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Individual and school-class correlates of youth cannabis use in Sweden: A multilevel study

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Abstract

Background and aims: The school-class context is a crucial social environment for young people but substance use researchers have largely overlooked potential influences operating at this level. This study explores associations between school-class and individual-level factors and cannabis use in Swedish youth. **Data and methods:** Data comprised four waves (2012–2015) of the Swedish Council for Information on Alcohol and Other Drugs' (CAN) nationally representative school surveys among individuals in 9th and 11th grade. For the present analyses, we had data on totally 28,729 individuals from 2377 unique school classes. Multilevel logistic regressions predicted lifetime and 10+ times use of cannabis from both individual-level predictors and school-class-level measures derived from the individual-level variables. **Results:** There were individual-level associations between most predictor variables and cannabis use. An early debut of tobacco use and binge drinking as well as low cannabis related risk perceptions had strong associations with cannabis use. Conversely, several school-class-level variables had aggregate relationships with cannabis

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use, most notably the overall level of risk perceptions in the school class. Some of the school-class factors predicted cannabis use over and above the individual-level covariates, suggesting the presence of contextual effects. Surprisingly, while female gender was negatively related with cannabis use at the individual level, a higher proportion of females in the classroom increased the odds for lifetime cannabis use even after controlling for individual and other contextual-level covariates. **Conclusions:** Youth cannabis use is related to various factors at both the individual and school-class level in Sweden. Truancy and perceived risk related to cannabis use had contextual associations with cannabis use. The positive contextual association between a higher proportion of females in the classroom and lifetime use should be explored further.

Keywords
cannabis use, contextual, multilevel, school class, Sweden, youth

Cannabis is the most commonly used illicit substance in Europe (EMCDDA, 2017). While considered less harmful than some other illicit substances, using cannabis poses some significant risks (Hall, 2015). The risk of accidents increases twofold if drivers are intoxicated by cannabis and around one in ten users develop dependence problems (Hall, 2015). Cannabis is longitudinally related with depressive disorder (Lev-Ran et al., 2014) and a dose-response relationship between adolescent cannabis use and negative outcomes in young adulthood have been reported (Silins et al., 2014). In Sweden, cannabis use is relatively rare. For example, the rate of lifetime cannabis use among 16-year-olds in Sweden is typically around 4–7%, and the European average for the same age group is 16% (ESPAD Group, 2016). The 2016 figures from the Swedish Council for Information on Alcohol and Other Drugs (CAN, 2016) show that only 5% of 9th grade students, and 18% of students in 11th grade upper secondary school had ever used any illicit drug. Since cannabis use is a relatively marginal phenomenon among Swedish youth, its correlates may not be the same as those observed in countries with higher prevalence rates (Sznitman et al., 2015). This warrants empirical studies in low prevalence contexts such as the Swedish one.

The present study draws upon a large, nationally representative sample of Swedish youth to explore the relation between individual and aggregate school-class variables and cannabis use. To date, despite being a potentially influential social context for youth substance use, little research has explored factors operating at the school-class level, with a couple of exceptions (Araos, Cea, Fernández, & Valenzuela, 2014; Johansen, Rasmussen, & Madsen, 2006; Kuntsche & Jordan, 2006). In contexts where the individual's choice of class to attend is limited, the school class can be viewed as an imposed, influential environment (Araos et al., 2014) where classmates serve as an involuntary peer group (Müller, Hofmann, & Arm, 2017). Moreover, variability in substance use within such higher contextual units is to be expected, suggesting the need to assess predictors at both the individual and school-class level simultaneously. There is some evidence to suggest that the variance between school classes is larger than between schools in substance-use outcomes (Johansen et al., 2006; Rosendahl, Galanti, Gilljam, Bremberg, & Ahlbom, 2002), and that school-class-level factors such as the proportion being supported by parents are associated with substance use (including cannabis use) (Johansen et al., 2006). Thus, while the literature on school-class-level influences on youth substance use is small, it does suggests that this level is crucial to consider.

Most research on youth substance use addresses individual-level relationships and there is less research on broader contextual influences (Sloboda, Glantz, & Tarter, 2012). Exploring the role of social contexts in driving youth cannabis use is arguably important, as these are generally assumed to shape behaviours and attitudes (cf. Smetana, Campione-Barr, & Metzger, 2006). In line with the emphasis in the general literature on adolescent development where social-ecological theories are the dominating frameworks (Smetana et al., 2006), researchers have argued that factors at varying levels shape substance use patterns and other behaviours (e.g., Mayberry, Espelage, & Koenig, 2009; Zimmerman & Farrell, 2017). The school environment is presumably an important context. Youth spend many waking hours in school together with classmates and the school is generally considered a potent formative institution for youth development. For example, primary socialisation theory sees drug use as essentially learned behaviour and the school environment is proposed as one key arena for socialisation (Oetting & Donnermeyer, 1998). In addition, the social development model postulates that the school is an important learning environment for substance use (Catalano et al., 1996). The broader school level has in Swedish research been shown to be a crucial factor in explaining variability in alcohol consumption and binge drinking (Carlson & Almquist, 2016). Moreover, the between-school variation appears to be larger for risk behaviours than for other behaviours, at least in England (Hale et al., 2014). A range of studies point at a non-trivial variability in substance use across schools (Botticello, 2009; Kairouz & Adlaf, 2003; Maes & Lievens, 2004; Mayberry et al., 2009; Olsson & Fritzell, 2015; but see Ennett et al., 2008). However, the evidence is inconclusive as to whether the variance between schools is larger for marijuana use compared to alcohol use and smoking (cf. Kumar, O'Malley, Johnston, Schulenberg, & Bachman, 2002; Mrug, Gaines, Su, & Windle, 2010). Factors considered in prior studies focusing on school differences in substance use include school climate and "sense of community" (Mayberry et al., 2009), as well as school connectedness (Vogel, Rees, McCuddy, & Carson, 2015) or school bonding (Araos et al., 2014), school adjustment (Henry, Stanley, Edwards, Harkabus, & Chapin, 2009) and social capital (Takakura, 2011). A review on school environmental influences on health outcomes concluded that in schools with higher than expected attainment and lower than expected truancy ("value added") the levels of substance use were lower (Bonell et al., 2013). Importantly, research shows that school-aggregated measures derived from individual responses are related to consumption net of their individual-level counterparts (see, e.g., Kairouz & Adlaf, 2003), suggesting the presence of contextual effects. Substance-use norms at the school level, for example, have been found to be associated with substance-use outcomes, controlling for individual-level norms and other covariates (Kairouz & Adlaf, 2003; Kumar et al., 2002) and the same holds true for risk perceptions (Kairouz & Adlaf, 2003). These studies support the view, common among multilevel researchers, that some influences on higher levels have effects over and above the individual characteristics that compose the higher units; there is something in the "climate" or "atmosphere" that cannot be reduced to individual-level characteristics.

The main aim of this study was to explore the relationship between individual and school-class factors and youth cannabis use, focusing on the Swedish case. Drawing upon a large nationally representative sample of Swedish youth in 9th and 11th grade, it aims to:

- Explore the individual and school-class-level associations between cannabis use and predictors related to students.
- Explore whether school-class-level variables predict youth cannabis use net of the individual attributes (i.e., contextual effects).

The analyses largely focus on modifiable risk factors, including for example parental approval of substance use, early onset of substance use and risk perceptions. These are commonly targeted in prevention and are theoretically possible to influence if they are found to be important in shaping youth cannabis use. We also include variables that should capture bonding to school, the latter being a central tenet of the social development model (Catalano et al., 1996). Due to the relative lack of research on school-class-level correlates of youth substance use, this article takes a somewhat exploratory approach. Further, with the exception of Henry et al. (2009), Keyes et al. (2011) and Kairouz and Adlaf (2003), we have found few prior attempts in the broader multilevel research on youth substance use to disentangle individual and aggregate level associations of the *same* predictors variables (e.g., gender, parental monitoring) and substance-use outcomes. The approach we use is straightforward and entails including in a multilevel regression analysis both the individual level predictor (e.g., gender) and a corresponding measure aggregated at the school-class level (e.g., proportion of females in the class) (Snijders & Bosker, 2012). Disentangling the individual and school-class level associations is crucial not only to identify important associations at different levels but also as a way to develop as parsimonious models as possible of youth cannabis use. If some constructs are shown to have the same individual and aggregate-level relationships with the outcome, we may not need to consider both levels in future empirical or theoretical work. Conversely, if the associations do differ across levels this suggests that we should consider both levels to describe the relationship between the given predictor and the outcome accurately (Hoffman & Gavin, 1998).

Method

Data

We used repeated cross-sectional data from the 2012–2015 waves of The Swedish Council for Information on Alcohol and Other Drugs' (CAN) annual school surveys. These nationally representative surveys cover approximately 5% of Swedish students in 9th and 11th grade, respectively. Students completed the questionnaire during class. Totally 36,007 individuals participated in the 2012–2015 waves, of whom 28,762 (80%) had no missing values on the variables used in this study. We excluded a small set of individuals who were the only respondents from their school class who had data for all variables considered ($n = 33$). This left a sample of 28,729 students from 2377 unique school classes. A small minority of school classes (44 classes, covering 88 respondents) involved two students only. Few individuals per cluster do not appear to bias the fixed effects estimates in multilevel studies, but the variance estimates may be somewhat exaggerated if all groups consist of two or fewer participants (Clarke & Wheaton, 2007). As few school classes contained only two individuals, the risk of inflated school-class-level variance estimates should be low.

Variables

Dependent variables. We used two dependent variables to account for the potential that the predictors may have different relationships with different consumption frequencies. The first dependent variable tapped lifetime prevalence of cannabis use (yes/no) whereas the second outcome concerned lifetime use of cannabis 11 times or more (yes/no). Although use > 10 times can hardly be defined as heavy in an international context, we deemed it a reasonable choice given the low levels of cannabis use in Sweden. Both variables were derived from a question asking how many times respondents had used hash and/or marijuana, with answers ranging from "zero times" to "more than 50 times". Although lifetime prevalence can be derived from another separate variable in the data we used the frequency measure to obtain data on both outcomes for the same respondents.

Independent variables. Independent variables included gender (male or female), perceived risk related to using cannabis one or two times, early substance use debut, parental approval of substance use, parental monitoring, and school connectedness. Those who responded that the *risks of using cannabis are small or non-existent* were defined as having low risk perceptions. Two separate indicators were used to indicate an *early substance use debut*, with respondents having used tobacco or being drunk at age 13 or younger defined as having an early debut for each of these substances. *Parental approval of substance use* was also measured by two separate indicators. Individuals who responded "agree somewhat/fully" to the statement "It is okay for my parents/caregivers if I (smoke cigarettes/drink myself intoxicated)" were classified as having approving parents. *Parental monitoring* was measured by two questions. The first asked students whether their parents/caregivers know their friends, defined as "yes" for those who responded "Yes, all" and "Yes, majority". The responses "Yes, a few" and "No, none" were coded as "no", and the response "don't know" was coded as "missing". The second question asked about whether parents/caregivers know about students' whereabouts on Friday and Saturday nights. The responses "Always" and "Mostly" were defined as "yes", and "Sometimes" and "Mostly not" were defined as "no". *School connectedness* was measured by two indicators. Individuals who responded that they skipped school either sometime per semester or at least once a month were coded as truants. Those who reported quite poor or very poor satisfaction with school were defined as dissatisfied with school. Descriptive statistics for the included variables are shown in Table 1.

Table 1. Descriptive statistics for individual-level variables ($n = 28729$).

	n	Percentage
Used cannabis ever	3242	11
Used cannabis 10+ times	881	3
9th grade	15440	54
11th grade	13289	46
2012	6886	24
2013	7535	26
2014	7047	25
2015	7261	25
Female	14778	51
Parents approve binge drinking	4169	15
Parents approve smoking	1470	5
Drunk at 13	2641	9
Used tobacco at 13	5797	20
Low perceived risk cannabis	11524	40
Parental ignorance Friday and Saturday[a]	1876	7
Parental ignorance friends[b]	2722	9
Truancy[c]	10675	37
Dissatisfaction school[d]	1273	4

[a]Parents/caregivers sometimes or mostly do not know about students' whereabouts on Friday and Saturday nights. [b]Parents/caregivers know a few or none of students' friends. [c]Skipping school sometimes or at least once per month per semester. [d]Quite poor or very poor satisfaction with school.

Statistical analysis

The relationship between the independent variables and cannabis use was estimated by multilevel logit models. We first estimated a null model in which only a random school-class-level intercept was included to assess the variance across school classes. Then a "hybrid model" (Schunck, 2013) was estimated to assess the individual and school-class level associations with cannabis use (henceforth within and between-class associations). This entailed including cluster (i.e., school-class) mean centred individual-level variables together with the cluster means. These analyses show the association between individual and school-class-level predictors and cannabis use, respectively. The individual-level predictors are adjusted for other individual-level variables but also for school-class-level factors, whereas the school-class-level variables are only adjusted for other variables at this level. To assess contextual associations we ran analyses including the predictors in raw form together with the cluster means. The coefficients for the aggregate variables in this case express the potential contribution of the school-class-level variables to cannabis use, *over and above* the contribution of the individual-level predictors (see, e.g., Snijders & Bosker, 2012).

Because the aggregation to cluster means was done on individual-level binary variables, the school-class-level means represent the proportion of students in the classroom having a certain attribute. These proportions (range 0–1) were then rescaled to percentages (range 0–100) before analyses to give the coefficients a meaningful metric (i.e., the school-class-level predictors were multiplied by 100 before analyses). As the coefficients pertaining to a one-percentage-point change were found to be small, and to avoid excessive use of decimal points, we ran a final set of models in which the school-class-level variables were rescaled so that a one-unit change reflects a change of 10 percentage points in the school-class-level predictors. The coefficients for classroom-level means in the regression models thus pertain to the change in odds for a 10-percentage-point change in the classroom predictors (e.g., a change from 5% to 15% females). The intraclass correlation (ICC) and the median odds ratio (MOR) (Merlo et al., 2006) were used as variance measures. A more elaborated description of the models and the variance measures is found in the Appendix. All models were estimated by the *meglm* command in Stata. Graphs were created by Jann's (2014) *coefplot* command for Stata.

Results

Multilevel regression models

Empty models. The ICC for the empty model on lifetime use of cannabis was 0.21 whereas the median odds ratio (MOR) was 2.47. The MOR suggests that if moving from a school class with lower odds to a school class with higher odds the odds for cannabis use more than doubles. The ICC for the empty model regarding cannabis use 10+ times was 0.25, whereas the MOR was 2.75.

Individual and school-class-level associations. Multilevel logistic models on lifetime use and use 10+ times of cannabis are presented in Table 2. Both a within and a between-classroom estimate is shown for each predictor variable. For lifetime use, several of the within predictors were clearly related to consumption. For instance, an early debut of binge drinking and tobacco use increased the odds for lifetime use about three times, and a low risk perception was associated with more than four times higher odds for lifetime use. Having parents who accept binge drinking and smoking also predicted lifetime use, and so did truancy.

As to between-class associations, a higher proportion of students with an early substance use debut in the classroom was related to the lifetime-prevalence estimates, and so were the proportions playing truancy and holding lower-risk perceptions. Higher levels of parental ignorance about students' friends and about students' whereabouts on Friday and Saturday nights increased the odds for cannabis use as well, and a higher share of females in the school class was also related to lifetime use.

Many of the patterns identified for the first outcome were present in the regression model for use 10+ times as well. Male gender, early debut of binge drinking and tobacco use, parental approval of smoking, low risk perceptions, parental ignorance about students' whereabouts on Friday and Saturday nights, truancy and dissatisfaction with school were individual-level predictors that all increased the odds for having used cannabis 10+ times. Although several of the between-group associations failed to reach statistical significance, there were significant associations between this outcome and the proportions of students in the classroom having an early tobacco or binge drinking debut and the share who perceived low risks with cannabis use. Parental approval of smoking was also related to use 10+ times at the classroom level and so was truancy.

Table 2. Multilevel logistic models on cannabis use (hybrid model): first panel – lifetime prevalence of cannabis use; second panel – cannabis use 10+ times.

	Lifetime use		Cannabis 10+ times	
	OR	95% CI	OR	95% CI
Within classroom				
Female	0.70***	[0.63, 0.78]	0.43***	[0.35, 0.52]
Parents approve binge drinking	1.40***	[1.24, 1.57]	1.13	[0.93, 1.37]
Parents approve smoking	2.50***	[2.13, 2.94]	3.16***	[2.51, 3.97]
Drunk at 13	2.94***	[2.58, 3.36]	2.87***	[2.35, 3.51]
Used tobacco at 13	3.17***	[2.84, 3.55]	3.05***	[2.51, 3.70]
Perceived risk cannabis	4.66***	[4.20, 5.18]	5.24***	[4.25, 6.47]
Parental ignorance Friday and Saturday	2.05***	[1.75, 2.40]	2.35***	[1.84, 3.00]
Parental ignorance friends	0.93	[0.80, 1.08]	0.89	[0.69, 1.16]
Truancy	2.57***	[2.32, 2.85]	2.17***	[1.80, 2.60]
Dissatisfaction school	1.33**	[1.09, 1.62]	1.44*	[1.06, 1.96]
Between classroom[a]				
Female	1.03**	[1.01, 1.06]	1.00	[0.96, 1.03]
Parents approve binge drinking	1.01	[0.97, 1.05]	1.03	[0.96, 1.10]
Parents approve smoking	1.04	[0.98, 1.11]	1.13**	[1.03, 1.24]
Drunk at 13	1.12***	[1.06, 1.18]	1.17***	[1.07, 1.28]
Used tobacco at 13	1.15***	[1.10, 1.20]	1.13***	[1.06, 1.21]
Perceived risk cannabis	1.31***	[1.27, 1.35]	1.26***	[1.19, 1.33]
Parental ignorance Friday and Saturday	1.07*	[1.01, 1.14]	1.06	[0.96, 1.18]
Parental ignorance friends	1.06*	[1.01, 1.12]	1.06	[0.99, 1.18]
Truancy	1.15***	[1.12, 1.19]	1.16***	[1.10, 1.22]
Dissatisfaction school	1.02	[0.94, 1.11]	1.01	[0.88, 1.15]
Random effects				
σ^2 (log scale)	0.381		0.597	
ICC (log scale)	0.104		0.154	
MOR	1.802		2.090	
N level 2 (classrooms)	2377		2377	
N level 1 (individuals)	28729		28729	
Average level 1 units per level 2 unit	12.1		12.1	

Note: Estimates controlled for grade (9th vs. 11th grade in upper secondary school) and survey year. OR = odds ratio; CI = confidence interval; ICC = intraclass correlation; MOR = median odds ratio.
[a]The between-cluster ORs refer to a change of 10 percentage points. *$p \leq 0.05$. **$p \leq 0.01$. ***$p \leq 0.001$.

While there was a reduction in the variance between the null and full models, a notable variance remained after including the predictors. The ICC was over 10% for both outcomes and the MORs were 1.8 and 2.1, respectively.

Contextual associations

Figures 1a and 1b display the contextual "effects" of the school-class-level variables, also including the school-class-level associations (referred to as "aggregate" in the figures) for comparative purposes. The estimates for contextual associations show the added "effect" of the context variables, over and above the contribution of their individual-level parts. The individual-level associations are exactly the same in the models for the between-group and contextual models, respectively, and so are omitted from the figures. The association measures are presented on the log scale (i.e., log odds) as the estimates are not comparable on the odds ratio scale. Thus, the estimates for the between-class relationships in Figures 1a and

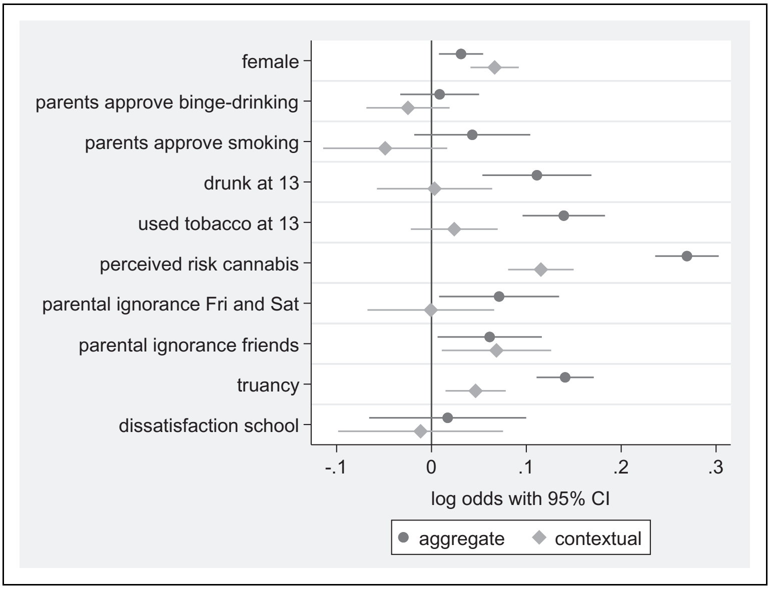

Figure 1a. Aggregate and contextual associations with lifetime use of cannabis.

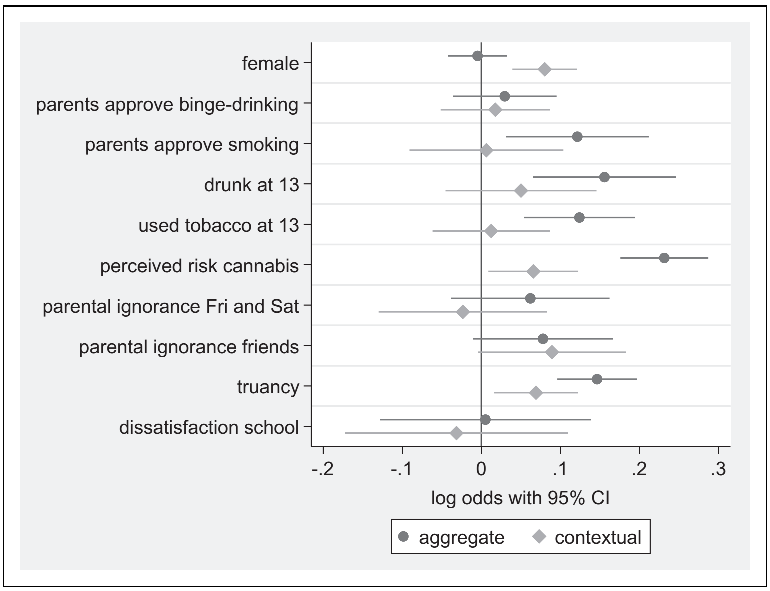

Figure 1b. Aggregate and contextual associations with cannabis use 10+ times.

1b (referred to as "aggregate" in the figures) are the log of their counterparts in Table 2.

As could be expected, most contextual relationships were smaller than the between-class associations, and the confidence intervals (95%) covered zero in several cases. The figures show that the proportions of females and truants in the school class predicted lifetime use of cannabis over and above their individual-level counterparts and so did a higher proportion of students holding low risk perceptions. The same held true for the proportion of students whose parents did not know with whom they associated.

While there was no between-class association between the proportion of females in the school class and use 10+ times (see Table 2, right panel), there was a contextual association between this variable and consumption of cannabis 10+ times. There were also contextual associations between a higher proportion of truants and individuals holding low risk perceptions in the classroom and use 10+ times (Figure 1b). The CI for the proportion of students whose parents did not know who they associate with "touches" 0 and the association was exactly $p = 0.05$.

Stratified analyses of contextual effects of lifetime use

To probe deeper into the link between gender and lifetime use we ran grade-stratified analysis. We did not run a corresponding stratified analyses for the 10+ times outcomes as there was no statistically significant between-group association between percentage female and use. Because students choose educational track in upper secondary school in Sweden it is plausible that the proportion of females in the classroom could reflect unobserved heterogeneity in this grade and that this could drive the association. If so, we could expect to not find this association in 9th graders.

The results are presented in Figures 2a and 2b. When looking at the variable proportion of females in the classroom we do see a positive association in both 9th and 11th graders, separately. However, the CI for 9th graders covers zero so we cannot rule out the possibility that the proportion of females in the classroom, at least to some extent, is reflective of other aggregate variables.

Discussion

This study set out to disentangle individual and school-class-level associations with cannabis use in Swedish youth. Most individual-level variables were associated with cannabis use net of other individual-level variables and aggregate school-class factors, and the direction of the associations were generally as expected. Being male, having parents approving of tobacco use, an early substance use debut, parental ignorance about their children's whereabouts on Friday and Saturday nights, truancy and dissatisfaction with school were all independently and directly associated with lifetime use and cannabis use more than 10 times. Risk perceptions had a strong association with the outcomes. Low risk perceptions increased the odds with a factor of 4.7 for lifetime use and 5.2 for use 10+ times, but the odds ratios for several other variables were also notable. The odds ratios for the indicators of an early substance use debut were around three throughout the models. These findings corroborate prior research pinpointing the importance of various individual-level factors in driving substance use (see, e.g., Hawkins, Catalano, & Miller, 1992; Sloboda et al., 2012; Swadi, 1999).

The null models suggested notable variability in prevalence levels across classrooms, as measured by the median odds ratio (MOR). We found significant associations between the proportions having an early substance use debut, low risk perceptions and playing truant, and both cannabis use outcomes at the school-class level. For example, an increase of 10 percentage points in the share holding low risk perceptions in the classroom increased the odds of cannabis use by about 30% for both lifetime and 10+ times use, adjusted for other school-class factors. However, there was still a substantial MOR for both outcomes in the adjusted models. Thus, there is residual variance across classrooms that the included predictors did not account for. Future research should consider exploring other school-class-level covariates that may account for this variability. West,

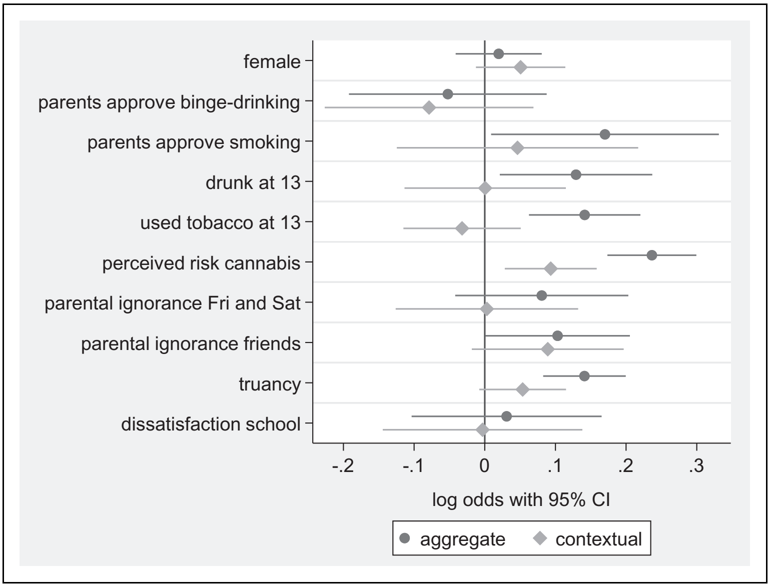

Figure 2a. Aggregate and contextual associations with lifetime prevalence of cannabis use – 9th grade.

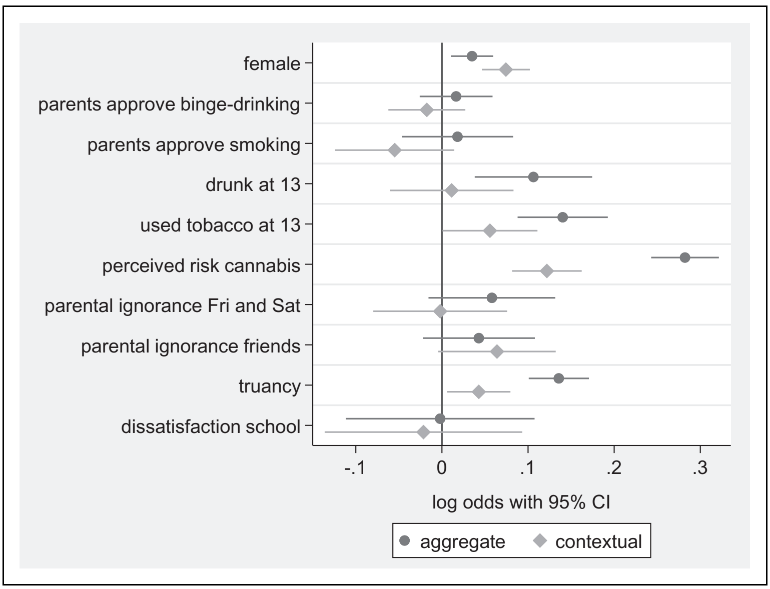

Figure 2b. Aggregate and contextual associations with lifetime prevalence of cannabis use – 11th grade.

Sweeting, and Leyland (2004), though focusing on variability across schools, found some evidence that the "ethos" of the school is related to use of some substances, and it has been argued that "school ethos" may be an important target for drug prevention efforts (Fletcher, Bonell, & Hargreaves, 2008). This factor is worth looking into further.

Results from the second set of analyses (contextual models) showed that higher proportions of students in the school class holding low risk perceptions and engaging in truancy correlated consistently with lifetime and 10+ times use, net of individual-level covariates and other contextual variables. This suggests that "moving" to a classroom with higher proportions of such characteristics increases the risk of cannabis use, also in those individuals who themselves already hold low risk perceptions and are truants; the school-class "atmosphere" pertaining to risk perceptions and truancy may thus more or less independently of other factors be related to cannabis use in Swedish youth. Keyes et al. (2011) similarly found that the aggregated level of disapproval of marijuana use in birth cohorts of US students predicted marijuana consumption net of individual-level variables. The "collective" level of risk perceptions in the classroom may perhaps promote cannabis use by providing a more lenient atmosphere towards consumption (cf. Thrash & Warner, 2016). Truancy also appears to have these properties in youth cannabis use in Sweden. It is plausible that a school-class culture of truancy may promote cannabis use through mechanisms of school disconnectedness. Henry et al. (2009) report similar findings for indicators of school attachment, where school environments characterised by higher levels of school attachment among students were found to mitigate drinking.

While the study is exploratory, our analyses indicate that the school class is an important arena to focus upon in order to gain insights into social influences on youth substance use. Compared to peer context research, this approach should be somewhat less sensitive to the selection problem observed in research on peer influences on youth substance use (Bauman & Ennett, 1996); students have more leeway in choosing whom to be friends with than whom to attend the same class with. While youth can avoid "friends" they do not want to associate with during leisure time, they simply cannot avoid exposure to other students. It has been suggested that the influence of "imposed" peers is stronger than that of selected peers, and that there may be an underlying contagion mechanism driving the "imposed" peer influence (see Araos et al., 2014). Hale et al. (2014) discuss this point along similar lines, arguing that there is a crucial element of "social mimicry" involved when youth take up risky behaviours. As they note, a few individuals displaying a certain behaviour in school may lead to other students adopting such behaviour in order to become socially accepted. These influence processes, however, are likely to be complex. For example, research indicates that the type of friendship relationship (e.g., mutual) appears to matter regarding the extent of peer influence (Fujimoto & Valente, 2012). The influence of a cannabis-using student's behaviour on other students is probably also related to the person's popularity in the school-class network (cf. Vogel et al., 2015). These aspects should be crucial to address further in future research in order to understand the link between school-class factors and youth cannabis use.

An unexpected finding from the multilevel models on contextual associations was the positive relationship between the proportion of females in the classroom and lifetime cannabis use. Araos et al. (2014), also focusing on school classes, report a similar association for past-year use of marijuana, although this was not a variable of primary interest. In our as well as their study, this association remained despite extensive controls at both the individual and school-class level. However, even though the primary analyses cannot rule out that the gender composition of the classrooms may affect cannabis use, we believe that this finding should be treated with caution. The grade-stratified analyses showed that the association was only significant for upper secondary school students. It seems plausible that the gender composition of the classes in upper secondary school may be a "stand in" for unmeasured characteristics of the classrooms (e.g., stress, psychological ill-health, school performance anxiety). Future research should explore this further.

The results of this study should be considered in light of some limitations. The data consist of repeated cross-sectional surveys and therefore we cannot make causal inferences. We may have missed to control for potentially important confounders and the associations identified may be due to reverse causation. For example, lower risk perceptions and higher levels of truancy may also be affected by cannabis use, or the associations could be due to confounding. However, regarding confounding, the included contextual variables should "pick up" at least some unmeasured influences operating at the contextual level. For example, an early substance-use debut is a known risk factor for worse outcomes (Sloboda et al., 2012) and the early substance-use indicators included here probably proxy for norm-breaking behaviour to some extent.

Given the relative lack of prior studies addressing potential classroom correlates of youth cannabis use, the study is exploratory and the findings should thus be treated as such. Still, we included well-known and theoretically reasonable predictors and the associations were with some notable exceptions in the expected directions. There is also a risk that we have over-controlled for some factors and thus underestimated the importance of classroom environment factors. Aveyard, Markham, and Cheng (2004) point to problems with controlling for characteristics in students that could have been affected by the school if the former serve as mediators for the association between the latter and the outcomes. Another potential problem with a large study of this kind is that trivial associations may stand out as statistically significant. However, by judging from the odds ratios the associations were in many cases notable.

To conclude, this large-scale Swedish study suggests that there may be contextual influences on youth cannabis use that operate at the school-class level. The overall level of risk perceptions and truancy in the school class appears important. If these findings are replicated, there may be reason for preventive initiatives to target those contextual correlates that appear to have the strongest association with cannabis use in youth (e.g., truancy). The perplexing results for gender in this study – negative association between being female and cannabis use at the individual level but positive association at the aggregate level – deserve more attention.

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Appendix: Multilevel models

This appendix gives a more detailed presentation of the modelling strategy used. Multilevel studies often include higher-level measures that consist of aggregated individual-level variables to assess higher-level associations, and the current study is no exception. Because the main impetus was to explore relationships at two levels as accurately as possible, we needed to break down the predictors into their school-class and individual-level parts. This was done by including the school-class-level means of the predictors in addition to their individual-level parts (Enders & Tofighi, 2007). Importantly, the kind of estimates that are obtained from such aggregated variables in multilevel analyses are affected by how their individual-level counterparts are treated. Models including cluster-centred variables in addition to the cluster means (e.g., school class) are in some literature known as "hybrid models", whereas models instead including the raw individual-level variables are referred to as "correlated random effects models" (Schunck, 2013). Different research questions require different centring approaches (Enders & Tofighi, 2007; Hoffman & Gavin, 1998).

In the first analysis – corresponding to the first aim of the study – we estimated the separate within and between-group associations, i.e., we ran a hybrid model. Individual-level variables were centred about the cluster mean $(X_{ij} - \bar{X}_j)$ and were, together with the (rescaled) cluster means $\bar{X}_j$, included in these models. Using a single predictor case for the ease of presentation, the fixed part of the model amounts to the following specification (logit):

$$\ln\left(\frac{p}{1-p}\right) = a + b_1(X_{ij} - \bar{X}_j) + b_2\bar{X}_j$$

Exponentiating the coefficients gives the odds ratios, and these are the association measures that are presented for the first set of analyses (Table 2). In this model the level 1 predictors represent the within-classroom associations and the level 2 predictors represent the between-classroom associations (Rabe-Hesketh & Skrondal, 2008). Positive individual-level scores on a given predictor in these models imply a higher score than the school-class specific average, and negative scores conversely indicate a lower score. The individual-level scores are thus relative to the scores of the students in the same school class, and the variable so centred entails no between-cluster variation (Enders & Tofighi, 2007).

To estimate contextual effects – the second aim of the article – we instead included the raw (i.e., not cluster mean centred) level 1 predictors together with the (rescaled) cluster means, i.e., a correlated random effects model. Using a single predictor case also here, the fixed part of the regression model becomes:

$$\ln\left(\frac{p}{1-p}\right) = a + b_1X_{ij} + b_2\bar{X}_j$$

The b_2 coefficient captures the potential "incremental" prediction of cluster-level variables, over and above what may be predicted from the individual level measures (Hoffman & Gavin, 1998; Snijders & Bosker, 2012). This is in line with standard definitions of contextual effects (Blalock, 1984). A significant coefficient for the school-class level variables in these models suggests the presence of a contextual association. The estimates for the individual-level variables are the same in both sets of models used in the article.

Variance measures

A common measure of variability in multilevel modelling is the intraclass correlation (ICC). The ICC measures the amount of variance in the dependent variable that is attributable to the higher level, i.e., the variance at the higher level is divided by the total variance. However, compared to the linear case, there is no equivalent to the ICC for multilevel logit models, although different alternatives exist. One version, which is presented in the results section, is based on a latent variable view of the logistic model in which the variance σ^2 of the error term is assumed to be $(\pi^2/3) \approx 3.29$ and where the ICC becomes:

$$\frac{\sigma^2_{level2}}{\sigma^2_{level2} + 3.29} \text{ (Rabe-Hesketh \& Skrondal, 2008)}$$

Besides computing this ICC measure, we also calculated the median odds ratio (MOR) (Merlo et al., 2006). The MOR can be interpreted as the median odds ratio for the distribution of all odds ratios that could be calculated for pairs of respondents with similar covariate values but from different clusters (Merlo et al., 2006). It can be seen as a measure of the increase in the odds for the outcome if moving from a cluster with a lower odds to a cluster with a higher odds (Merlo et al., 2006). The MOR can be calculated by plugging in the estimate for the level 2 variance into the following formula:

$$\exp(\sqrt{2 * \sigma^2_{level2}} * \Phi^{-1}(0.75))$$
$$\text{(Rabe-Hesketh \& Skrondal, 2008, p. 257)}$$

where $\Phi^{-1}(0.75)$ refers to the 75th percentile of the inverse standard normal cumulative distribution function, corresponding to a value of 0.675 (Merlo et al., 2006).