School-Level Substance Use: Effects on Early Adolescents' Alcohol, Tobacco, and Marijuana Use*

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ABSTRACT. Objective: School-level use of tobacco and alcohol are related to individual students' use in high school, but few studies have examined the effects of school-level substance use in early adolescence. In addition, little is known about factors modifying individuals' vulnerability to school-level influences. This study examined school-wide levels of alcohol, cigarette, and marijuana use in relation to early adolescents' substance use and the role of peer deviance and parenting practices as modifiers of school-level effects. **Method:** This cross-sectional study included 542 students attending 49 public middle schools in a single metropolitan area. Students reported on their use of alcohol, cigarettes, and marijuana, and friends' deviant behavior in the last 12 months. Parents provided information about parental nurturance and harsh and inconsistent discipline. School-wide levels of substance use were obtained from the Pride Surveys completed by all students in Grades 6-8 at each school. Multilevel logistic regressions modeled individual use as a function of school-level use for each substance. Interactions of friends' deviance and poor parenting with school-level substance use evaluated differential susceptibility. **Results:** Among the three substances, only school-level rates of cigarette smoking were associated with individual smoking. The relationships of school-level smoking and alcohol use with individual use were stronger for students whose parents reported poorer parenting practices. **Conclusions:** Antismoking programs may need to preferentially target middle schools with high rates of cigarette smoking. Students who receive suboptimal parenting may benefit from increased support to deter them from early initiation of smoking and alcohol use, especially in high-risk schools. (*J. Stud. Alcohol Drugs, 71,* 488-495, 2010)

EARLY INITIATION OF SUBSTANCE USE increases the risk of future substance use disorders and other negative outcomes (e.g., lower educational achievement, early onset sexual behavior). Even among adolescents with no history of conduct problems, initiation of alcohol or polysubstance use before age 15 more than doubles the risk of substance use dependence and criminal convictions in adulthood, acquisition of herpes infection, and early pregnancy in females (Odgers et al., 2008). Likewise, earlier onset of smoking is associated with a greater likelihood and severity of nicotine addiction and difficulties quitting (Breslau and Peterson, 1996), and earlier cannabis initiation increases the risk of later cannabis abuse and dependence (Behrendt et al., 2009).

According to ecological theories of human development (Bronfenbrenner, 1999), adolescent behavior, including substance use, is affected by proximal social contexts such as peers and family, as well as more distal settings such as schools and neighborhoods. Moreover, these contexts do not affect behavior independently of each other but, rather, interact to produce unique effects based on specific combinations of influences in each setting. A large body of literature examines environmental risk factors for early initiation of substance use, focusing primarily on the roles of proximal influences of parents and peers (Beal et al., 2001; Best et al., 2005; Johnson et al., 2002; O'Donnell et al., 2008). In contrast, less is known about the effects of more distal contexts, such as schools and neighborhoods, and interactions between proximal and distal settings. In this study, we examine school-wide use of alcohol, tobacco, and marijuana in relation to early adolescents' use of these substances, and whether these relationships vary across degrees of two proximal risk factors: poor parenting practices and deviant peer affiliations.

Several studies suggest that schools vary widely in their levels of alcohol (Rehm et al., 2005), tobacco (Aveyard et al., 2004), and marijuana use (Ennett et al., 1997). In turn, school levels of substance use are related to neighborhood sociodemographic factors (Botticello, 2009; Ennett et al., 1997), as well as school policies and climate (Aveyard et al., 2004; Bisset et al., 2007; Fletcher et al., 2008; Moore et al., 2001). Importantly, school-level substance use is associated with individual students' rates and level of use. Among high school students (ages 14-18), school-level frequency of alcohol intoxication predicted individual heavy drinking (Botticello, 2009), and higher smoking rates among high school seniors were associated with more frequent smoking among junior students (Leatherdale et al., 2005). In addition, school-level rates of marijuana use were associated with in-

dividual use among Australian high school students (Coffey et al., 2000), and an aggregated school measure of perceived availability of marijuana was related to greater individual use of this substance (Swaim, 2003). Less research has been conducted on school-level substance use in elementary and middle schools, but existing studies yielded results that parallel those obtained with older populations. Specifically, smoking rates among eighth-grade students were linked with higher odds of smoking initiation in younger (sixth- and seventh-grade) peers (Leatherdale and Manske, 2005), and teachers' reports of students coming to school intoxicated by marijuana or using marijuana at school were associated with eighth and ninth graders' own marijuana use in Switzerland (Kuntsche and Jordan, 2006). School-level substance use may lead to individual students' use through multiple mechanisms, including greater acceptability or status of substance use, availability of substances, and modeling of substance-use behaviors (Hawkins et al., 1992).

Moreover, existing literature indicates that individual susceptibility to these negative school influences on substance use may vary across levels of proximal risk factors. In one study, smoking among high school seniors was more strongly related to smoking in junior students who had fewer versus more close friends who smoked (Leatherdale et al., 2005). In contrast, the presence of cannabis-intoxicated students at school was more strongly associated with individual marijuana use for students who reported having many versus few marijuana-using friends (Kuntsche and Jordan, 2006). It is possible that widespread substance use at school makes such use appear more acceptable and normative and, perhaps, makes it appear especially attractive for students with low levels of exposure from family and friends (as for smoking in the Leatherdale et al., 2005, study) or amplifies negative peer influences among those with substance-using friends (as for marijuana use in Kuntsche and Jordan, 2006). Clearly, replication of these findings and further research clarifying these results is needed.

Thus, existing literature supports the importance of school-level substance use as a broader social risk factor for adolescents' alcohol, cigarette, and marijuana use, with the negative effects modified by low- or high-risk peer and parental contexts. However, few studies have examined these issues in early adolescence, when initiation of substance use has the most detrimental long-term effects. In addition, little research has compared school-level effects across multiple substances. Finally, peer and parental risks in these studies have been defined very narrowly as parents' or peers' use of the given substance, despite the importance of more general peer and parental risk factors for substance use among adolescents, such as peer deviance or parenting practices (Best et al., 2005; O'Donnell et al., 2008). This study addressed these gaps in research by examining school-wide levels of alcohol, cigarette, and marijuana use in relation to early adolescents' use of these substances and by exploring the role of peer deviance and parenting practices as modifiers of these relationships. Consistent with the ecological theory of human development and previous literature, we expected that school-wide rates of alcohol, cigarette, and marijuana use would be associated with individual use of these substances among middle school students. We also hypothesized that these associations will be moderated by peer deviance and parenting, but given mixed evidence from previous research, no specific predictions about the moderated relationships were made.

Method

Participants and procedures

The sample included 542 middle school students who participated in Wave 2 of the Birmingham Youth Violence Study (Mrug and Windle, 2009) conducted from fall 2004 to summer 2005. Seven hundred four students were initially recruited from fifth-grade classrooms in 17 Birmingham area schools selected through a school-based probability sampling process; these students and their caregivers completed individual interviews at Wave 1. Of those, 603 families returned for Wave 2 interviews, on average 16 months later (86% retention rate). The retained sample did not differ from those lost through attrition in age and gender but included a slightly higher proportion of African Americans.

The Institutional Review Board for Human Use at the University of Alabama at Birmingham approved the study. Each adolescent provided information during individual interviews, with sensitive questions being answered privately through computer-assisted technology. During informed consent, confidentiality procedures and safeguards were explained, including the Department of Health and Human Services Federal Certificate of Confidentiality that was obtained for this study. Participants were financially compensated for their time.

Because of the high variability in the timing of Wave 2 from the initial recruitment, the students were attending sixth through eighth grade at Wave 2. Because of families moving and students transferring to different middle schools between the fifth-grade recruitment and Wave 2, adolescents were attending 53 different public schools and 9 private schools at the time of Wave 2 data collection. These schools or the appropriate school districts were contacted in 2007-2008 and asked to provide school-level substance use data from Pride Surveys collected in the same year as the Birmingham Youth Violence Study Wave 2 data. School-level data were successfully obtained for 49 (92%) of the public schools. None of the private schools participated in Pride Surveys; thus, school-level substance-use data were not available for them. Additional information on school-level poverty was gathered from school reports accessed at the Alabama State Department of Education Web site. Altogether, individ-

ual and school-level data were available for 542 (90%) of the 603 Birmingham Youth Violence Study Wave 2 participants.

Measures

Individual substance use. The use of alcohol, tobacco, and marijuana was measured with items adapted from existing national surveys (Add Health: Sieving et al., 2001; Youth Risk Behavior Survey: Brener et al., 2002). Adolescents indicated whether they smoked a whole cigarette in the past 12 months; whether they had more than a few sips of beer, wine, or distilled spirits in the past 12 months; and how often they used marijuana in the past 12 months (7-point frequency scale). All items were coded 1 for any use and 0 for no use in the last year.

School-level substance use. The Pride Surveys (www. pridesurveys.com) are completed annually in the spring by all Alabama public school students in Grades 6-12. Only aggregate data (i.e., percentages of students endorsing each item level) by grade and school were available. The questions used in the present study included: "Within the past year how often have you: smoked cigarettes; drank beer; drank wine or wine coolers; drank liquor; and smoked marijuana?" All items were rated on an 8-point scale ranging from *did not use* (1) to *every day* (8). The responses were highly positively skewed; therefore, we recoded all items into dichotomous variables indicating the percentage of students reporting any level of use within the last year (i.e., once or more). Because information on levels of any alcohol use was not available at the school level, an overall alcohol index was computed as the average of the three alcohol items (beer, wine or wine coolers, and distilled spirits; $\alpha = .89$). The final school-level use of cigarettes, alcohol, and marijuana was obtained by averaging the respective variables across all middle school grades with available data (sixth through eighth grade for 46 schools; seventh through eighth grade for 2 schools; sixth and eighth grade for 1 school).

Poor parenting. Parents provided information about three aspects of parenting: parental nurturance, harsh discipline, and inconsistent discipline. Parental nurturance was assessed with 5 items rated on a 3-point scale ranging from *almost always* (1) to *almost never* (3) ($\alpha = .65$) (Barnes and Windle, 1987). Harsh discipline (five items) and inconsistent discipline (four items) questions were rated on a 5-point scale ranging from *never* (1) to *always* (5) ($\alpha = .61$ and .59) (Ge et al., 1994). Because we were interested in overall parenting quality, the three scales were combined into a single index of poor parenting. All three scales were recoded so that higher scores indicated poorer parenting, were converted to *z* scores, and were averaged.

Peer deviancy. Adolescents answered six questions about the deviant behavior of their friends (Institute of Behavioral Science, 1987). They first specified how many close friends they had, and then indicated how many of these friends en- gaged in specific delinquent and substance-using behaviors. The proportions of close friends engaging in each of the six behaviors were averaged ($\alpha = .74$)

Individual and school-level covariates. The child's age in years, gender, racial/ethnic minority status, and family socioeconomic status were included as individual-level co- variates. Family socioeconomic status was computed from parent-reported family income (rated on a 13-point ordinal scale) and primary caregiver's education (rated on an 8-point scale). The two items were converted to *z* scores and aver- aged ($r = .52$, $p < .001$). School-level covariates included the proportion of racial/ethnic minority students at each school and school poverty, measured as a percentage of students eligible for free or reduced-price lunch.

Statistical analysis

Descriptive statistics were computed at both the individual and school level. Direct and moderating effects of school- level substance use on individual substance use were tested with hierarchical multilevel logistic regression models with individuals (at Level 1) nested within schools (at Level 2). All analyses were conducted in Mplus 5.2 (Muthén and Muthén 1998, 2008) separately for alcohol, cigarettes, and marijuana. The first step included school-level use of the pre- dicted substance (alcohol, cigarettes, or marijuana), as well as individual-level covariates (adolescent's age, gender, racial/ ethnic minority status, and family socioeconomic status) and school-level covariates (poverty and proportion of racial/ ethnic minorities). The two proximal risk factors—poor par- enting and friends' deviancy—were added at the second step. The third step included interactions between school-level substance use and the two proximal risk factors. In these last analyses, parenting and peer deviancy were centered at the mean for each school to reduce multicollinearity. In contrast to grand-mean centering, which analyzes the deviations from the overall sample mean, group-mean centering considers the levels of peer deviance and parenting in relation to the mean for each school. This group-mean approach is more appro- priate in situations where the meaning of the variables (par- enting, peer deviance) is determined primarily by proximal rather than distant norms, as it is here. For instance, a peer deviance score of 0.3 is likely to have a stronger negative effect on students' behavior in schools with average levels of peer deviance of 0.1 than those with average levels of 0.7. Using the overall mean (as in grand-mean centering) assumes that the meaning of peer deviance of 0.3 is the same regard- less of the individual school's level of peer deviance. The results using group-mean centering thus reflect the effects of deviations from local norms rather than deviations from the norm of a more distal referent group. Significant interactions were probed by computations of simple slopes for school- level substance use at low versus high levels of peer deviance or poor parenting (1 *SD* below or above the mean).

TABLE 1. Individual and school level characteristics

Individual level (*n* = 542)	*n* (%)	
Male	278 (51%)	
African American	423 (78%)	
White	111 (21%)	
Used alcohol in last 12 months	127 (23%)	
Smoked cigarettes in last 12 months	30 (6%)	
Used marijuana in last 12 months	18 (3%)	
Age, *M* (*SD*)	13.2 (0.9)	
School level (*n* = 49)	*M* (*SD*)	Range
Percentage of racial minorities	65% (36)	9-100%
Percentage of students eligible for free or reduced lunch	58% (29)	6-95%
Percentage of students who drank beer in last 12 months	22% (6)	1-36%
Percentage of students who drank wine in last 12 months	26% (9)	1-39%
Percentage of students who drank liquor in last 12 months	16% (6)	2-36%
Mean of beer, wine, and liquor percentages	21% (6)	1-33%
Percentage of students who smoked cigarettes in last 12 months	16% (6)	2-35%
Percentage of students who used marijuana in last 12 months	12% (7)	0-38%
No. of students providing data	369 (262)	25-1,083
No. of BYVS (individual level) students at each school	11 (12)	1-46
Percentage of BYVS (individual level) students at each school	4% (5)	.001-14%

Note: BYVS = Birmingham Youth Violence Study.

Results

Individual and school-level descriptives

Descriptive statistics for each level are listed in Table 1. The sample was primarily African American and evenly distributed by gender. Median family income was U.S. $25,000-$30,000 (range: <$5,000 to >$90,000); median parental education was some college but no degree (range: less than ninth grade to graduate or professional degree). Included schools were heterogeneous in socioeconomic status and proportion of racial/ethnic minorities, as well as school-level substance use. At both individual and school levels, alcohol was the most commonly used substance, followed by cigarettes and marijuana. At the individual level, 23% of adolescents reported drinking alcohol, 6% reported smoking cigarettes, and 3% stated that they used marijuana. At the school level, 1% to 39% of students across the 49 schools reported drinking wine (the most commonly used alcoholic beverage in this study), with the average school rate of wine drinking being 26%. The average rate of cigarette smoking across the schools was 16%, and for marijuana use it was 12%, but the school rates of substance use varied widely across the schools (e.g., 0%-38% for marijuana use).

School poverty was strongly related to the percentage of racial/ethnic minority students (r = .87, p < .001). Schools that had higher levels of poverty and more racial/ethnic minorities had greater proportions of students endorsing the use of alcohol (r = .44-.51, p < .001) and marijuana (r = .53-.56, p < .001) but not cigarettes (r = .09-.19, N.S.). The intraclass correlation coefficient (ICC) was computed for all individual-level variables of interest to indicate the

TABLE 2. Multilevel logistic regressions modeling individual substance use in last 12 months

Variable	Alcohol use		Cigarette use		Marijuana use	
	b (*SE*)	*p*	*b* (*SE*)	*p*	*b* (*SE*)	*p*
Step 1						
Age	**0.28 (0.11)**	**.011**	**1.01 (0.25)**	**.000**	0.26 (0.31)	.398
Female gender	0.23 (0.28)	.404	-0.06 (0.47)	.907	-0.27 (0.44)	.545
Racial/ethnic minority	0.44 (0.29)	.132	-0.48 (0.65)	.467	**23.71 (4.30)**	**.000**
Family SES	**-0.21 (0.10)**	**.041**	-0.45 (0.32)	.162	-0.41 (0.38)	.283
School level substance use	-0.02 (1.84)	.992	**8.49 (3.28)**	**.010**	-5.54 (6.79)	.415
School level poverty	-1.07 (1.11)	.335	-0.94 (1.96)	.632	1.43 (2.56)	.577
School level minorities	0.57 (0.79)	.469	0.51 (1.15)	.661	1.49 (2.21)	.499
Step 2						
Deviant friends	**4.71 (0.72)**	**.000**	**5.55 (0.79)**	**.000**	**7.04 (1.24)**	**.000**
Poor parenting	0.10 (0.14)	.502	0.33 (0.22)	.135	0.18 (0.37)	.624
Step 3						
School Use × Friends	-20.21 (12.85)	.116	-11.36 (18.60)	.541	15.75 (25.54)	.537
School Use × Parenting	**6.76 (2.70)**	**.012**	**8.17 (3.05)**	**.007**	2.56 (16.11)	.872

Note: Statistically significant effects are printed in **boldface.**
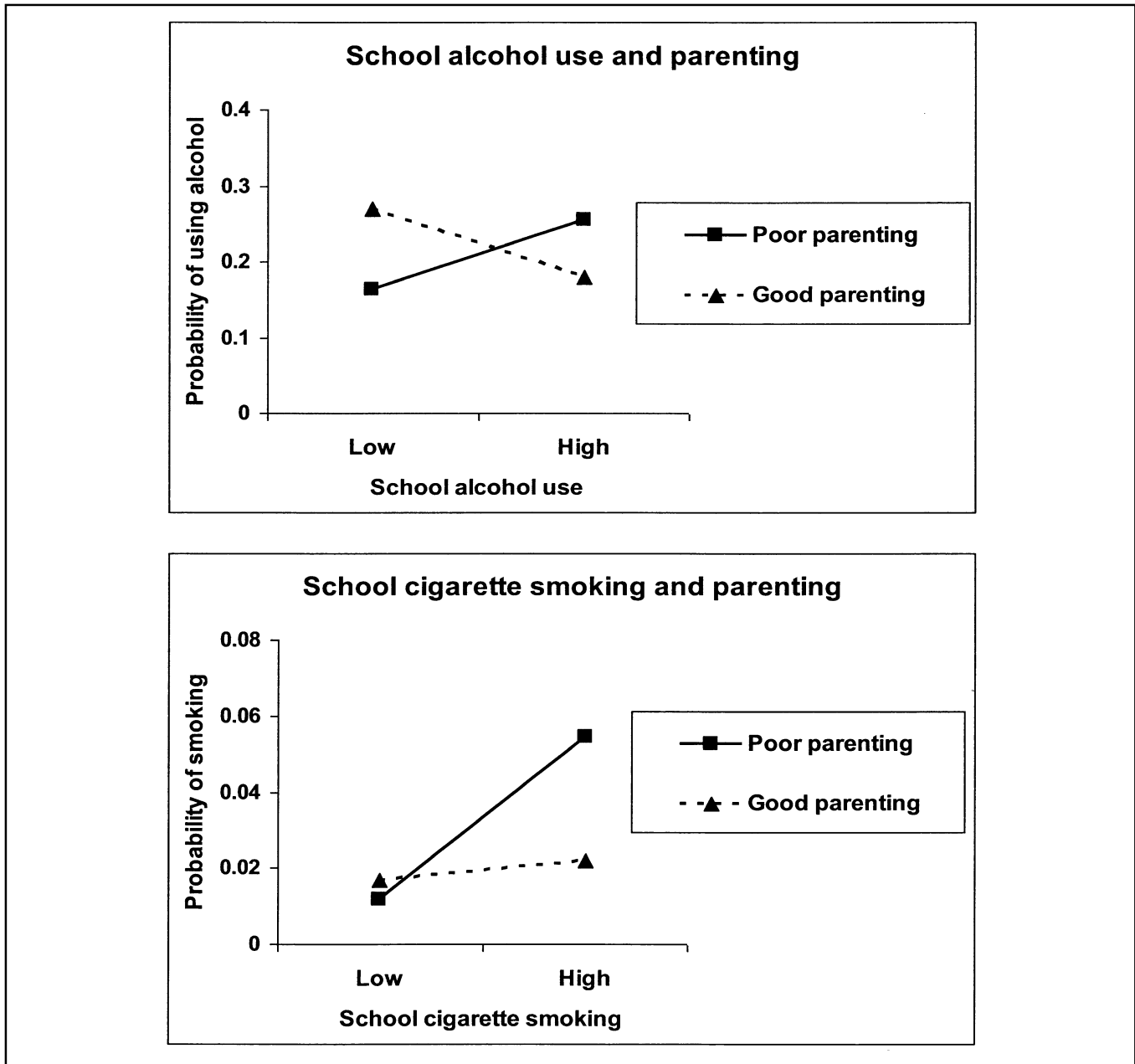
FIGURE 1.	Parenting moderates the effects of school-level alcohol and cigarette use on individual use of these substances

amount of total variance that resulted from variation between schools. For individual substance use, the ICC was greatest for marijuana use (.13), compared with alcohol use (.01) and smoking (.001). Among the proximal risk factors, between-school variability was greater for friends' deviant behavior (ICC = .10) than parenting (ICC = .03).

Multilevel models

After controlling for individual and school-level demographics, school-level alcohol and marijuana use were not related to individual use of these substances. However, cigarette use at the school level was positively associated with individual students' cigarette use (see Table 2). Given average values on all covariates, a student attending a middle school where only 2% of students smoked had a probability of .01 of smoking, but this probability increased to .15 if 35% of all students smoked. When the two proximal predictors (friends' deviancy and parenting) were added, friends' deviancy was uniquely associated with the use of all three substances. School-level smoking was no longer independently related to individual smoking ($b = 8.74$, $SE = 5.14$, p

= .089), suggesting that friends' behavior partly mediated the effects of school-wide cigarette use. At the final step of the multilevel models, two interactions between parenting and school-level alcohol and cigarette use reached significance (see Figure 1). In both cases, school-level substance use was positively related to individual use only when parenting quality was poor (alcohol: $b = 5.30$, $SE = 2.80$, $p = .059$; cigarettes: $b = 14.42$, $SE = 5.49$, $p = .009$). When parents reported the use of good parenting practices, higher school-level substance use was not associated with individual use (alcohol: $b = -3.44$, $SE = 2.49$, $p = .167$; cigarettes: $b = 1.52$, $SE = 5.89$, $p = .796$).

Discussion

Consistent with previous reports (e.g., Ennett et al., 1997), school-level rates of alcohol, cigarette, and marijuana use varied widely across middle schools (from near 0 to close to 40%). Although most of the specific rates of substance use could not be directly compared with national statistics because of differing lengths of reporting periods, the average school rate of past-year marijuana use obtained in this study (12%) was identical to the national average estimated for eighth graders in 2005 by the Monitoring the Future survey (Johnston et al., 2009). Likewise, identifying alcohol as the most commonly used substance followed by cigarettes and marijuana replicated identical patterns from national surveys of middle school students, such as the Monitoring the Future survey or the Youth Risk Behavior Surveillance (Shanklin et al., 2007). Of the three substances, only school-level cigarette smoking was associated with the use of the same substance among individual students. Although this finding held after adjusting for individual and school-level demographic factors, it became only marginally significant when peer deviance was added to the model, in line with existing literature suggesting relatively greater importance of more proximal than distal peer influences (Olds et al., 2005). Consistent with the ecological theory of human development (Bronfenbrenner, 1999) and our expectations, associations between school-level and individual use of tobacco and alcohol varied across levels of proximal risk, with stronger effects evident at higher levels of proximal risk. Specifically, school-level smoking and alcohol use were associated with individual smoking and alcohol use only among students whose parents reported poorer parenting practices (less nurturance and more harsh and inconsistent discipline).

The association of school-wide cigarette use with individual smoking is consistent with the predictions from ecological theories of human development (Bronfenbrenner, 1999), confirms similar findings reported for middle school students (Leatherdale and Manske, 2005), and adds to existing literature on the influence of tobacco use in adolescents' broader social contexts. Higher smoking rates in

middle schools may facilitate individual students' smoking through increased availability of cigarettes (Forster et al., 2003), perceptions of smoking as normative and acceptable (Simons-Morton, 2002), and friendship opportunities with cigarette-smoking peers (Cleveland and Wiebe, 2003). It was surprising that similar school-level effects were not obtained for alcohol and marijuana use. The lack of findings for marijuana may be best explained by generally later onset of use and thus lower prevalence rates in middle schools, resulting in a lower frequency of marijuana use compared with cigarette smoking in this and other studies (Johnston et al., 2009). On the other hand, school-level use of alcohol was not related to individual alcohol use in our sample of middle school students, despite the greater prevalence of alcohol use than cigarette smoking (at both individual and school levels) and evidence for school-level effects on individual alcohol use in high school (Botticello, 2009). A likely explanation for this discrepancy may arise from contextual differences in alcohol versus cigarette use. Whereas young smokers may use tobacco throughout the day and on or near school premises, alcohol use is more likely to take place in the evenings and on weekends and away from school (e.g., in the students' home). Therefore, alcohol use among nonfriends may be less visible than smoking, resulting in lower perceptions of acceptability and normative use in nonusers, as well as fewer opportunities to obtain alcohol from peers who are not close friends. In comparison, friends' deviancy was positively related to the use of all three substances, confirming the importance of more proximal peer influences on all types of early adolescent substance use.

Interestingly, school-level alcohol and cigarette use was more strongly related to individual use for students whose parents reported poorer parenting practices (less nurturance, more harsh and inconsistent discipline) in relation to other parents from the same school. It is possible that these young adolescents gravitate toward more deviant peers (as supported by a positive correlation between poor parenting and friends' deviance; $r = .18$, $p < .001$) and are able to find more opportunities for such friendships in schools with higher levels of substance use (Cleveland and Wiebe, 2003). Thus, poor parenting may increase susceptibility to school-level substance use by allowing more deviant peer affiliations or through lower ability to counteract negative peer influence by nurturing, monitoring, and consistent parenting (Mrug and Windle, 2009; Simons-Morton, 2002). The one study that showed greater negative school-level effects for low-risk students defined low-risk as nonsmoking parents or friends (Leatherdale et al., 2005). It would be useful for future studies to examine the combined roles of parental substance use and parenting practices in modifying students' susceptibility to both proximal and distal peer influences on substance use.

The present results suggest a greater need to implement more intensive antismoking prevention programs in high-risk schools, such as middle schools with high rates of student

smoking. Besides implementing prevention and intervention programs, schools with high rates of smoking may successfully reduce these rates (and corresponding risks of initiation for nonsmokers) by decreasing student smoking (or at least its visibility) through strong antismoking policies and their consistent enforcement (Aveyard et al., 2004; Lipperman-Kreda et al., 2009; Maes and Lievens, 2003; Moore et al., 2001) and by creating a culture disapproving of smoking (Kumar et al., 2002). Because school-level alcohol and marijuana use did not appear to influence individual students' substance use in middle school in this study, it might be more appropriate to select the intensity of prevention programs for nonusers based on other risk factors than on overall school rates for the use of these substances. Nevertheless, intervention programs for already-using students would likely be useful in schools with high rates of use for any of these substances. In addition, student- or family-centered support may need to be provided to young adolescents who are more vulnerable to negative peer influences, such as those whose parents do not employ appropriate levels of nurturance and discipline. Clearly, it will be important for future research to replicate these findings using a longitudinal design and a wider range of school-level variables that may influence students' substance use, such as school culture, student identities and peer dynamics, poor student-teacher relationships, student disengagement, and academic pressure (Fletcher et al., 2008, 2009).

The strengths of this study include multi-informant measurement, reliable estimates of school-wide levels of substance use, and generally small overlap between students assessed at the individual versus school level. Conversely, interpretation and generalizability of the findings may be limited by the cross-sectional nature of the study, focus on a single geographic area, and inability to include other potentially important predictors, such as parental substance use. In addition, the results may not generalize to populations with different racial and cultural makeups than the one included in this study (e.g., predominantly White or Hispanic samples). Despite these limitations, this study provides intriguing results supporting the importance of the broader school context for early initiation of smoking and greater vulnerability to school influences among youths with parents who have lower parenting skills.

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