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Trajectories of alcohol use problems based on early adolescent alcohol use: Findings from a 35 year population cohort

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ABSTRACT

Background: Early exposure to alcohol in adolescence is associated with a range of long term harms. Better understanding of trajectories of alcohol use from adolescence to early adulthood would help target prevention strategies to high risk groups.
Methods: Christchurch (New Zealand) general population birth cohort (n = 1265). A latent trajectory model of drinking behaviour at age 14–16 was used to predict drinking outcomes at age 18–35, net of covariate factors known to be associated with substance use outcomes in this cohort.
Results: Three classes of adolescent alcohol use were identified. These were: occasional drinkers, emergent binge drinkers and increasing heavy drinkers.
Conclusions: This analysis identifies three groups of adolescent alcohol users with differing patterns of use. Emergent binge drinkers likely require public policy responses to alcohol use whereas increasing heavy drinkers are potentially able to be identified individually on the basis of patterns of alcohol use and social variables. This group may benefit from psychosocial interventions and are unlikely to respond to a broad public health approach.

Introduction

Adolescent alcohol use remains an important preventable source of harm globally (Degenhardt, Stockings, Patton, Hall, & Lynskey, 2016) despite considerable research and extensive public health and policy efforts over many decades (Babor et al., 2010; Spoth, Reyes, Redmond, & Shin, 1999). Early and heavy alcohol use in adolescence is associated with injuries, diverse psychosocial harms and increased mortality (Hingson & Zha, 2009; Nutt, King, & Phillips, 2010). It also is associated with alcohol and other drug problems in adulthood (Hingson, Heeren, & Winter, 2006), which carry a significant burden in terms of both morbidity and cost (Rehm et al., 2009).

One of the difficulties in changing drinking culture may relate to patterns of drinking nationally. The natural history of alcohol consumption throughout the life course falls into two groups nationally: "wet" and "dry" drinking cultures (Room & Mäkelä, 2000). New Zealand is traditionally considered 'wet', although this broad macro-level descriptor has not affected overall change to alcohol harms, despite policy efforts. This descriptor is useful for generalisation of research from one comparative country to another, although there is a growing recognising of the need for 'micro-level' understanding of drinking culture within these broad groups to effect change (Savic, Room, Mugavin, Pennay, & Livingston, 2016). In most countries where alcohol use is normative, first exposure and first intoxication typically occur in late childhood or early adolescence (Newton-Howes, Cook, Martin, Foulds, & Boden, 2019). Consumption increases from adolescence into young adulthood, followed by a gradual decline with age (Casswell, Pledger, & Pratap, 2002). The most rapid changes in drinking behaviour happen in adolescence and early adulthood (Wells, Horwood, & Fergusson, 2006). Therefore it is logical to focus prevention efforts on this period of life, not only to address immediate harms but also to try to alter the long-term trajectory of alcohol use and prevent future harms.

Public policy interventions addressing the sale, supply and consumption of alcohol by adolescents (Babor, Robaina, Noel, & Ritson, 2017) have had variable effect (Donaldson & Britain, 2009; Rockville, 2007). This may relate to a lack of understanding of the mirco-level culture within adolescents some who do not drink (Raninen et al.,

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2018), while others become significant users of alcohol as adults (Schulenberg & Maggs, 2002). A further problem with primary prevention activities in adolescence and young adulthood is that drinking behaviour during this period is heterogeneous and unstable (Wells et al., 2006). Policy and prevention strategies which are effective for one group of young people at one age point therefore may not generalise well to the whole population.

One solution to this problem may be to identify groups of drinkers with similar drinking trajectories, antecedent risk and protective factors and long term outcomes including alcohol use disorder. By doing this, policy and prevention activities could be targeted towards those groups. Efforts to identify such 'high vulnerability' cohorts are rare (Meng, Holmes, Hill-McManus, Brennan, & Meier, 2014; Pitkänen, Kokko, Lyyra, & Pulkkinen, 2008), but a recent personality-focussed prevention program has shown promise (Conrod et al., 2013). However, studying the development of alcohol consumption over early adolescence in a general population cohort allows for the identification of risk and protective factors that, at the population level, can be targeted to reduce levels of alcohol-related harm. This approach can account for the effect of confounding variables such as measures of early social disadvantage, which tend to be correlated with both adolescent drinking behaviour and adverse long term psychosocial outcomes. General population birth cohorts such as the Christchurch Health and Development Study (CHDS) are relatively uncommon, but have major strengths in studying trajectories of complex behaviours such as alcohol consumption.

This study has two main aims. First, to identify groups with distinct trajectories of alcohol consumption from adolescence to early adulthood. Second, to determine the association between these trajectories and both antecedent risk factors and alcohol outcomes in adulthood. The object of these analyses is to help inform targeted alcohol policy and prevention strategies for adolescent drinkers.

Methods

Participants

The data were gathered from the Christchurch Health and Development Study (CHDS). In this study a birth cohort of 1265 children (635 males, 630 females) born in the Christchurch (New Zealand) urban region in mid-1977 has been studied at birth, 4 months, 1 year and annually to age 16 years, and again at 18, 21, 25, 30 and 35 years (Fergusson & Horwood, 2001; Fergusson, Horwood, Shannon, & Lawton, 1989). The original cohort was comprised of 97% of all individuals born in Christchurch during the study entry period. All study information was collected on the basis of signed consent from study participants and is fully confidential. All aspects of the study have been approved by the Canterbury (NZ) Ethics Committee. Sample sizes were 1025 (age 18), 1011 (age 21), 1003 (age 25), 987 (age 30) and 962 (age 35), representing 79% to 82% of the surviving sample at each observation.

Latent trajectory model of drinking behaviour (ages 14–16)

At ages 14, 15, and 16 cohort members were questioned regarding their consumption of alcohol over the previous 12 months. Specifically, cohort members were asked to report on: a) the frequency with which they consumed alcohol, using a six point scale ranging from "never" to "almost every day"; and b) were asked to indicate the number of drinks they would have consumed on a "typical" drinking occasion. For the purposes of analysis, the quantity data were then converted to New Zealand standard drink units.

Outcome measures

Alcohol consumption, problems with alcohol and alcohol use disorders (18–35 years)

At each interview from age 18 years, cohort members were asked a series of questions concerning their consumption of alcohol, including the frequency with which alcohol was consumed over the previous 12 months, the amount of alcohol that was typically consumed in a single drinking session, and whether the individual experienced any problems relating to their drinking (since the previous assessment). The latter measure was based on the Composite International Diagnostic Interview (CIDI) (Robins, Cottler, Bucholz, & Compton, 1995), in order to obtain information pertaining to DSM-IV (age 18 and above) (American Psychiatric Association, 1994) symptoms of alcohol abuse/alcohol dependence (alcohol use disorder). These data provide both: a) a count measure of the number of symptoms of alcohol use disorder since the previous assessment; and b) allow classification of participants as to whether they meet DSM criteria for an alcohol use disorder (AUD); during the period following the previous assessment. The alcohol consumption measure was treated as continuous, while the alcohol symptoms measure was a count measure. AUD was a dichotomous measure.

Covariate factors

Several covariate factors were included in the analyses, based on: a) use in a prior analysis of the age of first alcohol use in the CHDS cohort (Fergusson, Lynskey, & Horwood, 1994); or b) their relationship to substance use outcomes in other studies of the CHDS cohort (Fergusson, Lynskey, & Horwood, 1993; Fergusson, Lynskey, & Horwood, 1994; Fergusson, Horwood, & Lynskey, 1995; Lynskey, Fergusson, & Horwood, 1998; Fergusson, Horwood, & Ridder, 2007; Fergusson, Boden, & Horwood, 2008). These included:

Measures of family socio-economic and demographic background

- *Maternal age*. Assessed at the time of the survey child's birth.
- *Family living standards (0–10 years)*. At each year a global assessment of the material living standards of the family was obtained by means of an interviewer rating.
- *Maternal and paternal education*. Parental education level was assessed at the time of the survey child's birth reflecting the highest level of educational achievement attained.
- *Family socioeconomic status (SES)*. Family SES was assessed at the time of the survey child's birth using the Elley and Irving (1976) scale of socio-economic status for New Zealand.
- *Averaged family income (0–10 years)*. At each year, estimates of the family's gross annual income were obtained from parental report and were recoded into decile categories.
- *Maori ethnicity (at birth)*. Maori ethnicity was assessed at the time of the cohort member's birth.

Individual, personality and behavioural factors

- *Gender*. Recorded at birth.
- *Child conduct problems (7–9 years)*. When sample members were aged 7–9 years, information on child behaviour problems was obtained from parental and teacher report using a behaviour questionnaire combining items from the Conners (1970) and Rutter, Tizard, and Whitmore (1970) parental questionnaires. (α = .97).
- *Neuroticism (age 14)*. This was assessed using a short form version of the Neuroticism scale of the Eysenck Personality Inventory (Eysenck & Eysenck, 1964) at age 14. (α = .80).
- *Novelty-seeking (age 16)*. Novelty-seeking was assessed at age 16 using the novelty seeking items from the Tridimensional Personality Questionnaire (Cloninger, 1987), (α = .76).

Family functioning, parental behaviour and abuse exposure

measures

- *Parental illicit drug use (0–11 years).* At age 11, parents were questioned regarding their history of illicit drug use. The cohort member was classified as having a parent history of illicit drug use if one of his/her parents was reported to have a history of illicit drug use.
- *Parental alcohol problems (0–15 years).* This was assessed at age 15 years via parental report. These reports were used to form a dichotomous measure of whether or not the young person's parents reported experiencing problems with alcohol.
- *Parental criminality (0–15 years).* At age 15 years, parents were questioned as to whether any parent had a history of criminal offending (of any sort; the nature of the offending was not assessed). The cohort member was classified as having a parent history of criminality if one of his/her parents was reported to have a history of offending.
- *Parental alcohol consumption.* At age 11, parents were asked how many alcoholic drinks they would normally consume in a week and how many they had consumed in the past week. These measures were combined to form a measure of the parents' typical weekly alcohol consumption.
- *Parental approval of adolescent drinking.* At age 15 years, cohort members were asked to describe their parent's views about adolescent alcohol consumption on a five-point scale ranging from strongly opposed to unconcerned.
- *Parental attitudes to alcohol use*. At age 15 years, cohort members were asked to rate their parents attitudes toward alcohol use in general on six three-point scales reflecting both their parent's use of alcohol and attitudes to alcohol use.
- *Changes of parents (to age 15 years*). At each assessment from birth to 15 years, information was gathered on changes in the cohort member's family situation since the previous assessment. Using this information an overall measure of family instability was constructed up to age 15.
- *Parental attachment (age 15).* This was assessed using the parental attachment scale developed by Armsden and Greenberg (1987) and administered when sample members were aged 15. The full parental attachment scale was used in this analysis and was found to have good reliability ($\alpha = 0.87$).
- *Exposure to harsh/abusive physical punishment (childhood physical abuse; 0–16 years).* At ages 18 and 21 sample members were asked to describe the extent to which their parents used physical punishment during childhood (Fergusson & Lynskey, 1997). This information was used to create a four-level scale reflecting the most severe form of physical punishment reported for either parent.
- *Childhood sexual abuse (0–16 years).* At ages 18 and 21 years sample members were questioned about their experience of sexual abuse during childhood (< 16 years) (Fergusson, Lynskey, & Horwood, 1996). Questioning spanned an array of abusive experiences from episodes involving non-contact abuse (e.g. indecent exposure) to episodes involving attempted or completed intercourse. A four-level scale was devised reflecting the most extreme form of sexual abuse reported by the young person at either age. For the purposes of the present analyses, those cohort members who reported having been exposed to penetrative sexual abuse were classified using a dichotomous measure.
- *Parental intimate partner violence (0–16 years).* At age 18, sample members were questioned concerning their experience of parental intimate partner violence during their childhood (prior to age 17 years). The questioning was based on a series of eight items derived from the Conflict Tactics Scale (Straus, 1979).

Statistical analyses

The latent trajectory models using alcohol frequency and quantity data from ages 14, 15, and 16 were fitted using MPlus v.7 (Muthén & Muthén, 1998), using maximum likelihood estimation. Models were run using two, three and four class solutions, with the three class solution providing the best fit. The latent class model combining the six indicator variables into three classes (n = 878, 65, and 51, respectively) was found to fit the observed data well (X^2 (663) = 156.49, p = 1.00; AIC = 63342, BIC = 63,205). Assignment of cohort members to latent classes based on observed report data resulted in an estimated 97.61% of the sample being correctly classified, and an entropy estimate of .933. Trajectory 1 consisted of 431 males and 447 females, while Trajectory 2 had 34 males and 31 females. Trajectory 3 was comprised of 29 males and 22 females.

Following this, the analyses were carried out over several steps. In order to examine the key predictors of assignment to latent class, the covariate factors were entered into a series of bivariate multinomial logistic regression analyses, in which latent class was modelled as a function of each predictor. The raw scores from each measure used were analysed. Then, in order to account for correlations between predictors, those predictors that were found to be statistically significant ($p < .05$) at the bivariate level were entered into a multivariate multinomial logistic regression analysis, using methods of forward and backward substitution to arrive at a stable and parsimonious model.

In the next step, the associations between the latent classes of drinking behaviour and the repeated measures of alcohol outcomes (alcohol use disorder; alcohol use disorder symptoms; amounts of alcohol consumed) in adulthood were modelled by fitting population-averaged generalised estimating equation (GEE) models to the data for each outcome (Liang & Zeger, 1986; Zeger & Liang, 1986). For dichotomous outcomes logistic regression models were fitted, and for continuous outcomes, ordinary least squares models were fitted of the form:

$$f\text{Yit} = \text{B0} + \text{B1Xi} + \text{eit} \quad (1)$$

where Yit represents the score (for continuous measures) or log odds (for dichotomous measures) of outcome Y for participant i at time t, Xi represents the latent trajectory assignment for individual i, and eit is a random error term. The term eit was assumed to be normally distributed and uncorrelated with Xi. In this model the coefficient B1 represents the effect of the latent trajectories of drinking behaviour pooled over the repeated measures for each outcome, and the coefficient B0 represents the intercept for the model. Associations were tested for significance by comparing the three latent trajectory groups using design variates. All models were fitted using Stata 12 (StataCorp., 2011) and, in each case, the test of significance of the pooled association between the age of onset of alcohol consumption classification and the outcome will be obtained from a Wald chi squared test of the hypothesis that B1 = 0.

In the final step of the analyses, the GEE models of the associations between the latent trajectory groups and alcohol-related outcomes (ages 18–35) shown above in Eq. (1) were extended to include the statistically significant covariate factors in the previous analysis. All models were fitted using Stata 12 (StataCorp., 2011).

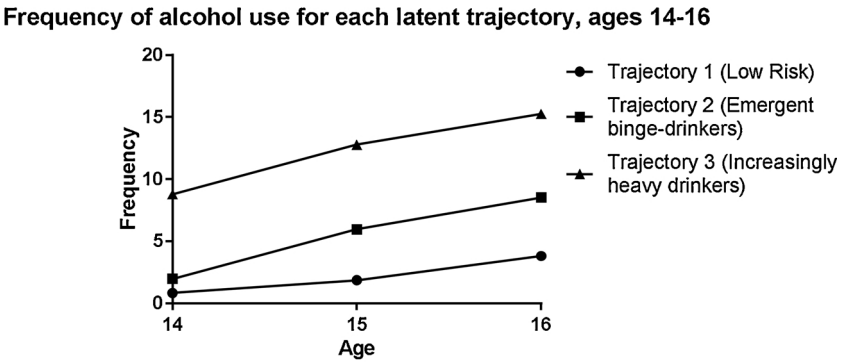
Results

Latent trajectory model of drinking behaviour (ages 14–16)

Fig. 1a shows the frequency of alcohol consumption for each trajectory at each age (number of occasions in the past 12 months). Fig. 1b shows the usual amount of alcohol consumed during a drinking session for each trajectory at each age (converted to standard drinks).

Fig. 1a shows clear differentiation between groups in frequency of alcohol consumption, such that frequency of alcohol consumption was lowest for Trajectory 1, intermediate for Trajectory 2, and highest for Trajectory 3. Fig. 1b, however, shows different trajectory-based

a



b

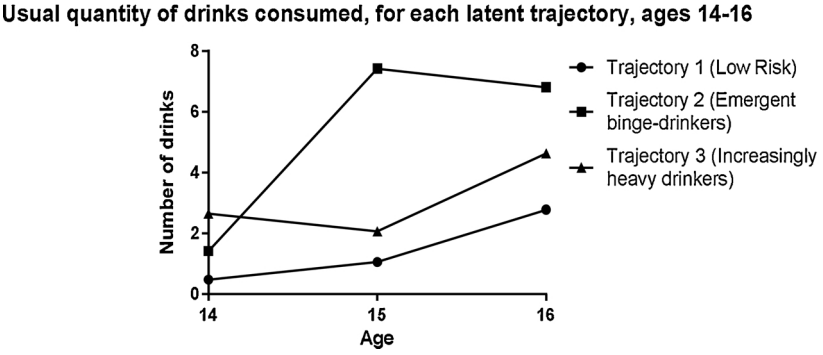


Fig. 1. xxx.

patterns for the typical quantity alcohol consumed during a drinking session. Trajectory 1 had the lowest amount of alcohol consumed across ages, whereas those in Trajectory 2 had a large increase from age 14 to age 15. Trajectory 3 displayed a slower growth in terms of amounts of alcohol typically consumed, peaking at age 15. Together, these data suggest that although those in Trajectory 2 are less frequent consumers of alcohol than those in Trajectory 3, they are more likely to drink larger amounts at an earlier age, suggesting that the primary differentiating factor between Trajectory 2 and Trajectory 3 is age of onset for heavier alcohol consumption (higher for Trajectory 2 at an earlier age). These patterns suggest that the trajectories can be described by the titles Low-risk, Emergent binge drinkers, and Increasingly heavy drinkers.

Bivariate associations between predictors and latent trajectory assignment (ages 14–16)

Table 1 shows a series of factors derived from the CHDS database and their bivariate associations with latent trajectory assignment. The Table shows that:

1 Individuals in the Emergent binge drinker and Increasingly heavy drinker trajectories (Trajectories 2 and 3) were from families that had generally lower levels of socioeconomic functioning (lower SES and family income) than those in the Low Risk trajectory (Trajectory 1); had higher levels of conduct problems and higher scores on novelty seeking; were generally more likely to report higher levels of family dysfunction, adversity and family instability than those in the Low risk trajectory; and had parents who reported significantly more permissive attitudes toward adolescent drinking, and positive attitudes towards drinking, than those cohort members in the Low risk trajectory.
2 Cohort members in Increasingly heavy drinking trajectory were significantly ($p < .05$) more likely to have been exposed to penetrative sexual abuse than those in either the Low Risk trajectory or the Emergent binge drinker trajectory, whereas both those in the Emergent binge drinker and Increasingly heavy drinker trajectories were significantly ($p < .05$) more likely to have been exposed to parental intimate partner violence than those in the Low risk trajectory.

Pairwise and multivariate associations between predictors and latent trajectory assignment (ages 14–16)

The results of the multivariate analysis is shown in Table 2. This shows the set of statistically significant predictors, unstandardized regression coefficients, standard errors, and p-values for pairwise comparisons for each predictor across each of pair of latent class assignments. The Table shows:

1 Those assigned to the Low risk trajectory had higher levels of anxious/withdrawn behaviour than those in the Increasing heavy drinker trajectory, were less likely to have a parent who reported having problems with alcohol than those in the Emergent binge drinker trajectory, had lower levels of novelty seeking than either trajectory, were less likely to have been exposed to sexual abuse than those in the Emergent binge drinker trajectory, had higher levels of parental attachment than either trajectory, and had parents with more negative attitudes toward adolescent alcohol use than the Emergent binge drinker trajectory.
2 The factor that differentiated the Emergent binge drinker and Increasingly heavy drinker trajectories was parental alcohol problems. Those in the Increasingly heavy drinker trajectory were less likely to have a parent with alcohol problems than those in the

Table 1
Associations between predictors and latent class assignment (ages 14–16). The numbers represent the Raw mean scores of each measurement tool for each domain.

Predictor (mean/%)	Trajectory 1 (Low risk)	Trajectory 2 (Emergent binge drinker)	Trajectory 3 (Increasingly heavy drinker)	1 v 2 p-value	1 v 3 p-value	2 v 3 p-value
Socio-demographic factors						
Family SES level at birth[a] (at birth)	3.55	3.94	3.78	.03	.25	.55
Average family income (ages 0–10)	51.85	47.98	44.75	.15	.02	.40
Childhood Behaviour and individual factors						
Conduct problems (ages 7–9)	49.58	51.48	52.02	.05	.03	.75
Anxious/withdrawn behaviour (ages 7–9)	26.00	25.67	24.86	.46	.03	.18
Novelty-seeking (age 16)	17.96	21.25	20.09	< .0001	.003	.19
Family functioning						
% Parental history of alcohol problems (age 15)	11.1	26.6	10.0	< .0001	.82	.03
% Parental history of criminal offending (age 15)	12.2	25.0	16.0	.004	.43	.25
% Parental history of illicit drug use (age 11)	23.2	38.7	35.3	.007	.05	.71
Family adversity score (to age 15)	7.09	9.98	8.59	< .0001	.05	.24
Parental attachment score (age 15)	73.46	67.73	69.18	< .0001	.002	.51
Changes of parents (to age 15)	1.13	2.17	1.84	.001	.03	.59
Abuse exposure						
Parental intimate partner violence score (to age 16)	9.15	9.98	9.90	.006	.03	.89
% Childhood exposure to penetrative sexual abuse (to age 16)	5.5	7.7	16.0	.40	.04	.40
Parental attitudes regarding alcohol						
Parental approval of adolescent drinking (age 15)	2.74	3.02	3.08	.02	.008	.69
Parental attitudes toward alcohol use (age 15)	1.38	1.45	1.47	.02	.003	.52

[a] Higher scores indicate lower levels.

Emergent binge drinker trajectory Class 2.

Associations between latent trajectory model of drinking behaviour (ages 14–16) and alcohol-related outcomes, ages 18–21, 21–25, 25–30, and 30–35 years

Table 3 shows the cohort classified into three groups based on latent trajectory assignment (as shown above). For each trajectory, the Table reports on: a) the proportion of the cohort meeting DSM criteria for an alcohol use disorder; b) mean number of symptoms of AUD, and c) the mean amount of alcohol consumed (in ml) over the 12 months prior to the assessment; pooled over the assessment periods at ages 18–21, 21–25, 25–30, and 30–35 years (data for each assessment period are shown in Table S1, Online Supplement). The Table shows:

1 Individuals in the Emergent binge drinker and Increasingly heavy drinker trajectories were significantly more likely to meet DSM criteria for an AUD than those in the Low risk trajectory.
2 Cohort members in the Emergent binge drinker and Increasingly heavy drinker trajectories had significantly higher levels of AD symptoms than those in the Low risk trajectory.
3 Those cohort members in the Increasingly heavy drinker trajectory reported consuming significantly larger amounts of alcohol in the 12 months prior to each assessment than those in the Low risk and Emergent binge drinker trajectories.

Adjustment of associations between latent trajectory model of drinking behaviour (ages 14–16) and alcohol-related outcomes in adulthood, ages 18–21, 21–25, 25–30, and 30–35 years

Table 4 reports on both the adjusted unstandardized regression coefficients, standard errors and tests of significance for the associations between latent trajectory assignment and each outcome. The Table shows that, after adjustment, there remained statistically significant differences between trajectory 1 (Low risk) and trajectory 3 (Increasingly heavy drinking) in predicting alcohol use disorder over adulthood. In addition, there remained statistically significant differences between the Low risk trajectory and both of the heavier drinking trajectories in predicting symptoms of alcohol use disorder in adulthood. Finally, after adjustment for confounding, the Increasingly heavy drinking trajectory reported consuming significantly more alcohol in adulthood than members of either the Low risk or Emergent binge drinking trajectories.

Table 2
Final fitted multivariate model of the associations between predictors and latent class model.

	Comparison								
	Trajectory 1 v Trajectory 2			Trajectory 1 v Trajectory 3			Trajectory 2 v Trajectory 3		
Predictor	B	SE	p	B	SE	p	B	SE	p
Anxious/withdrawn behaviour (ages 7–9)	−.04	.04	.41	−.12	.05	.019	−.09	.06	.18
Parental history of alcohol problems	1.10	.33	.001	−.31	.55	.62	−1.41	.61	.02
Novelty-seeking	.13	.03	< .0001	.07	.03	.027	−.07	.04	.121
Exposure to penetrative sexual abuse	−.17	.53	.57	1.12	.45	.12	1.29	.64	.113
Parental attachment	−.05	.01	< .0001	−.04	.01	.005	.01	.01	.696
Parental attitudes toward adolescent alcohol use	.40	.16	.011	.54	.19	.003	.15	.23	.55

Table 3
Associations between latent class model of drinking behaviour (ages 14–16) and alcohol-related outcomes, pooled over ages 18–35 years.

	Latent trajectory					
	1 (Low risk)	2 (Emergent binge drinker)	3 (Increasingly heavy drinker)	1 v 2 p-value	1 v 3 p- value	2 v 3 p-value
Population-averaged % Meeting criteria for AUD	19.1	29.3	29.8	.003	.008	.98
Population-averaged Mean (SD) AUD symptoms	1.57 (4.46)	2.85 (5.77)	2.27 (4.52)	< .0001	.004	.18
Population-averaged Mean (SD) alcohol consumption (ml/12months)	329.35 (992.76)	422.21 (1076.64)	813.32 (3470.24)	.37	< .0001	.004

Table 4
Parameter estimates for the associations between latent trajectory assignment (ages 14–16) and alcohol-related outcomes (ages 18–35), after adjustment for confounding factors.

	Trajectory 1 v Trajectory 2		Trajectory 1 v Trajectory 3		Trajectory 2 v Trajectory 3	
Outcome (ages 18–35)	B (SE)	p	B (SE)	p	B (SE)	p
AUD	.20 (.21)	.35	.46 (.21)	.04	.26	.37
AUD symptoms	.27 (.11)	.02	.27 (.13)	.04	.00	.98
Amount of alcohol consumed	−8.51 (105.67)	.94	478.31 (118.45)	< .0001	486.81 (151.31)	.001

Discussion

The primary purpose of this study was to identify the trajectory of alcohol use in adolescents, aged 14–16 years, and to examine their association with future alcohol use: Consumption, alcohol-related problems and alcohol use disorder. To our knowledge, this is the first study of alcohol use trajectories in a general cohort population, with contemporaneous data collection using multiple measures in multiple domains. Three groups of adolescent drinkers were identified: Low-risk drinkers, Emergent binge drinkers and Increasingly heavy drinkers. The Emergent binge drinkers and Increasingly heavy drinkers were differentiated by drinking larger quantities at age 15 or 16 years compared to the Low-risk cohort, while Increasingly heavy drinkers were differentiated from Emergent binge drinkers by the frequency with which they consumed alcohol.

A range of factors predicted adolescent drinking trajectories amongst this cohort. One group demonstrated emergent binge drinking at around 15 years of age; predicted by a permissive parental attitude to alcohol, parental alcohol problems, weaker attachment between adolescent and parent, and higher levels of externalizing behaviour. This group may be predisposed towards binge drinking to enhance novelty and risk taking behaviour (Foulds, Boden, Newton-Howes, Mulder, & Horwood, 2017), possibly modelling parental behaviour, drinking less frequently but heavily.

Another group of adolescents demonstrated a pattern of increasing heavy drinking where drinking frequency was highest and greater quantities were consumed from 16 years. Our findings indicate this group was more likely to have been exposed to trauma (sexual abuse) and were more likely to experience anxiety. It is possible this group uses alcohol as a primary coping mechanism supporting the literature linking alcohol, personality and trauma (Boyraz et al., 2018; Ertl, Saile, Neuner, & Catani, 2016; Read et al., 2012). Although not as likely to come to the attention of services during a discrete drinking episodes, the volumes consumed over time places this group at greater risk of physical and cognitive morbidity from a longitudinal perspective related to their total alcohol consumption.

Both the Emergent drinking and Increased heavy drinking groups are associated with increasing alcohol use, frequency and alcohol-related problems in adulthood. Interestingly similar categorisation of adult alcohol drinking behaviour has been postulated using clinical observation (Babor & Lauerman, 1986), gene/environment considerations (Oreland et al., 2018), analysing treatment response (Gibbs, 1980) and seeing personality as the driving factor (O'Leary, Donovan, Chaney, & O'Leary, 1980). These approaches, however, all fail to provide longitudinal evidence to support such categorisation of alcohol use disorder development, but the similarities do provide support for the categories identified by this study. Further, none of these approaches provide for the capacity to identify adolescents or adolescent groups at risk or appropriate prevention activities.

From a policy perspective (Consumption WECoPRtA & World Health Organization, 2007), the risk and protective factors that predict trajectory group membership provide an insight into potential public health approaches to minimise adolescent alcohol use and later alcohol use problems. For the Emergent binge drinkers, developing policies to highlight the harms of alcohol use (Kaner et al., 2018; Wilkinson & Room, 2009), reduce access (Wagenaar & Toomey, 2000) and exposure (Anderson, De Bruijn, Angus, Gordon, & Hastings, 2009) would appear the obvious candidates. These strategies are unlikely to be effective in the Increasing heavy drinking group who appear to have different drives to drink. In this group policies to support engagement in individual interventions (Anderson, Laurant, Kaner, Wensing, & Grol, 2004) are likely to show greater promise.

The strength of this study lies in is its ability to take into account multiple potential confounders measured contemporaneously, avoiding recall bias. Although this may reduce the strength of any association found, it significantly increases the likelihood of it being a true association and causality is clear in a longitudinal cohort such as this. The ability for the model to predict group assignment is excellent.

This analysis has weakness, in part created by the study design and longitudinal data collection. Alcohol consumption is bound into the society within which it exists, and this study is carried out in New Zealand. Alcohol use and misuse is widely prevalent in New Zealand, with 79% of the population drinking alcohol in the past year, including 57% of adolescents aged 15–17 years, and 20% of the population drinking hazardously. It is likely, however that these findings are generalizable to similar social environments in the western world. Like all longitudinal studies participant attrition is problematic, with the potential of systematic drop out introducing bias, however the CHDS study remains largely intact, with good retention of candidates and a statistical approach that minimises the risk of bias from this drop out. Similarly self-report provides the opportunity to incorrectly report use, although this is a problem found in most addictions research and in this study comparative reporting by parents provides robustness.

Despite these weaknesses this study gives clear direction as to potential targets for possible future public policy to minimise the harms from alcohol use in adolescents. This study found two at risk groups of adolescent drinkers: Emergent binge drinkers and increasing heavy drinkers. These groups are substantially different in their drives to drink and require tailored approaches to improve long term adult outcomes.

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Declaration of Competing Interest

None.

Appendix A. Supplementary data

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