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Cannabis supply and demand reduction: Evidence from the ESPAD study of adolescents in 31 European countries

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Abstract

Aims: Most national drug policies target both the supply side and the demand side of illicit drug use. Although such policies are intended to affect individual choices, they by definition operate on a national level and cannot be evaluated solely on the basis of individual-level differences. This study aims to evaluate the impact of country-level differences in the availability and perceived risk of cannabis use on individual-level adolescent cannabis use.

Method: The study is based on an analysis of 84,711 students in 31 European countries. Multilevel modelling techniques are used to estimate the effects of country-level differences in the perceptions of availability and risk among non-users on individual-level odds of 30-day cannabis use.

Findings: On the individual level, adolescents who use cannabis find it easier to obtain and less risky if they have used the drug. Controlling for these individual-level associations, adolescents are also found to be less likely to use cannabis in countries where non-users report less availability and more risks associated with cannabis use.

Conclusions: These findings support the notion that both supply reduction and demand reduction may reduce the prevalence of adolescent substance use.

Keywords: Adolescents, European, cannabis, prevention

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Introduction

Supply reduction and demand reduction are the two major types of policies that guide efforts to curb drug use in Western societies (Coggans, 2006; European Monitoring Centre for Drugs and Drug Addiction (EMCDDA), 2008; Hakkarainen, Tigerstedt, & Tuukka, 2007; Hanson, Venturelli, & Fleckenstein, 2004). Supply reduction policies rely primarily on law enforcement efforts to reduce the production, trafficking and sale of drugs, while demand reduction policies rely on public health efforts and specific prevention and treatment programmes to reduce the initiation and persistence of substance use. These policies are not mutually exclusive and international agencies such as the United Nations Office on Drugs and Crime (UNODC, 2007) and the EMCDDA (2007) have called for comprehensive national drug policies that target both the supply side and the demand side of the drug problem. Such policies by definition operate on the national level and although they are intended to affect individual choices they cannot be evaluated solely on the basis of individual-level factors. It is necessary to measure supply and demand independently of the prevalence of individual drug use in order to estimate the effects of reduced supply or reduced demand on such use. However, such an analytical distinction has proven elusive to maintain empirically.

The country-level supply of cannabis is difficult to assess, in particular, among adolescents. Drug-related arrests and the amount of confiscated drugs are, for instance, notoriously unreliable indicators of the supply of drugs in society (Thorisdottir, 2002). Although arrests and confiscations may indicate more drug offences coming to the attention of police because of greater availability, they also reflect differences in law enforcement policies and the success of police efforts to reduce availability. Paradoxically, police statistics may therefore either reflect increased supply or greater success of supply reduction efforts. Drug prices are also quite unreliable indicators of availability since they are not only a function of supply and demand, but also reflect differences in the level of risk of arrest and the severity of penalties (Bretteville-Jensen, 2006). As a result there does not appear to be a clear association between price and either rates of regular cannabis use or cessation, even though higher income and lower cannabis prices may encourage cannabis initiation among adolescents (Desimone & Farrelly, 2003; McCrystal, Percy, & Higgins, 2007; van Ours & Williams, 2007).

In addition to the challenges of mapping local, national and international illicit drug markets (Ritter, 2006), the access of adolescents to such markets is also difficult to assess. Adolescents typically obtain illicit drugs through informal social networks rather than regular contacts with drug dealers (Coomber & Turnbull, 2007; Harrison, Fulkerson, & Park, 2000). The supply of illicit drugs in the general population does, therefore, not translate directly into availability among adolescents. Surveys among adolescent populations can give some indication of their perceptions of cannabis availability. However, given the clandestine nature of illicit drug markets, it is difficult to separate the perceived availability of

cannabis from the actual use on the individual level. Simply put, perceived availability tends to be high among users and low among non-users.

A wide variety of adolescent drug use prevention programmes aimed at demand reduction has been proposed and implemented over the past half century. Some programmes attempt to raise awareness of the danger of drug use in the general population, while other programmes target specific schools, parents or at-risk groups by providing information about the consequences of drug use, building resistance through enhanced personal and social skills, providing alternative activities, and enhancing support systems (Cuijpers, 2003; Mallick, 2007; Streke, 2004). Meta-analyses of drug prevention programmes among adolescents have generally found minimal effects of lecture-oriented programmes emphasising knowledge about the dangers of cannabis use, while small-scale interactive programmes fostering the social competencies seem to yield the largest effects (Streke, 2004; Tobler, Lessard, Marshall, Ochshorn, & Roona, 1999).

Studies focusing on the effectiveness of specific prevention programmes by necessity use either matched comparison groups or estimates of societal levels of substance use as their baseline. Such studies are therefore limited to evaluating the marginal yield of a single programme implemented in the wider context of various nationwide campaigns, curriculum-based education and a multitude of other targeted prevention and intervention programmes. They are by design unable to assess the combined effect of demand reduction efforts in a given country. Adolescent drug surveys can give some indication of the perceived risk of cannabis use but the individual-level dynamic between attitudes and behaviours is far from simple. While more positive attitudes towards drug use are associated with a greater risk of initiation, the use of drugs has also been found to change perceptions of risk among users (Adalbjarnardottir, Dofradottir, Thorolfsson, & Gardarsdottir, 2003). Perceptions of the risks associated with drug use simply tend to be low among users and high among non-users. It is, therefore, also difficult to assess the success of cannabis demand reduction strategies on the individual level.

This dilemma can partly be solved by moving from the individual to the national level of analysis. While perceptions of availability and risk are inextricably tied up with actual use on the individual level, the perceptions of non-users are by definition unaffected by their own use. Indeed, acceptance among non-users has been argued to be a crucial aspect of the normalization of cannabis in society (Parker, Aldridge, & Measham, 1998; Roy, Wibberley, & Lamb, 2005). The collective perceptions of non-users can therefore be expected to tap the conditions and normative structure of adolescent society in a particular country. The proportion of non-users who think cannabis is easily available can thus be used as a proxy measure of cannabis supply in adolescent society as a whole and successful supply reduction policies should be reflected in a lower proportion of non-users who know where they could obtain cannabis if they wanted. Similarly, the proportion of non-users who believe there are serious risks associated with cannabis use can be used as a proxy measure of cannabis demand in adolescent

society as a whole and successful demand reduction policies should be reflected in a greater perception of cannabis risk among non-users.

In this article, we will assess the effects of availability and perceived risk on self-reported cannabis use among 84,711 adolescents in 31 European countries. At the individual level, adolescents who use cannabis can be expected to find it easier to obtain and less risky than their peers that have never used cannabis. This unique dataset allows us to assess the extent to which these individual-level covariances are invariant across European countries. More importantly, however, these data allow us to address important questions regarding the effects of societal-level perceptions of availability and risk on individual behaviours. Using multi-level modelling techniques we estimate the effect of societal availability on the odds of individual cannabis use, holding constant the fact that cannabis users are better able to obtain the drug. Similarly, the effect of societal perceptions of risk on the odds of individual cannabis use will be estimated, holding constant the beliefs of individual users that cannabis is relatively harmless. In the multivariate model the independent effects of perceived availability and perceived health risks can be assessed on both the individual level and the societal level.

Data and methods

The current study is based on data from the European School Survey Project on Alcohol and Other Drugs (ESPAD), a collaborative research project implemented by a network of European researchers (Hibell et al., 2004). The primary goal of the project is to provide comparative data on adolescent substance use in Europe for the purposes of research and policy formation. Independent research teams in each country survey 15–16-year-old students at 4-year intervals according to the ESPAD (2008) research protocol. Standardized questionnaires are administered to students in the classroom with the use of a blank envelope procedure to ensure anonymity (Bjarnason, 1995). For the current study, data were available from 31 European countries that participated in the third wave of the ESPAD project in 2003.

Table I provides demographic and survey information for the countries included in the current study. These countries reflect the diversity of European countries, including, for instance, the Faroe Islands (48 thousand inhabitants, 98% Lutheran), Austria (8 million, 78% Roman Catholic), Greece (11 million, 98% Orthodox), Ukraine (48 million, 70% Orthodox), the United Kingdom (59 million, 47% Anglican) and Turkey (70 million, 99.8% Muslim) (World Factbook, 2003). Some of these countries are among the oldest and most stable democracies in the world, while others have only recently achieved independence or democratic self-determination.

The current study is based on responses from 84,711 of students in the 31 participating countries. The national samples were in the range of 1663–5087 students, with the exception of Greenland, Faroe Islands and Isle of Man where the total cohort of 15–16-year-old students was <1000 and the entire cohort was

Table I. Overview of 31 countries participating in the 2003 European school project on alcohol and other drugs.

	Population 2003[1] (in thousands)		Survey information		
Countries	National population	15 to 16-year-old	Sample size	Response rate (%)	30-day cannabis use
Austria	8102	94	2377	90	10
Belgium	10,356	122	2320	81	17
Bulgaria	7846	103	2739	85	8
Croatia	4442	55	2884	88	8
Cyprus	715	11	2152	88	2
Czech	10,203	130	3172	95	19
Denmark	5384	59	2519	89	8
Estonia	1356	22	2463	86	6
Faroe Islands	48	0.7	591	86	1
Finland	5206	62	3222	91	3
France	61,832	816	2320	91	22
Germany	82,537	952	5087	89	12
Greece	11,006	117	1906	83	2
Greenland	57	0.9	554	68	11
Hungary	10,142	124	3143	82	6
Iceland	288	4	1663	81	4
Isle of Man	78	0.9	721	85	21
Latvia	2331	38	2841	84	4
Lithuania	3463	57	5036	88	6
Malta	397	6	3500	83	4
Netherlands	19,193	196	2095	93	13
Norway	4552	56	3833	87	3
Romania	21,773	354	4371	84	0
Russia (Moscow)	10,383	176	1925	80	7
Slovakia	5379	82	2276	87	10
Slovenia	1995	26	2785	88	14
Sweden	8941	111	3232	87	1
Switzerland	7314	84	2613	83	20
Turkey	69,770	1238	4177	91	2
Ukraine	48,004	746	4173	83	5
United Kingdom	59,438	778	2031	84	20
All countries	482,531	6622	84,721	86	9

[1]Source: Eurostat (2008) except Faroe Islands (Hagstova Føroya, 2008), Greenland (Statistics Greenland, 2008), Isle of Man (Hibell et al., 2004 and Isle of Man Government Treasury, 2006), Russia (Russian Federal Service of State Statistics, 2008) and Ukraine (State Statistics Committee of Ukraine, 2008).

included in the study. All but three of the samples were nationally representative. In Turkey the sample was representative of the regions of Adana, Ankara, Diyarbakir, Istanbul, Izmir and Samsun; in Germany the sample was representative of the states of Bayern, Brandenburg, Berlin, Hessen, Mecklenburg-Vorpommern and Thüringen. In Russia the sample was representative of Moscow only. Response rates in individual countries ranged from 68% to 95%, with an average of 86%. Further information about sampling and field procedures in each country is provided by Hibell et al. (2004).

Outcome measurement

The dependent variable is cannabis use in the past 30 days (0: None; 1: Any cannabis use).This dichotomous variable was recoded from the standard ESPAD seven-point response set. As shown in Table I, the 30-day cannabis use ranged from 0% to 22%, with an average of 9% when all participating countries are given equal weight irrespective of population size. If the results are weighted by the size of each country, the estimated prevalence of 30-day cannabis use in the population of European adolescents is 10%.

Gender

Gender was recoded into the dichotomous variable *Male* (0: No; 1: Yes). It is necessary to control for gender in the following analysis as some of the association of perceived availability and perceived risk with cannabis use may be attributed to gender differences in both perceptions and behaviour.

Perceptions of availability

These were based on responses to the standard ESPAD question asking how difficult students thought it would be to obtain different substances if they wanted (1: Impossible; 5: Very easy).

Aggregate availability

This was computed as the mean of individual availability in each country. Both individual perceptions and aggregate perceptions of availability were standardized across all countries with a mean of 0 and standard deviation of 1 in order to facilitate the comparison of effect sizes.

Perceptions of risk

These were based on responses to three items asking how much students thought people risked harming themselves physically or in other ways by using cannabis: (1) once or twice, (2) occasionally or (3) regularly (1: No risk; 4: Great risk) (Bjarnason & Jonsson, 2005). The three items formed a reliable short scale of perceived risk of cannabis use (Cronbach's $\alpha : 0.81$). Factor analysis was used to extract factor scores for the single underlying factor.

Aggregate risk

This was computed as the mean of perceived risk in each country. Both individual and aggregate perceptions of risk were standardized across all countries with a mean of 0 and standard deviation of 1.

Modelling strategy

The following data analysis is based on multilevel modelling techniques (Bryk & Raudenbush, 1992), and was conducted by use of the *HLM 6.0* software

(Raudenbush, Bryk, Cheong, & Congdon, 2004). This methodology allows several important theoretical and conceptual issues to be empirically tested. Hierarchical regression involves the estimation of individual-level and country-level effects of availability and perceived risk on cannabis use, as well as, allowing the estimation of variable slopes for individual-level predictors across countries.

Regular multivariate regression is based on the assumption that there is a single constant intercept and a single constant slope for each predictor in the regression model. In contrast, hierarchical regression defines both intercept and each slope as variables that can in turn be regressed on various predictors. This strategy allows us to estimate the association between country-specific levels of cannabis use and country-specific aggregate perceptions of availability and risk among non-users (Level-2 variables), after taking into account the association between individual cannabis use and individual perceptions of availability and risk (Level-1 variables). It also allows us to estimate the extent to which the strength of the association between individual cannabis use and individual perceptions of availability and risk varies across countries.

The Bernoulli model for dichotomous dependent variables extends this basic approach by transforming the predicted value into η_{ij} by use of the logit link function:

$$\eta_{ij} = \left(\log \frac{\Phi_{ij}}{1 - \Phi_{ij}}\right) = \beta_{0j} + \sum \beta_{qj} X_{qij}$$

The predicted value of a dichotomous dependent variable is equal to the probability of cannabis use, Φ_{ij} for student i in country j and η_{ij} is the log of the odds of cannabis use, β_{0j} is the individual-level intercept for each country, β_{qj} the qth individual-level slope for each country j, and X_{qij} is the qth individual-level predictor for student i in country j.

Results

The results of the multilevel analyses are given in Table II. The first column shows the bivariate results obtained by including one predictor at a time, and the second column shows the multivariate results obtained by including all individual-level and country-level predictors simultaneously in a single model. Males are found to be 1.4 times as likely as females to have used cannabis in the past 30 days. Controlling for gender differences in perceived availability and risk, males are 1.3 times as likely to have used cannabis in the past 30 days in the multivariate model.

Perceived risk

The perception of cannabis use as potentially harmful is associated with less 30-day cannabis use at both the individual level and the country level. An increase of one standard deviation in individual perceptions of risk is associated with a decrease in cannabis use by a factor of 0.38 in the bivariate analyses.

Table II. Multilevel models of 30-day cannabis use among 15 to 16-year-old students in 31 countries participating in the 2003 ESPAD survey.

	Bivariate OR (95% CI)	Multivariate OR (95% CI)
Intercept	0.09 (0.07; 0.13)	0.06 (0.04; 0.08)
Country-level		
Perceived availability among non-users	6.31 (2.89; 13.79)	2.25
Perceived risk among non-users	0.16 (0.07; 0.35)	0.43 (0.20; 0.90)
Individual-level		
Male	1.43 (1.33; 1.53)	1.33 (1.17; 1.51)
Perceived availability for each student	2.52 (2.25; 2.82)	1.62 (1.49; 1.76)
Perceived risk for each student	0.38 (0.36; 0.41)	0.52 (0.49; 0.56)

Note: Bernoulli models with dichotomous dependent variables, coefficients are odds ratios with 95% confidence intervals in parentheses. Country-level coefficients are all statistically significant at $p < 0.05$. Individual-level coefficients are all statistically significant at $p < 0.001$. Country-level variances in intercepts and slopes are all significant at $p < 0.001$.

Similarly, an increase of one standard deviation in country-level average perceptions of risk among non-users is associated with a decrease in cannabis use by a factor of 0.16. Controlling for individual perceptions of availability, a standard deviation increase in individual perceptions of risk is associated with a decrease in cannabis use by a factor of 0.52 in the multivariate analysis. Net of this, a standard deviation increase in country-level perceptions of risk among non-users is associated with a decrease in cannabis use by a factor of 0.43. In other words, for each standard deviation that individual perceptions of risk decrease, the odds of individuals using cannabis double (1/0.52). Similarly, for each standard deviation that societal perceptions of health risks decrease among non-users, the odds of individuals in that country using cannabis increase by a factor of 2.33 (1/0.43) in the multivariate analysis.

Perceived availability

At the individual level, an increase of one standard deviation in perceived availability is associated with a 2.5-fold increase in cannabis use in the bivariate analysis. Similarly, an increase of one standard deviation in country-level average perception of availability among non-users is associated with an increase in cannabis use by a factor of 6.3. Controlling for individual-level perceptions of risk, a standard deviation increase in individual availability is associated with an increase in cannabis use by a factor of 1.6. Net of this, a standard deviation increase in country-level perceptions of availability among non-users continues to be associated with an increase in cannabis use by a factor of 2.3 in the multivariate analysis.

Variation in slopes

The variances in individual-level slopes for perceived availability and perceived risk are highly significant ($p < 0.001$). This indicates that neither the individual-

level association between perceptions of availability and 30-day cannabis use nor the individual-level association between perceptions of risk and 30-day cannabis use are invariant between countries. Availability appears to be a stronger predictor of actual use in some countries than in others, even controlling for differences in perceived risk of cannabis use. The strongest effects of perceived availability were found in the United Kingdom and Switzerland while the weakest effects were found in Romania and Cyprus. Conversely, perceived risk is a stronger obstacle to cannabis use in some countries than others after taking into account the effects of perceived availability. The strongest effects of perceived risk were found in France and the Czech Republic, while the weakest effects were found in Romania and the Faroe Islands.

Conclusion

An estimated 10% of the total population of 15–16-year-old European adolescents have used cannabis in the past 30 days. This is considerably less than in the United States where the same measure yielded an estimated 30-day prevalence of 17% (Johnston, O'Malley, Bachman, & Schulenberg, 2004). Across the 31 countries under analysis, individuals who use cannabis find it more easily available and less risky than those who do not use it. However, there is a considerable geographical and cultural variation within Europe. Prevalence rates of 19–22% were, for instance, found in Britain, the Czech Republic, France and Switzerland, while countries as diverse as the Faroe Islands, Greece, Romania, Sweden and Turkey reported 30-day prevalence rates of 2% or less. There is also substantial variation in the individual-level association between 30-day cannabis use and perceptions of availability and risk.

Future studies should explore why availability and perceived risk have stronger effects in some countries than others. It is, for instance, possible that the effects of perceived risk are stronger in countries that have experienced declining cannabis use than in countries where such use is on the rise. The cross-sectional design of the current study does not allow us to evaluate our findings in the context of such different national trajectories. It should nevertheless be noted that the multilevel approach goes beyond the limitations of both cross-sectional and longitudinal studies of individual-level processes. Relying on the responses of non-users, we were able to obtain country-level estimates of both perceived availability and perceived risk of cannabis use among adolescents. However, while perceptions of availability and risk among non-users are not contaminated by their own substance use, their distance from specific locations and instances of substance use may introduce a different kind of bias. It is, for instance, possible that successful demand reduction policies may affect perceptions of availability as well as perceptions of risks among non-users. More importantly, it is possible that underlying cultural values of the populace account for differences in policies, perceptions among non-users, and the prevalence of substance use alike.

Our analysis nevertheless shows that in countries where non-users report more availability, students are also more likely to have used cannabis in the

past 30 days. Furthermore, in countries where non-users believe cannabis use to be more risky, fewer students have used cannabis in the past 30 days. Importantly, these country-level effects on individual behaviour persist after individual-level differences in perceived availability and risk have been taken into account. In other words, the perceptions of non-users predict individual cannabis use independently of the perceptions of the individual user in question. Regardless of their own perceptions of risk and availability, individuals are more likely to have used cannabis if they live in countries where non-users perceive cannabis to be easily available and benign. Conversely, regardless of their own perceptions, individuals are more likely to have used cannabis in countries where non-users perceive cannabis to be dangerous and difficult to obtain.

The current study assumes a link between national policies of supply reduction and demand reduction on one hand and adolescent perception of availability and risk on the other. This includes the intervening efforts of law enforcement and public health agencies as well as a myriad of regional and local prevention and treatment programmes. While future studies must examine this crucial link between public policy and individual behaviour, these results nevertheless strongly suggest that both supply-reduction and demand-reduction efforts may have a substantial effect on adolescent cannabis use.

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