Polydrug use by European adolescents in the context of other problem behaviours

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ABSTRACT

AIM – Previous studies of the association between polydrug use and other risk behaviours have generally been limited to specific substances and a small number of behaviours. The aim of this study is to obtain better insight into polydrug use (comprising legal and illegal substances: tobacco, alcohol, tranquillisers/sedatives, cannabis, and other illegal drugs) and its association with co-occurring problem behaviours drawn from various broad domains (sexual, aggressive, delinquent, school achievement, relationships) among European adolescents. METHODS – Data were obtained from 101,401 16-year-old students from 35 European countries participating in the 2011 ESPAD survey. Associations between polydrug use and other problem behaviours were examined by multinomial and binary logistic regression analyses. RESULTS – Tranquillisers/sedatives appeared among the commonest combinations in the polydrug use pattern, especially for females. A strong trend was found between levels of involvement with polydrug use and other problem behaviours for both genders. The highest associations with polydrug use were for problems with the police, risky sexual behaviour and skipping school. Gender differences showed higher prevalences among boys than girls of problem behaviours of aggressive, antisocial type, while girls prevailed over boys in relationship problems. CONCLUSION – An incremental relationship exists between the level of involvement with polydrug use and the co-occurrence of problem behaviours. Preventative interventions should consider the misuse of tranquillisers/sedatives within the context of polydrug use by adolescents and expand their target groups towards multiple problem behaviours.
KEYWORDS – polydrug use, adolescents, ESPAD, problem behaviours

Introduction

The use of multiple substances – polydrug use – is reported to be an increasingly common phenomenon among young people in Europe (EMCDDA, 2009). The self-reported use of alcohol, cigarettes, cannabis and other psychoactive substances by young Europeans has increased since the 1990s in a variety of drug-using repertoires. Just over 20% overall of 15–16-year-old school students in twenty-two European countries in 2003 reported the use of both alcohol and cigarettes during the previous month, 6% reported using cannabis with either alcohol or cigarettes or both, and a further 1% reported the use of ecstasy, cocaine, amphetamines, LSD or heroin in addition. Since then, an increase in the range of licit and illicit drugs that are available in many parts of Europe has been accompanied by growing concerns about the social acceptance of drug use and subsequent increases in polydrug use (EMCDDA, 2013).

What exactly is meant by "polydrug use" is not unanimously agreed, either with regard to the type of substances included or to the frequency and intensity of their use. However, two types of polydrug use are considered most often in the literature: "concurrent", which refers to the use of more than one drug during a given period (e.g., one day, one month or one year) and "simultaneous", which denotes the use of two or more substances on the same occasion (Collins, Ellickson, & Bell, 1999; Smit, Monshouwer, & Verdurmen, 2002). Our analysis in the present paper is concerned with concurrent use.

Polydrug use in adolescence increases health risks, given that adolescents comprise the group most vulnerable to the toxic pharmacologic effects of substances (Earleywine & Newcomb, 1997). In addition, polydrug use among adolescents increases the risk of more frequent use of drugs and the development of substance use disorders (Galaif & Newcomb, 1999; Mackesy-Amiti, Fendrich, & Goldstein, 1997). Furthermore, the use or abuse of one substance during adolescence may, according to the "gateway theory", lead to further involvement with drugs (Kandel, Yamaguchi & Chen, 1992). Drug use in adolescence also correlates with other risk behaviours, in support of Jessor and Jessor (1977), who suggested that adolescents' drug use might be part of a constellation of co-occurring problem behaviours.

Examination of the literature shows a paucity of population-based research investigating the association of multiple substance use and other risk behaviours among adolescents (Brière, Fallu, Descheneaux, & Janosz, 2011; Collins, Ellickson, & Bell, 1999). Most studies focus on single substances (typically alcohol, tobacco or cannabis) and on a limited range of other risk behaviours such as dropping out of school, self-harm, unprotected sex and violence (Bachman & Peralta, 2002; Connell, Gilreath, & Hansen, 2009; Huas, Hassler, & Choquet, 2008; Kokkevi et al., 2012; Lynne-Landsman, Graber, Nichols, & Botvin, 2011; Miller, Naimi, Brewer, & Jones, 2007; Reyes et al., 2011; Sen, Averett, Argys, & Rees, 2009; Simons, Maisto, & Wray, 2010; Townsend, Flisher, & King, 2007; Wu, Witkiewitz, McMahon, & Dodge, 2010).

Crucially, there is a lack of data on the non-prescribed use of psychoactive medicines as part of polydrug use by adolescents, especially in Europe. This is so despite data showing that the non-pre-

scribed use of psychoactive medicines is increasingly reaching the levels of use of illicit drugs other than cannabis, both in the USA and in various European countries (e.g., Hibell et al., 2009; Johnston, O'Malley, Bachman, & Schulenberg, 2008; McCabe, Cranford, Morales, & Young, 2006; ONDCP, 2007), and evidence that their abuse may cause adverse health effects, especially when combined with other substances (McCabe, Boyd, & Teter, 2009; McCabe et al., 2006; NIDA, 2011; SAMHSA, 2013; Sung, Richter, Vaughan, Johnson, & Thom, 2005). The non-prescribed use of tranquillisers or sedatives has been found to be part of a polydrug use pattern among adolescents in a preliminary descriptive analysis of European data (Kokkevi, 2012). Furthermore, there is a lack of data on the association between the non-prescribed use of this type of prescription drugs and other problem behaviours.

A wider or more frequent and intensive involvement with drug use, or involvement with multiple risk behaviours is considered to be a threat to the mental, social and physical health of the adolescent, with repercussions extending into adulthood (Newcomb, 1997). However, some engagement in high-risk behaviours related to substance use – such as using tobacco and alcohol or trying cannabis – might be considered to be a normative feature of adolescence within the context of the developmental need for experimentation in this phase of life. This is supported by data from the 2011 ESPAD survey of 16-year-old students in 35 European countries showing the prevalence of any use of the commoner substances in the last 30 days: 28% had smoked tobacco, 57% had

drunk alcohol and 7% had smoked cannabis (Hibell et al., 2012). A study of polydrug use drawing on earlier ESPAD data reported that one third of European school students aged 15–16 had consumed two or more substances in the last 30 days (Olszewski, Matias, Monshouwer, & Kokkevi, 2009). The aim of that study and another in the Netherlands (Smit et al., 2002) was to establish typologies of polydrug users. The results are dominated numerically by alcohol and tobacco because of the much higher prevalences of any use of these substances compared to others.

In line with the above, and in order to avoid labelling as polydrug users a very large number of adolescents showing apparently normative behaviours, the approach adopted in our work was to exclude occasional smoking or consumption of alcohol so that our definition of polydrug use corresponds to more clearly problematic behaviours. Taking a similar approach, Höhne, Pabst, Hannemann & Kraus (2013) also selected appropriate cut-offs to define intensive users of alcohol, tobacco and cannabis in a study of the concurrent use of multiple substances in an adult general population study.

Expanding upon the studies mentioned above, our general aim in the present study was to identify those adolescents with more serious patterns of risk behaviours that increase the probability of psychological dysfunction and mental disorders (White and Labouvie, 1994; Biglan et al., 2004). The findings may allow the timely detection of vulnerable youth who need to be protected by appropriate preventative interventions. The study has the following specific aims:

a) To evaluate the extent of polydrug use and problem behaviours in a large sample of European adolescents from 36 European countries;
b) To examine the relationship between polydrug use and problem behaviours during the developmentally sensitive period of mid-adolescence in which high-risk behaviours such as substance abuse, self-harm, recklessness (leading to accidental injuries), unsafe sexual behaviour and delinquency are initiated and may escalate. We hypothesise that there is an association between the incremental use (intensity and frequency) of substances and of other risk behaviours. We further expect that the combination of specific substances might be more strongly associated with some problem behaviours than others.
c) To examine differences that might exist between genders regarding the above.

We expect that findings from the present paper will provide us with better insight into the association between patterns of more intense polydrug use and other co-occurring problem behaviours by European adolescents. We wished to approach polydrug use from a global European perspective and not by investigating country or regional differences at this stage. In particular, we applied regression models in order to examine the possible relationship between polydrug use – in which we include current (last 30 days) intensive use of tobacco and alcohol, any current cannabis use, lifetime non-prescribed use of tranquillisers or sedatives and lifetime use of illicit drugs other than cannabis – and other co-occurring problem behaviours. We further examine the combinations of

substances within polydrug use that are most strongly related to each of the problem behaviours under examination. The large sample size available at the European level makes it possible to include less commonly used substances, such as illicit drugs other than cannabis. This also applies to the less common forms of risk behaviours and the non-prescribed use of psychoactive medicines such as tranquillisers or sedatives. These analyses should be considered as exploratory and not aetiological. Exploring multivariate data assists in the better understanding of patterns of risk behaviours.

Methods

Sample
The sample was drawn from the 2011 wave of the ESPAD survey, which collected data from 16-year-old students in 36 European countries by means of a common self-completed questionnaire and was conducted following standardised methodology. Details of the sampling and fieldwork procedures in each country can be found in the ESPAD report by Hibell and associates (2012). The United Kingdom was excluded from the present analysis because of a low response rate (6%) among the sampled schools (Hibell et al., 2012). The final sample size was 101,401 students (48.7% boys), ranging from 366 in Liechtenstein to 6084 in Serbia.

Measures of substance use
Definition of polydrug use. As there are no generally agreed cut-offs for what constitutes "acceptable" or "normative" as opposed to "high risk", "deviant" or "problematic" behaviours in this age group, we set cut-offs for substance use that took into

account the prevalence of each given behaviour in the total sample. In this way, we avoided including behaviours that are reported by a large proportion of the adolescent population and are thus "normative" in statistical terms. We therefore defined polydrug use based on: current regular tobacco use (6+ cigarettes/day in the last 30 days), current frequent alcohol use (10+ times in the last 30 days), any use of cannabis in the last 30 days, any lifetime use of tranquillisers/sedatives without prescription and any lifetime use of illicit drugs apart from cannabis. The corresponding questionnaire items are listed below and the prevalences of each behaviour are shown in Table 1. The choice of cut-offs was restricted by the response categories employed on the ESPAD questionnaire. For example, the alternatives to using 6+ cigarettes (prevalence 9.6%) were 1+ and 11+, with prevalences 17.0% and 4.6%, respectively. Similarly, the difference in time frames between the measures is imposed by the availability of data. The ESPAD questionnaire asks only for lifetime use of tranquillisers or sedatives and illicit drugs other than cannabis (with the sole exception of ecstasy, for which 12-month and 30-day prevalences are also available) because these two classes of substances have very low prevalence of use within short time frames in this age group. However, "lifetime" substance use among 16-year-olds seems unlikely to have occurred over a long time span.

Smoking: "How frequently have you smoked cigarettes during the last 30 days?" The seven response categories – "not at all", "less than one cigarette per week", "less than one cigarette per day", "1–5 cigarettes per day", "6–10 cigarettes per day", "11–20 cigarettes per day" and "more than 20 cigarettes per day" – were grouped as "smoking at least 6 cigarettes per day" and "fewer/none".

Alcohol use: "On how many occasions (if any) have you had any alcoholic beverage to drink during the last 30 days?" The seven responses – "0", "1–2 ", "3–5", "6–9", "10–19", "20–39" and "40 or more" – were dichotomised as "10 or more occasions" and "never/fewer than 10 occasions".

Cannabis use: "On how many occasions (if any) have you used marijuana or hashish (cannabis) during the last 30 days?" Responses on the same seven-point scale as for the use of alcohol were dichotomised as "yes" for any reported use and "no" otherwise.

Tranquillisers or sedatives (non-prescribed use): "On how many occasions in your lifetime (if any) have you used any of the following drugs?" was followed by separate responses for tranquillisers/sedatives without a doctor's prescription, ecstasy, amphetamines, LSD or other hallucinogens, crack, cocaine, heroin and GHB, each using the same seven-point scale of frequency from "0" to "40 or more" occasions as for alcohol and cannabis. The response for tranquillisers/sedatives was dichotomised as "yes" for any reported use and "no" for none. An earlier question about the prescribed use of tranquillisers/sedatives was preceded by a country-specific list of the relevant pharmaceuticals that fall into this category.

Any illicit drug other than cannabis: Illicit drugs other than cannabis are grouped together because individually these substances have very low prevalences of use (3% for ecstasy and amphetamines, lower

for the others). The final categorisation was "yes" for any reported use of at least one of ecstasy, amphetamines, LSD or other hallucinogens, crack, cocaine, heroin and GHB in response to the previous question, otherwise "no".

Other problem behaviours

Measures used to capture students' involvement in problem behaviours apart from substance use were drawn chiefly from the following broader domains: risky sexual behaviour, aggressive or delinquent behaviour, academic dysfunction and poor relationships with parents and friends. The corresponding questionnaire items were as follows.

Slot machines: The question "How often (if at all) do you do each of the following?" was followed by a list of activities including "Play on slot machines (the kind in which you may win money)?" The five responses – "never", "a few times a year", "1–2 times a month", "at least once a week" and "almost every day" – were grouped into "never" and "sometimes/often".

Skipping school: "During the last 30 days on how many days have you missed one or more lessons, because you skipped or 'cut' school?" Responses on a six-point scale – "none", "1 day", "2 days", "3–4 days", "5–6 days" and "7 days or more" – were dichotomised as "at least 2 days" and "none/once".

Physical fight, problems with parents, problems with friends, poor performance at school, trouble with police, unprotected sex, regretted sex: The occurrence of these behaviours was established from the question "How often during the last 12 months have you experienced the following?" followed by separate responses

for: physical fight; serious problems with parents; serious problems with friends; performed poorly at school or work; trouble with police; engaged in sexual intercourse without a condom; and engaged in sexual intercourse you regretted the next day. Responses for each item were on the seven-point scale of frequency from "0" to "40 or more" occasions already given above for alcohol use. Answers for trouble with police, unprotected sex and regretted sex were each dichotomised into "at least once" and "never". Answers for physical fight, problems with parents and problems with friends were dichotomised into "3 times or more" and "never/less than 3 times". Responses for poor performance at school were dichotomised into "6 times or more" and "never/less than 6 times".

Statistical analysis

Percentage prevalences of items for the entire survey are presented here as the unweighted average of the separate prevalences in the 35 countries. This is the method adopted in the ESPAD Report and it is discussed there in some detail (Hibell et al., 2012). In particular, it is claimed that "it has the advantage of emphasising the cultural context of different countries. If patterns of licit and illicit drug use that evolve in each country are taken as indicators of a complex, evolving European scene, it is appropriate to give large and small countries equal weight in the European average" (Bjarnason, 2012). According to the comparisons given there, however, averages obtained in this way are in many cases little different from those obtained by weighting by population sizes.

Chi-squared tests were used to compare the percentages of boys and girls who used

a particular combination of substances. Bonferroni corrections were used because of the multiple testing. The relationship between multiple substance use and the other problem behaviours was investigated using multinomial logistic regression. The dependent variable – multiple substance use – was grouped into three categories according to how many of the five substances were used (at the levels indicated above): 0, 1 and 2 or more substances used. The reference category was the use of no substances. The independent variables were the other problem behaviours and also gender, which was entered into the analyses as a controlling factor. Possibly different associations between multiple substance use and problem behaviours, in boys and girls, were examined by fitting a second multinomial logistic regression, in which interactions between gender and problem behaviours were added to the independent variables. As none of the interactions was found to be statistically significant, these results are not reported here. Subsequently, associations between each one of the problem behaviours as dependent variable and the most frequent combinations of polydrug use as independent variables were investigated, by conducting separate binary logistic regressions.

In each item of the results, all available cases were used. For example, the prevalence of cannabis use was based on all adolescents who answered this specific question, but the number of substances used was calculated from the adolescents who had answered all five questions concerning substance use.

Table 1. Prevalence (%) of use of specific substances above the cut-off levels and number of substances used: average across 35 European countries, in the total sample and by gender. The average is the unweighted average of the separate prevalences in each country. All differences between genders are statistically significant with p<0.001.

	Total (%)	Boys (%)	Girls (%)
Substances	(*n* = 101,401)[†]	(*n* = 49,343)	(*n* = 52,058)
Tobacco	9.6	11.0	8.4
Alcohol	8.7	11.5	6.0
Cannabis	6.8	8.4	5.3
Tranquillisers/sedatives	6.4	5.0	7.8
Other illicit	6.1	7.0	5.2
Number of substances	(*n* = 98,643)[††]	(*n* = 47,752)	(*n* = 50,891)
0 substances	76.2	73.3	78.9
1 substance	15.3	16.8	13.9
2 substances	5.3	6.1	4.5
3+ substances	3.3	3.9	2.9

Notes. [†] Up to 1.4% missing values for individual substances; [††] With complete data for all five substances. Tobacco: more than 5 cigarettes per day during the last 30 days; Alcohol: 10+ times during the last 30 days; Cannabis: any use during the last 30 days; Tranquillisers/sedatives: any lifetime use without a doctor's prescription; Other illicit: lifetime use of any of the following drugs: amphetamines, LSD or other hallucinogens, crack, cocaine, heroin, ecstasy and GHB.

The design weights applicable to each country, if any, and the effect of the clustered sampling design, with school as cluster and country as stratum, were incorporated into the analyses. All analyses were performed using the Complex Samples procedure of IBM SPSS (v. 19.0, Armonk, NY: IBM Corp.).

Some analysts have approached the use of multiple substances through latent class analysis, seeking to obtain a parsimonious description of the phenomenon in terms of a small number of clusters of substances (e.g., Smith, Farrell, Bunting, Houston, & Shevlin, 2011; White et al., 2013). However, we were interested in examining particular combinations of substances rather than finding broad groups. Furthermore, in earlier work, we had found that the number of substances used was almost as effective as their type of combination in predicting the severity of involvement of young people with problem behaviours (Kokkevi et al., 2012). Similarly, we were less interested in defining clusters of problem behaviours than in finding the association of each behaviour with polydrug use.

Results

Table 1 shows the prevalence of use of each one of the specific substances at the cut-off levels defined above, as well as the number of substances used. The overall prevalences (averaged across countries) ranged from 6.1% for any lifetime use of illicit drugs other than cannabis to 9.6 % for frequent last-month tobacco use. The large majority of students (76.2%) did not use any of the substances at or above these cut-off levels and 15.3% used only one. Two or more substances were used above these levels by 8.6% of the population. Tran-

quillisers or sedatives were used without a doctor's prescription by more girls than boys (7.8% versus 5.0%), but each of the other substances was used more by boys than girls. The prevalence of the use of only one substance was higher among boys than girls (16.8% versus 13.9%), as was the use of two or more substances (10.0% versus 7.4%). Because of the very large sample sizes, all these differences between genders were statistically highly significant (p<0.001).

Table 2 shows the various combinations of substances used by students, among those who used at least two substances above the cut-off level. The three most frequent combinations were: the two licit substances, tobacco and alcohol (14.1%); tobacco and cannabis (9.2%); and tranquillisers/sedatives with illicit drugs other than cannabis (7.5%). Examining gender differences in the combination of substances, the largest differences occurred for the combination of tobacco with alcohol (higher for boys) and for the combination of tranquillisers/sedatives with other illicit drugs and with tobacco (higher for girls). There was a general trend for girls to have higher prevalence rates than boys for almost all the combinations that included non-prescribed use of tranquillisers or sedatives.

Table 3 presents the other problem behaviours apart from substance use. The three with highest prevalence at our cut-off levels were: playing on slot machines (17.1%); performing poorly at school (15.2%); and having serious problems with parents (15.1%). Comparisons by gender show that boys prevailed in behaviours of aggressive, antisocial type including trouble with police (15.9% versus 7.3%

Table 2. Unweighted average prevalence (%) across countries of use of specific combinations of substances among users of 2+ substances, in the total sample and by gender.

Substances	Total (%) (n=8,285)	Boys (%) (n=4,816)	Girls (%) (n=3,469)	
Tobacco Alcohol	14.1	15.4	12.0	**
Tobacco Cannabis	9.2	8.7	9.7	
Tranquillisers[†] Other illicit[††]	7.5	5.6	10.5	**
Tobacco Other illicit	6.5	6.6	6.3	
Cannabis Other illicit	6.5	7.3	5.3	**
Tobacco Tranquillisers	5.3	3.5	8.0	**
Alcohol Cannabis	4.9	6.5	3.0	**
Tobacco Cannabis Other illicit	4.8	4.8	4.7	
Tobacco Alcohol Cannabis	4.3	5.5	2.7	**
Tobacco Alcohol Cannabis Other illicit	3.9	4.6	2.7	**
Alcohol Other illicit	3.8	4.7	2.6	**
Cannabis Tranquillisers Other illicit	3.7	4.0	3.4	
Alcohol Tranquillisers	3.3	2.6	4.6	
Tobacco Cannabis Tranquillisers Other illicit	3.2	2.9	3.4	**
Tobacco Alcohol Cannabis Tranquillisers Other illicit	2.6	2.8	2.5	
Tobacco Tranquillisers Other illicit	2.4	1.6	3.5	**
Alcohol Cannabis Other illicit	2.1	2.7	1.2	**
Tobacco Alcohol Other illicit	2.0	2.0	2.1	
Cannabis Tranquillisers	2.0	1.7	2.3	**
Alcohol Cannabis Tranquillisers Other illicit	1.5	2.1	0.8	**
Tobacco Cannabis Tranquillisers	1.4	0.9	2.0	**
Alcohol Tranquillisers Other illicit	1.4	1.0	1.9	
Tobacco Alcohol Tranquillisers	1.3	0.9	1.7	
Tobacco Alcohol Tranquillisers Other illicit	1.1	1.0	1.3	
Tobacco Alcohol Cannabis Tranquillisers	0.7	0.4	0.9	**
Alcohol Cannabis Tranquillisers	0.5	0.2	0.9	**

Notes. **p < 0.01 for gender difference; [†] Tranquillisers/sedatives; [††] Illicit drugs other than cannabis.

of girls) and physical fights (16.3% versus 4.7%). Girls prevailed in relationship problems: problems with parents (18.1% versus 12.1% of boys) and problems with friends (14.0% versus 9.9%). Less than half of the student population (46.1%) showed no problem behaviours (according to the cut-offs we adopted) while one in six (16.1%) reported three or more. The prevalence of problem behaviours was higher for boys than girls overall, and gender differences increased with the increasing number of problem behaviours.

Table 4 shows the other problem behaviours in relation to the number of substances used. The prevalence of each

Table 3. Prevalence (%) of specific problem behaviours: unweighted average across countries, in the total sample and by gender.

	Total (%)	Boys (%)	Girls (%)
Problem behaviours	(*n*=101,401)[†]	(*n*=49,343)	(*n*=52,058)
Slot machines	17.1	24.6	10.0
Performed poorly at school	15.2	16.3	14.2
Serious problems with parents	15.1	12.1	18.1
Engaged in unprotected sexual intercourse	14.3	16.2	12.6
Skipped school lessons	13.6	14.3	13.0
Serious problems with friends	12.0	9.9	14.0
Trouble with police	11.5	15.9	7.3
Physical fight	10.4	16.3	4.7
Regretted engaging in sexual intercourse	8.2	9.2	7.3
Number of problem behaviours	(*n*=88,265)[††]	(*n*=42,899)	(*n*=45,365)
0 problem behaviours	46.1	40.1	51.7
1 problem behaviour	24.5	26.0	23.1
2 problem behaviours	13.3	14.9	11.8
3+ problem behaviours	16.1	19.0	13.4

Notes. [†] Up to 7.5% missing values for individual behaviours; [††] With complete data for all behaviours. Slot machines: at least a few times a year; Performed poorly at school: at least 6 times during the last 12 months; Serious problems with parents: at least 3 times during the last 12 months; Engaged in unprotected sexual intercourse: at least once during the last 12 months; Skipped school lessons: at least 2 days during the last 30 days; Serious problems with friends: at least 3 times during the last 12 months; Trouble with police: at least once during the last 12 months; Physical fight: at least 3 times during the last 12 months; Regretted engaging in sexual intercourse: at least once during the last 12 months.

behaviour increased steeply with increasing number of substances used. Among students who did not use any substance, the *highest* prevalence of any of these behaviours was 13.5%, in contrast to the *lowest* prevalence of 31.1% among those who used three or more substances. More than half of the students who had used three or more substances reported unprotected sex and having had trouble with the police. As shown in Figure 1, the large majority (about 70%) of those who used three or more substances also reported three or more other problem behaviours.

Table 5 presents findings from the mul-tinomial logistic regression with polydrug use as dependent variable (one substance and 2+ substances versus the reference category of no use) and the nine problem behaviours and gender as independent variables. All the rate ratios for the associations between problem behaviours and polydrug use were significant at the 1% level, both for the use of one substance and 2+ substances, with the sole exception of the association between having serious problems with friends and the use of 2+ substances. Rate ratios were substantially higher for 2+ substances than for one substance, except for having serious problems

Table 4. Unweighted average prevalence (%) across countries of other problem behaviours, by number of substances used.

Problem behaviour[†]	Number of substances			
	0	1	2	3+
	(n=74,896)	(n=15,462)	(n=5,054)	(n=3,231)
Trouble with police	6.3	20.2	34.8	54.2
Regretted engaging in sexual intercourse	4.7	13.7	23.4	33.3
Engaged in unprotected sexual intercourse	8.5	23.6	38.8	56.5
Physical fight	6.6	16.5	27.7	46.1
Serious problems with friends	9.7	16.9	22.6	31.1
Serious problems with parents	11.5	22.0	30.9	41.9
Performed poorly at school	11.7	22.0	30.0	40.9
Skipped school lessons	9.3	21.7	33.1	48.2
Slot machines	13.5	23.4	31.4	46.6

Note. [†] Up to 7.2% of missing data for individual problem behaviours.

Fig. 1. Unweighted average prevalence (%) across countries of three or more other problem behaviours, by number of substances used at the cut-off levels defined in this paper.
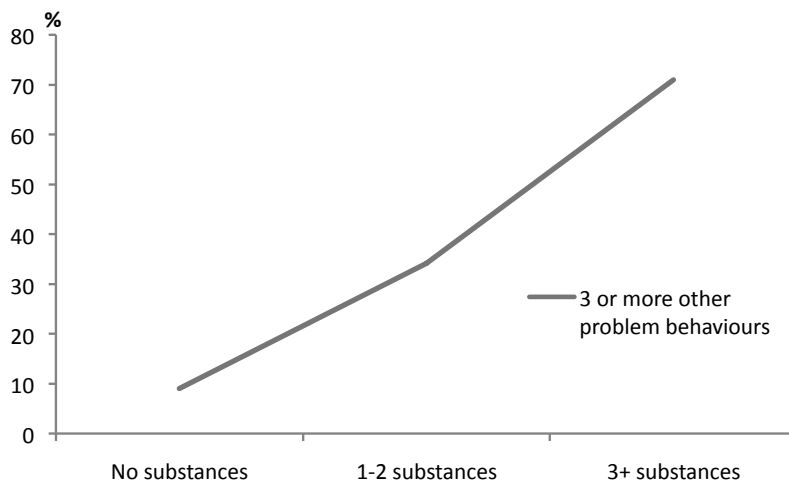
with friends. The highest associations with polydrug use were found for problems with the police, risky sexual behaviour and skipping school.

Table 6 shows the inverse relationship to Table 5, with the nine problem behav-

iours as dependent variables in turn, and selected combinations of polydrug use as independent variables. The great majority of the associations were highly significant (p<0.001). The highest associations between the occurrence of a prob-

Table 5. Rate ratios (with 99% confidence intervals) from multinomial logistic regression analysis with independent variables the problem behaviours and dependent variable polydrug use in three categories: no substances used, one substance used, two or more used. The reference category is no substances used. The analysis is based on n = 83,511 adolescents with complete data for all substances and all problem behaviours.

		1 substance used vs. none used	2+ substances used vs. none used
Trouble with police	at least once vs. never	2.14 [†] (1.96, 2.34) [††]	3.94 (3.54, 4.38)
Engaged in unprotected sexual intercourse	at least once vs. never	2.05 (1.89, 2.22)	3.77 (3.41, 4.17)
Skipped school lessons	at least 2 days vs. no/less than 2 days	1.94 (1.79, 2.09)	2.86 (2.60, 3.15)
Physical fight	at least 3 times vs. 0–2 times	1.56 (1.42, 1.71)	2.19 (1.97, 2.45)
Serious problems with parents	at least 3 times vs. 0–2 times	1.53 (1.41, 1.67)	2.18 (1.96, 2.41)
Regretted engaging in sexual intercourse	at least once vs. never	1.60 (1.44, 1.77)	2.12 (1.87, 2.41)
Slot machines	any vs. never	1.41 (1.31, 1.51)	1.97 (1.79, 2.16)
Performed poorly in school	at least 6 times vs. 0–5 times	1.41 (1.30, 1.53)	1.91 (1.72, 2.12)
Serious problems with friends	at least 3 times vs. 0–2 times	1.16 (1.06, 1.27)	1.06 (0.95, 1.19)
Gender	Female vs. Male	0.91 (0.86, 0.97)	0.97 (0.88, 1.07)

Notes. [†] RR = rate ratio versus the use of no substances; [††] 99% confidence interval.

lem behaviour and patterns of polydrug use were between trouble with the police and the combinations tobacco-cannabis-other illicit drugs (odds ratio, OR, 9.33), tobacco-alcohol-cannabis (OR 7.16) and tobacco-other illicit drugs (OR 6.49), and between engaging in unprotected sexual intercourse and the combinations tobacco-other illicit drugs (OR 8.87) and tobacco-cannabis-other illicit drugs (OR 8.84).

Discussion

Teenage polydrug use has been reported to be a significant predictor of health risks and of polydrug use and drug dependence in adulthood (Earleywine & Newcomb, 1997; Galaif & Newcomb, 1999; Mackesy-Amiti, Fendrich, & Goldstein, 1997). Aiming to fill the existing gaps in the literature,

we covered in our study a comprehensive range of drugs including tobacco, alcohol, tranquillisers/sedatives, cannabis and other illicit drugs as well as a large range of other problem behaviours. Based on previous findings pointing to the importance of the number of substances used in increasing the odds of reporting problem behaviour such as suicide attempt – approximately doubled for every additional substance used (Kokkevi et al., 2012) – we took care in our analysis to check whether the above stands for other risk behaviours too, such as the ones assessed in the present study.

Almost one in ten students was a polydrug user according to the definition that we adopted. Our findings on the relationship between European adolescents' poly-

Table 6. Binary logistic regressions with each problem behaviour as dependent variable in turn, and gender and specific combinations of substances as independent variables.

	Trouble with police	Regretted sexual intercourse	Unprotected sexual intercourse	Physical fight	Serious problems with parents	Serious problems with friends	Performed poorly at school	Skipped school	Slot machines
	(n=94,741)	(n=92,561)	(n=92,521)	(n=94,807)	(n=94,594)	(n=94,301)	(n=94,225)	(n=88,486)	(n=94,861)
Female gender	0.39†	0.69	0.65	0.25	1.57	1.43	0.83	0.91	0.33
	(0.37 , 0.42)	(0.64 , 0.75)	(0.61 , 0.70)	(0.23 , 0.27)	(1.48 , 1.66)	(1.35 , 1.52)	(0.78 , 0.88)	(0.86 , 0.98)	(0.31 , 0.35)
Tobacco – Alcohol	4.90	3.88	4.92	4.45	2.45	2.43	2.52	3.97	2.60
	(4.10 , 5.87)	(3.17 , 4.74)	(4.14 , 5.86)	(3.67 , 5.39)	(2.02 , 2.98)	(1.99 , 2.98)	(2.08 , 3.05)	(3.32 , 4.75)	(2.17 , 3.13)
Tobacco – Cannabis	4.74	2.97	3.90	2.53	3.14	2.18	3.58	3.53	2.08
	(3.80 , 5.92)	(2.30 , 3.83)	(3.17 , 4.79)	(1.99 , 3.21)	(2.57 , 3.84)	(1.72 , 2.76)	(2.88 , 4.44)	(2.85 , 4.39)	(1.68 , 2.57)
Tranquillisers/sedatives – Other illicit	3.69	4.33	3.50	3.19	3.91	3.01	2.48	1.93	1.83
	(2.75 , 4.96)	(3.19 , 5.88)	(2.67 , 4.60)	(2.28 , 4.47)	(3.03 , 5.06)	(2.27 , 4.00)	(1.86 , 3.30)	(1.42 , 2.62)	(1.36 , 2.48)
Tobacco – Other illicit	6.49	4.04	8.87	3.76	3.93	2.78	2.89	4.00	2.27
	(4.82 , 8.74)	(2.89 , 5.63)	(6.69 , 11.77)	(2.67 , 5.30)	(2.94 , 5.26)	(2.01 , 3.86)	(2.12 , 3.95)	(2.96 , 5.42)	(1.65 , 3.12)
Cannabis – Other illicit	5.28	4.95	5.40	3.41	2.70	1.73	2.64	3.11	2.02
	(4.05 , 6.90)	(3.63 , 6.75)	(4.10 , 7.11)	(2.55 , 4.57)	(2.02 , 3.61)	(1.23 , 2.44)	(1.98 , 3.51)	(2.33 , 4.14)	(1.52 , 2.68)
Tobacco – Tranquillisers/sedatives	6.01	4.78	5.71	3.47	3.97	2.92	2.98	4.15	2.89
	(4.47 , 8.08)	(3.51 , 6.51)	(4.35 , 7.48)	(2.39 , 5.06)	(3.01 , 5.23)	(2.18 , 3.91)	(2.22 , 4.00)	(3.11 , 5.54)	(2.13 , 3.92)
Alcohol – Cannabis	3.61	2.76	3.12	1.91	2.18	1.39	2.87	2.41	1.95
	(2.54 , 5.12)	(1.97 , 3.87)	(2.31 , 4.21)	(1.35 , 2.71)	(1.55 , 3.06)	(0.93 , 2.08)	(2.04 , 4.03)	(1.75 , 3.30)	(1.44 , 2.65)
Tobacco – Cannabis – Other illicit	9.33	5.10	8.84	5.10	3.92	2.72	3.31	4.79	3.18
	(6.89 , 12.62)	(3.66 , 7.12)	(6.53 , 11.97)	(3.73 , 6.96)	(2.89 , 5.30)	(1.99 , 3.72)	(2.43 , 4.51)	(3.56 , 6.43)	(2.34 , 4.34)
Tobacco – Alcohol – Cannabis	7.16	4.50	5.81	4.17	3.23	2.08	3.53	5.19	3.50
	(5.31 , 9.64)	(3.20 , 6.33)	(4.36 , 7.76)	(3.09 , 5.62)	(2.41 , 4.34)	(1.46 , 2.96)	(2.64 , 4.72)	(3.84 , 7.02)	(2.60 , 4.72)

Note. † Odds ratio for presence versus absence of the problem behaviour, with 95% confidence interval in parentheses

drug use and other problem behaviours show clearly that involvement with poly-drug use entails strong associations with other problem behaviours. This finding concurs with our hypothesis of co-existing problem behaviours in line with Jessor's and Jessor's theory (1977) that involvement in any one problem behaviour increases the likelihood of involvement in other problem behaviours. This is because of their linkages within the social ecology of youth and the similar psychological meanings and functions that behaviours may have such as overt repudiation of conventional norms or expression of independence from parental control.

Our hypothesis of an association between the incremental (intensity and frequency) use of substances and other problem behaviours was also confirmed. Finally, we also confirmed our hypothesis of the varying strengths of associations, depending on the specific combination of substances and the particular problem behaviours, and that there are gender differences. The stronger these associations between problem behaviours the greater is expected to be the probability of severe repercussions, as indicated by studies documenting that young people who engage in multiple problem behaviours have more serious levels of each problem behaviour and are less likely to improve (Biglan et al., 2004).

Among the substances appearing within the commonest combinations in the poly-drug use pattern are tranquillisers/sedatives. This is more evident for girls than for boys. The non-prescribed use of psychoactive medicines such as tranquillisers has been considered to be a "hidden" problem of abuse or dependency in the general population, conforming more to female stereotypes of societal norms (Graham & Vidal-Zeballos, 1998; Kokkevi, Fotiou, Arapaki, & Richardson, 2008). That problem behaviours – drug-use related and others – are more common among boys than girls has been reported by many studies. A WHO report explains how the different behaviours exhibited by males and females may be influenced by gender norms within society; in some societies, being male is associated with risk-taking and extroverted aggressive behaviours (WHO, 2010). In fact our findings show that females have more problems in relationships, which suggests that they are more inclined towards internalising problems and thus present a greater tendency than males towards self-medication with tranquillisers/sedatives.

The appearance of non-prescribed use of tranquillisers/sedatives within the polydrug use patterns among adolescents in the present study reinforces the importance of closer monitoring of their use and that their onset during adolescence should be considered as an early sign of possible misuse and dependence later on in adulthood, especially among females as shown in a study by McCabe, West, Morales, Cranford, & Boyd (2007).

Interestingly, despite the different prevalences of polydrug use and other risk behaviours in boys and girls, the relationship between these different types of risk behaviours appears to be the same for both genders, as shown by the non-significant interaction terms with gender in our regression analyses.

It is to be also noted that although the proportion of adolescents who report the non-prescribed use of tranquillisers/seda-

tives and frequent use of alcohol is small, it is a substantial one and warrants appropriate screening and an early intervention focus to limit the inherent risk of combining tranquillisers or sedatives with alcohol.

A final point of interest of our findings is that intensive tobacco use by adolescents is present among the common polydrug use patterns that show the highest probability of co-occurrence with other problem behaviours such as behaviours that cause trouble with the police and risky sexual behaviour. This finding confirms previous reports that tobacco use is an important associated factor of another problem behaviour that it was not possible to examine in this paper, namely, self-harm by adolescents (Arenliu, Kelmendi, Haskuka, Halimi, & Canhasi, 2014; Beratis, Lekka, & Gabriel, 1997; Hacker, Suglia, Fried, Rappaport, & Cabral, 2006; Hawton, Rodham, Evans, & Weatherall, 2002; Kokkevi, Rotsika, Arapaki, & Richardson, 2010, 2012; O'Connor, Rasmussen, Miles, & Hawton, 2008).

Strengths
Among the strengths of our study is that we were able to analyse data from a very large sample of European adolescents from a large number of countries in which the investigation was carried out with the same standardised methodology. We are not aware of any previous paper that has examined the relationship between patterns of polydrug use and other problem behaviours using comparable data from so many countries. We adopted definitions of polydrug use and other behaviours that took into account their prevalences, in order to avoid including behaviours that could be "normative" for the age group of adolescents. The cut-offs we used thus

help to identify the students who are most prone to maladaptive behaviours. We examined patterns of licit and illicit drug use including non-prescribed use of licit pharmaceuticals such as tranquillisers/ sedatives. We applied regression analyses that allow us to gain a more valid insight into the constellation of polydrug use and other problem behaviours.

Limitations
Among the limitations of the present study are three standard reservations that generally apply to school surveys. First, it is not possible to infer causality from the associations that have been found, because of the cross-sectional nature of the survey. Second, the sample by its nature excludes adolescents of this age who do not attend school at all (or were absent on the day of data collection). They may differ in experiences and behaviours from the students in the sample, and possibly are more liable to engage in high-risk behaviours and have different patterns of co-occurrence of risk. Third, the sensitive nature of some of the issues under study, especially those of an illegal nature, may result in underestimation of the prevalence of the risk behaviours.

Employing different time frames for the use of different drugs – last 30 days for some, but lifetime for others – could be considered a weak point of the present study, because it means that we might not be examining truly concurrent use. As explained in the Methods section, our choice was in part imposed by the selection of time frames in the ESPAD questionnaire, but beyond that our aim was to base the cut-offs for different behaviours on their deviance from the norm. With this ration-

ale, lifetime use of illicit drugs other than cannabis has a similar prevalence to cannabis use in the last 30 days, suggesting that at least statistically it has similar importance in this age group. Furthermore, as using illicit drugs other than cannabis usually occurs later than cannabis use, a 16-year-old adolescent who has used another illicit drug just once has a high risk of repeating its use. Also, as reported elsewhere, having used an illicit drug (including cannabis) even once constitutes a risk factor in adolescence (Huas, Hassler, & Choquet, 2008).

Finally, there is the possibility that more extensive statistical analysis could be undertaken of this rich data set. Approaches based on latent class analysis have already been mentioned. This is a complementary analysis that could be undertaken in the future. One further step could be to introduce country-level variables in addition to the individual-level variables that have been employed here, within the framework of a multilevel model in order to explore and explain differences between countries.

Prevention policy implications (recommendations)

Information on the association between polydrug use and other high-risk behaviours should be taken into consideration for more effective directing of preventative interventions. In particular, our findings regarding the strong associations between polydrug use and other problem behaviours suggest that preventative interventions should not focus on separate risk behaviours (targeted approach seeking to prevent a single risky behaviour) as is often the case, but instead should address multiple risk behaviours (Hair, Park, Ling, & Moore, 2009). This implies that interventions should expand their target populations to include adolescents at risk for multiple behaviours which seem to share common risk and protective factors (Brooks, Magnusson, Spencer, & Morgan, 2012; DuRant, Smith, Kreiter, & Krowchuk, 1999; Rees, Argys, & Averett, 2001; Terzian, Andrews, & Anderson Moore, 2011; Tubman, Gil, & Wagner, 2004). There is a need for timely intervention targeted towards those adolescents who are involved in multiple behavioural problems, with the aim of protecting them from compromising their physical, psychological and social health. Particular attention should be paid to the misuse of psychoactive medicines such as tranquillisers/sedatives, especially by girls. Gender-specific interventions should take into account the internalising-externalising difference in expressions of risk behaviours between boys and girls. Finally, the importance of tobacco smoking should not be overlooked, for despite the fact that this is a legal substance in widespread use, its intensive use in adolescence seems to be highly correlated with problem behaviours. For these European student adolescents the implementation of school-based mental health programmes including early interventions could be the focus; there is evidence of the impacts of such interventions across a range of emotional and behavioural problems (O'Connell, Boat, & Warner, 2009). Care should also be taken by the countries' social and health systems to ensure the availability of the necessary community mental health services for children and adolescents, and their linkage to the schools.

Declaration of interest None.

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