



## Secondary Effects of an Alcohol Prevention Program Targeting Students and/or Parents



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### ABSTRACT

The secondary effects of an alcohol prevention program (PAS) on onset of weekly smoking and monthly cannabis use are examined among >3000 Dutch early adolescents (M age = 12.64) randomized over four conditions: 1) parent intervention (PI), 2) student intervention (SI), 3) combined intervention (CI) and 4) control condition (CC). Rules about alcohol, alcohol use, and adolescents' self-control were investigated as possible mediators. PI had a marginal aversive effect, slightly increasing the risk of beginning to smoke at T1, and increased the likelihood of beginning to use cannabis use at T1 and T2. SI delayed the onset of monthly cannabis use at T3. CI increased the risk to use cannabis at T3. No mediational processes were found. In conclusion, though this study show mixed results, negative side effects of the PI were found, particularly at earlier ages. Moreover, these results indicate the need for multi-target interventions.

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### 1. Secondary effects of an alcohol prevention program targeting students and/or parents

Alcohol is the most prevalent drug among adolescents followed by cigarettes and cannabis. In the Netherlands, at age sixteen more than 90% of the adolescents have consumed alcohol, nearly 60% have smoked a cigarette and about 30% have tried cannabis (Verdurmen et al., 2012). Alcohol use is highly related to the use of other drugs including cigarettes, marijuana and hard drugs (Kandel, Yamaguchi, & Klein, 2006). In fact, early initiation of alcohol use increases the likelihood of use of other substances, particularly cigarettes and cannabis (Duncan, Duncan, & Hops, 1998; Komro, Tobler, Maldonado-Molina, & Perry, 2010). The combined parent–student intervention program 'Prevention of Alcohol use in Students' (PAS) effectively postponed the onset of (heavy) weekly drinking in underage adolescents (Koning et al., 2009; Koning, Van den Eijnden, Engels, Verdurmen, & Vollebergh, 2011a; Koning, van den Eijnden, Verdurmen, Engels, & Vollebergh, 2013). This study extends an earlier investigation of the effectiveness of the PAS program by examining whether the intervention also impacts smoking and cannabis use.

#### 1.1. Early onset of alcohol use as a risk factor

Several studies state that an early age of onset of drinking may increase the likelihood of getting involved in other forms of drug use (Duncan et al., 1998; Kandel et al., 2006; Reich, Dietrich, & Martin, 2011), most probably due to an increased exposure to opportunity (Wagner & Anthony, 2002). Further, adolescents who initiate the use of alcohol at later ages may be more equipped to refrain from substance use and are also more capable to withhold from involvement in other risky behaviors, due to so-called shared underlying processes (i.e. common processes that underlie the use of different substances; Chung & Elias, 1996; Degenhardt, Dierker, & Chiu, 2010). So, as alcohol use is a risk factor for other substances, delaying the onset of drinking is expected to prevent other substance use as well. The increased risk of early alcohol use for involvement in subsequent use of other drugs underlines the importance of investigating whether alcohol prevention programs impact the onset of other types of drug use as well, i.e. the secondary effects.

#### 1.2. Secondary effects of alcohol interventions

Effects of an alcohol intervention program on other substances not targeted by the intervention itself are referred to as secondary effects. By examining secondary effects, insight is gained on the importance of delaying the onset of drinking and also on the full impact of intervention programs. Yet, the number of studies examining secondary effects is limited. Most, yet not all (Grossbard et al., 2010), intervention studies have found favorable secondary effects of an alcohol intervention on

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smoking (Forsberg, Ekman, Halldin, & Ronnberg, 2000;) and/or cannabis (Grossbard et al., 2010; Magill, Barnett, Apodaca, Rohsenow, & Monti, 2009; Perry et al., 1996). For example, Grossbard et al. (2010) demonstrated that high school athletes receiving a combined parent–student alcohol intervention also less frequently used marijuana ten months later compared to the student only and control group; no secondary effects were reported for 30-day monthly cigarette use. The review study of McCambridge and Jenkins (2008) of 41 brief alcohol intervention studies demonstrated no favorable secondary effects on smoking behavior. However, this review was of adult-only programs on responsible drinking and only 7 of these included smoking data. Furthermore, a recent review on the secondary effects of brief alcohol interventions also concluded that these types of programs were effective in reducing alcohol use, but had negligible effects on untargeted illicit drug use (Tanner-Smith, Steinka-Fry, Hennessy, Lipsey, & Winters, 2015). However, the number of alcohol intervention studies reporting effects on other substances included in the study was low ( $k = 7$ ) and had relatively short follow-up measurements ( $M = 30.5$  weeks,  $SD = 16.8$ ). Moreover, the lack of family-based alcohol interventions included in this review should be taken into account. Particularly as it is known that in adolescence, a combined parent–student approach is more effective than either approach alone (Smit, Verdurmen, Monshouwer, & Smit, 2008). The current state of knowledge makes it impossible to draw conclusions on the potential effect of an alcohol prevention program targeting adolescents and their parents on untargeted substance use. Thus, though the empirical evidence is scarce, we may hypothesize that parent–student interventions targeting alcohol use may also impact involvement in other forms of drugs favorably in two potential ways: 1) the delay in onset of alcohol use also delays the onset of cigarette and cannabis use (cf. Gateway theory), and 2) a higher level of self-control in adolescents and strict parental rules regarding alcohol that have resulted in a delayed alcohol initiation also delay the onset of cigarette and cannabis use.

### 1.3. Prevention of alcohol use in students (PAS)

In a cluster randomized trial, including three experimental conditions (parents only, students only, combined parent–student) and a control condition, more than 3000 adolescents and their parents participated in the PAS study. The parent intervention consists of three components: (i) a presentation at a general parents' meeting in high school, (ii) consensus building among a shared set of rules among parents of children of the same class, and (iii) an information leaflet with a summary of the presentation and the outcome of the class meeting. In the student intervention, teachers conducted the intervention (four lessons) in all first-year classes. A booster session was provided one year later.

Previous work showed significant effects of the combined parent–student intervention on the onset of (heavy) weekly drinking at the 10, 22 (Koning et al., 2009), 34 (Koning et al., 2011a) and 50-month (Koning et al., 2013) follow-up measurements. Furthermore, the combined intervention increased the intervention-targeted behaviors; that is, the parents increased their strict rule setting, and adolescents increased their level of self-control (Koning, van den Eijnden, Engels, Verdurmen, & Vollebergh, 2011b). Therefore, the delayed onset of regular drinking, and the increase in effective parenting and adolescents' self-control due to the PAS intervention may also curb its subsequent use of other drugs (based on Komro et al., 2010; Welte & Barnes, 1985).

### 1.4. Current study

In the current study, we examined the secondary effects of an effective alcohol prevention program (PAS) targeting early adolescents and/or their parents. The pattern of earlier results set the stage to address whether the favorable effects on onset of drinking also impact engagement in other substance use behaviors, such as onset of cigarette and cannabis use. Given the likelihood that students in the combined

parent–student intervention received greater exposure to strategies postponing the onset of drinking and actually initiated drinking at a later age, it is posited that the combined PAS intervention effectively postpones the onset of cigarette and cannabis use. In addition, this direct effect is hypothesized to be caused by an increase in adolescents' self-control, strict parental rule setting and a later onset of alcohol use. No (in)direct effects of the separate parent and student intervention conditions on substance use are expected.

## 2. Method

### 2.1. Design and procedure

From a list of Dutch public secondary schools (650 registered schools), 80 schools were randomly selected and invited to participate as part of an original alcohol intervention study if the following inclusion criteria were met: (i) at least 100 first-year students, (ii) <25% students from migrant populations and (iii) not offering special education. Five schools, including 696 students per condition, were needed to achieve the necessary power for the original intervention study. An independent statistician assigned nineteen secondary schools randomly to one of the four conditions: (1) parent intervention, (2) student intervention, (3) combined student–parent intervention, and (4) control condition (business as usual). Randomization was carried out centrally, using a blocked randomization scheme (block size 5) stratified by level of education, with the schools as units of randomization. Within each participating school, all first-year students participated in the intervention. One school originally assigned to the control condition withdrew from participation for reasons not relating to the study.

The baseline data were collected at the beginning of the first year in high school (September/October 2006) before any intervention was carried out, and again 10 (T1: 2007), 22 (T2: 2008) and 34 (T3: 2009) months later. Adolescent data were collected by means of digital questionnaires administered in the classroom by trained research assistants. Parents were sent a letter of consent at baseline and a letter that informed parents about the participation of the school in the project, and they were given the opportunity to refuse participation of their child (0.01% refusal). The trial protocol (NTR649) was approved by the Medical Ethical Committee.

### 2.2. Participants

Nineteen schools with a total of 3490 adolescents were selected to participate in the study. Due to non-response at all measurements ( $n = 122$ ), 3368 respondents were initially included. Of these, 103 adolescents were excluded because they had experienced onset of smoking, and 55 for cannabis at or before the baseline measurement. The final sample comprised 3265 and 3313 adolescents eligible for analyses of the onset of smoking and cannabis respectively.

At baseline (T0), the intervention conditions differed significantly from the control condition with respect to gender ( $F(3,2450) = 9.893$ ,  $p < .01$ ) and adolescents' level of education ( $F(3,2450) = 36.91$ ,  $p < .01$ ). We expect these school-level differences to be caused by chance in the selection procedure (see Koning et al., 2009 for more details on the composition of the study).

The final total student sample had a mean age of 12.64 ( $SD = 0.48$ ), consisting of 49% boys, and 38% in lower secondary education.

### 2.3. Loss to follow-up

3085 adolescents completed the questionnaire on smoking at T1. At subsequent waves, some adolescents dropped out, leading to smaller sample sizes (T2:  $n = 2846$ , T3:  $n = 2617$ ).

3123 adolescents completed the questionnaire on cannabis use at T1. At subsequent measurements, some adolescents dropped out, leading to smaller sample sizes (T2:  $n = 2886$ , T3:  $n = 2685$ ). Attrition at T2

and T3 was higher among males, particularly those at the lower levels of high school.

## 2.4. Interventions

The interventions are briefly described below. See Koning et al. (2009) for a more detailed description of the interventions.

### 2.4.1. Parent intervention

This intervention targets parental rules for their children's alcohol use. The intervention was modeled after a Swedish intervention, The Örebro Prevention program (for details, see Koutakis, Stattin, & Kerr, 2008). The intervention was carried out at the first parents' meeting at the beginning of each school year (September/October 2006, 2007 and 2008), in which other school-related topics were also discussed. The intervention consisted of three elements: 1) a brief presentation (20 minutes), 2) consensus building among a shared set of rules among parents of children of the same class, and 3) an information leaflet with a summary of the presentation and the outcome of the class meeting.

### 2.4.2. Student intervention

The student intervention is the renewed digital alcohol module of the Dutch prevention program 'The Healthy School and Drugs' (HSD). The alcohol module targets the students' abilities to develop a healthy attitude toward alcohol use and to train their refusal-skills. After receiving training, the teachers conducted the intervention (four lessons) in all first-year classes in March/April 2007. Each lesson was composed of (1) an introduction movie followed by a few questions, (2) questions to assess knowledge, (3) questions/exercises to reflect upon their own attitude/behavior and (4) a closing assignment integrating the program's information. A booster session was provided one year later in March/April 2008.

### 2.4.3. Combined intervention

Schools in this condition carried out both the parent and student intervention.

### 2.4.4. Control condition

Schools in the control condition were contracted not to start any alcohol-related interventions throughout the study period. However, because basic information about alcohol use is part of the standard curriculum in the Netherlands, schools were allowed to continue this practice (business-as-usual).

## 2.5. Outcome measures

All outcome measures were reported by the adolescent at four waves. Since smoking cigarettes is more prevalent among youth than cannabis (De Looze, Van Dorsselaer, Roos, et al., 2014), we included a weekly measure for smoking and monthly for cannabis use.

### 2.5.1. Smoking (weekly)

Smoking was measured by two questions (Currie et al., 2012): asking if the adolescent has ever smoked a cigarette (1 = yes, only a few puffs, 2 = yes, a whole cigarette or more, 3 = no, never) and how often the adolescent smokes (1 = every day, 2 = at least once a week, not every day, 3 = less than once a week, 4 = I don't smoke). To tap the prevalence of smokers, adolescents who responded 1 or 2 on the first item and 2 on the second item were categorized as weekly smokers respectively (= 1). Self-reported smoking has been considered a valid indicator of the actual smoking status (Dolcini, Adler, Lee, & Bauman, 2003; Patrick et al., 1994).

### 2.5.2. Cannabis use (monthly)

Cannabis use was assessed by asking the adolescent how often he/she has used cannabis in the previous month (ranging from 0 = never

to 14 = 40 times or more; O'Malley, Bachman, & Johnston, 1983). Adolescents indicated to have used cannabis in the previous month were categorized as monthly cannabis users (= 1).

## 2.6. Mediators

The mediating variables (adolescents' self-control, their drinking behavior and parental rules about alcohol) were reported by the adolescent at baseline, T1 and T2.

### 2.6.1. Self-control

Self-control reflects the ability to control responses, to interrupt undesired behavioral tendencies and refrain from acting upon them. The measure is the shorter version of the original one developed and tested by Tangney, Baumeister, and Boone (2004). It consists of 13 items (Cronbach's alpha = 0.74) that were rated on a five-point scale, ranging from 1, 'not at all like me' to 5, 'very much like me'. Example items are 'I have trouble saying no' and 'I do certain things that are bad for me, if they are fun'. Items were reverse-scored; higher scores indicated higher self-control.

### 2.6.2. Rules about alcohol use

Rules about alcohol use reflect the degree of rule-setting behavior by the parents as experienced by the adolescents (Van der Vorst, Engels, Meeus, Dekovic, & Van Leeuwe, 2005). Items included 'I am allowed to have one glass of alcohol when my parents are at home', 'I am allowed to drink several glasses of alcohol when my parents are not home' and 'I am allowed to drink alcohol at a party with my friends'. It consisted of the mean of 10 items (alpha = 0.90) rated on a five-point scale from 1 'never' to 5 'always' reverse-scored, i.e. higher scores indicated more rule-setting behavior.

### 2.6.3. Alcohol use (monthly)

Alcohol use was assessed by asking the adolescent how often he/she has drunk alcohol in the previous month (ranging from 0 = never to 14 = 40 times or more; O'Malley et al., 1983). Adolescents indicated to have drunk alcohol in the previous month were categorized as monthly drinkers (= 1).

## 2.7. Statistical analyses

Descriptive analyses per condition were conducted to check whether randomization had resulted in a balanced distribution of important characteristics of the students across the four conditions. The randomization resulted in a slightly uneven distribution across the active conditions compared to the control condition in terms of age, sex and level of education (Table 1). Therefore, all subsequent analyses were conducted with these variables as covariates to control for any possible bias stemming from the imbalance. In addition, we controlled for the monthly prevalence of drinking at baseline. The cluster effect—students were 'nested' in classes—was handled by obtaining robust variance-related estimates based on the first-order Taylor-series linearization method using Stata's procedures for design-based analyses. We corrected for the cluster effects at class-level, as the interventions were carried out

**Table 1**  
Baseline characteristics of participants at baseline.

Variable	Conditions			
	Parent intervention	Student intervention	Combined intervention	Control condition
N	774	889	757	893
Male, n (%)	363 (46.9)	436 (49.0)	455 (60.1) <sup>a</sup>	469 (52.5) <sup>a</sup>
Age, years: mean (s.d.)	12.6 (0.46) <sup>a</sup>	12.7 (0.50)	12.7 (0.52)	12.7 (0.52) <sup>a</sup>
Low level of education, n (%)	222 (28.7) <sup>a</sup>	371 (41.8) <sup>a</sup>	257 (33.9) <sup>a</sup>	533 (59.8) <sup>a</sup>

Note. Shared superscripts indicate a significant difference between the experimental and control condition at  $p < .05$ .

in classes. Based on previous reports on the consistent effects of the combined intervention on the onset of drinking and the lack of effect of the separate parent and student components, we compared each of the experimental conditions with the control condition. Odds ratios (ORs) of weekly smoking and monthly cannabis use were obtained using logistic regression of the binary outcome (case, not a case) on the treatment dummies, while adjusting for the covariates and the nested data. NNT represents the number of students who need to receive the intervention rather than its alternative (regular curriculum) in order to avoid one adverse outcome (Pinson & Gray, 2003). NNT was obtained as the inverse of the risk difference.

The mediating effects of the intervention-induced factors (rules about alcohol, adolescents' drinking and self-control) were analyzed according to the steps suggested by MacKinnon, Taborga, and Morgan-Lopez (2002). First, it was tested whether the interventions had an effect on the mediating variable. Because mediational processes may cancel each other out, a direct effect of the intervention on onset of cigarette and marijuana use is not required for mediation to occur (MacKinnon et al., 2002). For this reason, the non-effective intervention conditions were also included in the models. Second, the effect of the mediating variables on the onset of substance use was analyzed, while controlling for the effects of the prevention programs. Finally, it was tested whether the effect of the intervention conditions on substance use was mediated through the intermediate factors.

Data were analyzed (using Stata/SE version 12) in accordance with the intent-to-treat principle. Missing data were handled by regressing imputation as implemented in Stata. Intention-to-treat analysis requires that all participants be analyzed in the condition to which they have been randomized. Therefore, missing observations at follow-up were imputed using regression imputation with best predictors of both the clinical end-point and dropout. The first set of predictors is needed to replace missing observations with the most likely values; the second is needed to correct for bias that may have been caused by differential loss-to follow-up (cf. Demirtas, 2004).

**3. Results**

*3.1. Direct effects on smoking*

Table 2 presents the results of the interventions on the onset of weekly smoking at follow-up measurements. At T1, the effect of the parent intervention on weekly smoking ( $OR = 1.98, p = 0.048, NNT = 36.9$ ) was significant compared to the control condition. This indicates that, at T1, the odds of adolescents in the parent intervention having

**Table 2**  
The effect of the intervention conditions on the onset of weekly smoking (N = 3320) at follow-up (incidence rates between parentheses).

	ICC	OR	p	NNT
T1	0.067			
Parent intervention (5.7%)		1.98*	0.04	36.9
Student intervention (3.8%)		1.13	0.71	994.7
Combined intervention (2.6%)		0.79	0.54	61.1
Reference = control condition (3.7%)				
T2	0.039			
Parent intervention (10.7%)		1.63*	0.02	41.7
Student intervention (6.5%)		0.95	0.83	50.1
Combined intervention (8.4%)		1.49	0.08	61.5
Reference = control condition (6.7%)				
T3	0.043			
Parent intervention (13.8%)		1.00	1.00	118.1
Student intervention (10.2%)		0.75	0.14	44.6
Combined intervention (13.1%)		0.99	0.99	154.4
Reference = control condition (13.3%)				

Note: ICC = intra-class correlation, OR = odds ratio, NNT = numbers needed to treat. Autoregressive logistic regression analyses, adjusted for confounders (age, level of education, sex and monthly alcohol use), cluster effect and outcome at t - 1.

smoked on a weekly basis was 1.98 times higher compared to adolescents in the control condition. Out of 37 adolescents, 1 will have started to smoke weekly due to the parent intervention. No significant effects of either the student intervention or combined intervention were found on the onset of weekly smoking at T1.

At T2, the parent intervention significantly increased the chances of smoking on a weekly basis compared to the control condition ( $OR = 1.63, p = 0.02, NNT = 41.7$ ). No significant effects of the student or combined intervention on weekly smoking at T2 were found.

At T3, no significant effects of any of the intervention conditions on the onset of weekly smoking were found.

*3.2. Direct effects on cannabis use*

Table 3 presents the effects of the intervention conditions on the onset of monthly cannabis use at follow-up assessments. At T1 no significant effects of the intervention conditions on the onset of monthly cannabis use were found.

At T2, significantly more students in the parent intervention and combined intervention had started to use cannabis on a monthly basis (parent intervention:  $OR = 1.77, p = 0.02, NNT = 48$ ; combined intervention:  $OR = 1.75, p = 0.02, NNT = 54.8$ ). No significant effects of the student intervention on cannabis use were found.

At T3, significantly fewer adolescents in the student intervention had used cannabis in the previous month ( $OR = 0.50, p = 0.00, NNT = 23.1$ ).

*3.3. Mediation effects*

We investigated whether the increase in adolescents' self-control (Koning, Van den Eijnden, & Vollebergh, 2014) and strict rule setting (Van der Vorst et al., 2005), and the prevalence of monthly drinking at T1 and T2 could (partly) explain the significant effects of the intervention conditions on smoking and cannabis use at T2 and T3 respectively.

Step 1, the effect of the intervention conditions on the adolescents' self-control at T1 showed a significant positive effect of the combined intervention on the level of self-control at T1 ( $\beta = .06, SE = .02, p = .001$ ), but not at T2 ( $\beta = .04, SE = .02, p = .07$ ). No significant effects of the parent intervention ( $\beta = -.02, SE = .02, p = .33$ ) and student intervention ( $\beta = -.01, SE = .02, p = .59$ ) on adolescents' self-control at T1 were found. At T2, lower levels of adolescents' self-control were significantly predicted by the parent ( $\beta = -.05, SE = .02, p = .01$ ) and student intervention ( $\beta = -.05, SE = .03, p = .02$ ).

**Table 3**  
The effect of the intervention conditions on the onset of monthly cannabis use (N = 3342) at follow-up (incidence rates between parentheses).

	ICC	OR	p	NNT
T1	0.033			
Parent intervention (4.4%)		1.79	0.13	55.4
Student intervention (3.2%)		1.12	0.75	395.9
Combined intervention (2.6%)		0.92	0.82	110.9
Reference = control condition (2.9%)				
T2	0.026			
Parent intervention (9.2%)		1.77*	0.02	48.0
Student intervention (6.5%)		1.30	0.28	107.7
Combined intervention (8.3%)		1.75*	0.02	54.8
Reference = control condition (5.0%)				
T3	0.018			
Parent intervention (10.0%)		0.70	0.06	103.3
Student intervention (6.9%)		0.50*	0.00	23.1
Combined intervention (12.3%)		0.89	0.51	44.7
Reference = control condition (12.0%)				

Note: ICC = intra-class correlation, OR = odds ratio, NNT = numbers needed to treat. Autoregressive logistic regression analyses, adjusted for confounders (age, level of education, sex and monthly alcohol use), cluster effect and outcome at t - 1.

\* =  $p < .05$

Rules about alcohol at T1 and T2 were significantly improved by the combined intervention (T1:  $\beta = .12$ ,  $SE = .02$ ,  $p < .00$ ; T2:  $\beta = .10$ ,  $SE = .02$ ,  $p < .00$ ) compared to the control condition. The parent intervention (T1:  $\beta = .01$ ,  $SE = .02$ ,  $p = .78$ ; T2:  $\beta = .03$ ,  $SE = .02$ ,  $p = .18$ ) and student intervention ( $\beta = .01$ ,  $SE = .02$ ,  $p = .88$ ; T2:  $\beta = .03$ ,  $SE = .02$ ,  $p = .19$ ) did not significantly impact the level of rules about alcohol.

Prevalence of monthly drinking at T1 and T2 was significantly lowered by the combined intervention (T1:  $\beta = -.10$ ,  $SE = .02$ ,  $p < .00$ ; T2:  $\beta = -.12$ ,  $SE = .02$ ,  $p < .00$ ) compared to the control condition. The parent intervention (T1:  $\beta = -.01$ ,  $SE = .02$ ,  $p = .83$ ; T2:  $\beta = -.04$ ,  $SE = .02$ ,  $p = .10$ ) and student intervention (T1:  $\beta = .02$ ,  $SE = .02$ ,  $p = .45$ ; T2:  $\beta = -.02$ ,  $SE = .02$ ,  $p = .40$ ) did not significantly impact the prevalence of monthly drinking.

### 3.3.1. Mediation effects for smoking

In step 2, we tested the effect of the mediating variables on smoking at T1 and T2. Adolescents' lower self-control and monthly drinking significantly predicted the subsequent onset of smoking on a weekly basis (T1: self-control:  $OR = 0.50$ ,  $p < 0.00$ , monthly alcohol use:  $OR = 2.00$ ,  $p < 0.00$ ; T2: self-control:  $OR = 0.64$ ,  $p < 0.00$ , monthly alcohol use:  $OR = 2.10$ ,  $p < 0.00$ ).

In step 3, we tested the indirect effects of the intervention conditions on smoking at T2 and T3 via rules about alcohol, self-control and monthly drinking at T1 and T2 respectively. This revealed no significant indirect effects, as the direct effects of the intervention conditions on smoking when including the mediating variables did not show any significant changes.

### 3.3.2. Mediation effects for cannabis use

In step 2, we tested the effect of the mediating variables at T1 and T2 on cannabis use at T2 and T3 respectively. Results showed that rules about alcohol did not significantly predict the onset of monthly cannabis use, while adolescents' lower level of self-control and monthly drinking did (rules T1:  $OR = 1.10$ ,  $p = 0.37$ ; self-control T1:  $OR = 0.48$ ,  $p < 0.00$ ; alcohol use T1:  $OR = 2.17$ ,  $p < 0.00$ ; rules T2:  $OR = 1.01$ ,  $p = 0.84$ ; self-control T2:  $OR = 0.50$ ,  $p < 0.00$ ; alcohol use T2:  $OR = 2.10$ ,  $p < 0.00$ ).

In step 3, we tested the indirect effects of the intervention conditions on cannabis use at T2 and T3 via rules about alcohol, self-control and monthly drinking at the previous time point. Again, this revealed no significant indirect effects, as the direct effects of the intervention conditions on cannabis use when including the mediating variables did not show any significant changes.

## 4. Discussion

Previous studies demonstrated the effectiveness of the alcohol prevention program 'Prevention of Alcohol use in Students' (PAS; Koning et al., 2009, 2011a, 2013) when parents and adolescents were jointly targeted. The current study elaborates on these findings by demonstrating that the student and combined interventions did not consistently influence the onset of smoking and cannabis use. Negative (trend) effects were found for the parent intervention on the onset of cannabis use and smoking at ages 13 and 14. The rules about alcohol, alcohol use and adolescents' self-control did not explain the direct effects.

To the best of our knowledge, this is one of the few studies that examined the effects of an alcohol prevention program targeting parents and/or adolescents on the initiation of other substances among adolescents with long-term follow-up measurements. Though available intervention research suggests the relevance of postponing the onset of drinking to lower the risk of involvement in other drugs (Forsberg et al., 2000; Grossbard et al., 2010; Magill et al., 2009), this could not be confirmed by the current study. Our findings are in line with the results from a meta-analysis on the effects of brief alcohol interventions on illicit drugs use among 17 year old adolescents (Tanner-Smith et al., 2015). Tanner-Smith et al. conclude that brief alcohol interventions

targeting 17 year-old adolescents did not impact their illicit drug use. Overall, though adolescents in the combined intervention initiated drinking at later ages, these adolescents did not differ in their cigarette and cannabis use compared to their peers in the control condition. That is, adolescents in the combined PAS intervention show no delayed initiation of smoking and cannabis use. In fact, adolescents in the combined intervention were more likely to have used cannabis 22 months later. Moreover, the mechanisms through which the previous effects of the onset of drinking were obtained, i.e. strict parental rule setting and more self-control in adolescents (Koning et al., 2011b), were not relevant with respect to smoking and cannabis use. This indicates that strict alcohol-specific parenting and higher levels of self-control due to the intervention do not seem to be of importance to the onset of smoking and cannabis use. In turn, the current results point at the importance of implementing multi-target interventions (multiple substances), rather than alcohol-specific interventions (cf. Tanner-Smith et al., 2015).

It should be noted that the parent intervention overall had a negative (trend) effect on the onset of smoking and cannabis at age 13 (smoking and cannabis) and 14 (cannabis); more adolescents in the parent intervention had initiated smoking and cannabis use compared to their peers in the control condition. In addition, the combined intervention showed negative effects on cannabis use at age 14. We can only speculate about the interpretation of these findings. It is possible that the strict parental rules, which are encouraged in the separate parent and combined intervention, are, as opposed to previous cross-sectional research (De Looze et al., 2012), counter effective for other substances. It is also possible that the strict rules regarding alcohol caused adolescents to rebel against their parents in other ways, by for example start smoking and using cannabis. These speculations can be supported by the lack of mediation by rules about alcohol and adolescents' self-control. These factors did not play a role in explaining the effect of the intervention on smoking and cannabis use. More research is needed to investigate the role of alcohol-specific rules in relation to the manifestation of other risk behaviors.

It is interesting that both the separate parent (marginally) and student interventions lower the likelihood to use cannabis at age 15, whereas at ages 13 and 14 negative effects of the parent intervention are found. We can only speculate about the reasons for the protective effect of these intervention conditions at age 15. Prevalence rates show that the steepest increase is reported by adolescents from age 14 to 15 in the control condition; from 5% at age 14 to 12% at age 15. The number of adolescents in the intervention conditions who started using cannabis in this period just increased slightly. Adolescents using at ages 13/14 is not highly prevalent (De Looze et al., 2014) and thus this can be considered as risky, even rebellious behavior. Having stricter parenting at this age regarding alcohol use may, therefore, evoke adolescents to be involved in other risk behavior, such as cannabis use (as we discussed previously). However, by 15, while the total number of adolescents using cannabis continues to increase overall, for those who have participated in an intervention program, their numbers remain stable, i.e. significantly fewer new onsets of the behavior compared to the control condition. It is likely that the intervention conditions enabled adolescents to abstain from cannabis involvement at an age where more adolescents start using this substance. Yet, it is unknown what mechanisms caused this protective effect of the separate intervention conditions, as the strict rules, adolescents' self-control and their drinking do not explain this. The current study underlines the importance of long-term follow-up studies on the secondary effects of alcohol interventions and the need to investigate the mechanisms that may underlie these effects.

### 4.1. Limitations and future directions

Although this study has many strengths such as the number of participants, design of the study, and long-term follow-ups, limitations

should be considered. First, data are obtained by means of self-reporting. Though this is found to be a reliable method of assessment (Koning, Harakeh, Engels, & Vollebergh, 2010; Wagenaar, Komro, McGovern, Williams, & Perry, 1993) and rather common in such large trials, it may result in report biases. Second, it was assumed that the delayed alcohol initiation would impact onset of other substances. However, a later onset of drinking could have affected the amount of cigarette and cannabis use. In addition, it is warranted to investigate the role of behavior specific as well as general (Darling & Steinberg, 1993) parenting practices such as parental control and support in relation to other risk behaviors. More insight into how parents can influence their child's behavior may enhance future intervention development. Last, as we have tested three potential mechanisms underlying the effect of the intervention on smoking and cannabis use, other mechanisms, such as peer processes, may be involved and should be investigated in future studies.

#### 4.2. Implications

This study has important implications for the prevention of substance use among youth. The early onset of substance use is an important predictor of a variety of negative consequences such as lower school engagement (Roebroek & Koning, 2015) and delinquency (Zhang, Wieczorek, & Welte, 1997). It is important to gain knowledge about how involvement in substance use behaviors can be delayed. As this study demonstrated that the PAS alcohol intervention did not prevent adolescents from using cigarettes and cannabis, the need for multi-target interventions is recommended. Moreover, current findings point to the importance of including parents as well as adolescents, as parent-only interventions may be counter-effective. Thus, parent-adolescent interventions targeting multiple substances seem to be more promising than single-target interventions (cf. Tanner-Smith et al., 2015).

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