

The topography of multiple drug use among adolescent Australians: Findings from the
National Drug Strategy Household Survey

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ABSTRACT

Introduction and Aims: Despite evidence that many Australian adolescents have considerable experience with various drug types, little is known about the extent to which adolescents use multiple substances. The aim of this study was to examine the degree of clustering of drug types within individuals, and the extent to which demographic and psychosocial predictors are related to cluster membership. *Design and Method:* A sample of 1402 adolescents aged 12-17 years was extracted from the Australian 2007 National Drug Strategy Household Survey. Extracted data included lifetime use of 10 substances, gender, psychological distress, physical health, perceived peer substance use, socioeconomic disadvantage, and regionality. Latent Class Analysis was used to determine clusters, and multinomial logistic regression employed to examine predictors of cluster membership. *Result:* There were 3 latent classes. The great majority (79.6%) of adolescents used alcohol only, 18.3% were limited range multidrug users (encompassing alcohol, tobacco, and marijuana), and 2% were extended range multidrug users. Perceived peer drug use and psychological distress predicted limited and extended multiple drug use. Psychological distress was a more significant predictor of extended multidrug use compared to limited multidrug use. *Discussion and Conclusion:* In the Australian school-based prevention setting, a very strong focus on alcohol use and the linkages between alcohol, tobacco and marijuana is warranted. Psychological distress may be an important target for screening and early intervention for adolescents who use multiple drugs.

Keywords: adolescent, multidrug use, latent class analysis

1. INTRODUCTION

Adolescence is a high risk period for drug use, particularly alcohol, tobacco and marijuana (AIHW, 2008b; de Looze et al., 2011; Palmer et al., 2009), and the risks associated with the use of these substances is well established (Booth et al., 2010; Department of Health and Human Services, 2004; Ellickson, Tucker, & Klein, 2003; Hall & Solowij, 1998; Swahn, Simon, Hammig, & Guerrero, 2004). Despite evidence that the use of one drug increases the probability of use of other types of drugs (Fergusson, Boden, & Horwood, 2008; Korhonen et al., 2008; van Leeuwen et al., 2011), comparatively little research has examined the prevalence rates of adolescent multiple drug use (broadly defined as the use of two or more drugs either within a given time period). Using latent class analysis on a nationally representative sample of American students (Grades 7-12), Dierker et al. (Dierker, Vesel, Sledjeski, Costello, & Perrine, 2007) identified clusters of ‘low users’ (none or minimal experimentation with alcohol, tobacco or marijuana) (55%); ‘Alcohol users’ (no or little use of any other drugs) (15%); ‘alcohol-marijuana users’ (no or few who had used tobacco) (8%); tobacco users (no or little use of alcohol or marijuana) (8%); and ‘three-substance’ users (heavy smokers, recent drinkers, with large numbers also using marijuana) (14%). Studies like this indicate that the topographies of adolescent drug use are variable and that large proportions of adolescents may use multiple drugs. However, it is not clear how Australian adolescents cluster on the use of different drugs. Available comparisons suggest that young Australians have higher rates of alcohol misuse and lower rates of illicit drug use than in the United States (Evans-Whipp et al., 2004; Evans-Whipp, Bond, Ukoumunne, Toumbourou, & Catalano, 2010; Toumbourou et al., 2005).

LCA - Latent class analysis

LMR-LRT - Lo-Mendel-Rubin likelihood ratio test

BLRT - Bootstrap likelihood ratio test

BIC - Bayesian Information Criterion

AIC - Akaike Information Criterion

SSABIC - Sample Size-Adjusted Bayesian Information Criterion

The primary aim of this study was to examine how young Australians cluster in relation to their use of different drugs. The study also examined the extent to which a variety of demographic and psychosocial variables were related to membership of drug use clusters. Specifically, the objectives of the study were to investigate the relationship of to adolescent multiple drug use (Briere, Fallu, Descheneaux, & Janosz, 2011; Connell, Gilreath, Aklin, & Brex, 2010; Malmberg et al., 2010); the association of psychological distress and multiple use (Connell, et al., 2010; Dierker, et al., 2007; Lynskey et al., 2006; Smith, Farrell, Bunting, Houston, & Shevlin, 2011); investigation of the peer influence in predicting alcohol and tobacco use (Kelly, O’Flaherty, Connor, et al., 2011; Kelly, O’Flaherty, Toumbourou, et al., 2011; Kelly, Toumbourou, et al., 2011) and simultaneous use of alcohol and marijuana (Briere, et al., 2011); and exploration of regionality (distance from major population centres) and community socioeconomic disadvantage concerning alcohol and tobacco use among adolescents (Kelly, O’Flaherty, Connor, et al., 2011; Kelly, Toumbourou, et al., 2011).

2. MATERIAL AND METHOD

2.1. Sample

Sample data were drawn from the Australian *2007 National Drug Strategy Household Survey* (Australian Institute of Health and Welfare, 2008a, 2008c), in which 23,356 people participated. In this survey, households from all states and territories were randomly selected using a multistage stratified design based on statistical local areas (Australian Bureau of Statistics, 2009). Respondents within each geographic stratum were assigned weights to address any disparity as a consequence of survey design or implementation. For each household, the respondent was the household member aged 12 years or older whose birthday was next to occur in the family. Since the present study focused on adolescent drug use, participants who were 18 years old or above were excluded from the analysis. The initial sample data employed in this study consisted of 1,510 participants aged 12-17 years. Of the

initial sample, 108 were excluded from analysis due to non-response to any drug-related items. The final sample size was 1,402. Descriptive statistics of this final sample was shown in Table X.

2.2. Measures

Lifetime tobacco use was assessed with the item ‘Have you ever smoked a full cigarette?’ (yes/no). *Lifetime alcohol use* was assessed with the item ‘Have you ever had a full serve of alcohol?’ (yes/no). *Lifetime use of other drugs* (pain killers, tranquilisers, marijuana, meth/amphetamine, cocaine, hallucinogens, ecstasy, inhalants) was assessed using the item ‘Have you ever used [drug type] for non-medical purposes?’ (yes/no).

Psychological distress was assessed using the Kessler Psychological Distress Scale (Andrews & Slade, 2001), which is a 10-item scale measuring depressive mood in the last month (e.g., In the past 4 weeks, about how often did you feel hopeless? (5-point Likert scale, $\alpha = .86$). *Perceived peer drug use* was assessed with the item ‘About what proportion of your friends and acquaintances use any of the following? Alcohol/ Tobacco/ Marijuana’ (5-point response scale ranging from 1 ‘None’ to 5 ‘All’. Responses were recoded as 0 ‘Less than half’ or 1 ‘Half or more’ for the analyses. *General health* was measured with the item ‘In general, would you say your health is ...’ (1 ‘Excellent’ to 5 ‘Poor’). Due to the low frequency of participants reporting poor health, the categories ‘fair’ and ‘poor’ were combined to form a single category. Other variables assessed were age, gender (0 ‘Male’ 1 ‘Female’), if the participant was still in school (0 ‘Yes’ 1 ‘No’), a quartiled index of socioeconomic disadvantage (ABS, 2009) (derived from Australian 2006 Census variables related to disadvantage - low income, low educational attainment, unemployment, and dwellings without motor vehicles) and regionality (1 ‘Major cities’; 2 ‘Inner regional’; 3 ‘Outer regional’; 4 ‘Remote or very remote’).

2.3. Procedure

Sample data were drawn from the Australian *2007 National Drug Strategy Household Survey* (Australian Institute of Health and Welfare, 2008a, 2008c), in which 23,356 people participated. In this survey, households from all states and territories were randomly selected using a multistage stratified design based on statistical local areas (Australian Bureau of Statistics, 2009). Respondents within each geographic stratum were assigned weights to address any disparity as a consequence of survey design or implementation. For each household, the respondent was the household member aged 12 years or older whose birthday was next to occur in the family.

Survey data collection modes included both drop and collect ($n = 19,818$ respondents) and computer-assisted telephone interview ($n = 3,538$). For the drop and collect method, self-completion questionnaire booklets were delivered to and collected from households (where the questionnaire could not be collected, a reply-paid pre-addressed envelope was provided and where necessary a reminder telephone call was made). The computer-assisted telephone interviews were conducted from a national random selection of households. For both survey methods signed parent/guardian consent was required for persons under the age of 15 years. The survey was approved by the Australian Institute of Health and Welfare Health Ethics Committee. The Centre for Youth Substance Abuse Research was granted access to the survey data by the Australian Social Science Data Archive and the research approved by the University of Queensland Human Research Ethics Committee.

2.4. Analysis

The model of analysis focused on four main areas. Based on prior research, gender was included in the model, given inconsistent findings concerning the relationship of gender to adolescent multiple drug use (Briere, Fallu, Descheneaux, & Janosz, 2011; Connell, Gilreath,

Aklin, & Brex, 2010; Malmberg et al., 2010). The model also included psychological distress as some research points to the association of mental health and multiple use (Connell, et al., 2010; Dierker, et al., 2007; Lynskey et al., 2006; Smith, Farrell, Bunting, Houston, & Shevlin, 2011). Perceived peer drug use was also included because peer influences are among the strongest predictors of alcohol and tobacco use (Kelly, O’Flaherty, Connor, et al., 2011; Kelly, O’Flaherty, Toumbourou, et al., 2011; Kelly, Toumbourou, et al., 2011) and simultaneous use of alcohol and marijuana (Briere, et al., 2011). Finally, we controlled for regionality (distance from major population centres) and community socioeconomic disadvantage, given that these factors have been associated with alcohol and tobacco use among adolescents (Kelly, O’Flaherty, Connor, et al., 2011; Kelly, Toumbourou, et al., 2011).

To identify patterns of multiple substance use, latent class analysis (LCA) was performed on the lifetime use of 10 drugs: tobacco, alcohol, pain-killers, tranquillizers, meth/amphetamine, marijuana, cocaine, hallucinogens, ecstasy and inhalants. LCA is a technique that identifies sub-classes within a large population based on similarity of responses to measured variables (Hagenaars & McCutcheon, 2002). This technique is characterized by two sets of parameters: (1) The estimated proportion of each class in the population and (2) the probability of an individual in a particular class using a certain drug. Determination of the correct number of classes was based on a number of fit criteria. In this analysis, model selection was based on two sets of criteria – Information Criteria and Likelihood-based tests. The first set of criteria involved likelihood-based tests. In this analysis the Lo-Mendel-Rubin likelihood ratio test (LMR-LRT)(Lo, Mendell, & Rubin, 2001) and the bootstrap likelihood ratio test (BLRT) (McLachlan & Peel, 2000) were employed. A significant p values (<.05) from these tests indicates that a given model fits the data better than a model with one less class. The second set of criteria was information criteria that select a model by balancing the

competing goal of maximizing the likelihood function and keeping the model parsimonious. The Bayesian Information Criterion (BIC) (Schwarz, 1978), the Akaike Information Criterion (AIC) (Akaike, 1974) and the Sample Size-Adjusted Bayesian Information Criterion (SSABIC) (Yang, 2006) were used. Model fitting began with a 1-class solution, and the number of classes was increased successively up to a 6-class solution. Once the optimal number of classes was determined, correlates of latent class membership were examined with a multinomial logistic regression. In this study, data was prepared with STATA 11 (StataCorp, 2009) and analyses were performed with Mplus 6.01 (Muthen & Muthen, 2011).

3. RESULTS

The life time prevalence of different drug use were shown in Table X. The most commonly used drug was alcohol and 51.86% of the participants reported life time alcohol use. Cigarette and marijuana were the second and third commonly used drug among adolescent and the prevalence were 16.48% and 11.06% respectively. The prevalence of other drugs were less than 10%.

3.1. Latent class analysis

Model fit statistics for 1-6 class solutions are presented in Table 1. A three-class solution attained the lowest AIC, BIC and SSABIC value and significant p-values from the LMR-LRT and BLRT. Although the p-value from LMR-LRT was also significant for a four-class solution, suggesting that a four-class solution might be appropriate, a simulation study (Nylund, Asparouhov, & Muthén, 2007) showed that LMR-LRT tended to overestimate the number of classes. A three-class model was chosen as the best fitting model as the majority of indicators supported the three-class solution over the four-class solution, the average assignment probabilities were very high (see Table 2), and the classification of the three-class model was considered conceptually reasonable.

Insert Table 1 here

Insert Table 2 here

To name each class within the three-class solution, probabilities of lifetime use for each drug were mapped for each of the three classes (see Figure 1).

Class 1: Participants in class 1 were either alcohol users or non-users. These participants had a 0.4 probability of alcohol use, essentially zero tobacco use, and a negligible probability of using any illicit drug (less than 0.005). The class was labeled *no multiple drug use*, and the prevalence estimate of this class was 79.6% ($n = 1,116$).

Class 2: These participants reported very high probabilities of alcohol use (0.97), tobacco smoking (0.77), and elevated probability of marijuana use (0.50), but only a small probability of ecstasy use (0.05), and negligible use of other drug types (less than 0.03). This class was labeled *limited range multiple drug use*, and the prevalence estimate of this class was 18.3% ($n = 257$).

Class 3: These participants universally reported use of alcohol and tobacco (probability 1.00), very high probability of marijuana use (0.96), high probabilities of painkiller, amphetamine and ecstasy use (0.40-0.77), and smaller probabilities of tranquilizer, cocaine, hallucinogen and inhalant use (0.20-0.30). This class was labeled *extended range multiple drug use*, and the prevalence estimates of this class was 2.0% ($n = 28$).

Insert Figure 1 about here

3.2. Multinomial logistic regression

In this analysis, all predictors were entered into a multinomial logistic regression with class membership as the dependent measure and the *no multiple drug use* class was used as the referent class. The *no multiple drug use* class and *limited range multiple drug use* class were sufficient in size for this type of analysis. The number of participants in the *extended range multiple drug use* class was small ($n = 28$). The small cell size for this class may result in a large confidence interval for the estimates which decreases statistical power to detect effect and results in the potential instability of estimates. Given the focus of this study was on empirical identification of drug use classes and a review of the data revealed three very different patterns of multiple drug use, it was decided to retain the three identified classes rather than collapsing the *extended range multiple drug use* class with the *limited range multiple drug use* class.

Results from the logistic regression are presented in Table 3. Relative to the *no multiple drug use* class, membership in the *limited range multiple drug use* class was significantly associated with suboptimal general health ($ps < .05$) and living in an outer or remote regional area ($ps < .05$). Both memberships in the *limited range* and *extended range multiple drug use* classes were significantly associated with self-reported age ($p < .001$), distress ($p < .001$) and perceived peer drug use ($ps < .001$). Comparison of the 95% confidence of the relative risk ratios revealed that the association between psychological distress and the membership in the *extended range multiple drug use* class (95% CI: 1.11 – 1.25) was stronger than that between psychological distress and membership in the *limited range multiple drug use* class (95% CI: 1.01 - 1.08). Gender, attendance at school and

socioeconomic indices for areas, were unrelated to membership in either multiple drug use classes. For the *extended range multiple drug use* class, the CIs for non-significant variables (including general health and regionality) were large relative to the estimates in the *limited range multiple drug use* class, so it remains possible that these effects may have been significant had our sample size been larger. While the results for non-significant predictors must be treated with caution, the findings for age and psychological distress appeared relatively robust as their standard errors were small and the confidence intervals were far away from zero.

 Insert Table 3 about here

4. DISCUSSION

There has been a paucity of population-based research investigating multiple substance use. This study focuses on adolescents and is the first known examination of the profile of multiple substance use by 12 to 17 year old youth. It specifically explores how the use of various types of drugs clustered together. A three class solution was identified as the best explanation of the pattern of multiple drug use among the young people in this sample. A somewhat similar class solution is reported by Smith et al (2011), although the British study was drawn from an adult population sample, reports only the last year of use, and the LCA was conducted using illicit substances. Consequently the proportions are different to that of the present study.

In our youth-based study, the classes were characterised as *no multiple drug use* (limited alcohol use only), *limited range multiple drug use* (mostly alcohol, tobacco and marijuana), and *extended range multiple drug use* (very high probability of marijuana use and

high probability of tranquilizer, cocaine, hallucinogen and inhalant use). Significant predictors of *limited range multiple drug use* included self-reported age, suboptimal general health, and living in an outer or remote regional area. Memberships in both the *limited range and extended range multiple drug use* class were significantly associated with psychological distress and perceived peer drug use, with the association strongest between psychological distress and membership in the *extended range multiple drug use* class.

The significant effect for age on *limited range and extended range multiple drug use* class membership relative to *no multiple drug use* membership, is consistent with the possibility that adolescents who are older tend to have a more extended drug use repertoire than younger adolescents. Studies based on adolescent populations show that the use of one substance is associated with an increased likelihood of concurrent or subsequent use of other substances. In particular, tobacco and alcohol use separately predict cannabis use (Fergusson, et al., 2008; Korhonen, et al., 2008), and comorbid use of alcohol and tobacco predicts subsequent cannabis use independent of preceding singular drug use (either alcohol or tobacco) (van Leeuwen, et al., 2011). It also remains possible that both *limited range multiple drug use* and *extended range multiple drug use* arise from a common liability (e.g., proneness to deviancy and family liabilities to addiction) (van Leeuwen, et al., 2011), though such variables were not available for analysis in this study.

The findings of an association between psychological distress, perceived peer drug use and membership in the *limited and extended range multiple drug use* classes, are generally consistent with the research. Previous studies have shown that poor physical and mental health (Smith, et al., 2011) and engagement with peers who use drugs (Kelly, O'Flaherty, Connor, et al., 2011; Kelly, O'Flaherty, Toumbourou, et al., 2011), may contribute to the risk of adolescents expanding their use of drug types. In particular, psychological distress may be an important correlate of adolescents' expansion of drug types

into the illicit range. This is particularly salient given the finding in the present study that psychological distress was most strongly associated membership in the *extended range multiple drug use* class.

This study is limited as it is cross-sectional and therefore conclusions about the aetiology of multiple drug use or transitions from use of a specific drug to multiple drug use are not possible. In addition, the size of the *extended range multiple drug use* group was small ($n = 28$), which may have limited the statistical power to detect significant effects, and the original survey was not designed specifically for this study, so other variables outside the scope of this study are likely to be important in predicting multiple class membership.

Another consideration is that the study used a relatively liberal definition of multiple drug use (use of two or more drugs in a participant's lifetime) as definitions employing shorter time frames (use in the last month/week) produced cell sizes too small to be analysed. Whilst this lifetime definition of multiple drug is consistent with the LCA study by Lynskey et al. (2006), more research on the use of different drug types over narrower windows of time (e.g., last month or on the same occasion) is required. This would necessitate much larger samples than that of the present study as the prevalence of multiple drug use in the last month as noted above were very small (e.g. excluding alcohol, tobacco and marijuana, the prevalence of other drug in the last month in this age group was less than 1%). Finally, the findings of the present study were based on the reports of adolescents present in the home and for whom parental consent was obtained. These potential selection biases may have led to an underestimation of the prevalence of multiple drug use and illicit drug use in particular.

5. CONCLUSION

The findings have significant implications for Australian drug prevention programs. Clearly, alcohol use is largely exclusive for the majority of young Australians (79.6% of users of any type of drug combined with nonusers), a substantial minority primarily use three drug types, and a small minority have high probabilities of using many types of drugs. The present findings are consistent with the need for a heavy prevention focus on alcohol use. Furthermore, research findings that early adolescent alcohol use is associated with alcohol dependence and tobacco use, and cannabis use is associated with cannabis dependence in young adulthood (Degenhardt et al., 2010; Hayatbakhsh, Najman, Jamrozik, Mamun, & Alati, 2006; Swift et al., 2009), highlight the need for prevention programs that address the multiple potential links between alcohol, tobacco and cannabis use. The significance of outer regionality in the prediction of limited range multiple drug use membership underscores the importance of improving accessibility to evidence-based prevention strategies for families living outside major Australian population centres. Finally, the results highlight the importance of screening and assessment of psychological distress for adolescents who have used multiple drug types, particularly those with an extended range of multiple drug use.

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Contributors

All authors were involved in designing the study. G.C.K.C., A.B.K and P.B. undertook statistical analysis. All authors contributed to drafting the manuscript and approved the final submission.

Conflict of Interest

None declared.

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