0.88-0.89; Costantini et al., 1999; Herrmann, 1997).

Previous research indicates that the K10 and the HADS are comparable measures of PD used in the study of drug users and other populations (Arnaud et al., 2010; Dunbar et al., 2008). In a study measuring PD in a population at risk of alcohol use disorders (Arnaud, et al., 2010), the K10 and the HADS were highly correlated ($r=0.71$), and the convergent validity of these scales compares well to other instruments used to screen for PD (Kessler et al., 2003b). Because our study is concerned with clinically relevant symptoms we selected cut-offs for the K10 and the HADS that are indicative of high levels of distress. Consistent with previous studies, a cut-off of 27 was used in the K10 (Hides et al., 2007) and a cut-off of 16 was used for the HADS (Spinhoven et al., 1997).

**Data analysis**

Group differences on demographic variables were analysed using chi-square tests for categorical data and the nonparametric two-sample Wilcoxon rank-sum test for age of drug use initiation data, given that the latter was skewed. Three prediction models were developed, using multivariable logistic regression, to examine the relationship between Ecstasy use, other drug use and PD. Model 1 comprises the early drug use initiation variables (Ecstasy, alcohol, tobacco and cannabis), Model 2 comprises the frequent drug use variables (Ecstasy, alcohol, tobacco and cannabis), and Model 3 is a combined model comprising all of the variables that were significantly associated with PD in Model 1 or Model 2. The estimates for each model are adjusted for gender and all other included variables. A p-value of < 0.05 was adopted as a threshold for significant results in all analyses. Data were analyzed using Stata Special Edition 11.0.
RESULTS

Demography

Demographic characteristics of participants in each study are presented in Table 1. There was no significant difference between the samples with regard to the ages of participants, but there were lower rates of age-relevant societal commitments among the EDRS compared to the NHS participants. In particular, EDRS participants were less likely than their NHS counterparts to be studying full-time and less likely to be married or in a de facto relationship. They were also less likely to be living with their parents, which is likely to reflect the higher rates of full-time study among NHS participants (given the financial constraints of studying). Additionally, male EDRS participants were considerably less likely to be employed than male NHS participants, despite the lower rate of involvement in full-time study. The gender distribution of the two studies also differed. While there were equal proportions of males (50.7%) and females (49.3%) in the NHS, there were more males (59.9%) than females (40.1%) in the EDRS.

Drug use patterns

Participants’ levels of drug use exposure (early initiation and frequent use) are presented in Table 2. The drug use patterns of the two samples were similar, with the exception of Ecstasy use and current levels of cannabis use. Compared to NHS participants, a slightly higher proportion of EDRS participants had commenced Ecstasy use early (i.e. prior to age 17 years; 23.1% vs. 17.1%; $\chi^2=3.9$, $p<0.05$), and they were also considerably more likely to be using Ecstasy at least weekly (28.7% vs. 9.1%; $\chi^2=42.9$, $p<0.001$). Daily Ecstasy use was non-existent in both samples. The EDRS participants were more likely to be daily cannabis users (14.2% vs. 8.6%; $\chi^2=5.5$, $p<0.05$).
Psychological distress

The proportions experiencing clinically significant levels of PD in each sample are not directly comparable, given that the K10 was used in the EDRS and the HADS was used in the NHS. Scores on the K10 ranged from 10 to 39 with a mean score of 18.5 (SD=5.8). Roughly equal proportions of males (10.7%) and females (11.1%) in the EDRS met the cut-off for clinically significant PD. In the NHS, scores on HADS ranged from 0 to 28, and the mean score was 8.6 (SD=5.3). There were 15.0% of females and 9.9% of males in this study who met the cut-off for PD. The higher proportion of female compared to male participants in the NHS who were experiencing PD is consistent with gender differences in PD that are observed in the general population of young adults, including young adults with drug use problems (Slade, Grove, & Burgess, 2011). Accordingly, we control for gender when testing multivariable associations between drug use and PD.

Psychological distress and drug use

The unadjusted associations between PD and patterns of drug use (i.e. early initiation and frequent use) are reported for each study in Table 2. A significant association between early Ecstasy use and PD was found in both studies. Early tobacco use and early cannabis use were associated with PD within the NHS but not the EDRS. In regard to frequent drug use, daily tobacco use was the only type of current drug use that was associated with PD, and this unadjusted association was observed in both studies.

Three multivariable prediction models for PD, assessed separately for each study, are presented in Table 2. In Model 1, concerning early initiation to drug use (for Ecstasy, alcohol, tobacco and cannabis), early cannabis use was the only independent predictor of PD in the NHS, while early Ecstasy use was the only independent predictor of PD in the EDRS. The unadjusted effects of early Ecstasy and early tobacco use, observed within the NHS, were attenuated in this model.
In Model 2, concerning frequent drug use (for Ecstasy, alcohol, tobacco and cannabis), daily tobacco use remained the only significant predictor of PD. The estimates pertaining to frequent use of other drug types, including Ecstasy and cannabis, were reduced in this model. In addition, the magnitude of association between daily tobacco use and PD was considerably greater in the EDRS compared to the NHS.

Model 3 is a combined model of PD that only includes early initiation and frequent drug use variables that were significant in any of the previous models. In this model daily tobacco use is associated with PD in both studies, with the magnitude of association stronger in the EDRS. The only early initiation variable that independently predicted PD was early cannabis use, and this association was only observed in the NHS. The effect of early Ecstasy use, observed in the EDRS, was attenuated with the inclusion of daily tobacco use in this model. Additional analyses showed that, within the EDRS, those who commenced Ecstasy use early (i.e. < 17 years of age) were far more likely than later initiates to be daily tobacco users in early adulthood (56.6% vs. 31.5%; $\chi^2=17.2, p < 0.001$).

### TABLE 2 ABOUT HERE

**DISCUSSION**

We examined associations between drug use patterns and psychological distress (PD) among Ecstasy users in two Australian community studies to assess whether different sampling methods would yield comparable results. In addition to Ecstasy, we examined the use of alcohol, tobacco and cannabis, which are commonly associated with Ecstasy use. Moreover, we considered two important and interrelated aspects of drug use: frequency of use and age of drug use initiation. The study adds to the literature concerning Ecstasy use by showing a consistent association between daily tobacco smoking and PD across both a purposive sample and a population sample of Ecstasy users. Given the high rates of tobacco smoking among...
Ecstasy users, the associations between Ecstasy use and PD that have been observed in earlier studies could reflect underlying associations between tobacco use and both PD and Ecstasy use. With regard to Ecstasy use specifically, our findings indicate that early initiation to Ecstasy use is a more robust indicator of PD among young adult Ecstasy users than the frequency with which they useEcstasy. This suggests that it is the characteristics of those who initiate Ecstasy use early rather than Ecstasy use per se that are associated with PD.

The association between tobacco use and PD is well documented, as is the association between levels of tobacco use and other drug use, but the nature and implications of any such associations pertaining to Ecstasy use have not previously been adequately addressed. Prospective research has indicated that the relationship between PD and frequent tobacco use may be reciprocal, with early PD leading to smoking initiation but smoking also exacerbating levels of ongoing PD into adulthood (Orlando, Ellickson, & Jinnett, 2001; Patton et al., 1998). However, there is also strong evidence that much of the association between tobacco use and PD is not causal, originating instead from common factors in childhood and adolescence (e.g. family relationships, school performance and adverse circumstances) that predispose individuals to both outcomes (Breslau, Kilbey, & Andreski, 1993; Fergusson, Goodwin, & Horwood, 2003).

In this context, it is of interest that there was a significant association between young adult Ecstasy users’ PD and, respectively, adolescent Ecstasy initiation in the EDRS and adolescent cannabis initiation in the NHS. Although daily tobacco smoking in early adulthood was the factor most strongly associated with PD for these Ecstasy users, it is clear that this tobacco use is just one element of longer-term trajectories of drug use that are linked to PD. Participants’ early drug use exposure is likely to have been brought about by childhood and adolescent factors that could have also predisposed the participants to PD.
(Spooner, 1999). This does not rule out the possibility that their drug use may have contributed to the PD.

These findings raise questions regarding the validity of research concerning the mental health of Ecstasy users that focuses primarily on Ecstasy use patterns to the exclusion of other illicit and licit drug use, especially tobacco use. Many studies linking Ecstasy use with psychological problems have not controlled for other drug use, while others have only controlled for the use of illicit drugs (Guillot, 2007). Additionally, the findings of the present study highlight the limitations of studies that only focus on current patterns of drug use. Associations between Ecstasy users’ current patterns of drug use and their mental health might be a proxy for more complex associations involving long-term drug use trajectories.

Considered together, the findings from the purposive (EDRS) and population (NHS) samples provide some guidance regarding appropriate preventative health programs for young adult Ecstasy users. The NHS findings indicate that more than one-third of young adults who use Ecstasy recurrently (defined as using 3 or more times in the past year) are daily tobacco smokers. This suggests that young adult Ecstasy users are an important population for smoking cessation initiatives. However, to maximize the prospects of success any such initiatives must take into account the PD experienced by these young adults (Orlando, et al., 2001). The EDRS findings indicate that, compared to other Ecstasy users, these daily tobacco smokers could have five times the relative odds of experiencing clinically significant PD. Thus, the targeting of smoking behavior among Ecstasy-using populations may provide an opportunity not only to address harmful tobacco use but to reduce, through timely intervention, the impact of young people’s psychological problems.

There are many large drug use studies that purposively recruit participants, including those like the EDRS which collect data for monitoring drug use patterns (Griffiths, Vingoe,
Hunt, Mounteney, & Hartnoll, 2000; Mounteney, Fry, McKeeganey, & Haugland, 2010). This study provides insight regarding the potential for different sampling methods, including purposive sampling, to provide similar results with regard to relevant associations in Ecstasy (and other illicit drug) research. Sampling in the NHS is population based and intended to provide population estimates of drug use behavior. Sampling in the EDRS is selective and targets volunteers who are frequent users. Data taken from such samples is not intended to provide population estimates of drug use behavior. Indeed, key parameters of the two samples, such as educational participation and involvement in de facto relationships or marriage, were significantly different. However, our findings suggest that both study designs may produce relevant estimates of internal associations. While the estimates of the magnitude of some associations differ, the key findings regarding daily tobacco use and early drug use initiation are broadly consistent. The EDRS involves a sample of more frequent Ecstasy users who may have higher rates of PD and other drug use. Such a sample could be expected to provide a stronger estimate of association than does a population sample. In particular, the estimate of risk of PD for daily tobacco smokers in the EDRS was higher than the corresponding estimate in the NHS (odds ratio: 4.70 vs. 2.16).

LIMITATIONS

There are several limitations of our comparative analysis. Firstly, although the two studies comprised relatively large samples of Ecstasy users (N > 300), the statistical power to detect small differences was limited. Secondly, there were some differences between the studies. The NHS is based in the state of Queensland whereas the EDRS is a national study. Nonetheless, in the EDRS there was no significant variation between Australian states regarding the proportions reporting PD or frequent Ecstasy use. There were also measurement differences, with the K10 used in the EDRS and the HADS in the NHS. Consequently, the prevalence of PD was not directly comparable (Sumnall & Cole, 2005;
Verheyden, et al., 2003). However, the consistent associations found across the studies suggest that the two instruments were measuring the same construct. Finally, all analyses presented in this paper are cross-sectional and based on self-report data collected during early adulthood (ages 19 to 23 years). Consequently, it is not possible to establish the causal nature of the observed associations, and these associations could be subject to change as participants continue to use. Young adults’ recollection of their first drug use may also be subject to recall bias, which could have resulted in some misclassification of participants into early vs. later drug use initiation categories.

CONCLUSIONS

Our comparative analysis of purposive and population-based samples indicates that psychological distress among young adult Ecstasy users is primarily associated with daily tobacco use in early adulthood, and is also linked with long-term trajectories of drug use that commence in adolescence. More than one-third of the young adult Ecstasy-using population in Australia smoke tobacco daily. Young adult Ecstasy users are an important target population for integrated smoking cessation and mental health initiatives. Our findings also show that the age at which Ecstasy and other drugs are first used is a stronger marker of psychological distress than the frequency of Ecstasy use. Future research concerning the mental health of Ecstasy users should take into account not only Ecstasy users’ patterns of other illicit drug use, but also their patterns of licit drug use and the age at which they first use various drugs. The present study demonstrates that the complementary use of data sources obtained through different sampling methods can provide meaningful information regarding the stability, magnitude and community-level implications of associations pertaining to Ecstasy use.
References


TABLE 1. Demographic characteristics, by sex and study group

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<th>N&lt;sup&gt;b&lt;/sup&gt;</th>
<th>Mean Age (SD)&lt;sup&gt;c&lt;/sup&gt;</th>
<th>% Married/De facto</th>
<th>% Living with parents</th>
<th>% Completed Year 12 / Tertiary&lt;sup&gt;d&lt;/sup&gt;</th>
<th>% Employed</th>
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<td>20.9 (1.2)</td>
<td>9.9</td>
<td>66.9</td>
<td>89.0</td>
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<td>EDRS</td>
<td>215</td>
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<td>2.3&lt;sup&gt;**&lt;/sup&gt;</td>
<td>47.9&lt;sup&gt;***&lt;/sup&gt;</td>
<td>91.2</td>
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<td>89.2</td>
<td>88.0</td>
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<td>21.0 (1.4)</td>
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<td>35.4&lt;sup&gt;***&lt;/sup&gt;</td>
<td>93.8</td>
<td>80.6</td>
<td>11.1&lt;sup&gt;***&lt;/sup&gt;</td>
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<sup>a</sup> Values are percentages, except as specified;  
<sup>b</sup> Number within each study group;  
<sup>c</sup> Mean reported with standard deviation in parenthesis;  
<sup>d</sup> Year 12 is final year of secondary school, and tertiary education includes trade qualifications.  
* p < 0.05, ** p < 0.01, *** p < 0.001
TABLE 2. Prediction models of psychological distress (PD) for each study group, reporting odds ratios, with age of first drug use and frequent drug use as predictors\(^a\)

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<tr>
<th></th>
<th>N exposed</th>
<th>N not exposed</th>
<th>% with PD – exposed</th>
<th>% with PD – not exposed</th>
<th>Unadjusted (95% CI)</th>
<th>Adjusted – Model 1 (95% CI)(^d)</th>
<th>Adjusted – Model 2 (95% CI)(^e)</th>
<th>Adjusted – Model 3 (95% CI)(^f)</th>
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<td><strong>Natural History Study (N=339)</strong></td>
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<td>Early initiation(^b)</td>
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<tr>
<td>Early Ecstasy use</td>
<td>58</td>
<td>281</td>
<td>20.7</td>
<td>10.7</td>
<td>2.18 (1.04-4.57)*</td>
<td>1.32 (0.52-3.31)</td>
<td>0.98 (0.40-2.41)</td>
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<td>Early alcohol use</td>
<td>48</td>
<td>291</td>
<td>16.7</td>
<td>11.7</td>
<td>1.51 (0.65-3.50)</td>
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<td>Early tobacco use</td>
<td>65</td>
<td>274</td>
<td>20.0</td>
<td>10.6</td>
<td>2.11 (1.03-4.34)*</td>
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<td>Early cannabis use</td>
<td>54</td>
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<td>25.9</td>
<td>9.8</td>
<td>3.21 (1.56-6.62)**</td>
<td>3.01 (1.19-7.64)*</td>
<td>2.67 (1.13-6.32)*</td>
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<td><strong>Frequent use(^c)</strong></td>
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<td>Weekly Ecstasy use</td>
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<td>308</td>
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<td>13.0</td>
<td>0.46 (0.11-2.01)</td>
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<td>322</td>
<td>5.9</td>
<td>12.7</td>
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<td>Daily tobacco use</td>
<td>125</td>
<td>214</td>
<td>19.2</td>
<td>8.4</td>
<td>2.59 (1.34-4.99)**</td>
<td>2.53 (1.23-5.17)*</td>
<td>2.16 (1.05-4.42)*</td>
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</tr>
<tr>
<td>Daily cannabis use</td>
<td>29</td>
<td>310</td>
<td>24.1</td>
<td>11.3</td>
<td>2.50 (1.00-6.28)</td>
<td></td>
<td>1.98 (0.70-5.58)</td>
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</tr>
<tr>
<td><strong>EDRS (N=359)</strong></td>
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<td></td>
</tr>
<tr>
<td>Early initiation(^b)</td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Early Ecstasy use</td>
<td>83</td>
<td>276</td>
<td>19.3</td>
<td>8.3</td>
<td>2.63 (1.31-5.25)**</td>
<td>3.07 (1.39-6.76)**</td>
<td>2.01 (0.91-4.42)</td>
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<tr>
<td>Early alcohol use</td>
<td>68</td>
<td>291</td>
<td>16.2</td>
<td>9.6</td>
<td>1.81 (0.85-3.85)</td>
<td>1.95 (0.78-4.90)</td>
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<tr>
<td>Early tobacco use</td>
<td>54</td>
<td>305</td>
<td>11.1</td>
<td>10.8</td>
<td>1.03 (0.41-2.59)</td>
<td>0.51 (0.16-1.61)</td>
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<tr>
<td>Early cannabis use</td>
<td>58</td>
<td>301</td>
<td>12.1</td>
<td>10.6</td>
<td>1.15 (0.48-2.76)</td>
<td>1.05 (0.52-2.12)</td>
<td>0.78 (0.29-2.11)</td>
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<tr>
<td><strong>Frequent use(^c)</strong></td>
<td></td>
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</tr>
<tr>
<td>Weekly Ecstasy use</td>
<td>103</td>
<td>256</td>
<td>15.5</td>
<td>9.0</td>
<td>1.86 (0.94-3.69)</td>
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<td>1.68 (0.81-3.46)</td>
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<tr>
<td>Daily alcohol use</td>
<td>13</td>
<td>346</td>
<td>7.7</td>
<td>11.0</td>
<td>0.68 (0.09-5.34)</td>
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<td>0.39 (0.05-3.28)</td>
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</tr>
<tr>
<td>Daily tobacco use</td>
<td>134</td>
<td>225</td>
<td>20.9</td>
<td>4.9</td>
<td>5.14 (2.46-10.72)***</td>
<td>5.50 (2.56-11.81)***</td>
<td>4.70 (2.19-10.08)***</td>
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</tr>
<tr>
<td>Daily cannabis use</td>
<td>51</td>
<td>308</td>
<td>13.7</td>
<td>10.4</td>
<td>1.37 (0.57-3.30)</td>
<td></td>
<td>0.78 (0.31-1.58)</td>
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</tr>
</tbody>
</table>

\(^a\) Reporting odds ratio with 95% confidence interval. PD measured using K10 in NDSHS and EDRS, and HADS in NHS. \(^b\) Early drug use initiation is < 13 years for alcohol and tobacco, < 14 years for cannabis, and < 17 years for Ecstasy; later drug use initiation (including never used) is the reference category; \(^c\) For Ecstasy, less often than weekly use is the reference category, and for the other drugs, less than daily use (including not used) is the reference category; \(^d\) Model 1 is early initiation model, with adjustment for all early drug use variables and gender; \(^e\) Model 2 is frequent drug use model, with adjustment for all frequent drug use variables and gender; \(^f\) Model 3 is combined model, with adjustment for all included variables and gender.

\* p < 0.05 level, \** p < 0.01 level, \*** p < 0.001
**GLOSSARY**

*Population sampling:* Sampling members of a specified population who each have a known probability of inclusion in the sample. This generally requires the use of a sampling frame (e.g. municipal register) of the population from which the sample is drawn. This is sometimes not possible when the behavior of interest is rare or illegal or both. In the Natural History Study, a random selection of the target population (i.e. young adults) was screened for their drug use behavior to develop a sampling frame.

*Psychological distress:* Psychological distress is a subjective emotional state which can be characterized as being at the opposite end of an emotional continuum from psychological wellbeing. In this study it is measured in terms of symptoms of anxiety and depression, but it can also manifest in the form of other emotions such as anger and shame.

*Purposive sampling:* A form of sampling in which participants are selected on the basis of possessing a certain attribute (e.g. frequent drug use) or set of attributes which are relevant to the objectives of a study. Purposive samples are often drawn from groups of research volunteers recruited through non-random methods such as advertising and word-of-mouth.