Is the Association between Neighborhood Drug Prevalence and Marijuana use Independent of Peer Drug and Alcohol Norms? Results from a Household Survey of Urban Youth

Kathryn M. Leifheit, Jenita Parekh, Pamela A. Matson,
Lawrence H. Moulton, Jonathan M. Ellen, and
Jacky M. Jennings

ABSTRACT *To inform policy debates surrounding marijuana decriminalization and add to our understanding of social and structural influences on youth drug use, we sought to determine whether there was an independent association between neighborhood drug prevalence and individual-level marijuana use after controlling for peer drug and alcohol norms. We analyzed cross-sectional data from a household survey of 563 youth aged 15–24 in Baltimore, Maryland. The study population was 88 % African-American. Using gender-stratified, weighted, multilevel logistic regression, we tested whether neighborhood drug prevalence was associated with individual-level marijuana use after controlling for peer drug and alcohol norms. Bivariate analyses identified a significant association between high neighborhood drug prevalence and marijuana use among female youth (AOR=1.76, 95 % CI=1.26, 2.47); the association was in a similar direction but not significant among male youth (AOR=1.26, 95 % CI=0.85, 1.87). In multivariable regression controlling for peer drug and alcohol norms, high neighborhood drug prevalence remained significantly associated among female youth (AOR=1.59, 95 % CI=1.12, 2.27). Among male youth, the association was attenuated toward the null (AOR=0.95, 95 % CI=0.63, 1.45). In the multivariable model, peer drug and alcohol norms were significantly associated with individual-level marijuana use among female youth (AOR=1.54, 95 % CI=1.17, 2.04) and male youth (AOR=2.59, 95 % CI=1.65, 4.07). This work suggests that individual-level marijuana use among female youth is associated with neighborhood drug prevalence independent of peer norms. This finding may have important implications as the policy landscape around marijuana use changes.*

KEYWORDS *Cannabis, Adolescent, Environment, Peer group, Social epidemiology, Cross-sectional studies, Multilevel analysis*

Leifheit, Parekh, Matson, Ellen, and Jennings are with the Center for Child & Community Health Research, Department of Pediatrics, Johns Hopkins School of Medicine, Mason F. Lord Building, Center Tower-Suite 4200, 5200 Eastern Avenue, Baltimore, MD 21224, USA; Leifheit and Moulton are with the Department of International Health, Johns Hopkins Bloomberg School of Public Health, 615N. Wolfe Street, Baltimore, MD 21205, USA; Parekh is with the Department of Population, Family, and Reproductive Health, Johns Hopkins Bloomberg School of Public Health, 615N. Wolfe Street, Baltimore, MD 21205, USA; Ellen is with the Department of Pediatrics, All Children's Hospital, Johns Hopkins University School of Medicine, 501 6th Ave S, St Petersburg, FL 33701, USA; Jennings is with the Department of Epidemiology, Johns Hopkins Bloomberg School of Public Health, 615N. Wolfe Street, Baltimore, MD 21205, USA; Jennings is with the Center for Child and Community Health Research (CCHR), Department of Pediatrics, School of Medicine, Bayview Medical Center, Johns Hopkins University, 5200 Eastern Ave, Mason F Lord Building, Center Tower Suite 4200, Baltimore, MD, USA.

Correspondence: Jacky M. Jennings, Center for Child and Community Health Research (CCHR), Department of Pediatrics, School of Medicine, Bayview Medical Center, Johns Hopkins University, 5200 Eastern Ave, Mason F Lord Building, Center Tower Suite 4200, Baltimore, MD, USA. (E-mail: jjennin1@jhmi.edu)

INTRODUCTION

Over the past decade, evidence has emerged that marijuana can negatively affect the developing adolescent brain. A recent review published in the New England Journal of Medicine cites ample evidence linking adolescent marijuana use to poor development, health, and educational outcomes later in life.[1] As the consequences of marijuana use among teenagers are becoming clearer, laws and social policy are shifting in favor of decriminalization of marijuana. These policy changes may increase the availability of marijuana within neighborhoods and galvanize community norms in favor of marijuana use.

This raises questions regarding the extent to which the neighborhood environment may be related to marijuana use. We know that peer norms surrounding use are considered by many to be the most important risk factors for drug involvement among youth, facilitating exposure opportunities for illicit substances and individual-level substance use in youth.[2–5] More recently, urban health research suggests that neighborhood environmental factors such as local exposure opportunity, physical disorder, and observational learning may work in concert, predisposing urban youth toward drug and alcohol use.[6] Moreover, research suggests that the neighborhood environment may be particularly salient for youth because they may be more geographically limited (e.g., attend neighborhood schools) as compared to adults greater than 24 years of age.[7–9] There is a paucity of research, however, regarding whether or not the association between neighborhood environments and drug use among youth operates independently of peer drug and alcohol norms. This independent association seems feasible: if a drug is readily available in a young person's neighborhood and he or she regularly sees neighbors and persons of influence buying, selling, and using drugs, one might expect barriers to personal usage to be substantially lowered, regardless of peer norms. A finding of independent association would suggest that peer-level interventions alone may be insufficient to decrease marijuana use among youth and suggest instead a need for multilevel interventions with neighborhood- and peer-level components.

The current study sought to determine whether perceived neighborhood drug prevalence (hereafter referred to as neighborhood drug prevalence) is associated with individual marijuana use among urban youth after adjusting for perceived peer drug and alcohol norms (hereafter referred to as peer drug and alcohol norms). We hypothesized that marijuana use would be independently associated with neighborhood drug prevalence, regardless of whether or not youth perceive drug and alcohol use as normal in their peer groups (Fig. 1). Further, we hypothesized that the relationship would differ by gender. Our rationale for this gender-based hypothesis is threefold. First, it is known that males are more likely than females to use marijuana.[10,11] Second, perceptions of neighborhood drug prevalence and peer norms may differ by sex, given that young males are granted more access to their neighborhoods[12] and are more likely to be offered drugs[13] relative to young females. Third, evidence suggests that males and females respond differently to peer norms and stimuli in their local environments, leading to differential associations between peer/neighborhood factors and individual-level problem behaviors.[14–17]

METHODS

Study Design, Sampling, and Data Collection

Data was collected via the Neighborhood Influences on Adolescent and Young Adult Health (NIAAH) cross-sectional household study, conducted from 2004 to 2007. The study targeted English-speaking, sexually active persons aged 15–24,
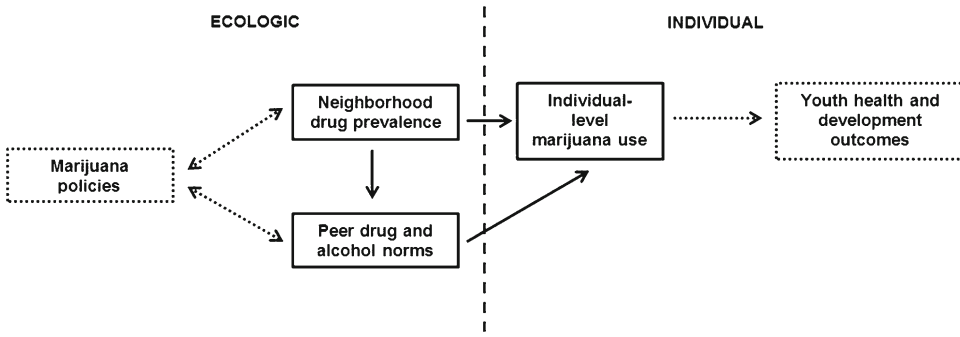
FIG. 1 Theoretical framework of the hypothesized relationships connecting neighborhood drug prevalence, peer drug and alcohol norms, and individual-level marijuana use. Relationships with marijuana policies and youth health and development outcomes are not tested in this paper and are thus indicated with *dotted lines*.

residing within one of 63 neighborhoods, i.e., census block groups, in Baltimore City, Maryland. Briefly, neighborhoods were selected through a two-stage cluster sampling design. Study design and sampling process have been described elsewhere.[18] Eligible youth who were willing to participate and provided assent and parental or guardian consent were enrolled in the study and received US$25–US$45 remuneration upon completion of their participation. Participants completed an audio computer-assisted self-interview (audio-CASI) designed to capture demographic and behavioral risk-related information. The Western Institutional Review Board for Johns Hopkins University reviewed the study for ethical and human participants concerns.

Two of the 65 census block groups initially selected were found to be comprised exclusively of retirement communities and were thus excluded from the analysis. A total of 10,173 households selected for sampling via nonlinear optimization[19] were successfully screened, and 12 % (1270) were identified as having at least one English-speaking 15–24-year old. Screenings for eligibility were attempted on one age-eligible person randomly selected from 77 % (981) of households with a completion rate of 70 % (682). Ultimately, 88 % (599) of the individuals who completed the screening went on to complete the full audio-CASI survey. Of the 599 individuals with complete survey data, six percent (*n*=36) had missing data and were excluded. This resulted in a final study population of 563 individuals.

Measures

Outcome: The outcome of interest was self-reported use of marijuana at least once in the past 90 days.

Main exposure variable: Participants in the NIAAH study responded to the following three items regarding the prevalence of drug transactions in their respective neighborhoods: (1) In your neighborhood, are there places where drug activity like people selling or buying drugs happens? (yes, no); (2) How many people in your neighborhood sell drugs? (many, some, a few, none); and (3) How many people in your neighborhood buy drugs? (many, some, a few, none). We conducted an exploratory factor analysis and found that the three items hung together well in a single factor, with good reliability (Cronbach's α=0.80). To generate a composite score, we used the resulting variable correlation matrix and factor loadings to weight observed values of the items and predict regression scores, assuming a mean

of zero and standard deviation of one.[20] Scores ranged from –2.6 to 0.9, with higher scores indicating perceptions of prevalent drug activity in one's neighborhood. When individual perceptions of neighborhood drug activity were aggregated by census block group, within-neighborhood respondent agreement had a reliability of 0.66 with a statistically significant intra-class correlation coefficient (ICC) of 0.18 ($p<0.0001$). Neighborhood drug prevalence was assessed for construct validity by conducting a correlation analyses with two measures of drug prevalence including drug arrest data from 2004 to 2007 obtained from the Baltimore City Police Department and systematic social observations of neighborhood-level drug activity obtained using NIFETY study[21] methods in every NIAAH study census block group. Neighborhood drug prevalence was positively correlated with average number of neighborhood drug arrests in deciles (odds ratio (OR) =1.16, 95 % CI=1.08, 1.16, $p<0.001$) and with observed neighborhood-level drug activity (OR=1.33, 95 % CI=1.11, 1.58, $p<0.01$).

Main Confounder: Perceived peer drug norms and perceived peer alcohol norms were combined in this analysis given evidence that marijuana use and problem drinking are both highly correlated and share patterns of psychosocial risk, particularly among youth.[22] The norms were measured based on participants' degree of agreement (Likert scale ratings: strongly agree, agree, disagree, strongly disagree) with the following four statements: (1) My friends think it is okay to use drugs everyday; (2) My friends think it is okay to use drugs at a party; (3) My friends think it is okay to get drunk everyday; and (4) My friends think it is okay to get drunk at a party. The terms hung together well in factor analysis and demonstrated good reliability (Cronbach's α=0.80). A composite score was generated via the same regression-based methods described above with respect to neighborhood drug prevalence. Peer drug and alcohol norms scores ranged from approximately –3.3 to 2.5, with higher scores indicating perceived peer approval of drug and alcohol use.

Other variables of interest: Age at time of survey, based on participants' reported date of birth, was considered a probable confounder of the exposure-outcome relationships. Drug use has been shown to increase with age and exposure to peer and neighborhood factors also likely increases with age.[23] Given past research indicating differential effects of neighborhood on problem behaviors by gender,[14–16] exposure-outcome relationships were modeled separately for males and females (participant-reported gender). Self-reported race and maternal education were used to describe the population but not treated as confounders, given a lack of direct causal association with the outcome and likely collinearity with explanatory variables.

Statistical Analysis

All statistical analyses were conducted using STATA (STATA Intercooled, version 12.1, STATA Corp. LP, College Station, TX). Inverse probability weights were used to adjust for the complex sampling strategy. An odds ratio was considered statistically significant when its 95 % confidence interval did not include 1.0.

Weighted summary statistics were calculated using STATA's survey (svy) commands across gender strata. t tests assuming unequal variance were employed to compare means of continuous variables by gender, while Pearson's χ^2 statistics were used to compare frequencies of categorical variables. This exploratory work was used to inform the generation of multilevel probability models using Generalized Linear Latent and Mixed Models (GLLAMM).[24] GLLAMM allows

the modeling of logistic outcomes, incorporating sample weights and correcting for the non-independence of this multilevel (i.e., participants nested within neighborhoods) dataset.[25] Weighted GLAMM regression was used to first test for an association between neighborhood drug prevalence and individual-level marijuana use in gender-stratified, age-adjusted models. Second, we tested for an association between peer drug and alcohol norms and individual-level use. Third, we tested whether the association between neighborhood drug prevalence and marijuana use persisted after adjusting for peer drug and alcohol norms.

RESULTS

Study participants were on average 19 years of age (Table 1). 63 % were female, 88 % African-American, and 81 % had mothers with a high school degree/GED or greater. Mean peer drug and alcohol norms and neighborhood drug prevalence values were approximately zero. Of all participants, 53 % reported ever using marijuana, 32 % reported use in the past 90 days, and 16 % reported frequent use in the past 90 days. Female participants tended to be older than males, while males were more likely to report marijuana use and perceived more permissive peer drug and alcohol norms.

Higher perceived neighborhood drug prevalence was associated with significantly increased age-adjusted odds of marijuana use among females (AOR=1.76, 95 % CI=1.26, 2.47, Table 2, model a1). The association was in the same direction for males, but was not significant (AOR=1.26, 95 % CI=0.85, 1.87). More permissive perceived peer drug and alcohol norms were associated with significantly increased age-adjusted odds of marijuana use among females (AOR=1.70, 95 % CI=1.31, 2.20, Table 2, model a2) and males (AOR=2.56, 95 % CI=1.67, 3.92).

When peer drug and alcohol norms and neighborhood drug prevalence were entered into the same model (Table 2, model b), the age-adjusted odds ratio associated with neighborhood drug prevalence was slightly attenuated in females (AOR=1.59, 95 % CI=1.12, 2.27) and highly attenuated in males (AOR=0.95, 95 % CI=0.63, 1.45). The effect estimate for peer drug and alcohol norms remained robustly significant in model b for both females (AOR=1.54, 95 % CI=1.17, 2.04) and males (AOR=2.59, 95 % CI=1.65, 4.07).

DICUSSION

We sought to determine whether neighborhood drug prevalence is independently associated with marijuana use among males and females separately, after adjusting for perceived peer drug and alcohol norms. The study population is comprised of urban, largely African-American youth, aged 15–24. The significance of whether the neighborhood environment is associated with youth drug use has increased in recent years given measures to decriminalize sales and use of recreational and medical marijuana in the USA.

Higher neighborhood drug prevalence is associated with marijuana use in our study population. This result is similar to findings regarding the association of other neighborhood-level factor variables and drug use among adolescents. A study among urban African-American 9–15-year-old girls found that neighborhood and family exposure to drug activities increased one's odds of having drug use history or intention by 56 %.[26] Similarly, a longitudinal study of 434 12th graders in Baltimore found a strong correlation between neighborhood disorder trajectory and

TABLE 1 Characteristics of a household sample of 15–24-year olds overall and by gender, Baltimore, Maryland, 2004–2007 (n=563)

	Total		Females (n=350)		Males (n=213)		p value[a]
Age	Mean	Std. error	Mean	Std. error	Mean	Std. error	
	19.1	0.16	19.5	0.16	18.4	0.24	0.002
Sex	Count	Percent	Count	Percent	Count	Percent	
Female	350	63.4					
Male	213	36.6					
Race/ethnicity							0.784
Black	485	88.1	302	88.4	183	87.7	
White	43	7.1	25	6.7	18	7.8	
Other	35	4.8	23	4.9	12	4.5	
Maternal education (n=549: 343 females, 206 males)							0.670
Less than a high school degree or GED	104	19.4	63	16.7	41	24.2	
High school degree or GED	251	45.0	154	44.8	97	45.2	
Greater than a high school degree or GED	194	35.6	126	38.5	68	30.5	
	Mean	Std. error	Mean	Std. error	Mean	Std. error	
Peer drug and alcohol norms	0.04	0.05	−0.05	0.05	0.20	0.09	0.050
Neighborhood drug prevalence	0.02	0.08	0.04	0.09	−0.01	0.10	0.931
	Count	Percent	Count	Percent	Count	Percent	
Marijuana use							
Ever use	285	52.5	165	48.0	120	60.3	0.034
Use in the past 90 days	166	32.0	87	26.9	79	40.7	0.002
Frequent (once per week or more) use in the past 90 days	90	16.4	39	11.2	51	25.2	<0.001

Unweighted counts and weighted means/standard errors/percentages presente

[a]Based on two-sided t test (unequal variance) or Pearson's χ^2 comparing male vs. female subjects

TABLE 2 Age-adjusted odds (AOR) of the association between peer drug and alcohol norms, neighborhood drug prevalence and marijuana use by gender, Baltimore, Maryland, 2004–2007 (n=563)

	Marijuana use in the past 90 days			
	Females (n=350)		Males (n=213)	
	AOR	95 % CI	AOR	95 % CI
a1. Neighborhood drug prevalence	1.76	1.26, 2.47	1.26	0.85, 1.87
a2. Peer drug and alcohol norms	1.70	1.31, 2.20	2.56	1.67, 3.92
b. Bivariate model				
Neighborhood drug prevalence	1.59	1.12, 2.27	0.95	0.63, 1.45
Peer drug and alcohol norms	1.54	1.17, 2.04	2.59	1.65, 4.07

subsequent marijuana use.[6] Psychological studies suggest that an urban adolescent's perception of neighborhood disorder is key in predicting marijuana use.[16] Neighborhood of residence and neighborhood disadvantage have also been linked to "exposure opportunity" for drugs, alcohol,[2,27] and problem behaviors.[14]

Our finding of a stronger association between neighborhood drug prevalence and marijuana use among females than males may support the idea that young females are more susceptible to features of their neighborhood environments than young males. A study of over 500 African-American adolescents found that, relative to their male counterparts, females perceive less control over their neighborhoods and find their substance use beliefs and behaviors more highly influenced by neighborhood disorganization and local drug activity.[16] Alternately, the nonsignificant finding among males could represent a type II error. A post hoc power analysis for this regression indicated a power of 0.26, suggesting that the study was underpowered to detect a significant effect of neighborhood drug prevalence on marijuana use among males.

We found more permissive peer drug and alcohol norms to be significantly associated with marijuana use among both females and males after adjusting for age. These findings are similar to those from a longitudinal study in which affiliation with tobacco and alcohol-using peers early in adolescence was found to significantly predict individual-level initiation of marijuana use later in adolescence.[28] A study of New Jersey middle school students also found that having drug-using peers was nearly five times more predictive of individual drug use than drug use in one's neighborhood.[29]

For both males and females, but particularly among males, the effect of neighborhood was attenuated toward the null when peer drug and alcohol norms were added to the model. Relatedly, a study of nearly 4000 New York adults by Ahern and colleagues found that the association between neighborhood drinking norms and individual-level drinking was not robust to adjustment for the drinking norms of family and friends.[17] These findings suggest that neighborhood drug prevalence effects may operate in part through peer drug and alcohol norms, especially among male youth. If peer norms act as mediators of neighborhood effects, this would lead to underestimates of the direct effect of neighborhood on individual substance use.[30] While this study is the first to our knowledge to measure peer drug and alcohol norms and neighborhood drug prevalence simultaneously, similar frameworks and findings echo these results. For example, normative problem behaviors within one's peer group have been shown to mediate the influence of neighborhood-level single-parent family prevalence on female adolescent conduct problems.[31] Another analysis of a large sample of US adolescents by Chuang et al. found that neighborhood influences on cigarette and alcohol use are mediated by peer behaviors.[32] These findings remind us that though neighborhood factors indeed appear to influence individual-level problem behaviors, a young person's peers continue to be powerful agents that can either mitigate or amplify neighborhood-level risk.

Our study has a number of limitations. The cross-sectional design and analytic methods cannot rule out a "clustering of risk" or Problem Behavior Theory argument, i.e., that environmental and individual psychosocial risk factors cluster with problem behaviors like marijuana use in populations of youth.[33,34] Another limitation is that of dependency of measurement error, given that exposures and outcomes are measured via the same data source (i.e., one survey questionnaire). Future studies could overcome this limitation by assessing individual marijuana use with a validated biomarker or utilize a non-survey-based measure for neighborhood drug use. Additionally, perceived norms may be influenced by an individual's own marijuana use, given that drug-using youth may have social networks that overlap with drug markets.[35] Moreover, youth are likely to project their own behaviors onto

peers.[36,37] This biased reporting could potentially inflate associations between individual and group-level substance use.[37] Lastly, survey was conducted in 2004–2007 and may not necessarily reflect current trends. Despite these limitations, we feel that this analysis fills an important gap in the literature to characterize relationships between neighborhood drug prevalence, peer drug norms, and individual-level marijuana use among youth in an urban setting.

Our findings suggest that neighborhood drug prevalence, independent of peer drug norms, is associated with marijuana use among urban youth. The framework we put forth suggests that a young person is far more likely to use marijuana if he or she lives in a neighborhood with high drug prevalence and if his or her peers condone drug and alcohol use. Though not currently central to public discourse surrounding marijuana legalization, adolescent marijuana use and the health and developmental consequences thereof is of major concern to the pediatrics community.[38] Our work highlights a need to study the effects of potential policy changes on peer drug use norms and neighborhood drug prevalence.

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