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The Effect of Neighborhood Context on the Relationship Between Substance Misuse and Weapons Aggression in Urban Adolescents Seeking ED Care

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Abstract

Background—Frameworks for studying the ecology of human behavior suggest that multiple levels of the environment influence behavior and that these levels interact. Applied to studies of weapons aggression, this suggests proximal risk factor (e.g., substance use) effects may differ across neighborhoods.

Objectives—To estimate how the association between weapons aggression and substance use varies as a function of several community-level variables.

Methods—Individual-level measures (demographics, behavioral measures) were obtained from a survey of youth aged 14–24 years old seeking care at a Level-1 ED in Flint, Michigan. Community-level variables were obtained from public sources. Logistic generalized additive models were used to test whether community-level variables (crime rates, alcohol outlets, demographics) modify the link between individual-level substance use variables and the primary outcome measure: self-reported past 6-month weapon (firearm/knife) related aggression.

Results—The effect of marijuana misuse on weapons aggression varied significantly as a function of five community-level variables: racial composition, vacant housing rates, female

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Declaration of Interest

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headed household rates, density of package alcohol outlets, and nearby drug crime rates. The effect of high-risk alcohol use did not depend on any of the eight community variables tested.

Conclusions—The relationship between marijuana misuse and weapons aggression differed across neighborhoods with generally less association in more disadvantaged neighborhoods, while high-risk alcohol use showed a consistently high association with weapons aggression that did not vary across neighborhoods. The results aid in understanding the contributions of alcohol and marijuana use to the etiology of weapon-related aggression among urban youth, but further study in the general population is required.

Keywords

violence; spatial; marijuana; alcohol

INTRODUCTION

Weapon related violence is a significant public health problem in the United States. Homicide is the leading cause of death among African American youth (Anderson, Kochanek, & Murphy, 1997; CDC, 2005) and the second leading cause of death among Caucasian youth (CDC, 2005). Among individuals aged 15–24, U.S. firearm related homicide rates are 42.7 times higher than among similarly aged youth in 22 other developed nations (Richardson & Hemenway, 2011). The cost of firearm related violence is high, with estimated lifetime medical costs per firearm injury of $17,000 and a total of $2.3 billion for all US firearm related injuries (Cook, Lawrence, & Ludwig, 1999). After inclusion of on-going medical costs, long-term disability, and psychological care, firearm related injury costs are estimated to be as high as $100 billion annually (Cook & Ludwig, 2000).

Substance Use and Violence

The link between individual substance misuse and youth violence has been well established. In particular, alcohol use has been identified as an important risk factor for youth violence, aggression, and weapon related behaviors (Borowsky, Ireland, & Resnick, 2002; Carter et al., 2013; Chermack & Blow, 2002; Chermack, Wryobeck, Walton, & Blow, 2006; Ellickson, Tucker, & Klein, 2003; Loh et al., 2010; Rivara et al., 1997; Swahn & Donovan, 2004; Walton et al., 2009) and marijuana use has been identified as an important correlate of youth firearm possession, carriage and future violent perpetration (Dawkins, 1997; Friedman, Glassman, & Terras, 2001; Loh et al., 2010; Steinman & Zimmerman, 2003; Sussman, Simon, Dent, Steinberg, & Stacy, 1999; van den Bree & Pick-worth, 2005; Walton et al., 2009). These associations can be explained through a combination of the substances' psychotropic effects (Bushman & Cooper, 1990; Friedman, Terras, & Glassman, 2003), the monetary commitment required to sustain regular substance use that may not be available to adolescents through nonviolent means (Friedman et al., 2001), and/or through theories on the clustering of problematic behaviors (Jessor, 1991).

While there are commonalities, there is also evidence that marijuana and alcohol use influence the propensity for violence in different and specific ways. The developing adolescent brain is more susceptible to the disinhibitory effect of alcohol (Bushman &

Cooper, 1990), which may cause individuals to become agitated and/or unable to control their violent impulses when under the influence of alcohol, particularly those predisposed to aggressive behavior (Giancola, 2002). Carter, et al. (2013) found that youth with firearms have high rates of binge drinking, alcohol use prior to fighting, and concurrent alcohol use while carrying weapons and that this combines with high rates of firearm related aggression to suggest that the impulsivity associated with alcohol may translate into subsequent weapon related violent acts. On the other hand, the pharmacological effects of marijuana, and their implications to weapon related violent behavior in youths, are less clear. Epstein-Ngo et al. (2013), for example, found that youth dating aggression was more likely to occur on days when alcohol, as opposed to marijuana, was used. In addition, youth who misuse marijuana are more likely to come into contact with violence intrinsic to the activities of illegal drug distributors and traffickers (Friedman et al., 2001; Harper, Davidson, & Hosek, 2008). Thus, the association of marijuana use and serious aggression with weapons may arise more from proximity to illegal activity than pharmacological effects.

Conceptual Framework

Influential frameworks for the ecological exploration of human behavior have emphasized how transactions between the social context and the individual combine to produce behavior (Bronfenbrenner, 1989; Sallis et al., 2008). Specifically, one core tenant of Bronfenbrenner's ecological framework is that multiple levels of the individual's environment (family, friends, community) interact to influence behavioral outcomes (Bronfenbrenner, 1989; Sallis et al., 2008). As an illustrative example, if marijuana use and violence tend to co-occur primarily because they both arise as a member of a cluster of problem behaviors (Jessor, 1991), it may be that the way behaviors cluster depends on the type of community in which the individual lives. That is, marijuana use and violence may exist on different planes of "problem behavior" in some communities but not in others. Yet, we have little empirical evidence to support this idea, making rigorous statistical analysis of the influence of environmental factors on the association between substance use and violent behaviors an important gap to be filled.

The aforementioned dynamics can be elucidated by exploring statistical interactions between community-level and individual-level variables in models of weapons aggression. For example, researchers have found that areas with higher package alcohol outlet concentration are also those with less surveillance and guardianship (Gruenewald, Freisthler, Remer, LaScala, & Treno, 2006; Lipton & Gruenewald, 2002; Lipton et al., 2013), clarifying their role as a marker of social disorganization. Thus, analyzing how package alcohol outlet concentration modulates the association between substance use and violence gives a basis for empirically establishing differences in how substance use and violence cohere in more vs. less socially organized areas. Similarly, exposure to community violence is known to affect individual-level tendencies for violence perpetration, particularly in poorly functioning families (Gorman-Smith, Henry, & Tolan, 2004). Envisioning area crime rates as an effect modifier is this setting provides a basis for elucidating whether exposure to violence—and everything it entails—defines a neighborhood context that modulates how problem behaviors (e.g., substance use and violence) cluster.

Study Overview

In the present study, we examine the relationship between substance use and violence as a function of the broader, location-specific, context in which these behaviors occur. While other researchers have examined how the relationships between substance use indicators and physical aggression differ across racial groups (Mercado-Crespo & Mbah, 2013), few have examined how these associations vary as a function of various place-based features such as community demographics, alcohol outlet density and local crime rates. We take an ecologically grounded approach and consider risk factors for violence as interconnected components, rather than as static features that are independent of each other. Specifically, we analyze a unique combination of data to understand how individual-level risk factors for violence (e.g., substance use habits) operate differently in different types of neighborhoods (e.g., those with more alcohol outlets or higher crime rates) in terms of their violence-producing potential. Further, we know of no other research that has empirically tested individual-by-community interaction effects on violent behavior using semi-parametric regression approaches that control spatial dependence (instead of, e.g., multi-level models). Our approach has the advantage of controlling for spatial dependence in greater generality than standard multi-level models and without relying upon pre-determined, and often arbitrary, discrete spatial units. Thus, our study both contributes to our understanding of contextual effects on adolescent weapon violence and demonstrates an innovative statistical approach for considering ecological effects on behavior.

METHODS

Data

Data used for this work was obtained from four sources. Individual-level measurements were obtained from a screening survey administered to high risk youth in Flint, Michigan. Community-level measurements were obtained from a combination of the 2010 Census, the Flint Police Department and the State of Michigan Alcohol Licensing Board. All study protocols were approved by the Institutional Review Boards of both Hurley Medical Center and University of Michigan. We also obtained an NIH certificate of confidentiality for all individual-level information that we also shared with respondents.

Study Design and Site—Individual-level measures were obtained from the screening survey administered as part of the Flint Youth Injury Study (FYI), a two-year longitudinal study of high risk youth. The study was conducted at Hurley Medical Center, a level-1 trauma center in Flint, Michigan. Flint poverty and crime rates are comparable to other urban centers such as Detroit, Camden, Hartford, St. Louis and Oakland (Federal Bureau of Investigation, 2006). Given the relative paucity of data on youth presenting to emergency departments with violent injuries, the FYI study was designed to oversample this demographic. The screening survey for entry into the longitudinal FYI study was administered to youth aged 14–24 years old presenting for assault related injury and a sample of youth seeking nonassault related care (balanced to have similar proportions of participants based on age and gender). The data resulting from this screening survey is what we analyze here.

Recruitment was conducted between December 2009 and September 2011, 7 days/week; 21 hours/day on Tuesday and Wednesday and 24 hours/day Thursday through Monday. Assault injured patients and their nonassault injured counterparts were identified through electronic patient logs and approached by trained research assistants in the waiting room or treatment areas. Exclusion criteria included presentation for sexual assault, child abuse, suicidal ideation or other conditions precluding consent (non-English speaking, altered mental status, unavailability of adult parent/guardian to provide consent). Unstable trauma patients that stabilized within 72 hours of their injury were also recruited in the hospital. Following written consent, patients self-administered a computerized survey and received a $1.00 gift. The survey was administered privately—family and friends were not allowed to observe or participate. A total of 849 assault injured patients and 846 nonassault injured patients were approached, with 718 (84.5%) and 730 (86.3%) providing consent, respectively; see Cunningham et al. (2014) for complete details on rates and reasons for exclusion/nonparticipation. Among the resulting 1448 screened individuals, all home addresses were successfully geocoded. Only those that reported a home address in Flint, MI were retained for this analysis, leaving us with a sample size of 878.

Individual-level Variables—The main outcome measure, weapons aggression, utilized three questions from the National Longitudinal Study of Adolescent Health (Bearman, Jones, & Udry, 1997). Respondents were asked how many times in the past 6 months they had: (1) pulled a knife on someone, (2) pulled a gun on someone, (3) shot or stabbed someone, each measured on a seven-point scale (“Never”, “Once”, “Twice”, “3–5”, “6–10”, “11–20”, “20+”). The questions and response scale were collapsed for this analysis to a single binary indicator (yes/no) of whether the individual reported committing any act of weapon related aggression in the past 6 months. This binary indicator was used for ease of interpretation and to circumvent challenges related to constructing a numeric scale from these ordinal measurements and satisfying the distributional assumptions of the subsequent statistical models.

Individual-level demographics (Age, Gender, Race, Educational Level, Living with Parents, Public Assistance) were assessed with measures from the National Longitudinal Study of Adolescent Health and NIH Drug Abuse Treatment Outcome Study of Adolescents (Bearman et al., 1997; Handelsman, Stein, & Grella, 2005). Demographic variables were collapsed to binary indicators, as appropriate, for the study population (e.g., Gender, High School Graduate). In addition, the home addresses of all individuals in the sample were geocoded and used for all subsequent spatial referencing. The resulting lat/long coordinates were converted Universe Transverse Mercator (UTM) coordinates prior to analysis. UTM coordinates give a localized 2-dimensional representation of Earth so that locations within the same UTM zone (Zone 17 for Flint, Michigan) may be non-ambiguously characterized in two dimensions and coordinates can be used directly to calculate distances between points. All subsequent mentions of spatial coordinates refer to the UTM coordinates.

Alcohol and drug use variables were assessed using the Alcohol Use Disorders Identification Test consumption questions (AUDIT-C) (Bush, Kivlahan, McDonell, Fihn, & Bradley, 1998) and the Alcohol, Smoking, and Substance Involvement Screening Test (ASSIST) (Humeniuk et al., 2008), respectively. Marijuana use and associated consequences

were captured with six ASSIST questions used to produce a score; misuse was defined as an ASSIST score ≥ 4. Both the scoring and use of the cut point of '4' were taken from NIDA recommendations on scoring and interpretation (National Institute of Drug Abuse, 2010). Use of other substances was quite sparsely endorsed in these data so all other illicit drugs (cocaine, metham-phetamine, inhalants, hallucinogens) were combined into a single indicator of whether an individual scored ≥ 4 on the ASSIST scale for any of the group, and similarly with misuse of prescription drugs (stimulants, opioids, sedatives). High-risk alcohol use was defined as an AUDIT-C score of ≥ 3 for adolescents under 18 years old and AUDIT-C score ≥ 4 for youth over 18 years old. The cut-point of 4 for adults was established by Chung et al. (Chung et al., 2000). Noting the recommendation by Fairlie et al. for a lower cut-point for adolescents (Fairlie, Sindelar, Eaton, & Spirito, 2006), the threshold is reduced from 4 to 3 for individuals under 18. This definition of high-risk alcohol use has been used in other publications using these data (e.g., Cunningham et al., 2014).

Community-level Variables

Demographics: Community-level demographics were collected from the 2010 Census. We used census block group as our unit of analysis rather than the census tract to make the information more proximal to the individual. We including the following demographic features identified by Sampson et al. (1997) as important correlates of violence: African-American (%), vacant houses (%), Female-headed households (%), and youth under 18 (%). Other important census-based measures identified by Sampson et al., such as income/wealth indicators, were unavailable in the 2010 census and thus were excluded out of necessity.

Alcohol outlets: Alcohol outlet data (alcohol license type, alcohol outlet address) were obtained from the Michigan Liquor Control Commission for Genesee County. Addresses were geocoded and converted to UTM coordinates. All alcohol outlet locations in the county were successfully geocoded. We created an alcohol outlet concentration measure by calculating the number of alcohol outlets within ¼ mile from the home address of each individual in the study. This radius was chosen to reflect "nearby" in the sense of "within easy walking distance". Within a tight urban area, larger buffer zones (e.g., 1 mile) can cross over into potentially many different types of neighborhoods, thus we opted for a smaller radius here. Concentration was calculated separately for outlets that allow (e.g., bars, restaurants) and do not allow (e.g., package stores) consumption on-premises.

Crime data: Crime data for the year 2010 was obtained from the Flint Police Department, which provided the nearest street corner of every police-involved incident. The nearest street corner was geo-located to yield UTM coordinates for each crime. Over 99% of crime locations were successfully geocoded; nongeocodable incidents were omitted. Violent (Assault Offenses, Homicide Offenses, Robbery, Sex Offenses—Forcible) and drug (Drug and Narcotic Offenses) crimes were identified using the NIBRS categorizations (Federal Bureau of Investigation, 2006) entered by the police. These data were subsequently summarized by calculating the number of each type of crime that occurred within $\frac{1}{4}$ mile of each home address in the year 2010. We counted incidents that included multiple crimes as a single incident (i.e., all incidents were counted only once for analytic purposes). For

incidents that included both drug offenses and violence we included these both in the count of drug crimes and the count of violent crimes.

Statistical Analysis

We began with a bivariate analysis, comparing individuals that have committed weapons aggression with those that have not on all study variables. To address the primary research question, we used logistic regression with modifications to (a) allow non-linear interactions between community-level variables and substance use indicators and (b) control potential spatial dependence in the data. Both of these goals are achieved by using a generalized additive model, fit using the mgcv package in R (Wood, 2006). We choose this approach rather than a traditional multi-level model primarily because it handles the potential correlations between individuals in a far more general way. Within a standard multilevel model (individuals within neighborhoods, in this case) the correlations are tightly constrained: everyone within a neighborhood is equally correlated, these intra-class correlations are the same for every neighborhood, and there are no correlations between neighborhoods (i.e., the "sphericity" correlation structure). If there is a continuous spatial trend or any "spillover" between neighborhoods, this would not be captured and the standard extensions of multi-level models (e.g., random slopes) would not alleviate these shortcomings. The approach used here continuously models the spatial trend, rather than using discrete spatial units, which can accommodate more general spatial dependence structures.

To be more precise, our analytic approach for individual *i*'s indicator of weapons aggression, Y_i was to model this behavior in terms of the corresponding *p*-length vector of individual-level variables, $X_i = \{X_{i1,}\ldots, X_{ip}\}$, the *r*-length vector of community-level variables, $Z_i = \{Z_{i1}\ Zi_r\}$, and the individual's home location, s_i. All community-level variables were allowed to have potentially non-linear effects, the need for which was apparent during preliminary analysis. The statistical model is:

$$\log\left(\frac{P(Y_i=1|X_i,Z_i,s_i)}{P(Y_i=0|X_i,Z_i,s_i)}\right)=\alpha+\sum_{j=1}^{p}X_{ij}\beta_j+\sum_{k=1}^{r}h_k(Z_{ik})+f(s_i) \quad (1)$$

The left-hand side and the first two terms on the right are familiar components of standard logistic regression models. The function *f* is a non-parametrically estimated thin-plate spline function of the spatial coordinates that is used to separately model the residual spatial trend. This approach produces residuals that are free from spatial autocorrelation, which is required for all subsequent statistical inference. The functions $h_1,\ldots,h_r$ are community-level covariate effect functions. The properties (smoothness level, shape) of the estimated functions in this model are determined by maximum likelihood as part of the fitting procedure rather than through a priori specification. Because all but one of the individual-level predictors (age) were categorical, their effects are fully parameterized by the corresponding regression coeffcients—$\beta_i,\ldots, \beta_p$—and so the more general non-linear function estimation framework described is not necessary. All covariate effects are interpreted as (log) odds ratios as they would be in an ordinary logistic regression model. Note that the odds ratios estimated by

logistic regression are valid estimates of the population (youth aged 14–24 at high risk for presenting to the ED, in this case) odds ratios even when different members of the population have different sampling probabilities, as long as the odds ratio does not depend on selection status (conditional on all other predictors in the model), which is a tenable assumption here. This is similar to how logistic regression remains a valid tool for unmatched case-control studies (Prentice & Pyke, 1979).

The main hypotheses of interest regarding context dependence are formulated statistically by adding stratification to model (1), analogous to testing an interaction effect in an ordinary logistic regression model, with the primary difference being that this approach is free from the (log) linearity constraint. That is, we test whether the odds ratio between weapons aggression and substance use (marijuana misuse; high-risk alcohol use) varies as a function of a given community-level variable. All eight community-level variables (4 block group demographics, 2 alcohol outlet, 2 crime incident) were tested, one at a time, as potential effect modifiers. The χ^2 statistics reported in Table 1 correspond to these hypothesis tests. For all tests, all community and individual-level variables were included in the model as main effects.

RESULTS

Bivariate Analysis

Of the full screening sample residing in Flint (n = 878), 137 (15.6%) report past 6 month weapons aggression. On bivariate comparison, demographic factors were not notably different between the two groups except for failure to complete high school, which was significantly higher in the group with past 6 month history of weapons aggression (Table 2). Individuals reporting weapons aggression were more likely to have initially presented to the ED with a violent injury than those who did not report weapons aggression. Participants reporting weapons aggression were noted to misuse marijuana, engage in high-risk drinking, and misuse at least one prescription drug at higher rates than participants not reporting weapons aggression. At the community-level, participants with a history of recent weapons aggression had a lower number of on-premise alcohol outlets within a $\frac{1}{4}$ mile of the home address.

Spatial Analysis

We began by fitting the model with all of the aforementioned predictors, but no interactions. Within this model, we first tested whether the spline was successful at removing any potential spatial signal. Using an exponential weighting matrix,

$$W_{ij}=\exp(-\mathrm{D_{ij}}) \quad (2)$$

where D_{ij} is the distance between the home addresses of observation i and j, in miles (for i = j, the weights were fixed at zero), we calculated the Moran's I coefficient and got I = −0.004 vs. an expected value of −0.001 (sd = 0.002), yielding a p-value of .177 in the test of spatial autocorrelation in the residuals. This result alleviates any potential concerns about contaminated statistical inference arising from correlated measurements.

Working from the full model with all variables, interactions between each of the community-level variables and the marijuana misuse and high-risk alcohol use indicators were tested (Table 1). Controlling for all other variables, marijuana misuse was associated with greater odds of weapons aggression (OR = 2.72, 95% CI: [1.75,4.22]); number of package alcohol outlets within $^1/_4$ mile, number of drug crimes within $^1/_4$ mile, percent African-American in the block group, percent Vacant Housing in the block group, percent Female Headed Households in the block group were all found to be significantly modify the size of this association (Table 1). Controlling for all other variables, high-risk drinking was associated with greater odds of weapons aggression (OR = 1.60, 95% CI: [1.01, 2.62]), but none of the eight community variables tested significantly modified this association (Table 1). The main effects of all other variables were similar to the descriptive results shown in Table 2 and so, for brevity, are not shown.

For each of the significant effects, Figure 1 shows how the odds ratio between weapons aggression and marijuana misuse changes as a function of the effect modifier. The association between marijuana misuse and weapons aggression decreases as a function of the number of drug crimes within $^1/_4$ mile,% of Female Headed Households and the number of package alcohol outlets within $^1/_4$ mile (Figure 1B – D). In other words, marijuana use is less of a risk factor for weapons aggression in areas with higher values for these variables. The association between marijuana misuse and weapons aggression appears to be maximized in areas with about 50% African Americans, with lower associations in communities with racial compositions that are farther from 50% African American (Figure 1A). Conversely, that same association is minimized in an area with a moderate percentage of vacant housing (Figure 1E).

DISCUSSION

Using a semi-parametric statistical modeling framework we conducted an ecological analysis of substance use and violent behavior among adolescents. This study was one of the first to consider a spatially varying relationship between substance use and weapons violence as a strategy for understanding ecological influences on behavior. We found evidence that alcohol and marijuana misuse correlate with weapon-related violent behavior in different ways. In particular, the role of marijuana use in the etiology of weapons aggression appears to depend on a number of different contextual factors. In areas with elevated indicators of concentrated disadvantage—more drug crimes, more female heads of household, and more liquor stores—marijuana misuse was less of a risk factor for weapons aggression. In contrast, the level of risk conferred by individual high-risk alcohol use is consistently high regardless of the community characteristics we studied. These findings contribute to our understanding of community-level effects on behavior and suggest that sometimes neighborhood environment may matter, but in some cases it may be less relevant.

One explanation for our lack of findings that neighborhood environment was associated with the relationship between high-risk alcohol use and violent weapon-related behavior is that the physiological effects of alcohol on the brain may be more dependent on immediate social interaction than the more distal environmental influences we studied (Bushman & Cooper, 1990). The disinhibitory properties of alcohol and its effect on one’s decision

making abilities may make an individual more likely to exhibit aggressive behavior than they normally would, particularly for those who have a pre-existing tendency for aggression (Giancola, 2002). Thus, the alcohol-violence link may be more socially and individually determined for adolescents, and the neighborhood environment in which it occurs may be less relevant. The fact that we did not find alcohol outlets of either kind (on premises drinking or package stores) to be related to adolescent violence or its link with alcohol use challenges the commonly held belief that adolescent alcohol related violence is a symptom of poverty and disorganization at the community-level. Rather, our results suggest it is a more proximally determined phenomenon that may require more individual and interpersonal strategies. Thus, programs that help adolescents (a) control their alcohol consumption (or emotional regulation in other ways), (b) recognize potentially provocative social situations, and (c) cultivate strategies to avoid social confrontations may be more generally useful.

In contrast to alcohol use and violent behavior, the relationship between marijuana misuse and weapons aggression appears to depend on the community environment in which they occur. Insofar as marijuana does not have a clear physiological basis associated with violence, it may be part of the common causes associated with problem behavior theory (Jessor, 1991), with this finding indicating that problem behaviors cluster differently under different circumstances. These results are consistent with Friedman et al. (2003) who found that marijuana has a larger effect on propensity for violence in individuals at lower risk for delinquent behavior. This finding gives evidence against the notion that community disorganization is the fundamental cause of the connection between adolescent marijuana misuse and their violent behavior. In fact, we found that community-level markers more indicative of a middle class setting were emblematic of scenarios where the association between marijuana misuse and weapons aggression was maximized. Parents and school officials should always take marijuana misuse in youth seriously as a potential marker of generalized problem behaviors, but our results suggest this may be most salient in middle class areas.

Limitations

Beginning with limitations related to the study setting, the geographically localized study area of Flint, Michigan raises concerns about external validity. Nevertheless, our results may be generalizable to other U.S. cities that have experienced economic hardship. Future research that examines neighborhood environmental factors in a multi-city study would alleviate this concern and the results here provide assurance that this would likely be a fruitful undertaking. Related to this are limitations inherent to the study design, as our sample only allows us to make inference about individuals presenting to the ED, rather than the general population of Flint. Whether or not these results generalize to the population at large is questionable, but the sub-population under study is at elevated risk for both weapons aggression involvement and substance use, making its study important in its own right. In addition, our study design features two major practical advantages: (i) the elevated rates of substance use and weapons aggression involvement present in this enriched sample provide enough power to study moderators of the association between weapons aggression and substance use with economically feasible sample sizes; (ii) home addresses for all

participants are collected, allowing us to link each individual to geographic features, which is rare in studies of the general population. These advantages do not take away from the fact that an analogous study in the general population is required, but they have allowed us to see that such a study would likely be a worthwhile endeavor.

Other shortcomings relate to the relatively coarse neighborhood-level measures available. Researchers have found, for example, that different types of alcohol outlets, beyond simply package versus on-premises alcohol outlets confer different types of risks (Lipton et al., 2013). A supermarket that sells alcohol may imply a different atmosphere for conferring risk than a neighborhood liquor store. Similarly, our community-level demographic profile is somewhat limited as we could not include measures such as unemployment and other stressors that may be associated with psychological factors. The reason for this omission was that several variables recommended by Sampson et al. (1997) (e.g. unemployed percentage, poverty line percentage, percent without college degree) were not available in the 2010 census. Our results suggest that future research utilizing finer neighborhood-level measures is a useful next step in understanding moderators of the connection between substance use and violence.

The final primary class of shortcomings relates to the substance use measurements used here. For one, the inability to examine substances other than marijuana and alcohol limits a complete understanding of the spectrum of substance use disorders and their relationship with weapons aggression. Yet, because marijuana and alcohol are by far the most commonly used substances in youth, they represent a critical place to start the investigation of place-based moderators. Similarly, our assessment of substance use behaviors took place in a screening setting and thus relied on self-report measurements (AUDIT-C and ASSIST) which, the way they are summarized, lack precise behavioral specificity. Future inquiries would benefit from more sensitive tools such as daily interactive-voice-response assessments or timeline-followback methodologies. Related to this is the inability to assess the effect of combined drug use (particularly within the same occasion), how this maps onto violent outcomes, and how those risks vary based on different neighborhood environments. These shortcomings could also be alleviated using the aforementioned methodologies.

Conclusion

Our study empirically tested how substance use behaviors interact with the surrounding community environment to contribute to an individual’s propensity for weapons related violence. The stark contrast in the way marijuana misuse and high-risk alcohol use interact with the neighborhood environment suggests there may be different mechanisms at work. In particular, high-risk alcohol use may be thought of as an etiological factor when dealing with violence while marijuana misuse may be thought of as a marker of a problematic behavior profile among urban youth, with its salience as such a marker depending on the type of community the individual comes from. This improved understanding provides a basis for greater clarity about the roles of alcohol and marijuana misuse and where they lie on the spectrum of problem behaviors, what behaviors they tend to cluster with, and where.

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Biographies

Jason E. Goldstick, PhD, is currently an Assistant Professor in the school of Health Sciences at Oakland University. Prior to this, he was research faculty in Emergency Medicine at the University of Michigan. Dr. Goldstick is a statistician whose substantive research has focused on understanding complex dynamics in a variety of health-related applications including mental health, infectious disease, substance use, and violence. A prominent theme in his broadly ranging work is the use of contextual information (e.g., age or properties of the environment) to uncover how relationships between variables change under different circumstances.

Robert I. Lipton, PhD, is currently works at the CA department of health helping to run the office of health equity, specifically supervising the health research statistics unit. Previous to this he was an associate professor in the emergency medicine department at the University of Michigan where he studied the spatial epidemiology of violence. He has been working on spatial methods in public health for over fifteen years and is very interested in how place effects individual health and social processes that negatively and positively affect health. He is also a poet and musician. His next book of poetry will be coming out next year.

Patrick M. Carter, MD, is an Assistant Professor of Emergency Medicine within the University of Michigan School of Medicine and an Injury Researcher within the CDC-

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Sarah A. Stoddard, PhD, is an Assistant Professor in the Division Department of Systems Leadership and Effectiveness Science, University of Michigan School of Nursing. Dr. Stoddard is also an Assistant Professor in the Department of Health Behavior and Health Education, University of Michigan School of Public Health. Her research focuses on understanding the interaction between individual-level factors and social and environmental factors and their influence on psychosocial development and health trajectories of at-risk youth. She is also interested in the application of behavioral and ecological approaches to preventing substance use and aggression among youth.

Manya F. Newton, MD, is a Emergency Physician/ Researcher who is an Clinical Lecturer in Emergency Medicine at the University of Michigan. After completing her emergency medicine residency she pursued additional training in research methods through a Robert Wood Johnson Clinical Scholars fellowship, obtaining an advanced degree in health and health care research design. Her research interests include medically underserved populations, drug and alcohol use in the inner city population, and geospatial analysis. Dr. Newton has worked for the last four years in the University of Michigan Injury Center researching injury and violence in the inner city population.

Thomas M. Reischl, PhD, is an Associate Research Scientist in the Department of Health Behavior and Health Education at the University of Michigan School of Public Health. He received his PhD in Community Psychology at the University of Illinois at Urbana-Champaign. His current research interests focus on the development and the evaluation of community-based public health programs, violence prevention programs, and obesity prevention programs. He is interested in conducting process and outcome evaluation studies that are collaborative, responsive, and client-centered. His previous work has included evaluations of family support programs, self-help programs, and programs for persons with disabilities.

Maureen A. Walton, PhD, his research interests include developing the efficacy of interventions for alcohol, drugs, and violence in community health care settings, such as the emergency department (ED), primary care, and substance use treatment. Her research focuses on the interrelationship among multiple risk behaviors, particularly among understudied populations such as adolescents, women, and African-Americans. Dr. Walton and colleagues recently completed studies examining the effectiveness of brief interventions for alcohol and violence among adolescents presenting to urban ED's, marijuana prevention interventions among youth in primary care settings, and health services interventions among adults with substance use disorders presenting to the ED.

Marc A. Zimmerman, PhD, is a Professor of Health Behavior and Health Education, and Pyschology at the University of Michigan. He is also Editor of Youth & Society. His research focuses on adolescent health and resilience.

Rebecca M. Cunningham, MD, is the Director of the UM Injury Center a CDC ICRC, Associate Chair for Research and Professor in the Department of Emergency Medicine, University of Michigan Medical School, and Professor, Health Behavior & Health Education, University of Michigan School of Public Health. Dr. Cunningham has a distinguished career in researching intentional injury and substance use prevention, particularly of youth and young adult populations. Her focus on brief interventions in the emergency room has helped position the emergency department as a critical location for public health interventions, specifically for violence. She is currently leading two NIH-funded studies on substance abuse: one focusing on the intersection of youth violence and drug use, and one focusing on underage alcohol misuse and associated injury. Dr. Cunningham concurrently continues her work as a practicing Emergency Department physician at the University of Michigan Health System.

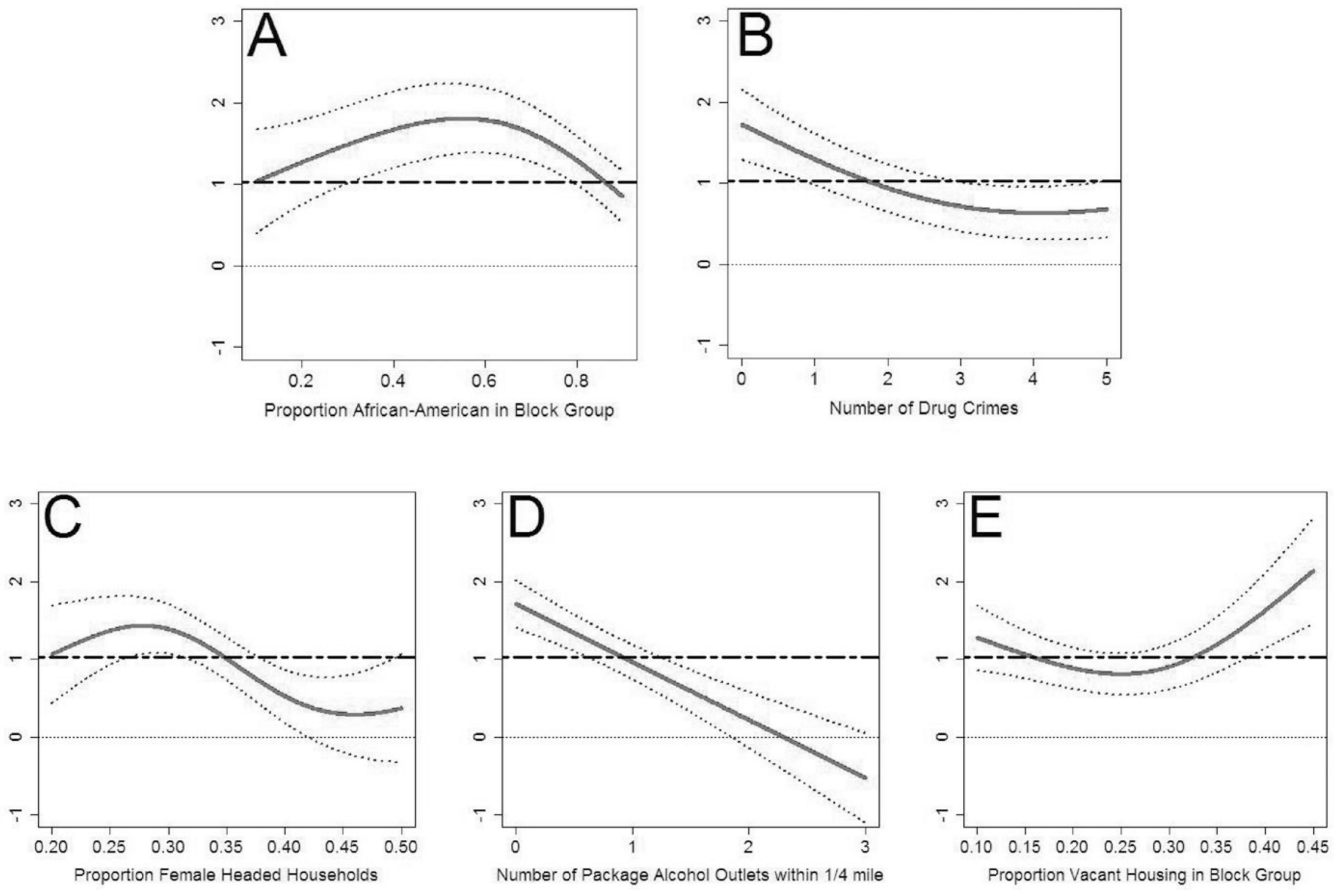

FIGURE 1.

Log odds ratio between individual marijuana misuse and weapon aggression for five community variables.

TABLE 1

Significance testing for modification of the relationship between Marijuana/Alcohol use and weapon aggression

Effect modifier	Marijuana Misuse	High-risk Drinking
% African-American		
Middle 50% of OR range	(1.99, 3.58)	(1.38, 1.93)
Likelihood Ratio Test Statistic	7.73(df = 1.91)[a]	0.61(df = 1.00)
% Housing Vacant		
Middle 50% of OR range	(2.22, 3.24)	(1.55, 1.65)
Likelihood Ratio Test Statistic	8.18(df = 2.12)[a]	0.04(df = 1.00)
% Female Head of Household		
Middle 50% of OR range	(1.76, 3.67)	(1.48, 1.98)
Likelihood Ratio Test Statistic	15.59(df = 3.43)[b]	1.26(df = 1.00)
% Under 18		
Middle 50% of OR range	(2.20, 2.98)	(1.55, 1.74)
Likelihood Ratio Test Statistic	2.75(df = 1.00)	0.29(df = 1.00)
# Package Outlets $^1/_4$ mile		
Middle 50% of OR range	(2.49, 5.66)	(1.55, 1.89)
Likelihood Ratio Test Statistic	12.21(df = 1.00)[b]	0.59(df = 1.00)
# On-premises Outlets $^1/_4$ mile		
Middle 50% of OR range	(2.83, 2.83)	(1.64, 1.64)
Likelihood Ratio Test Statistic	0.22(df = 1.00)	0.17(df = 1.00)
# Drug Crimes $^1/_4$ mile		
Middle 50% of OR range	(1.96, 3.54)	(1.38, 1.89)
Likelihood Ratio Test Statistic	9.78(df = 2.20)[a]	1.17(df = 1.00)
# Violent Crimes $^1/_4$ mile		
Middle 50% of OR range	(2.46, 3.42)	(1.57, 1.65)
Likelihood Ratio Test Statistic	1.71(df = 1.00)	0.02(df = 1.00)

TABLE 2

Bivariate comparisons between weapon aggression and non-weapon aggression groups

Bivariate comparison	Weapon aggression (*n* = 137, 15.6%) Mean (S. E.)	No weapon aggression (*n* = 741, 84.4%)
	Individual demographics	
Age	19.9 (0.20)	19.7 (0.10)
Male (%)	43.8% (4.3%)	50.3% (1.8%)
Live with parents (%)	45.9% (4.3%)	51.0% (1.8%)
African–American (%)	75.2% (3.7%)	71.0% (1.7%)
High school dropout (%)	37.2% (4.1%)[b]	24.7% (1.6%)[b]
On public assistance (%)	72.2% (3.8%)	75.1% (1.6%)
At ED for violent injury (%)	69.3% (4.0%)[a]	52.9% (1.8%)[a]
	Individual drug use	
Alcohol misuse (%)	29.2% (3.9%)[b]	16.9% (1.4%)[b]
Marijuana misuse (%)	63.5% (4.1%)[a]	37.7% (1.8%)[a]
Other illicit drug misuse (%)	7.3% (2.2%)	2.6% (0.6%)
Prescription drug misuse (%)	10.9% (2.7%)[c]	5.3% (0.9%)[c]
	Community demographics	
African–American (%)	69.2% (2.6%)	66.4% (1.2%)
Vacant housing (%)	24.2% (0.8%)	23.4% (0.4%)
Female head of house (%)	36.7% (1.3%)	34.5% (0.5%)
Under 18 (%)	30.8% (0.7%)	29.6% (0.3%)
	Alcohol outlets/crime	
# Package outlets $^1/_4$ mile	0.82 (0.08)	0.87(0.03)
# On-premises outlets $^1/_4$ mile	0.20 (0.05)[c]	0.38 (0.04)[c]
# Drug crimes $^1/_4$ mile	3.17 (0.24)	3.29 (0.12)
# Violent crimes $^1/_4$ mile	51.99 (1.88)	47.52 (0.76)

[a] $p < .001$,

[b] $p < .01$,

[c] $p < .05$.