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Can cannabis use be prevented by targeting personality risk in schools? Twenty-four-month outcome of the adventure trial on cannabis use: a cluster-randomized controlled trial

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Aims To examine the effectiveness of a personality-targeted intervention program (Adventure trial) delivered by trained teachers to high-risk (HR) high-school students on reducing marijuana use and frequency of use. **Design** A cluster-randomized controlled trial. **Setting** Secondary schools in London, UK. **Participants** Twenty-one secondary schools were randomized to intervention ($n = 12$) or control ($n = 9$) conditions, encompassing a total of 1038 HR students in the ninth grade [mean (standard deviation) age = 13.7 (0.33) years]. **Interventions** Brief personality-targeted interventions to students with one of four HR profiles: anxiety sensitivity, hopelessness, impulsivity and sensation-seeking. **Measurements** Primary outcome: marijuana use. Secondary outcome: frequency of use. Assessed using the Reckless Behaviour Questionnaire at intervals of 6 months for 2 years. Personality risk was measured with the Substance Use Risk Profile Scale. **Findings** Logistic regression analysis revealed significant intervention effects on cannabis use rates at the 6-month follow-up in the intent-to-treat sample [odds ratio (OR) = 0.67, $P = 0.05$, 95% confidence interval (CI) = 0.45–1.0] and significant reductions in frequency of use at 12- and 18-month follow-up ($\beta = -0.14$, $P \leq 0.05$, 95% CI = –0.6 to –0.01; $\beta = -0.12$, $P \leq 0.05$, 95% CI = –0.54 to 0.0), but this was not supported in two-part latent growth models. Subgroup analyses (both logistic and two-part models) reveal that the sensation-seeking intervention delayed the onset of cannabis use among sensation seekers (OR = 0.25, $\beta = -0.833$, standard error = 0.342, $P = 0.015$). **Conclusions** Personality-targeted interventions can be delivered effectively by trained school staff to delay marijuana use onset among a subset of high-risk teenagers: sensation-seekers.

Keywords Adolescents, drug prevention, impulsivity, personality, sensation seeking, targeted prevention.

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INTRODUCTION

Marijuana (cannabis) is the second most popular drug of choice among teens and young adults, following alcohol, and is currently the most commonly used illicit drug in the United States and world-wide [1,2]. It is particularly popular among teenagers; in the United States, 12.5% of adolescents report annual use by 8th grade, a figure that rises to 36.4% by the 12th grade [1].

Misuse of cannabis during adolescence can be particularly pernicious, as the pre-frontal cortex is developing and cannabis prominently affects frontal-limbic neurocircuitry [3]. When compared with late-onset use, early-onset chronic cannabis users present neurocognitive deficits on tasks assessing sustained attention, impulse control and executive functioning [4,5].

Taking into consideration the shifting political landscape surrounding the legalization of medical and recreational marijuana use, there is a pressing need to determine whether maladaptive marijuana use can be prevented, delayed or reduced. School settings provide an ideal place for preventive interventions to take place, as they allow for systematic screening and targeted interventions to large numbers of students before drug use onset begins [6]. Effective school-based interventions for alcohol and substance use will typically target high-risk (HR) populations and are of short duration [7].

Substance use and abuse is an aetiologically complex disorder composed of differential HR pathways, with many theories proposing that personality risk factors represent intermediate phenotypes of substance misuse vulnerability [8]. Accordingly, two broad domains of personality, the

disinhibited and inhibited domains, can be captured in lower order traits of impulsivity (IMP), sensation-seeking (SS), anxiety–sensitivity (AS) and negative-thinking/introversion–hopelessness (H) which are associated with specific patterns of substance use and misuse. The presence of these personality traits is theorized to indicate specific motivational profiles for substance use and, in turn, incur differential pharmacological sensitivity to various substances based on their reinforcing effects, and predict comorbid psychological disorders [8–11].

While the majority of evidence supporting this personality model of addiction vulnerability is based on alcohol consumption data, some research suggests that IMP, NT and SS are associated with an increased probability of using marijuana, with SS specifically identified as a prospective risk factor for accelerated growth in cannabis use over time [10,12]. The association between SS and cannabis use has been well documented by other researchers [13–18]. SS has also been associated with polysubstance use and to the use of drugs that enhance experience, such as cannabis [9,19]. While IMP has shown some association with cannabis use vulnerability, it appears to be associated more specifically with cocaine use and dependence [6], as shown in adolescents and young adults [9].

A selective, personality-targeted approach that targets liability to substance use has been shown in randomized trials to be effective in the prevention and reduction of substance misuse [6,20,21] in youths and adults. We report herein the results of the Adventure trial [22], a cluster-randomized personality-targeted prevention programme delivered by trained teachers to London high-school students. The successful effects of this trial on reducing alcohol use have been reported elsewhere [20,22]. The intervention was designed to provide personality-relevant coping skills to HR adolescents according to their HR personality profile in order to delay and reduce alcohol use and secondary substance use. The previous Preventure trial established evidence of treatment efficacy when delivered by mental health professionals, such that the intervention was associated with a marginal reduction in odds of taking up the use of marijuana over a 24-month period among HR adolescents [6]. The Adventure trial sought to establish empirical evidence of treatment effectiveness, i.e. under real world conditions, with interventions delivered by trained teachers rather than mental health professionals [23]. Demonstrating that cannabis use can be prevented, reduced or delayed would be of great public use and benefit.

The present paper reports the 2-year outcome of this intervention on marijuana use, using two-part latent growth modelling. As the programme was designed originally to target alcohol misuse, the intervention may only be effective for those with a particular risk for cannabis use, given that different personality factors predict different drug preferences and motives for use. For example, Comeau *et al.* [24] found that AS was related to conformity motives for drinking and cannabis use. The hypothesis that a personality-targeted intervention delivered by teachers in a school setting would reduce or delay marijuana use and frequency successfully during a 2-year period was tested. We investigated this hypothesis by examining personality × intervention interactions following analyses of personality–cannabis relationships.

METHODS

Schools

Twenty-one secondary schools signed up for this study, representing 14% of all schools approached ($n = 148$). After recruitment, a computerized random digit generator was used by the trial coordinator to allocated schools to intervention ($n = 12$) or control ($n = 9$) conditions using a cluster-randomized design on a one-to-one ratio with no additional blocking or stratification. One intervention school ($n = 198$) and one control school ($n = 135$) were excluded from this trial and the consort diagram in Supporting information, Fig. S1. The control school withdrew from the study after the baseline survey and the intervention school could not commit to the full trial protocol. Each school assigned to the intervention condition had four staff members trained to administer the intervention programme, according to a standardized set of criteria [22]. This was an open-label trial; however, intervention assignment was masked from youth and teachers who did not participate in the programme, and youth participating in interventions were not informed of other interventions being offered and which of their peers participated in these other interventions. Those conducting follow-up sessions and quality control of data were also blind to intervention status. Schools were spread across 18 London boroughs and were located in both densely populated, low-income areas and suburban areas. All but one school were state-funded.

Adolescents

Participants ($n = 2904$) were attending school in September 2007 (year 9 cohort). The only exclusion criterion was not providing passive consent from parents (active parental refusal) or active student assent. After exclusion of unreliable cases (responding inconsistently or positively to a sham drug item), the sample numbered 2401 participants who participated in follow-up assessments at 6, 12, 18 and 24 months after the intervention (see Supporting information, Fig. S1 for a flowchart). The trial was scheduled to stop after the 24-month follow-up. The mean [standard deviation (SD)] age of the sample was 13.7 (0.33) years. The sample was composed of 55.7% males, with 41.3% of students reporting white ethnicity. Eligibility

for the intervention was established by identifying HR youth who scored 1 SD above the school mean on one of the four subscales of the SURPS. While baseline assessments and follow-ups were conducted for all students who took part in the baseline, only outcomes on HR youth ($n = 1038$), the intent-to-treat (ITT) sample, are reported. This study was approved by the King's College London College Research Ethics Committee and an independent steering committee.

SAMPLE SIZE DETERMINATION

The Adventure trial was powered for alcohol use measures. Therefore, this trial was 80% powered to detect a moderate intervention × time effect in HR and LR youth. To detect a standardized between-group mean difference of 0.3 ($P = 0.5$) in a trial using at least three measurement occasions, 420 HR and 420 LR students are required from 14 schools. When accounting for a 20% dropout rate, 17 schools with 100 students per school are required. The trial was sufficiently powered to detect a 50% reduction in rates of cannabis use uptake within this sample (25 versus 12.5%). According to g-power, a sample size of 1035 HR youth is sufficient to detect between 30 and 50% reduction in cannabis use rates (assuming a 25% rate of use in the control group; $P = 0{,}05$; $\beta = 0.90$) at any given timepoint. Cocaine use and other drug use were prevalent in 3 and 6% of HR students, respectively, in this trial, which would mean that 3500–9000 HR youth would be needed to detect a similar intervention effect on cocaine use (with similar power) and 1400–2200 for other drug use. Therefore, we report only cannabis use outcomes in this study.

Measures

All data were collected using self-report questionnaires during school hours at 6-month intervals for 2 years. Given the sensitive nature of the questionnaires, measures were undertaken to maximize self-report accuracy, including emphasizing confidentiality and anonymity with regard to parent and school access, as well as adding reliability checks via sham items (fake drug) and repeated items across assessments. Participants who reported unreliable data at baseline were excluded from the ITT sample; those responding positively at follow-ups on this item were indicated as having missing data.

Outcome measures

1 Primary outcome

Marijuana use was assessed using item number 4, 'used marijuana (weed)', on the Reckless Behavior Questionnaire (RBQ) [14], originally a six-point scale ('never' to 'daily or almost daily') which was dichotomized to represent use or non-use in the past 6 months.

2 Secondary outcome

The same non-dichotomized item was also used to calculate marijuana use frequency, an estimate of the severity of use, assuming that marijuana use had occurred.

3 Subgroup analyses

Personality was assessed across the four HR domains of IMP, SS, H and AS using the Substance Use Risk Personality Scale (SURPS [20]), an instrument that has good concurrent, predictive and incremental validity for differentiating between reinforcement-specific patterns of substance use and misuse in youths and adults [9,10,12]. Personality group was determined based on standard deviation from school mean on each the four SURPS subscales. Drinking was measured with two six-point scales (frequency: 'never' to 'daily or almost daily' and quantity: 'I have never had a full drink' to '10 or more on one occasion') and was included as a covariate.

Interventions

The interventions were brief and involved two 90-minute group sessions carried out at the participants' schools by school staff who had been trained by the Preventure team. HR students received only one of four interventions targeting their most dominant personality trait of the four assessed by the SURPS. Intervention manuals included psychoeducational, motivational and cognitive behavioural therapy exercises as well as real-life scenarios lived by high-personality risk British youth. The interventions were designed to change how individuals cope with the specific vulnerabilities associated with their personality risk. To enhance motivation for behavioural change, the first section of the manual was focused on goal-setting. The second section focused on the target personality

Table 1 Baseline characteristics in high-risk youth attending intervention and control schools.

	High-risk youth (intent-to-treat sample)		
Baseline behaviour	*Intervention (n = 595)*	*Control (n = 443)*	*F*[a]
SURPS			
Hopelessness	13.80 (4.42)	13.87 (4.17)	0.06
Anxiety–sensitivity	12.06 (3.32)	12.07 (3.08)	0.01
Sensation-seeking	17.25 (3.75)	16.84 (3.67)	3.05
Impulsivity	13.66 (3.05)	13.53 (3.09)	0.47
Alcohol use			
Quantity[b]	1.67 (1.05)	1.66 (1.14)	0.34
Frequency[c]	1.85 (1.23)	1.78 (1.21)	1.03

SURPS = Substance Use Risk Profile Scale. Results reported as mean (standard deviation) unless indicated otherwise. [a]There were no significant differences at $P < 0.05$. [b]Ordinal six-item scale ranging from 1 = none (I've not had a full drink); 2 = 1 or 2; 3 = 3 or 4; 4 = 5 or 6; 5 = 7–9; 6 = 10 or more. [c]Ordinal six-item scale ranging from 1 = never; 2 = less than monthly; 3 = once a month; 4 = 2 or 3 times a month; 5 = weekly; 6 = daily or almost daily.

Table 2 Summary of primary and secondary outcomes by time and intervention status.

Primary outcome: marijuana use							*Secondary outcome: marijuana use frequency*[a]					
Personality trait × time	*Control % prevalence*		*Intervention % prevalence*				*Control*		*Intervention*			
	Raw	*Adjusted*[b]	*Raw*	*Adjusted*[b]	*OR*[c]	*95% CI*	*Mean (n)*	*SD*	*Mean (n)*	*SD*	β^d	*95% CI*
HR	$n = 442$[e]	$n = 403$	$n = 593$	$n = 527$								
Baseline	8.8		11.1		$\chi^2 = 1.48$		1.92 (39)	1.13	1.92 (66)	1.11	$F = 0.00$	
6 Months	17	(11.7)	14.7	(8.7)	0.67*	0.45–1.00	1.56 (75)	0.81	1.83 (87)	1.10	0.79	–0.11 to 0.42
12 Months	16.4	(11.2)	19.1	(14.6)	1.11	0.77–1.60	2.13 (72)	1.14	1.79 (113)	1.01	–0.14*	–0.60 to 0.01
18 Months	24.4	(19.9)	26.6	(20.9)	1.05	0.76–1.40	2.12 (107)	1.16	1.87 (149)	1.07	–0.12*	–0.54 to –0.00
24 Months	24.7	(21.3)	25.2	(22.4)	1.00	0.74–1.36	2.09 (109)	1.10	2.23 (149)	1.13	0.07	–0.12 to 0.43
NT	$n = 107$	$n = 93$	$n = 137$	$n = 123$								
Baseline	13.1		10.2		$\chi^2 = 0.49$		1.93 (14)	1.21	2.29 (14)	1.20	$F = 0.61$	
6 onths	18.9	(12.9)	15.3	(8.1)	0.76	0.34–1.70	1.75 (20)	1.02	2.10 (21)	1.18	–0.00	–0.68 to 0.67
12 Months	17.1	(10.8)	19	(13)	1.16	0.53–2.60	2.33 (18)	1.33	1.92 (26)	1.06	–0.24	–1.20 to 0.05
18 Months	20.2	(14)	24.1	(17.9)	1.43	0.69–2.97	2.10 (21)	1.22	2.03 (33)	1.10	–0.25	–0.68 to 0.53
24 Months	30.5	(26.9)	24.8	(21.1)	0.76	0.41–1.42	1.94 (32)	1.08	2.38 (34)	1.16	0.22	–0.06 to 1.05
AS	$n = 123$	$n = 118$	$n = 170$	$n = 162$								
Baseline	4.1		4.7		$\chi^2 = 0.07$		1.60 (5)	0.89	1.50 (8)	1.07	$F = 0.03$	
6 Months	8.9	(6.8)	7.7	(6.2)	0.79	0.31–2.03	1.73 (11)	0.91	1.46 (13)	0.88	–0.20	–1.11 to 0.42
12 Months	12.2	(9.3)	10.1	(9.3)	0.78	0.35–1.72	1.60 (15)	0.83	1.71 (17)	0.92	0.03	–0.67 to 0.77
18 Months	15.4	(12.7)	18.3	(15.4)	1.18	0.59–2.37	1.74 (19)	0.99	1.87 (31)	1.06	0.15	–0.28 to 0.92
24 Months	16.3	(13.6)	15.4	(15.4)	0.90	0.47–1.73	2.00 (20)	1.08	1.88 (26)	1.07	–0.03	–0.76 to 0.65
IMP	$n = 109$	$n = 99$	$n = 132$	$n = 107$								
Baseline	9.2		18.9		$\chi^2 = 4.59$*		1.9 (10)	1.20	2.00 (25)	1.08	$F = 0.06$	
6 Months	17.6	(12.2)	26	(15)	1.32	0.61–2.84	1.37 (19)	0.68	1.74 (34)	1.02	0.15	–0.10 to 0.66
12 Months	20.4	(14.3)	30.5	(23.4)	1.58	0.77–3.26	2.18 (22)	0.96	1.95 (40)	1.18	–0.124	–0.83 to 0.27
18 Months	30.6	(24.5)	35.1	(28)	1.05	0.56–1.97	2.24 (33)	1.09	1.67 (46)	0.92	–0.28*	–1.03 to –0.12
24 Months	23.9	(21.2)	34.4	(29.9)	1.62	0.88–3.00	2.50 (26)	1.14	2.16 (45)	1.15	0.16	–.078 to –.031
SS	$n = 103$	$n = 93$	$n = 154$	$n = 135$								
Baseline	9.7		12.3		$\chi^2 = 0.43$		2.10 (10)	1.20	1.74 (19)	1.10	$F = 0.68$	
6 Months	24	(16.1)	12.3	(7.4)	0.25***	0.10–0.57	1.48 (25)	0.65	1.95 (19)	1.27	0.24	–.03 to 0.97

(Continues)

Table 2 (Continued)

Primary outcome: marijuana use							*Secondary outcome: marijuana use frequency*[a]					
	Control % prevalence		*Intervention % prevalence*				*Control*		*Intervention*			
Personality trait × time	*Raw*	*Adjusted*[b]	*Raw*	*Adjusted*[b]	*OR*[c]	*95% CI*	*Mean (n)*	*SD*	*Mean (n)*	*SD*	β^d	*95% CI*
12 Months	16.3	(10.8)	19.2	(15.6)	0.98	0.47–2.04	2.29 (17)	1.31	1.50 (30)	0.73	−0.36**	−1.37 to −0.17
18 Months	32.7	(30.1)	30.5	(24.4)	0.81	0.45–1.47	2.24 (34)	1.26	1.96 (47)	1.20	−0.13	−0.90 to −0.26
24 Months	29.8	(25.8)	28.4	(25.9)	0.89	0.50–1.59	1.97 (31)	1.08	2.39 (44)	1.13	0.22	−0.05 to 1.02

HR = high risk; NT = negative thinking; AS = anxiety–sensitivity; SS = sensation-seeking; *n* = size of the sample; OR = odds ratio; CI = confidence intervals; SD: = standard deviation; β = standardized beta. *Significant at $P \leq 0.05$; **significant at $P = 0.01$; ***significant at $P = 0.001$. [a]Among those who reported use in the past 6 months, ordinal four-item scale including 1 = '1 time', 2 = '2–5 times', 3 = '6–10 times' and 4 = 'more than 10 times'. As there was very little variability in this data, unadjusted and adjusted (controlling for baseline use, gender, race, drinking quantity and frequency) means were almost identical. Therefore, only raw means are reported here. [b]Adjusted by excluding baseline users in order to better reflect our modeling results, which co-vary for baseline marijuana use, a strong predictor for future use. [c]χ^2comparisons between intervention conditions at baseline reported on raw data. When tested on the adjusted data, the same effects are maintained. For all other time-points, ORs are presented, calculated using logistic regression while co-varying for baseline use, gender, race, drinking quantity and frequency. [d]*F*-statistic presented for baseline frequency of use. For all other time-points, standardized betas are presented, calculated using linear regression while co-varying for baseline frequency of use, gender, race, drinking quantity and frequency. [e]Sample size for primary outcome shown for baseline data only to reduce table load.

variable and their associated problematic coping behaviours. The final part of the manual introduced students to the cognitive–behavioural model and guided the breaking down of personal experiences into thoughts, emotions and behaviours in personality-specific ways. Students were instructed to challenge their personality-specific cognitive distortions. All manuals were equivalent in length and structure; the only differences across the four interventions were the examples described and the thoughts and behaviours targeted in these exercises. Cannabis was not mentioned directly in any intervention manual, but would have been discussed if youth raised it in the group sessions. While not all HR participants in intervention schools received the intervention ($n = 100$), due to time and resource constraints, these participants were also included in the intent-to-treat analyses.

Control condition consisted of statutory drug education which is provided through the regular national curriculum in the United Kingdom.

Missing data

Full information maximum likelihood estimation in SPSS statistical software (SPSS Inc., Chicago, IL, USA) was used using all available data to replace data missing not at random, a procedure that is considered valid when less than 25% of a data set is missing. Previous analyses on this sample revealed that only HR status predicted attrition (odds ratio 0.67, $P = 0.02$), when two control schools with problematic follow-up at 6 and 24 months were removed. Supplemental analyses were conducted for the primary outcome variable, where negative outcome was assumed in the case of missing data, such that missing a follow-up would suggest marijuana uptake.

Data analysis

Logistic regression (onset of use) and linear regression (frequency of use), controlling for baseline demographic (gender and ethnicity), drinking quantity and frequency and baseline cannabis use rates, investigated intervention effects at each follow-up period (Table 2). Two-part latent growth modelling (LGM; using the same baseline covariates) was used to model the main effects of the intervention across time [(reflected by the intercept centered at 6 months) and the time-dependent effects of the intervention (reflected as the slope from 6 to 24 months]. This analysis strategy has the advantage of modelling both onset and frequency of substance use behaviour as correlated phenomena while tracking individual level change across time; however, despite this advantage, it is worth mentioning that such models have less power to detect small effects, particularly for behaviours that have low prevalence. The probability of use and frequency of use (assuming onset

had occurred) in the past 6 months was modelled through a random-effects probit model, whereby frequency and probability of use were regressed on an intercept and a growth parameter. Using a procedure outlined by Brown *et al.* [25], linear and quadratic growth functions were tested, which revealed that change in cannabis use and frequency variables was best represented linearly. Multi-level analyses included subject (time) and intervention, but did not include a cluster-level variable because intraclass correlations for school were below 0.1 on all outcomes and there was little variation accounted for by schools across time. The intervention variable represented whether the school was assigned to the intervention or followed treatment as usual.

RESULTS

Characteristics of the participants

There were no differences between intervention and control schools on personality and marijuana use variables at baseline (Tables 1 and 2), with the exception that IMP participants in intervention schools were twice as likely (18.9 versus 9.2%) to report having used marijuana in the past 6 months compared with IMP counterparts in control schools ($\chi^2 = 4.586$, $P = 0.032$). Participant flow and follow-up rates can be viewed in Supporting information, Fig. S1. Follow-up rates among the HR sample range from 73.1 to 87.4% across different time-points. Reasons for non-completion were mainly absence from school or school failure to organize a grade-wide testing session at a particular follow-up.

Intervention outcomes: HR group

Primary and secondary outcome measures by intervention and personality risk group are displayed in Table 2, along with results of logistic and regression analyses. Intervention effects were revealed on cannabis use at 6 months post-intervention, and then on frequency of use in cannabis users at 12 and 18 months. Rates of cannabis user were 33% lower in the intervention group at the 6-month follow-up. However, the LGM testing intervention effects across time revealed no significant main or time-dependent intervention effects on growth (Table 3). The model assuming negative outcomes for those who were not followed revealed a marginal effect ($P = 0.06$) of intervention on the intercept of the dichotomous outcome (cannabis use).

Subgroup analyses: personality effects

Logistic and linear regression analyses revealed intervention effects on cannabis use rates in the SS subgroup, with the SS intervention being associated with a 75% reduction in cannabis use rates at 6 months post-intervention and then reduced frequency of use at 12 months. Two-part LGM showed that sensation-seeking was associated with greater cannabis use onset and that IMP was associated with greater frequency of use among those who are using cannabis (Table 4). Table 5 reports the results of a two-part model testing the interaction between SS and intervention effects on primary and secondary outcomes and revealed a significant effect on the intercept of the dichotomous variable. Probing the interaction term further, the intervention was associated with a significant decrease in the probability of reporting marijuana use at 6 months post-intervention among SS participants [$\beta = -0.833$, standard error (SE) = 0.342, $P = 0.015$), an effect that appeared to be maintained over the 2-year period.

A model testing intervention effects for IMP relative to the other personality traits revealed no intervention effect for the IMP group. While the model reported in Table 4 revealed an association between IMP scores and the intercept

Table 3 Two-part latent growth modeling intervention outcomes on the high-risk group.[a]

	Dichotomous part (marijuana use)			*Continuous part (marijuana use frequency)*		
Variable	*Estimate (SE)*	*Estimate/SE*	*P-value*	*Estimate (SE)*	*Estimate/SE*	*P-value*
Using replaced missing data						
Intercept						
Intervention control	–0.105 (0.176)	–0.594	0.552	–0.010 (0.061)	–0.157	0.875
Slope						
Intervention versus control	0.076 (0.083)	0.917	0.359	0.002 (0.029)	0.066	0.947
Assuming negative outcome						
Intercept						
Intervention control	–0.235 (0.128)	–1.841	0.066			
Slope						
Intervention versus control	0.067 (0.061)	1.103	0.270			

[a]Covariates included intercept, demographic variables (sex and ethnicity), baseline marijuana consumption and baseline drinking quantity and frequency. Effects are maintained when controlling for cluster. The intercept reflects the mean constant in quantity or frequency for any individual across time (6–24 months); slope of the outcome reflects any mean deviance from the intercept over time. SE = standard error.

Table 4 Two-part latent growth model examining the contribution of personality to marijuana use among the high-risk sample only.[a]

	Dichotomous part (marijuana use)			*Continuous part (marijuana use frequency)*		
Variable	*Estimate (SE)*	*Estimate/SE*	*P-value*	*Estimate (SE)*	*Estimate/SE*	*P-value*
Intercept						
Intervention versus control	–0.131 (0.175)	–0.753	0.452	–0.013 (0.061)	–0.211	0.833
NT	0.028 (0.022)	1.271	0.204	0.007 (0.07)	1.010	0.312
AS	–0.015 (0.027)	–0.542	0.588	–0.004 (0.01)	–0.397	0.692
SS	0.057 (0.027)	2.005	0.045*	0.000 (0.011)	0.0229	0.977
IMP	0.049 (0.033)	1.498	0.134	0.019 (0.009)	2.122	0.034*
Slope						
Intervention versus control	0.073 (0.082)	0.890	0.374	0.003 (0.029)	0.088	0.930
NT	0.008 (0.010)	0.814	0.416	0.000 (0.004)	0.026	0.979
AS	–0.017 (0.014)	–1.238	0.216	–0.003 (0.005)	–0.730	0.465
SS	0.017 (0.013)	1.271	0.204	0.005 (0.005)	0.957	0.339
IMP	0.010 (0.014)	0.719	0.472	–0.005 (0.004)	–1.050	0.293

NT = negative thinking; AS = anxiety sensitivity; SS = sensation-seeking. [a]Covariates included intercept, demographic variables (sex and ethnicity), baseline marijuana consumption and baseline drinking quantity and frequency. The intercept reflects the mean constant in quantity or frequency for any individual across time (6–24 months); slope of the outcome reflects any mean deviance from the intercept over time. *Significant at < 0.05.

Table 5 Two-part latent growth modelling intervention outcomes in the sensation-seeking group relative to other high-risk traits.[a]

	Dichotomous part (marijuana use)			*Continuous part (marijuana use frequency)*		
Variable	*Estimate (SE)*	*Estimate/SE*	*P-value*	*Estimate (SE)*	*Estimate/SE*	*P-value*
Using replaced missing data						
Intercept						
Intervention versus control	0.154 (0.207)	0.742	0.458	0.015 (0.720)	0.205	0.838
SS versus others	0.735 (0.298)	2.468	0.014*	–0.008 (0.088)	–0.086	0.932
Intervention × SS versus others	–0.987 (0.399)	–2.475	0.013*	–0.100 (0.133)	–0.752	0.452
Slope						
Intervention versus control	–0.001 (0.095)	–0.090	0.993	–0.018 (0.034)	–0.513	0.608
SS versus others	–0.081 (0.154)	–0.527	0.598	0.016 (0.044)	0.356	0.722
Intervention × SS versus others	0.280 (0.197)	1.425	0.154	0.070 (0.063)	1.122	0.262
Assuming negative outcome						
Intercept						
Intervention versus control	–0.074 (0.148)	–0.498	0.619			
SS versus others	0.424 (0.212)	2.001	0.045*			
Intervention × SS versus others	–0.625 (0.288)	–2.168	0.03*			
Slope						
Intervention versus control	0.055 (0.068)	0.799	0.424			
SS versus others	0.001 (0.113)	0.005	0.996			
Intervention × SS versus others	0.040 (0.144)	0.275	0.783			

SS versus others = sensation-seekers versus the three remaining high-risk personality traits (impulsivity, anxiety sensitivity, negative thinking). [a]Covariates included intercept, demographic variables (sex and ethnicity), baseline marijuana consumption and baseline drinking quantity and frequency. Intervention effects are maintained when controlling for cluster. The intercept reflects the mean constant in quantity or frequency for any individual across time (6–24 months); slope of the outcome reflects any mean deviance from the intercept over time. *Significant at < 0.05.

for frequency of use, being in the IMP group was not necessarily associated with more frequent cannabis use.

DISCUSSION

The primary and secondary outcomes of this study were tested using logistic and LGM and revealed conflicting results: regression analysis revealed that the intervention was associated with a significant delay in onset of cannabis use at 6 months and then subsequent reduction in frequency of use at 12 and 18 months among users, while LGM did not reveal significant intervention effects on any of the outcomes. Power analysis revealed that the study is sufficiently powered to detect 30–50% reductions in

cannabis use rates at any given time-point; however, the study was not sufficiently powered to detect small effects, particular within a LGM. It is reasonable to expect that intervention effects on intercept or growth functions will be smaller, as they require that effects are either maintained or change significantly over time. Due to limitations associated with each analytical strategy, we cannot conclude whether the personality-targeted interventions were effective in reducing onset and frequency of cannabis use among all HR youth.

However, results were consistent, and therefore more convincing for the effect of the intervention on cannabis use among sensation-seeking youth. The results of this trial suggest that over and above the risk for cannabis use presented by the other HR personalities, as reported by Castellanos-Ryan *et al*. [10], higher SS levels confer an additional vulnerability to early-onset cannabis use. This was demonstrated by an increase in the probability of reporting cannabis use at 6 months post-intervention and throughout the 2-year trial. This vulnerability is not surprising, given that motives for marijuana use among young people are tied primarily to enjoyment, enhancement and experimentation [26], which fit the behavioural profile of this HR group and their self-report drinking motives [9,24]. Both regression and LGM analyses revealed that interventions designed to help youth manage their SS personality more easily were more effective at delaying cannabis onset when compared with the other personality-targeted interventions and when compared to high SS youth who did not receive interventions.

Increases in IMP among the HR group also conferred a heightened risk of using cannabis more frequently, but not necessarily the likelihood of taking up cannabis use. However, relative to the other three personality groups, being classified as IMP did not confer additional risk to cannabis use, suggesting that individual differences in impulsivity might be most related to cannabis use at lower levels of impulsivity. However, impulsivity-targeted interventions were not shown to reduce cannabis use or frequency of use in youth identified as high in impulsivity.

The reason an intervention effect was detected only among SS students may be due to the fact that there was simply more cannabis use among SS students in this young HR sample, setting the stage for an intervention effect to be detected in this group (at least at the 6-month follow-up). It is possible that SS is particularly associated with early onset and frequency of cannabis use, whereas the other personality traits become more predictive in older cohorts [9,11,27]. In fact, the previous Preventure trial [6,28] reported marginal effects of all personality-targeted interventions on cannabis use in adolescents who were, on average, 1 year older than the current sample, suggesting that greater intervention effects on cannabis use might be achieved by targeting older HR youth. This might also explain the small and inconsistent intervention effects detected for the full ITT sample in the current analysis.

Alternatively, it is plausible that the other personality-targeted interventions do not target motives relevant to cannabis use in young adolescents, such as thrill-seeking, enjoyment and seeking altered perceptions [19,26,27]. It is possible that generalizing certain elements from the SS intervention, which may be particularly relevant to cannabis use onset, to the other interventions could decrease such use across the whole HR sample. Conversely, it is also possible that other HR personality groups may use cannabis for reasons that differ from their drinking motives, and that these motivations are not targeted by their respective interventions. Finally, it is also possible that the interventions manuals need to include more cannabis-relevant information to achieve stronger effects on cannabis use. Future studies should test whether adding cannabis-specific or SS-specific information and exercises to the interventions proves more effective in preventing cannabis use among HR youth. Additionally, more research is needed to examine the motives for using marijuana among the different HR samples.

The strengths of this study include the longitudinal examination of marijuana use and intervention status using developmentally sensitive statistical analyses that model substance use and frequency concomitantly, while capturing individual differences in trajectories. Limitations of this study included using self-report data for all outcomes and only using one item to measure cannabis use, although great care was taken to implement reliability checks and to reiterate that the nature of the study is confidential and with no consequences to disclosure. Overall, it was found that brief, selective, personality-targeted interventions, delivered by trained teachers, were effective in delaying the onset of marijuana use among young sensation-seekers. Given the well-documented and deleterious effects of early-onset marijuana use among teens, programmes that can prevent and delay this behaviour are of utmost importance for the public, particularly as society experiments with different public policies to regulate cannabis-related harm to society.

Clinical trial registration

Clinicaltrials.gov Identifier: NCT00776685

Declaration of interests

None.

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Supporting Information

Additional Supporting Information may be found in the online version of this article at the publisher's web-site:

Figure S1 CONSORT flow-chart.

