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Trajectories of adolescent alcohol and cannabis use into young adulthood

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ABSTRACT

Background Both alcohol and cannabis use carry health risks. Both are commonly initiated in adolescence. To date little research has described trajectories of adolescent cannabis or alcohol use or compared their respective consequences in young adulthood. **Methods** The design was a 10-year eight-wave cohort study of a state-wide community sample of 1943 Victorians initially aged 14–15 years. Moderate- and high-risk alcohol use was defined according to total weekly alcohol consumption. Moderate- and high-risk cannabis use were defined as weekly and daily use, respectively. **Results** Around 90% of young adults used either alcohol or cannabis. Although an association existed between alcohol and cannabis use, there was a tendency for heavy users to use one substance predominantly at any one time. Weekly or more frequent cannabis use in the absence of moderate-risk alcohol use in teenagers predicted a sevenfold higher rate of daily cannabis use in young adults but only a twofold increase in high-risk alcohol use. Conversely, moderate-risk adolescent alcohol use in the absence of weekly cannabis predicted an approximately threefold increased rate of both high-risk drinking and daily cannabis use in young adulthood. Selective heavy cannabis use in both adolescence and young adulthood was associated with greater illicit substance use and poorer social outcomes in young adulthood than selective alcohol use. **Conclusions** Heavier teenage cannabis users tend to continue selectively with cannabis use. Considering their poor young adult outcomes, regular adolescent cannabis users appear to be on a problematic trajectory.

Keywords Adolescent, alcohol drinking, cannabis, longitudinal studies, substance-related disorders.

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INTRODUCTION

Alcohol and cannabis use both begin commonly in adolescence. Alcohol use is more prevalent but cannabis use has become widespread among adolescents and young adults in many countries over the past three decades [1–3]. A majority of young people in the developed world experiment with cannabis and in some community studies the proportion of daily users has approached one in 10 [4–6]. A range of adverse sequelae in young adulthood have been documented for both heavier adolescent alcohol and cannabis use [7–9], with the available studies indicating dose–response relationships between teenage use and the risk of abuse in early adulthood [10,11]. However, existing studies have focused generally upon the progression and consequences of alcohol and cannabis use individually, with the other drug considered only as a potential confounder [12,13]. For that reason, little is known about the comparative consequences in adulthood of regular alcohol or cannabis use in adolescence. This question is of more than theoretical interest, given the evidence that policies affecting the use of alcohol (such as age of legal use and price) may affect the use of cannabis and vice versa [14].

In this report we used data from a cohort of almost 2000 adolescents followed from adolescence to young adulthood to examine the following questions:

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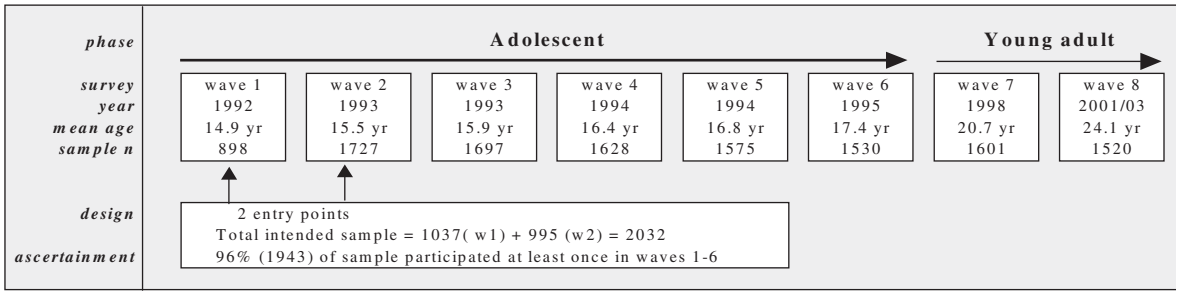

Figure 1 Sampling and ascertainment in the Victorian Adolescent Health cohort, 1992–2003

1 To what extent do individuals report potentially harmful use of alcohol and/or cannabis during adolescence and young adulthood?
2 To what extent does heavier adolescent use of alcohol and/or cannabis predict substance use in young adulthood?
3 To what extent does heavier adolescent use of alcohol and/or cannabis predict different social circumstances in young adulthood?

METHOD

Sample

Between August 1992 and March 2003 we conducted an eight-wave cohort study of health in adolescents and young adults resident in the state of Victoria, Australia. Data collection protocols were approved by The Royal Children's Hospital's Ethics in Human Research Committee. Sampling details are provided in earlier reports [15]. Briefly, the cohort was designed as a representative sample of the Victorian population of mid-secondary-school adolescents in 1992, defined in a two-stage cluster sample with two classes selected at random from a statewide sample of 44 schools, with one class entering the study in the latter part of the ninth school year (wave 1) and the second class 6 months later (wave 2). Participants were reviewed subsequently at a further four 6-month intervals during the teenage years (waves 3–6) with two follow-up waves in young adulthood, aged 20–21 years (wave 7) and 24–25 years (wave 8). In waves 1–6, participants self-administered the questionnaire on laptop computers with telephone follow-up of those absent from school [16]. The seventh and eighth waves of data collection were undertaken using computer-assisted telephone interviews.

From a total sample of 2032 students, 1943 (95.6%) participated at least once during the first six (adolescent) waves (Fig. 1). In wave 8, 1520 (75% of the initial sample, 78% of teenage participants) were interviewed between April 2001 and April 2003. Reasons for non-completion at wave 8 were refusal ($n = 269$), loss of contact ($n = 147$) and death ($n = 7$).

The sample of 1943 participants consisted of 943 males, 1443 from metropolitan schools, 617 had no parent complete secondary school, 630 had one parent complete secondary school or had a vocational diploma or certificate and 596 had a tertiary qualification, 717 had at least one parent who smoked regularly and 439 had parents who were divorced or separated by wave 6.

Measures

Alcohol use was assessed at each wave using self-reported frequency of use and a retrospective 1-week alcohol diary (beverage- and quantity-specific) for those reporting alcohol use in the previous week. For each wave, the total weekly alcohol consumption was calculated. Moderate- and high-risk drinking were defined according to the Australian National Health and Medical Research Council guidelines, which are based on risk for longer-term health problems in adults [17]. At least moderate-risk drinking was defined as exceeding 28 standard drinks (one standard drink = 10 g alcohol) for the previous week in males and 14 standard drinks in females. High-risk drinking was defined as exceeding 43 standard drinks in males and 28 standard drinks in females. As no definitions are available for alcohol-related risk in adolescence, the same thresholds were used throughout the cohort study in order to provide consistency of measurement.

Cannabis use was assessed using self-reported frequency of use in the previous 6 months (waves 1–6) and 12 months (waves 7 and 8). Risk associated with cannabis use was defined on the basis of previous studies examining risks of dependence or mental health problems in cannabis users [9,18]. At least moderate-risk cannabis use in both males and females was defined as at least weekly use and high-risk as daily or almost daily.

Analysis

We used the method of multiple imputation to address potential bias arising from respondents missing waves of data collection [19]. We imputed five complete data sets under a multivariate normal model incorporating all the outcome variables of interest measured at all waves of

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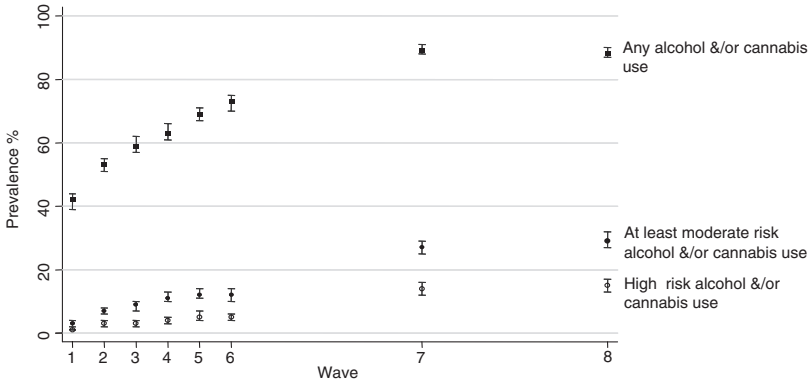

Figure 2 Prevalence of alcohol and/or cannabis use by wave and severity of use: any use, at least moderate-risk and high-risk. The *x*-axis scale represents the relative timing of each survey

Table 1 Cross-sectional associations between alcohol use and cannabis use by wave in 1943 cohort participants across three levels of risk.

	Age[1] *(years)*		*Any alcohol and/or cannabis*		*At least moderate risk alcohol and/or cannabis*		*High risk alcohol and/or cannabis*	
Phase	*Mean*	*(SD)*	*OR*	*(95% CI)*	*OR*	*(95% CI)*	*OR*	*(95% CI)*
Adolescent (wave 1–6)								
1	15.0	(0.50)	8.1	(4.5–15)	33	(8.9–122)	18	(2.3–142)
2	15.5	(0.50)	13	(8.3–21)	16	(8.2–30)	23	(4.1–136)
3	15.9	(0.50)	12	(7.4–19)	8.7	(5.1–15)	13	(3.0–58)
4	16.4	(0.49)	9.5	(6.0–15)	7.5	(4.4–13)	8.7	(3.0–26)
5	16.9	(0.49)	11	(5.9–19)	7.7	(4.9–12)	13	(5.7–30)
6	17.4	(0.50)	9.3	(5.8–15)	6.2	(3.7–11)	5.3	(1.5–19)
Young adult (wave 8)								
7	20.7	(0.51)	5.4	(4.0–7.3)	2.2	(1.6–3.0)	2.2	(1.3–3.7)
8	24.1	(0.61)	3.4	(2.2–5.1)	2.9	(2.1–3.9)	2.9	(1.7–4.9)

[1]Ages obtained by averaging across the five imputed data sets.

data collection, along with the fixed covariates of sex, age, rural/urban residence and parental education (available on all participants) [20]. Data analysis was undertaken using STATA 8 [21], with all estimates of prevalences (frequencies) and odds ratios obtained by averaging across the five imputed data sets. Multinomial logistic regression analysis was used to model longitudinal associations between persisting moderate-risk substance use during adolescence and substance use in wave 8 by category of high-risk substance use. Logistic regression analysis was used to model associations between social and behavioural outcomes and high-risk substance use in wave 8 and, similarly, persisting substance use in waves 1–6. Effect modification by gender was assessed in each model using the Wald test at the 0.01 level of significance.

RESULTS

Throughout cohort follow-up the prevalence of alcohol use was consistently higher than that of cannabis (waves 1–8 alcohol: 40%, 52%, 58%, 62%, 68%, 71%, 86%, 86%; cannabis: 8%, 17%, 18%, 20%, 21%, 21%, 59%, 35%). The overall prevalence of either alcohol or cannabis use at each of the three levels is shown in Fig. 2. 'Any' alcohol or cannabis use increased from 42% at wave 1 to 73% at wave 6 and stabilized at just under 90% for waves 7 and 8. At least moderate-risk use was infrequent at the study outset (1.3%), but rose to 10–12% between waves 4–6 and increased further to around 26% at waves 7 and 8. High-risk use of either alcohol or cannabis increased to 3–4% for waves 4–6 and then to around 13% at waves 7 and 8.

Table 1 shows associations between alcohol and cannabis use at the three levels of use (any, moderate- or greater and high-risk) at each study wave. Cannabis and alcohol use were associated at all levels of risk, but the strength of association declined as the cohort aged, reflecting the increasing prevalence of cannabis and alcohol use at each level.

Figure 3 displays the proportion of selective users of alcohol and cannabis at each of the three levels of use, in

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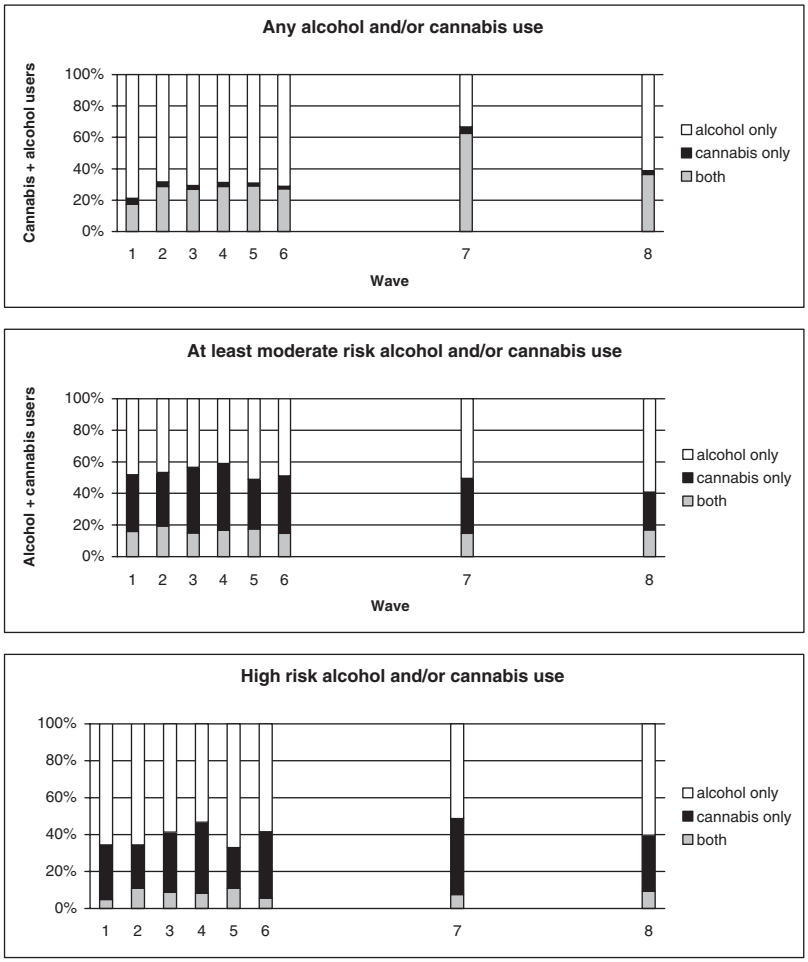

Figure 3 Alcohol users only, cannabis users only and both alcohol and cannabis users shown as a proportion of all users at each wave of survey, by three levels of use: any, moderate-risk and high-risk. The *x*-axis scale reflects the relative timing of each survey

each wave of data collection. Just under a third of those reporting any substance use during the teenage years were concurrent users of cannabis and alcohol. This fraction rose to 63% at wave 7 but fell to 36% at wave 8. Cannabis use alone was uncommon (< 4% at any wave) but alcohol use alone was common in adolescence (70–80%), but fell to 33% at wave 7 before increasing again to 61% at wave 8.

For those reporting at least moderate-risk use, concurrent use of alcohol and cannabis remained at around 15–17% throughout follow-up. The proportion using cannabis only at this level varied between 34% and 42% from waves 1–7 and then fell to 24% at wave 8. The proportion using alcohol alone was 41–51% for waves 1–7 and increased to 59% at wave 8.

For those using at a high-risk level, concurrent alcohol and cannabis use was consistently low throughout the study at 5–11%. The proportion of cannabis-only users varied between 22% and 33% for all waves except wave 7, when it peaked at 41%. The proportion of alcohol-only users varied between 51% and 67% throughout follow-up, with the lowest relative proportion at wave 7 and the highest at wave 5.

Table 2 examines continuities in cannabis and alcohol use from adolescence to young adulthood. Young adult high-risk use was classified into four categories: no high-risk use, high-risk cannabis only, high-risk alcohol only and both high-risk substances. Multinomial logistic regression was used to compare each of the three high-risk categories with those reporting no high-risk use. We assessed the associations between (at least) moderate-risk adolescent use and high-risk use in young adulthood, aiming thereby to investigate the progression towards high-risk use in young adults. Adolescent moderate-risk categories were not mutually exclusive. However, 90% of persistent (2 + waves) moderate-risk adolescent alcohol users and 80% of persistent moderate-risk cannabis users did not use the other drug persistently at a moderate-risk level concurrently or at other times.

Twenty-three per cent of persistent moderate-risk teenage cannabis users were daily users at wave 8 and 14% were high-risk drinkers. After adjustment for background factors, adolescent moderate-risk cannabis use predicted a sevenfold higher rate of high-risk cannabis use in young adulthood but only a twofold elevation

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Table 2 Associations between high-risk substance use in young adulthood and persistent (two or more waves) at least moderate substance use in adolescence.

		Young adult high risk cannabis and alcohol use (wave 8)					
		Selective high risk cannabis use [n[2] = 89 (59%male)]		*Selective high risk alcohol use [n[2] = 177 (66% male)]*		*Concurrent high risk cannabis and alcohol use [n[2] = 27 (92% male)]*	
Adolescent persistent alcohol and cannabis use (waves 1–6)[1]	*n*[2] *(%male)*	*OR*[3]	*(95% CI)*	*OR*[3]	*(95% CI)*	*OR*[3]	*(95% CI)*
Univariate							
Selective moderate cannabis use	106 (66)	9.9	(4.5–22)	2.4	(1.2–4.8)	14	(4.7–43)
Selective moderate alcohol use	112 (53)	2.9	(1.4–5.9)	3.1	(1.5–6.3)	3.7	(0.68–20)
Concurrent moderate alcohol and cannabis	41 (46)	7.6	(2.3–26)	1.1	(0.11–10.2)	15	(3.9–55)
Adjusted for all persistent substance use measures							
Selective moderate cannabis use	106 (66)	8.7	(3.9–20)	2.5	(1.2–5.2)	11	(3.2–40)
Selective moderate alcohol use	112 (53)	3.0	(1.4–6.3)	3.2	(1.6–6.3)	3.9	(0.90–17)
Concurrent moderate alcohol and cannabis	41 (46)	3.1	(0.81–12)	0.67	(0.07–6.7)	5.2	(0.94–29)
Adjusted for all persistent substance use measures and background measures[4]							
Selective moderate cannabis use	106 (66)	7.4	(3.3–17)	2.2	(1.1–4.5)	9.1	(2.5–34)
Selective moderate alcohol use	112 (53)	2.6	(1.2–5.7)	3.0	(1.5–6.0)	3.6	(0.83–16)
Concurrent moderate alcohol and cannabis	41 (46)	3.2	(0.80–13)	0.69	(0.07–7.1)	7.3	(0.75–70)

[1]Categories of (at least) persistent moderate substance use were not mutually exclusive. [2]Frequencies obtained by averaging across the five imputed data sets. [3]Odds ratios (OR) from univariate and multivariate multinomial logistics regression models with reference category for all outcome variables: neither hazardous alcohol use nor daily cannabis use in wave 8 (average $n = 1650$). [4]Estimates adjusted for all persistent substance using measures, gender, non-metropolitan school of origin, parental education and parental divorce/separation and smoking during particpant's adolescence.

in later high-risk alcohol use. In contrast, 10% of moderate-risk teenage drinkers were daily cannabis users at wave 8 and 20% were high-risk drinkers. Adolescent moderate-risk alcohol use independently predicted a threefold higher rate of later high-risk alcohol use, a similar level of association to that with later high-risk cannabis use. There was no evidence of effect modification by gender.

Cross-sectional associations between high-risk cannabis and alcohol use and social context and other substance use in young adulthood are shown in Table 3. High-risk cannabis use was associated with failure in education and training, not being in a relationship and higher rates of parenthood. It was also associated with a fivefold higher risk of daily smoking and over sevenfold higher risks of amphetamine and cocaine usage, and higher rates of consultation with drug and alcohol counselling services, particularly in females. With the exception of parenthood, those concurrently using alcohol at a high-risk level had similar associations to those in the selective high-risk cannabis group. High-risk alcohol users were more likely to use other substances, but with the exception of relationship status, their social circumstances and help-seeking did not differ from those without a history of high-risk substance use.

Associations between adolescent persistent moderate-risk cannabis and alcohol use and young adult social measures and other substance use are shown in Table 4. Moderate-risk adolescent cannabis use (weekly + on at least two occasions) predicted poor education and training outcomes in young adulthood, with less likelihood of being in a relationship and clearly elevated rates of later illicit substance use and drug and alcohol service consultation. Adolescent moderate-risk alcohol users were at elevated risk for later daily cigarette smoking, ecstasy and cocaine use, but with the exception of higher rates of parenthood in females, this group appeared similar in their later social context to non-risk substance-using adolescents.

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Table 3 Cross-sectional associations between young adult social and other illicit substance use outcomes with cannabis and alcohol use, adjusted for background factors.

	Young adult outcome measures (wave 8)								
Young adult high risk alcohol and cannabis use (wave 8)	*Unqualified and not studying ($n^2 = 499$) OR[3] (95% CI)*	*Not working ($n^2 = 855$) OR[3] (95% CI)*	*Not in a relationship ($n^2 = 702$) OR[3] (95% CI)*	*Had a baby ($n^2 = 174$) OR[3] (95% CI)*	*Daily cigarette smoking ($n^2 = 529$) OR[3] (95% CI)*	*Used amphetamines[1] ($n^2 = 229$) OR[3] (95% CI)*	*Used ecstasy[1] ($n^2 = 364$) OR[3] (95% CI)*	*Used cocaine[1] ($n^2 = 174$) OR[3] (95% CI)*	*Drug and alcohol counselling[1] ($n^2 = 76$) OR[3] (95% CI)*
No high-risk alcohol or cannabis	1	1	1	1	1	1	1	1	1
Selective high-risk cannabis use	2.5 (1.5–4.2)	1.6 (0.93–2.6)	1.7 (1.0–2.8)	2.1 (1.1–4.0)	5.1 (3.1–8.6)	11 (6.5–17)	8.4 (5.0–14)	7.3 (4.1–13)	male[4] 4.9 (1.8–13) female 23 (8.1–67)
Selective high-risk alcohol use	1.1 (0.8–1.7)	0.69 (0.47–1.0)	1.6 (1.2–2.3)	0.86 (0.45–1.6)	2.0 (1.3–3.1)	3.5 (2.2–5.4)	2.9 (2.0–4.2)	2.9 (1.7–5.0)	1.3 (0.54–3.0)
Concurrent high-risk cannabis and alcohol use	2.5 (1.0–6.0)	1.2 (0.48–3.2)	2.6 (0.96–6.9)	0.77 (0.08–7.7)	5.8 (2.4–14)	12 (5.0–29)	10 (3.0–34)	9.4 (3.7–24)	4.7 (1.4–15)

[1]Within the past 12 months. [2]Frequencies obtained by averaging across the five imputed data sets. [3]Odds ratios from logistic regression models adjusted for gender, non-metropolitan school of origin, parental education and parental divorce/separation and parental smoking during particpant's adolescence. [4]Wald test for interaction: $P = 0.03$.

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Table 4 Predictive associations between moderate-risk adolescent cannabis and alcohol use and young adult social outcomes and illicit substance use adjusted for background factors.

	Young adult outcome measures (wave 8)								
Adolescent persistent cannabis and alcohol use (> 1 in waves 1–68)	*Unqualified and not studying OR (95% CI)*	*Not working OR (95% CI)*	*Not in a relationship OR (95% CI)*	*Had a baby OR (95% CI)*	*Daily cigarette smoking OR (95% CI)*	*Used amphetamines*[1] *OR (95% CI)*	*Used ecstasy*[1] *OR (95% CI)*	*Used cocaine*[1] *OR (95% CI)*	*Drug and alcohol counselling*[1] *OR (95% CI)*
Univariate									
Selective moderate risk cannabis use	2.6 (1.7–3.9)	1.0 (0.57–1.8)	1.9 (1.2–3.0)	1.3 (0.51–3.1)	3.6 (2.1–6.3)	7.4 (4.5–12)	9.1 (5.5–15)	6.2 (3.2–12)	5.3 (2.7–10)
Selective moderate risk alcohol use	1.5 (0.81–2.6)	1.1 (0.59–1.9)	1.1 (0.64–1.9)	male[2] 1.0 (0.32–3.4) female 3.2 (1.5–6.6)	2.2 (1.4–3.4)	2.3 (0.83–6.2)	2.1 (1.2–3.8)	2.5 (1.2–5.0)	1.3 (0.45–3.5)
Concurrent mod risk cannabis and alcohol use	2.1 (1.0–4.6)	1.7 (0.70–3.9)	0.88 (0.41–1.9)	2.9 (0.79–10)	5.2 (2.1–13)	5.2 (2.5–11)	7.4 (3.7–15)	8.2 (3.4–20)	3.0 (0.56–16)
Adjusted for all persistent substance use measures and background measures[3]									
Selective moderate risk cannabis use	2.4 (1.5–3.7)	1.0 (0.54–1.7)	1.8 (1.1–2.9)	1.2 (0.38–3.5)	3.0 (1.7–5.4)	6.0 (3.6–10)	7.2 (4.3–12)	4.7 (2.3–9.7)	4.1 (1.8–9.3)
Selective moderate risk alcohol use	1.3 (0.69–2.4)	1.1 (0.57–2.0)	1.1 (0.66–1.9)	male[2] 1.0 (0.29–3.3) female 2.5 (1.2–5.2)	2.0 (1.3–3.1)	2.2 (0.81–6.0)	2.0 (1.1–3.6)	2.4 (1.2–4.7)	1.2 (0.40–3.5)
Concurrent moderate risk cannabis and alcohol use	1.5 (0.61–3.7)	1.5 (0.61–3.8)	0.69 (0.32–1.5)	2.6 (0.54–13)	3.2 (1.2–8.5)	2.6 (1.1–6.1)	4.1 (1.7–10)	4.7 (1.7–13)	1.7 (0.27–10)

[1]Within the past 12 months. [2]Wald test for interaction: univariate $P = 0.10$, multivariate $P = 0.17$. [3]Estimates adjusted for gender, non-metropolitan school of origin, parental education and parental divorce/separation and smoking during the participant's adolescence.

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DISCUSSION

Alcohol and/or cannabis were used by close to 90% of young adults in our sample. Moreover, close to one in five young adults used either alcohol or cannabis at a high-risk level. We found some association between alcohol and cannabis at each level of use but there was a tendency for high-level users to use one substance predominantly. Close to one in four moderate risk (weekly +) teenage cannabis users were later high-risk (daily) users as young adults. Weekly or more frequent teenage cannabis use predicted a later sevenfold higher rate of daily cannabis use compared with a doubling of the odds for high-risk drinking. In contrast, moderate-risk adolescent alcohol use in the absence of weekly cannabis predicted an approximately threefold increased rate of both later high-risk drinking and cannabis use. These findings seem consistent with an early selection into heavier cannabis use for a substantial minority.

What might explain an early selective progression to heavier cannabis use? One possibility is that it reflects a substance-specific heritable tendency to respond to cannabis and alcohol in different ways [22]. However, the evidence to date from twin studies suggests both that cannabis and alcohol misuse in adulthood are influenced by genetic factors, but these factors overlap substantially and are generally non-specific [23,24]. An alternative explanation is that substance selection in vulnerable young people is determined by psychosocial context [13,23]. This context might, in turn, explain the association between heavier cannabis use and both less settled social roles and high substance use in young adulthood. It is also possible that cannabis use may lead directly or indirectly to poorer young adult outcomes. Different peer group values and drug preferences as well as exposure to other drugs may explain the higher rates of other substance use. A further possibility is that academic failure and absence of a stable relationship lead to social marginalization and greater use of cannabis. There is, finally, a possibility that for a minority of young people the selective use of cannabis reflects a preference for the drug, a possibility that may be linked to the development of a dependence syndrome [25].

Ultimately this study is unable to delineate whether the selective use of cannabis reflects an individual's response to the drug or may arise from unmeasured background confounders. However, the associations between frequent cannabis use in adolescence and later illicit drug use are similar to that reported recently by Fergusson *et al*. [26], who had greater scope for control of potential early childhood confounders. An absence of relevant measures of alcohol-specific harms such as antisocial behaviour or accidental injury could explain the current study's failure to find an association between adolescent alcohol consumption and later adverse social outcomes. Even taking this limitation into account, the course of risky adolescent drinking appears very different from that of risky cannabis use.

Despite limitations, the policy relevance of the findings remains. The poor outcomes of regular adolescent cannabis users provide a strong rationale for prevention and early intervention. The tendency to specialize in cannabis use also raises a question about policies to reduce youth alcohol use. Such policies have been shown to increase youth cannabis use which in the light of this study's findings might increase inadvertently levels of risky cannabis use and the harms associated with the latter [27]. On the other hand, there is a risk that, because high-risk alcohol use appears to be associated with fewer social difficulties, it may escape policy attention and the intervention that it deserves, given its longer-term adverse health consequences [28].

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