

A longitudinal study of the association of adolescent polydrug use, alcohol use and high school non-completion

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ABSTRACT

Aims Failure to complete high school predicts substantial economic and social disadvantage in adult life. The aim of this study was to determine the longitudinal association of mid-adolescent polydrug use and high school non-completion, relative to other drug use profiles. **Design** A longitudinal analysis of the relationship between polydrug use in three cohorts at grade 9 (age 14–15 years) and school non-completion (reported post-high school). **Setting** A State-representative sample of students across Victoria, Australia. **Participants** A total of 2287 secondary school students from 152 high schools. The retention rate was 85%. **Measurements** The primary outcome was non-completion of grade 12 (assessed at age 19–23 years). At grade 9, predictors included 30-day use of eight drugs, school commitment, academic failure and peer drug use. Other controls included socio-economic status, family relationship quality, depressive symptoms, gender, age and cohort. **Findings** Three distinct classes of drug use were identified—no drug use (31.7%), mainly alcohol use (61.8%) and polydrug use (6.5%). Polydrug users were characterized by high rates of alcohol, tobacco and cannabis use. In the full model, mainly alcohol users and polydrug users were less likely to complete school than non-drug users [odds ratio (OR) = 1.54, 95% confidence interval (CI) = 1.17–2.03] and OR = 2.51, 95% CI = 1.45–4.33, respectively, $P < 0.001$]. These effects were independent of school commitment, academic failure, peer drug use and other controls. **Conclusions** Mid-adolescent polydrug use in Australia predicts subsequent school non-completion after accounting for a range of potential confounding factors. Adolescents who mainly consume alcohol are also at elevated risk of school non-completion.

Keywords Adolescent, alcohol use, education level, longitudinal, polydrug use, school non-completion, tobacco use.

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INTRODUCTION

International research shows consistently that high school non-completion is related to lower subsequent participation in paid work, fewer employment opportunities and lower engagement in further education [1–4]. Average rates of high school non-completion in western countries vary from 9 to 27% [2,5,6]. It is important to identify modifiable determinants of school non-completion to prevent poor educational, health and occupational outcomes. This study focuses on the association between patterns of adolescent substance use and school non-completion.

To date, research has focused primarily on cannabis and alcohol use which, along with tobacco, are the drugs

most often used by adolescents [7]. Research shows a consistent association between adolescent cannabis use and school non-completion [8–13]. Larger effects are found in young people from socio-economically disadvantaged backgrounds compared to those from advantaged backgrounds [12,14]. The association between alcohol use and school non-completion is less clear [15]. Alcohol use also predicts subsequent disconnection from school and poorer academic performance [16,17], but the strength of these associations varies with peer alcohol use [18], and these associations often become statistically non-significant after controlling for family background [17]. Alcohol use [12] and frequent intoxication [19] do not predict school non-completion, after controlling for

cannabis use, tobacco use and demographic variables. Tobacco use is also associated with school non-completion [12,17,20,21], with effect sizes smaller than those for cannabis. Other illicit drug use has been found to reduce grade level attainment by 1 year [22].

Mechanisms linking drug use and school performance probably vary by drug type. In the case of cannabis, poor educational outcomes may reflect its negative effects on neuropsychological/cognitive functioning [23–25], as well as a social component, in which users affiliate with deviant and drug-using peers [26] who foster ‘anticonventional’ attitudes and behaviours, including the devaluation of education [21]. In the case of alcohol, ‘hangovers’ result in poorer school attendance and classroom performance [27,28] and increased connection with antisocial peers [29]. The effects of tobacco use relate to health rather than educational outcomes, but peer influences are well established [30]. Drug use may be a marker of engagement with high-risk groups [31] and of school disengagement [32,33] that undermines school outcomes.

There is little longitudinal research on the extent to which polydrug use (defined as the consumption of more than one type of drug during a specific time-period [34]) is related to school non-completion. The available research has focused on communalities in drug use profiles across individuals, with findings indicating that polydrug use is not related significantly to school outcomes [20]. However, more recent studies indicate that adolescents vary in the extent and nature of polydrug use, and school non-completion may be more related to certain drug use profiles than others. Nationally representative studies show that between approximately 18 and 34% of adolescents (<16 years of age) report limited polydrug use (alcohol, tobacco and cannabis) and approximately 2% engage in more extended polydrug use (using these drugs plus other illicit drugs) [35–37]. Adolescent polydrug use may be associated more closely with school non-completion than individual drug use for at least two reasons. First, given legislative, educational policy and normative constraints on adolescent substance use, adolescent polydrug use may be an indicator of stronger anticonventional attitudes and behaviour than any single type of drug use. Secondly, large-scale cross-sectional research shows that adolescent polydrug users report more drug use among peers and more depressed mood than non-polydrug users [36]. These factors are likely to be related to poorer school performance.

This study examined whether adolescent polydrug use predicted school non-completion, after accounting for known confounding factors. Adolescents in middle high school (grade 9, age 14) were the focus, because in Australia cannabis use is comparatively rare before this age and cannabis use around this age is more predictive of school non-completion than use at older ages [12]. Tobacco use

[38–40] and heavy alcohol [41] use also increase in prevalence at this age. The study was conducted in two phases. In the first phase, latent class analysis (LCA) was used to classify individuals according to unobserved communalities in patterns of substance use [42]. LCA is a ‘person-centred’ analytical approach [42] that avoids the well-documented statistical challenges of distinguishing specific drug effects, given high collinearities in the use of different drugs [21]. In the second phase, we used the results of the LCA to examine the association between polydrug use and subsequent school non-completion in three longitudinal cohorts, and the extent to which socio-educational disengagement accounted for this association. Control factors included: depressed mood, family relationship quality [29,36,43–49], gender [1], age [36], family socio-economic status [12,14,50,51] and cohort differences.

METHOD

Sample

The participants were from the International Youth Development Study (Australia), a longitudinal study of adolescent health and problem behaviours. The study consisted of three cohorts (see Table 1). The youngest cohort ($n = 804$ at grade 9) participated in a seven-wave study from grade 5 (aged approximately 10 years) to post-high school (including grade 9 but excluding grade 8). The middle cohort ($n = 955$ at grade 9) participated in four waves (grades 7–9 and post-high school). The oldest cohort ($n = 973$ at grade 9) participated in three waves (grades 9/10/post-high school). The sample recruited was found to be representative of the school-aged population of Victoria [52].

Measures

Students completed a modified version of the *Communities That Care Youth Survey*, an epidemiological assessment of adolescent health and social problems used in the United States [53]. Minor language adaptations were made to fit it to Australian youth [52]. Psychometric analyses confirmed the reliability and longitudinal correlations confirmed the validity of these measures in Australian samples [54].

The key outcome variable was non-completion of grade 12 (assessed in the final wave). This was assessed with the item: ‘What was the highest grade level at secondary school you completed?’. Responses were coded as 0 ‘completed grade 12’ or 1 ‘not completed grade 12’.

The following predictors were measured at grade 9. Drug use was measured via questions on past-month use of tobacco (‘not at all’ to ‘40+ per day’), alcohol, cannabis,

Table 1 Cohort map of the International Youth Development Study (IYDS).

	<i>Cohort</i>			
	<i>Year</i>	<i>Youngest</i>	<i>Middle</i>	<i>Oldest</i>
Wave 1	2002	Grade 5	Grade 7	Grade 9
Wave 2	2003	Grade 6	Grade 8	Grade 10
Wave 3	2004	Grade 7	Grade 9	
Wave 4	2006	Grade 9		
Wave 5	2007	Grade 10		
Wave 6	2008	Grade 11		
Wave 7	2010	Age 19	Age 21	Age 23
<i>n</i> at grade 9		804	955	973
<i>n</i> at wave 7		727	814	788
Retention rate (from grade 9 to wave 7) ^a		90.4%	85.2%	81.0%
Demographic at grade 9 ^b				
Age		15.15	14.99	14.89
% female		51.5%	51.1%	52.2%
% students from				
Government schools		61.4%	62.1%	22.4%
Independent schools		16.2%	16.3%	21.6%
Catholic schools		22.4%	14.1%	22.7%

Bold text shows the wave used in the present study.

stimulants, ecstasy, glue/inhalants, lysergic acid diethylamide (LSD)/other psychedelics and cocaine/crack ('never' to '40+ times'). Response categories were recoded because of the low frequencies in the heaviest categories of use. Tobacco use was recoded to four categories from 'not at all' to '6+ per day'. Alcohol and cannabis use were recoded to four categories from 'never' to '6+ times' (past month). Use of other drugs was recoded to 'no' and '1+ times' (past month).

Academic failure was measured by two items: 'Putting them all together, what were your grades/marks like last year?' (1, 'very good' to 4, 'very poor') and 'Are your school grades better than the grades/marks of most students in your class?' (1, 'definitely yes' to 4, 'definitely no') ($r = 0.59$).

School commitment was measured with seven items (1, 'never' to 5, 'always', $\alpha = 0.78$) (e.g. 'During the last 4 weeks, how often do you feel the school work you are assigned is meaningful and important?').

Peer drug use was assessed with: 'In the past year, how many of your best friends have used (alcohol/tobacco/marijuana/other illegal drugs)?' (five-point scale, $\alpha = 0.75$) [55].

Depressive symptoms were measured using the 13-item Short Mood and Feelings Questionnaire [56] ($\alpha = 0.91$).

Family conflict, attachment and family management were measured using separate four-point scales with established validity [57–59] (e.g. 'We argue about the same things in my family over and over', 'Do you feel very close to your mother?', 'My parents ask if I've gotten my homework done') ($\alpha > 0.70$ for all three scales).

Family socio-economic status (SES) was based on an algorithm of mother/father education and income with known validity/reliability, based on parent telephone interviews conducted in the first year of the study (2002) [60,61].

A measure of honesty was calculated based on student responses to three survey items, including use of a fictional drug, as described previously [62].

Procedure

Approval for the research was obtained from the Ethics Committees of the Royal Children's Hospital and the University of Melbourne. The study used a two-stage cluster sampling design. In the first stage, public and private schools in Victoria, Australia were selected randomly via probability proportional to size sampling. A total of 234 schools were approached and 152 agreed to participate [53]. In the second stage, a single classroom was selected randomly. The three cohorts all participated in wave 1 in 2002, and the final assessment (post-high school) was conducted in 2010. Grade 9 surveys were administered by project staff in the classroom [53] and post-high school surveys were completed on-line. Active parental consent was required for participation.

Analysis

LCA was used to determine classes of drug use [63]. Based on existing research on adolescent polydrug use, a non-user class was specified a priori [64]. There is no single approach

that is generally accepted for determining the number of classes for LCA [65], so criteria included the sample size-adjusted Bayesian information criteria (SSABIC) [66] and the Lo–Mendell–Rubin likelihood ratio test (LMR–LRT) [67]. A lower value in SSABIC indicates a better balance between model fit and model parsimony. A significant LMR–LRT *P*-value indicates a better model fit than a model with one fewer classes. Because the robustness and utility of a given class is likely to be low when the size of a class is small, the solution was required to have a minimum class size of 1% [68]. Average posterior probabilities and entropy were used to evaluate classification quality [69]. Model fitting began with a two-class solution and was increased successively to five classes. Mplus version 6.01 [69] was used for the LCA.

Once the optimal number of classes was determined, class memberships were imputed based on the posterior probabilities [70,71]. Fifty data sets were imputed to take into account the probabilistic assignment of class membership and to replace missing values on controls [72]. School non-completion was regressed onto membership of drug classes and controls using logistic regression.

RESULTS

Forty-two participants were excluded because responses suggested dishonest reporting (e.g. reporting use of a bogus drug) at grade 9. A further 15 participants were excluded because of missing data on drug use, and 393 participants were excluded from the logistic regression analysis because of missing data on school completion. The sample for the LCA was 2675 and the sample for logistic regression modelling was 2287 participants (84% of the initial sample). Excluded participants were more likely to be male, to be from the middle/oldest cohorts, to be of low SES, to have more drug-using peers, lower school commitment and lower academic achievement ($P < 0.05$). They did not differ on age, depressive symptoms and family factors.

Prior to the main analyses, attrition rates and associated variations on key socio-demographic variables at grade 9 were assessed. The attrition rates for the three cohorts were consistently low (15%). Retention rates dropped somewhat across the youngest/middle/oldest cohorts, respectively (90.4, 85.2, 81.0%), which was due probably to the progressively larger lapses between the final school assessment and the post-high school assessment (Table 1). There was a small variation in age across the cohorts, reflecting the fact that school assessments occurred at different times of the year. Cohort differences in gender were statistically non-significant.

LCA model fit statistics and minimum group sizes are shown in Table 2. There was a large drop in the SSABIC from the two-class model to the three-class model, and

Table 2 Model fit statistics from the latent class analysis (LCA).

Class	SSABIC	LMR–LRT (<i>P</i> -value)	Minimum class size (% of <i>n</i>)	Entropy
Two	13195.25	< 0.001	35.4	0.81
Three	12694.56	0.0028	6.37	0.769
Four	12641.68	0.76	0.90	0.754
Five	12680.87	0.807	0.90	0.753

Three-class solution chosen as the optimal solution based on sample size-adjusted Bayesian information criteria (SSABIC), Lo–Mendell–Rubin likelihood ratio test (LMR–LRT) and minimum class size.

there was a further small drop in the SSABIC for the four-class model. The LMR–LRT indicated that the fit of the three-class model was significantly better than the two-class model, and the fit of the four-class solution did not improve significantly on the three-class solution. In the three- and four-class solutions, the smallest class sizes were 6.37 and 0.9% ($n = 24$), respectively. The three-class solution had very good classification quality (average posterior assignment probability 0.92, entropy 0.77) (see Tables 2 and 3). Overall, the three-class solution showed the best overall fit, parsimony and robustness/utility.

- Class 1: this was an a priori-specified class in which participants reported no drug use in grade 9 ($n = 847$, 31.7%).
- Class 2: participants in this class reported high probabilities of alcohol use, low but significant probabilities of any tobacco use (0.20) and negligible probabilities of using cannabis and other drugs and inhalants. The modal frequency of tobacco use was less than one cigarette/day. The class was labelled ‘mainly alcohol use’ ($n = 1653$, 61.8%).
- Class 3: there were elevated probabilities of alcohol (0.98), tobacco (0.90) and cannabis use (0.73), and low probabilities of other illicit drug use. This class was labelled ‘polydrug use’ ($n = 175$, 6.5%). Approximately half the participants in this class used tobacco 6+ times/day and used alcohol 6+ times in the last month; 73% used cannabis one or more times in the last month.

We modelled drug class membership and high school non-completion in two steps (Table 4). In model 1, school non-completion was regressed onto drug classes with controls included (gender, age, socio-economic status, family variables, depressed mood, cohort). There were significant effects for ‘mainly alcohol use’ and ‘polydrug use’ on school non-completion [odds ratios (ORs) = 1.93 and 5.42, respectively, $P < 0.001$] compared to the ‘no drug use’ class, and participants in the ‘polydrug use’ class were at significantly higher risk of school non-completion than those in the ‘mainly alcohol’ class (OR = 2.81, $P < 0.001$). In model 2, after other predictors of high school non-completion were added (peer drug use, low

Table 3 Three-class latent class analysis (LCA) model of probabilities of drug use by class.

	Past (30-day) use	Class 1: no drug use (31.7%)	Class 2: mainly alcohol use (61.8%)	Class 3: polydrug use (6.5%)
Alcohol	Never	1	0.17	0.02
	1–2 times	0	0.48	0.20
	3–5 times	0	0.2	0.25
	6 or more times	0	0.14	0.54
Tobacco	Not at all	1	0.80	0.10
	Fewer than 1 per day	0	0.12	0.21
	1–per day	0	0.04	0.24
	6 or more per day	0	0.04	0.45
Cannabis	Never	1	0.98	0.27
	1–2 times	0	0.02	0.38
	3–5 times	0	0	0.08
	6 or more times	0	0	0.27
LSD	No	1	1	0.94
	1 or more times	0	0	0.06
Cocaine	No	1	1	0.96
	1 or more times	0	0	0.04
Inhalants	No	1	0.95	0.83
	1 or more times	0	0.05	0.17
Stimulants	No	1	1	0.88
	1 or more times	0	0	0.12
Ecstasy	No	1	1	0.89
	1 or more times	0	0	0.11

Table 4 Partial and fully adjusted odds ratios [with 95% confidence intervals (CI)] of school completion.

	Model 1 [†]	95% CIs	Model 2 [†]	95% CIs
Drug use class (Ref: class 1: no drug use)				
Class 2: mainly alcohol use	1.93***	(1.42, 2.63)	1.54***	(1.17, 2.03)
Class 3: polydrug use	5.42***	(3.31, 8.89)	2.51***	(1.45, 4.33)
School variables				
Peer's drug use			1.25**	(1.08, 1.43)
Low school connectedness			1.14	(0.91, 1.43)
Academic failure			2.37***	(1.93, 2.90)

[†]Estimates for models 1 and 2 were adjusted for gender, age, socio-economic status, depressed mood, family conflict/attachment/management and cohort (youngest/middle/oldest). Model 1 (the partially adjusted model) does not adjust for school variables (peer drug use, school connectedness and academic failure). In model 1, the following controls were significant: gender, $P < 0.001$; age, $P < 0.01$; socio-economic status (SES), $P < 0.001$; cohort, $P < 0.01$; family management, $P < 0.05$; depressed mood, $P < 0.001$. Model 2 is the fully adjusted model (including the above listed controls as well as the three school variables). In model 2, the controls showed the same significance levels except for family management and depressed mood, which were non-significant. ** $P < 0.01$; *** $P < 0.001$.

school connectedness and academic failure), peer drug use and academic failure were significant ($P < 0.01$). Participants in the 'mainly alcohol' class and the 'polydrug use' class were at higher risk of school non-completion than the 'no drug use' class (OR = 1.54 and 2.51, respectively, $P < 0.001$). Participants in the 'polydrug use' class were at higher risk of school non-completion than those in the 'mainly alcohol' class (OR = 1.62, $P < 0.05$). Both models were adjusted for gender, age, cohort, family variables, depressed mood and socio-economic status (see Table 4). Sensitivity analyses were conducted to assess any effects of relationships between missing data and class membership. The adjusted ORs for the 'mainly alcohol use'

and the 'polydrug use' classes remained statistically significant and changed marginally to 1.38 and 2.24, respectively, after missing school completion data were imputed based on class membership and variables that discriminated between excluded and included cases. This indicates the robustness of the findings to missing data.

In supplementary analyses, we used a more traditional 'variable-centred' approach to examine whether the effect of polydrug use on school completion was related primarily to specific drugs within this class [i.e. alcohol, tobacco, cannabis use entered as independent variables in a $2 \times 2 \times 2$ design, with prevalence (yes/no) used to maximize cell sizes] using logistic regression analyses. There were

major statistical obstacles associated with this type of analysis applied to this data set. Cell sizes were heavily imbalanced (greater than 900 for two cells) and some cells had inadequate *ns* (one or two participants for two cells, between 30 and 40 for two cells). This meant that modelling of the effects of individual drugs on school completion was likely to produce distorted and/or unreliable estimates. We therefore do not report these results.

DISCUSSION

A small but notable proportion of mid-adolescents (6.5%) reported concurrent and frequent use of alcohol, tobacco and cannabis. Relative to non-users and mainly alcohol users, polydrug users were at significantly greater odds of school non-completion. Compared to non-users, those adolescents who mainly used alcohol (61.8% of the sample) also had higher odds of school non-completion. These relationships persisted after controlling for the effects of plausible confounding factors, including established correlates of substance use and school completion. Previous research has pointed to the prognostic importance of engagement with anticonventional subgroups, indicated by variables such as low school commitment, low academic achievement, peer drug use and polydrug use. For the present sample, the results were only partially consistent with this mechanism. Low school commitment was not a predictor of school non-completion, and there was a large effect for polydrug use that was independent of academic achievement. The results suggested that peer drug use partially accounted for the association of polydrug use and school non-completion, but the effect for polydrug use remained statistically significant after accounting for peer drug use.

Despite a longitudinal design, causal inferences are precluded. It remains possible that early vulnerabilities such as child conduct problems, environmental and/or genetic predispositions drive subsequent problems, including low school performance and polydrug use. The present study goes some way towards ruling out earlier-proposed environmental drivers, such as family dysfunction and socio-economic disadvantage [73], because these were controlled at grade 9. Family variables that were controlled included relationship quality (conflict/closeness), and it remains possible that poor parental supervision/monitoring may be important drivers of polydrug use and poor school performance [29,74]. Polydrug users may also be more likely than their peers to be subject to school disciplinary processes (such as suspension and expulsion), which may have long-term negative effects on school outcomes and peer networks [62,75]. Cannabis use was almost exclusively a characteristic of the polydrug use class, so it remains possible that cannabis use was the key agent in the effect for polydrug use. However, most polydrug users

reported relatively low frequencies of cannabis use (one to two times/month), and recent cross-sectional research has found that early cannabis use was not related to school non-completion [73]. For the present data set, regression models examining specific drug effects were severely unbalanced and/or contained inadequate sizes for some drug combinations, so estimates of individual drug effects were considered to be unstable.

We raise some possible implications for prevention cautiously, given that causal directions cannot be established and that effective prevention may not necessarily depend upon addressing original drivers. There was a stepped increase in the risk of school non-completion for adolescents engaging mainly in alcohol use and those engaging in polydrug use, relative to no drug use. If alcohol use and polydrug use increases the risk of school non-completion, universal prevention programmes addressing alcohol and polydrug use may improve school outcomes [76]. While beyond the scope of these data, alcohol use may increase the probability that vulnerable students transit to polydrug use. Given that the majority of the sample were mainly alcohol users, and the likelihood that alcohol acts as a 'gateway' to other drug use in adolescent populations [77], a universal prevention focus on alcohol use may be an important way of improving school completion rates, as well as limiting transitions to polydrug use where the risk of school non-completion is exacerbated. Targeted prevention programmes for mid-adolescent polydrug users may also improve outcomes.

The study capitalizes on three cohorts from a large prospective study, and its 'person-centred' analytical method accounts more effectively for the strong inter-relatedness of drug use patterns in adolescent subgroups than previous variable-centred approaches [42]. The study could not investigate factors occurring before or after age 14 years that may account for the core findings, and the study is limited by its reliance upon self-report.

CONCLUSION

Polydrug use in mid-adolescence predicted school non-completion longitudinally, and this effect was significant after accounting for known strong confounds. The results pointed to the importance of universal prevention programmes for alcohol use and targeted interventions for polydrug use.

Declaration of interests

The authors declare that the material has not been published in whole or in part elsewhere, the paper is not currently being considered for publication elsewhere, all authors have been personally and actively involved in substantive work leading to the report and will hold

themselves jointly and individually responsible for its content, and all relevant ethical safeguards have been met in relation to patient or subject protection. The authors declare that there are no potential conflicts of interest in relation to this study.

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