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Alcohol Availability and Violence among Inner-City Adolescents: A Multi-Level Analysis of the Role of Alcohol Outlet Density

Stella M. Resko · Maureen A. Walton · C. Raymond Bingham ·
Jean T. Shope · Marc Zimmerman · Stephen T. Chermack ·
Frederic C. Blow · Rebecca M. Cunningham

Abstract Researchers recognize that the connection between alcohol and peer violence may relate to community level ecological factors, such as the location of businesses that sell alcohol. Building on previous research among adults, this study examines the relationship between alcohol outlet density and violent behaviors among adolescents, taking into account demographic characteristics, individual alcohol use, and neighborhood level socioeconomic indicators. Data drawn from a diverse Emergency Department based sample of 1,050 urban adolescents, combined with tract level data from the state liquor control commission and U.S. Census, were analyzed. Results of multivariate multi-level regression analysis indicate that alcohol outlet density is significantly related to adolescents' violent behaviors, controlling for demographic characteristics and individual alcohol use. Census tract level socioeconomic indicators were not significantly associated with youth violence. Findings suggest that alcohol outlet density regulation should be considered as part of broader violence prevention strategies for urban adolescents.

Keywords Alcohol availability · Outlet density · Youth violence · Peer violence

S. M. Resko (✉)
Wayne State University, School of Social Work and Merrill
Palmer Skillman Institute, 4756 Cass Avenue, Detroit,
MI 48109, USA
e-mail: stella@wayne.edu

M. A. Walton · S. T. Chermack · F. C. Blow
Department of Psychiatry, University of Michigan Addiction
Research Center, Ann Arbor, MI, USA

C. R. Bingham · J. T. Shope · M. Zimmerman ·
R. M. Cunningham
University of Michigan, School of Public Health,
Ann Arbor, MI, USA

C. R. Bingham · J. T. Shope
University of Michigan, Transportation Research Institute,
Ann Arbor, MI, USA

S. T. Chermack · F. C. Blow
Serious Mental Illness Treatment Research Evaluation Center,
VA Ann Arbor Healthcare System, Ann Arbor, MI, USA

R. M. Cunningham
Department of Emergency Medicine, University of Michigan,
Ann Arbor, MI, USA

R. M. Cunningham
Department of Emergency Medicine, Hurley Medical Center,
Flint, MI, USA

Introduction

The connection between adolescents' alcohol use and violent behavior has been well documented in a variety of studies (Fergusson et al. 1996; Orpinas et al. 1995; Swahn and Donovan 2004, 2006; Swahn et al. 2004; Brewer and Swahn 2005; White et al. 1999). Rates of physical fighting and violent behavior are typically two to three times higher among adolescent drinkers than non-drinkers (Swahn et al. 2004). Several studies of adolescents have documented an association between alcohol use and violence-related injuries (Malek et al. 1998; Meropol et al. 1995; Swahn et al. 2004). At the individual level, explanations for the relationship between alcohol use and violent behaviors during adolescence include acute intoxication effects (e.g., selective disinhibition) and problem behavior clustering (Parker and Rebhun 1995; Jessor and Jessor 1977; Jessor 1991). The selective disinhibition framework focuses on

alcohol's negative effects on perception, judgment, and ability to interpret others' actions and intentions, which when combined with a particular social context could lead to interpersonal conflict and violent behaviors (Parker and Rebhun 1995). Problem behavior theories focus on the co-occurrence of alcohol and other risk behaviors, including violence, that make up a constellation of risk behaviors that emerge during adolescence (Jessor and Jessor 1977; Jessor 1991).

More recently researchers have recognized that the connection between alcohol and violence may also relate to community level ecological factors, such as the location of businesses that sell alcohol (Lipton et al. 2003; Parker and Rebhun 1995). Several theoretically grounded explanations could be advanced to explain the relationship between high alcohol outlet density and youth violence. Based on selective disinhibition, in areas of high alcohol outlet density where alcohol is more readily available there is a higher likelihood of increased violence and aggressive behavior (Parker and Rebhun 1995). More consistent with problem behavior theories, other researchers draw on routine activities theory and social disorganization theory, which focus on community-level factors and how alcohol-selling establishments can be attractors or generators of crime (Brantingham and Brantingham 1981, 1995; Kinney et al. 2008; Roncek and Bell 1981; Roncek and Maier 1991; Roncek and Pravatiner 1989). This research suggests that social control is reduced in inner-city settings as adolescents looking to obtain alcohol congregate around establishments that sell alcohol. In this environment where social norms and external controls are weakened, adolescents may be more likely to engage in illegal, dangerous, or violent activities even if they themselves are not acutely intoxicated.

During the mid-1990's there was a surge of ecological research examining the relationship between alcohol outlets and violence (Roman et al. 2008). Early research examining hotspots of crime found an association between violence and alcohol establishments among adult samples (Britt et al. 2005; Gorman et al. 2001; Scribner et al. 1994; Scribner et al. 1995; Scribner et al. 2000; Gorman et al. 1998a, b; Speer et al. 1998; Stevenson et al. 1999; Parker and Rebhun 1995). For example, Block and Block (1995) examined hotspots for violence in Chicago and found that high concentrations of liquor license establishments often coincided with dense concentration of adult criminal incidents. Similarly, Scribner et al. (1995) examined alcohol outlets and the risk of violent crime among adults in Los Angeles County; after adjusting for demographic factors, higher levels of outlet density were significantly associated with higher rates of criminal homicide, rape, robbery, aggravated assault and domestic violence. Speer and colleagues (1998) analyzed data from Newark, New Jersey,

and found that alcohol outlet density was a significant predictor of rates of violent crime among adults at both census tract and block group levels. Finally, a study of census tracts in Detroit, Michigan, found that alcohol availability was positively and significantly related to total crime, violent crime, property crime, and homicide among adults (Gyimah-Brempong 2001). To our knowledge, only one published study has examined this issue among adolescents. Alaniz and colleagues (1998) examined block groups in three northern California cities and found that areas with a higher density of alcohol outlets had significantly higher levels of crime among Latino youth aged 15–24; however, the amount of variance explained by alcohol sales varied greatly by city.

Despite the contributions of previous research, there are some common methodological issues that limit our understanding of the relationship between alcohol outlet density and violence. Research in this area has been limited by a reliance on aggregated datasets pertaining to large geographic units (Britt et al. 2005; Gruenewald 1993; Stockwell and Gruenewald 2004; Zhu et al. 2004). Studies using large units of analysis, such as the state, city or county, have produced mixed results (e.g. Gorman et al. 1998a, b). Studies using smaller units of analysis have consistently demonstrated a strong relationship between alcohol availability and violence at the census tract level (Gyimah-Brempong 2001; LaVeist and Wallace 2000) and the block group level (Alaniz et al. 1998; Costanza et al. 2001; Gorman et al. 2001).

Another limitation is that much of the early research in this area utilized regression analyses that do not separate the effects of individual (e.g. the adolescents access to alcohol) and structural variables (e.g. grouping of drinkers or adolescents outside alcohol outlets by neighborhood), which limits the interpretation of the findings in terms of the level of the effect (Duncan et al. 2002; Scribner et al. 2000).

Previous studies have also focused on crime and drawn heavily on police reports and official crime data which may undercount the true volume of violence. Analyses of victimization surveys consistently show that victims of crime often do not report victimizations and self-reported surveys of perpetrators indicate that most violence is not detected by law enforcement personnel (Kirk 2006). In addition, only a single study in this area has specifically focused on youths (ages 15–24) (Alaniz et al. 1998); at this point, it remains unclear if the relationship between alcohol outlet density and violence that has been documented among adults is present when exclusively focusing on adolescents who are not of legal drinking age and are from different racial and ethnic backgrounds.

The purpose of this study is to build on and extend previous research among adult samples and examine the

relationship between alcohol outlet density and violent behaviors, taking into account demographic characteristics and individual alcohol use, among adolescents seeking medical care at Hurley Medical Center who reside in Genesee County, Michigan. Additionally, we examined whether the relationship between alcohol outlet density and violent behaviors remains significant with the inclusion of census tract level socioeconomic measures such as median family income, percentage of families below the poverty line and percentage of adults with a bachelor's degree or higher. This study improves upon prior research by examining a small unit of analyses (census tract), using a multi-level data analytic approach, and including self-report youth violence data instead of relying on official crime data, which is not likely accurate for adolescents. For this study, we utilize an Emergency Department (ED) based sample of adolescents that includes a high proportion of African-Americans. Hypotheses were that alcohol outlet density would be significantly related to adolescents' violence perpetration, controlling for demographic characteristics, individual alcohol use, and census tract level socioeconomic indicators.

Method

Overview

Data for this study were collected from three distinct sources. Individual level data were collected from patients at Hurley Medical Center Emergency Department (ED) in Flint, Michigan. Neighborhood level data were obtained from the U.S. Census Bureau and from the Michigan Liquor Control Commission.

Study Site and Unit of Analysis

The current analysis is restricted to participants who reside in Genesee County ($n = 1050$). Genesee County is located approximately 60 miles northeast of Detroit and covers a total area of 649 square miles. According to the 2000 Census, the median household income for the county was $41,951 and the median income for a family was $50,090. The per capita income for the county was $20,883 (U.S. Census Bureau 2000). In Genesee County, about 16.7 percent of families and 20.2 percent of the population were below the poverty line, including 31.1 percent of those under age 18 (U.S. Census Bureau 2000). The main population center in Genesee County is Flint, a city once well known as a hub of the American automobile industry.

The unit of analysis for this study is the census tract. Previous research on alcohol availability and violence has demonstrated the importance of using smaller units of analysis, such as the census tract or block group (Roman et al. 2008). The census tract is a small, relatively stable subdivision designed to represent neighborhoods that are homogeneous with respect to population characteristics, economic status, and living conditions (United States Census Bureau 1994). Census tracts typically have between 2,500 and 8,000 persons and are delineated by local committees working in cooperation with the Census Bureau (United States Census Bureau 1994). Census block groups are smaller and consist of a cluster of census blocks (generally between 600 and 3,000 people). For the purpose of this study, the tract level captures sufficient variation in alcohol outlet density and other independent variables hypothesized to be related to youth violence and more closely match the self-identified neighborhoods within Genesee County. The use of census tracts over block groups also helps to avoid problems associated with data sparseness (Clarke 2008). To ensure an adequate number of participants per tract, census tracts with fewer than 15 participants were collapsed into adjacent tracts with similar socioeconomic characteristics. Use of census tracts required fewer adjustments than those that would have been required with census block groups.

Survey Procedures

Individual level data for this study were gathered at the Hurley Medical Center ED. Hurley Medical Center is a 540-bed public hospital in Flint, Michigan and the only Level I Trauma Center located in Genesee County. All study procedures were approved and conducted in compliance with the University of Michigan and Hurley Medical Center Institutional Review Boards for Human Subjects. A Certificate of Confidentiality was obtained from the National Institute on Alcohol Abuse and Alcoholism for this study. ED patients aged 14–18 were surveyed for eligibility to participate in a randomized controlled trial of an alcohol and violence intervention. Urban ED's such as Hurley Medical Center provide a unique opportunity to reach a diverse sample of adolescents including those who are not enrolled in school or whose attendance may be sporadic. Recruitment occurred during the afternoon and evening shifts, 7 days per week, over a 1 year period (September 2006 to August 2007). Patients presenting to the ED for either medical illness or injury were eligible for the study. Patients were excluded if they were being treated for sexual assault, acute suicidal ideation, or had unstable vital signs. Data were collected through audio computer-assisted self-interviews in order to increase confidentiality, allow for complex skip patterns, and to decrease literacy burden (Jones 2003). All participants received a token $1.00 gift of their choice (e.g., notebook, pens) for their participation in the 15 min

screening survey. Parental consent was obtained for youth under age 18.

Measures

Individual Level Variables

Demographic information, including age, gender and race/ethnicity, were collected using items from the National Study of Adolescent Health (Harris et al. 2003). Gender was coded as (0) male and (1) female. Self-reports of race were coded as (0) African American/Black (1) Caucasian/White, and (2) Other.

Frequency and quantity of alcohol use and heavy drinking were assessed with the three consumption items from the Alcohol Use Disorders Identification Test (AUDIT-C) (Bush et al. 1998), which is a reliable, valid and sensitive test for detecting heavy drinking among adolescents (Chung et al. 2002). Participants were asked to indicate how often they consumed alcohol in the past 12 months (from never to daily or almost daily), how many alcoholic drinks they typically consumed per drinking day (from 1–2 to 10 or more), and how often they consumed 5 or more drinks on one occasion (i.e., binge drinking) (from never to daily or almost daily). Responses were dichotomized using a cut-off score of 3 or more to indicate hazardous alcohol consumption (0 = no; 1 = yes) (Chung et al. 2002).

Participants were asked about violence perpetration during the past year using seven items drawn from the Conflict Tactics Scale (CTS, Strauss, 1979). Participants were instructed to include violence directed toward peers including friends, family, and strangers but not dating partners. Moderate violence included: pushed or shoved, hit or punched, slammed someone into wall, and slapped someone. Severe violence included: beat up, kicked, and used a knife or gun on someone. Responses were scored following the approach of Straus (1990): 0 (never), 1 (1 time), 2 (2 times), 3 (3–5 times), 4 (6–10 times), 5 (11–20 times), and 6 (20 + times). Summing the scores for the seven items yields a violence index with a possible range of 0–42.

Neighborhood Level Variables

Alcohol outlet data are based on license information for establishments in Genesee County registered with the Michigan Liquor Control Commission for 2007. These data were obtained from the Michigan Department of Labor and Economic Growth and included information on business type, street address, outlet name, and license number. In 2007, there were 50 licenses for businesses to sell alcohol in Genesee County for every 1,000 people. Companies licensed as caterers and wholesalers were excluded from

this analysis. Each license was geocoded to match the business location and the corresponding census tract. All addresses were validated prior to geocoding. Tract-level socioeconomic data were obtained from the 2000 U.S. Census. On the basis of previous neighborhood disadvantage research (e.g. Wikström and Loeber 2000; and Winslow and Shaw 2007), the following variables were used to create a neighborhood poverty index: median household income, the proportion of families living below the poverty level, proportion of adults having a college degree, the proportion of families headed by a single female, the proportion of households receiving public assistance, and the unemployment rate for the tract. Following the approach of Winslow and Shaw (2007), these variables were standardized using Z scores and averaged after reverse scoring median household income and proportion of adults having a college degree) ($\alpha = .91$).

Data Analysis

Data were analyzed with Mplus version 5.1 using maximum likelihood estimation with robust standard errors (Muthén and Muthén 2007). Basic descriptive statistics (means and standard deviations) were calculated for all variables. Spearman's rho correlational analyses were then conducted with the dependent variable (youth violence) and all individual and neighborhood-level predictor variables to investigate potential problems with multicollinearity (Menard 2002). These analyses provided no evidence of multicollinearity among individual level and neighborhood level predictors.

Multi-level zero-inflated Poisson (ZIP) regression models were used to examine predictors of youth violence. ZIP models are an extension of the Poisson regression approach that is typically used for count data. Whereas traditional regression assumes that errors are distributed symmetrically and that there is constant variance throughout the distribution, the Poisson distribution is skewed and the variance increases as the mean increases (Lambert 1992; Lee et al. 2006). Moreover, unlike traditional regression, the Poisson distribution (which uses a log transformation) does not include negative values. ZIP models use Poisson probabilities, but allow for a larger probability of zero scores (Zorn 1996; Hernandez-Avila et al. 2006). Given the hierarchical nature of the data (individuals nested within census tracts) and the violence outcome measure that is a count variable with a large number of zero scores, a multi-level ZIP model is the most appropriate analytic approach (Lee et al. 2006). Multi-level ZIP models have two parts, the first predicting the probability that the only possible observed value is zero (no violence), and the second predicting the frequency of the event among the non-zero cases. These coefficients can be

exponentiated, giving odds-ratios and incidence rate ratio, respectively.

Two separate multi-level ZIP models were used to identify predictors of past year violent behaviors toward peers. For model 1, individual level predictors included age, race, gender, alcohol use (AUDIT-C); the neighborhood level predictor variable was alcohol outlet density. Model 2 used the same individual level predictor variables (age, race, gender, alcohol use). In order to determine if alcohol outlet density remained significant with the inclusion of neighborhood level poverty measures, alcohol outlet density and the neighborhood socioeconomic index were included in model 2 as neighborhood level predictor variables.

Results

Recruitment and Overall Sample Description

Among 1,604 potentially eligible patients who presented to the ED during the recruitment period, 83.9% ($n = 1346$) were approached and 16.1% ($n = 258$) were missed. Common reasons for missing participants were: the research assistant was occupied with another participant (77.5%); the research assistant was unable to locate the patient (6.6%); the patient was discharged before the research assistant was able to approach the patient (6.6%), and computer problems (5.8%). Among eligible patients who were approached, 83.8% ($n = 1128$) completed the screening survey and 16.2% ($n = 218$) refused to participate (48% African American, 52% male). For the current analyses, participants were excluded if they lived outside of Genesee County ($n = 50$ or 4.4%), listed a post office box for their address ($n = 4$ or 0.4%) or the address could not be geocoded ($n = 24$ or 2.1%). This resulted in an analytic sample of 1050 participants (93.1% of the participants who completed the survey).

Descriptive statistics of the sample are presented in Table 1. More than half the participants were female (53.9%) and African American (60.2%). About one-third of the participants reported they were Caucasian (34.1%) and 5.8% reported other races. On average, participants were 16 years old (SD = 1.5), with a range of 14–18 years. Nearly three quarters of the adolescents (73.1%) reported violent behaviors toward their peers. The reported number of violent incidents toward their peers ranged from 0 to 34 and an average of 4.7 incidents were reported by youth engaging in violent behaviors. Intercorrelations among the predictor variables are reported in Table 2. The table illustrates a number of statistically significant relationships among the predictor variables, although the magnitude of the correlations generally was modest.

Table 1 Descriptive statistics

	N	Percentage	Mean (SD)
Outcome			
Peer violence (%+)	1,050	73.1	4.7 (5.7)
Individual level predictors			
Age	1,050		16.0 (1.5)
Race	1,050		
African American		60.2	
Caucasian		34.0	
Other		5.8	
Gender	1,050		
Female		53.9	
Male		46.1	
Alcohol use			
AUDITC	1,050		1.3 (2.5)
Neighborhood level predictors			
Alcohol outlet density (per 1,000 people)	50		1.6 (0.9)
Socioeconomic index	50		2.5 (1.0)

Model 1: Multilevel ZIP Regression Model Including Alcohol Outlet Density

Model 1: Individual Level Results

For the ZIP regression analyses, model 1, which included alcohol outlet density as the only neighborhood level predictor, was significant (see Table 3). The "Zero-Inflation" column includes variables related to the occurrence of violence, whereas the "Incident Count" column includes variables related to the number of violent incidents. Age, race, and alcohol use (AUDIT-C) were significantly associated with violence perpetration. Younger age, African American race, and more hazardous alcohol use were significantly related to perpetration of peer violence (see "Zero-inflation" columns in Table 3). Younger adolescents experienced significantly fewer incidents of violence, and those adolescents with hazardous alcohol use experienced significantly more incidents of violence (see "Incident count" column in Table 3). Gender was not a significant predictor of the occurrence or frequency of violent behaviors directed toward peers.

Model 1: Neighborhood (Census Tract) Level Results

The neighborhood-level predictor used in model 1 was alcohol outlet density, measured as the number of outlets per 1,000 population. Even after controlling for individual-

Table 2 Inter-correlations among individual and neighborhood level predictors

	1	2	3	4	5
Individual level predictors					
1. Age	1.00	0.004	−0.019	−0.067*	0.234**
2. Race: African American	0.004	1.00	−0.304**	−0.085**	−0.187**
3. Race: other	−0.019	−0.304**	1.00	0.032	0.120**
4. Gender	−0.067*	−0.085**	0.032	1.00	0.032
5. Alcohol use (AUDITC)	0.234**	−0.187**	0.120**	0.032	1.00
Neighborhood level predictors					
1. Alcohol outlet density (per 1,000 people)	1.00	0.069*			
2. Socioeconomic index	0.069*	1.00			

* Correlation is significant at the 0.05 level (2-tailed)

** Correlation is significant at the 0.01 level (2-tailed)

Table 3 Multi-level regression analyses predicting peer violence among adolescents

Predictor variables	Model 1		Model 2	
	Zero-inflation OR (95% CI)	Incident count IRR (95% CI)	Zero-inflation OR (95% CI)	Incident count IRR (95% CI)
Individual level predictors				
Age	1.33*** (1.21–1.46)	0.94** (0.89–0.98)	1.33*** (1.21–1.46)	0.94** (0.89–0.98)
Race				
African American	0.57*** (0.43–0.76)	1.07 (.90–1.27)	0.57*** (0.43–0.76)	1.07 (.90–1.27)
Other	0.50 (0.23–1.05)	0.90 (.64–1.26)	0.50 (0.23–1.05)	0.90 (.64–1.26)
Gender				
Male	0.89 (0.65–1.22)	1.00 (0.90–1.11)	0.89 (0.65–1.22)	1.00 (0.90–1.11)
AUDITC	0.80*** (0.74–0.86)	1.10*** (1.07–1.12)	0.80*** (0.74–0.86)	1.10*** (1.07–1.12)
Neighborhood level predictors				
Alcohol outlet density (per 1,000 people)	NA	1.08* (1.00–1.16)	NA	1.07 (0.96–1.19)
Socioeconomic index	NA	NA	NA	1.07 (0.99–1.16)
Overall model	χ^2 (10) = 147.5***		χ^2 (11) = 155.1***	

* $p < .05$, ** $p < .01$, *** $p < .001$

Odds ratios in the Zero-inflation column are for predicting a "certain zero" for the dependent measure. Thus, for significant predictors, odds ratios < 1 indicate a positive relationship between the predictor and the presence of violence (e.g., those with hazardous levels of alcohol use were more likely to engage in violence). For significant predictors in the incident count columns, values >1 indicate that variable is positively associated with the frequency of the outcome (e.g., hazardous levels of alcohol use were related to more incidents of violence)

level demographic characteristics (age, race, and gender) and alcohol use, alcohol outlet density in participants' neighborhoods was significantly associated with increased violence (see Table 3).

Model 2: ZIP Regression Model Including Alcohol Outlet Density and Socioeconomic Factors

Model 2: Individual Level Results

For the model 2 ZIP regression analyses, alcohol outlet density and the socioeconomic index were included as

neighborhood level predictors and the overall model was significant (see Table 3). Consistent with the results from model 1, younger age, African American race and hazardous alcohol use (AUDITC) were significantly related to perpetration of any peer violence (see "Zero-inflation" columns in Table 3). Younger adolescents perpetrated significantly fewer incidents of peer violence and those with hazardous alcohol use perpetrated significantly more incidents of peer violence (see "Incident count" columns in Table 3). Once again, gender was not a significant predictor of the occurrence or frequency of peer violence perpetration.

Model 2: Neighborhood (Census Tract) Level Results

The neighborhood-level predictors used in model 2 were alcohol outlet density, measured as the number of outlets per 1,000 population and the neighborhood level poverty index. Alcohol outlet density did not remain significant with the inclusion of the neighborhood level poverty index ($p = .08$ and $p = 0.24$, respectively).

Discussion

The present study adds to recent efforts to understand the complex relationship between individual and community level factors that are related to adolescent violence (e.g. Haynie et al. 2006; Sampson et al. 1997; Wikström and Loeber 2000; Simcha-Fagan and Schwartz 1986; Peeples and Loeber 1994; Aneshensel and Sucoff 1996; Elliott et al. 1996; Simons et al. 1996; McNulty and Bellair 2003, and De Coster et al. 2006). Previous studies with adult based samples have documented a relationship between alcohol outlet density and violence (e.g. Alaniz et al. 1998; Britt et al. 2005; Gyimah-Brempong 2001; Reid et al. 2003; Roman et al. 2008; Scribner et al. 2000; Zhu et al. 2004). To our knowledge, this study represents the first effort to focus exclusively on adolescents who are not of legal drinking age. Additionally, this study makes an important contribution to the literature by using novel statistical methods to examine the association between alcohol outlet density and perpetration of youth violence. Use of the multilevel ZIP model allowed us to examine factors associated with the occurrence of "any" violence, as well as the frequency of violent incidents among those engaging in violence directed toward their peers. This analysis strategy also made it possible to differentiate between individual and neighborhood level effects.

Over two-thirds of this ED-based sample of urban adolescents reported aggression towards their peers in the past year. Although this rate of aggression is high, it is in line with rates found in studies of other adolescent samples that utilized comparable measures of violence (Finkelhor et al. 2006). Younger age was associated with an increased likelihood of violent behaviors directed toward peers. Younger adolescents reported significantly fewer incidents of violence. Taken together, these findings on age fit with previous studies indicating that violence is a behavior that tends to decrease with age for most youth (Krug et al. 2002; Williams et al. 2007). Most adolescents who commit serious acts of violence generally cease their violent behaviors after 1–3 years (Krug et al.). There are some children, however, that exhibit aggressive behavior that escalates over time and carries over into adulthood (Williams et al. 2007). It may be that the groups of older

adolescents in our sample include a greater proportion of youth who commit more serious acts and are on a life course where they will continue their pattern of violent behaviors into adulthood. In terms of gender, statistically significant gender differences were not observed. Results of the current study revealed that adolescents who engage in hazardous alcohol use were more likely to engage in peer violence. Among adolescents reporting peer violence, hazardous alcohol use was also associated with an increased frequency of violent incidents. These findings replicate previous research that has documented a relationship between alcohol use and violence among adolescents (Fergusson et al. 1996; Orpinas et al. 1995; Swahn and Donovan 2004, 2006; Swahn et al. 2004; Brewer and Swahn 2005; White et al. 1999).

Results of this study suggest there is a complex relationship between alcohol outlet density and violence toward peers among adolescents that occurs at the neighborhood level. Alcohol outlet density was significantly associated with peer violence after controlling for individual characteristics including alcohol consumption. Alcohol outlet density did not maintain statistical significance ($p < .05$) after adjusting for neighborhood-level socioeconomic variables. With the small number of census tracts (50) in this sample, there may not be enough statistical power to detect a relationship with alcohol outlet density at the 0.05 level when neighborhood level socioeconomic measures are included. Correlational analysis indicated that alcohol outlet density and the poverty index are not strongly correlated (see Table 2). These findings raise the possibility that although the urban setting examined in this study was socio-economically deprived, alcohol outlet density may not be simply a proxy for poverty. Additional research is needed to determine whether alcohol outlets attract youth seeking to obtain alcohol. Alternatively, youth may be drawn to such locations by peers or in efforts to find "something to do", which may be particularly lacking for urban neighborhoods lacking collective efficacy (Smith et al. 2000). It is unclear to what extent peer violence occurs as a function of grouping together adolescents at risk for violence (routine activities theory and social disorganization theory), selective disinhibition following intoxication, or a combination of the two. Future qualitative research is needed to understand the interrelationships among alcohol outlet density, youth violence and socioeconomic factors.

As with all studies, this study had some limitations. This study utilized a multilevel approach where standard errors for the measures of association between neighborhood factors and violence are corrected for the non-independence of individuals within neighborhoods. This approach provides only limited information on the spatial distribution of violence and does not account for the potential bias

of spatial autocorrelation (Chaix et al. 2005). There is the potential that the effect of alcohol-outlet densities can spillover into adjacent geographical units, particularly when examining census tracts (Reid et al. 2003; Zhu et al. 2004). Although some evidence suggests that such an effect of spatial autocorrelation would likely be negligible (Gorman et al. 2001; Scribner et al. 2000), it could lead to Type I (in the case of positive spatial autocorrelation) or Type II (in the case of negative spatial autocorrelation) errors (Gruenewald et al. 2000; Zhu et al. 2004). The current study also used the census tract as the unit of analysis and it is possible that self-identified neighborhoods may more accurately reflect the neighborhood level relationship between alcohol outlet density and poverty (Britt et al. 2005). This study does not incorporate any measures that assess the characteristics of alcohol outlets such as size, amount of alcohol sold, type of clientele (Roman et al. 2008) or their proximity to other business outlets. Additional research to assess these features of alcohol outlets could enable a more nuanced understanding of how alcohol outlets impact the risk of violence.

Despite these limitations, these findings have important implications and provide further evidence of the need to understand the alcohol-violence relationship within a specific neighborhood context. Previous research using samples comprised primarily of adults has indicated that policies and interventions addressing the regulation of alcohol outlets may be effective for the prevention and intervention of violence (Roman et al. 2008). Policies such as those limiting hours of operation, or reducing the amount or types of alcohol sold can be an attractive option that can readily be implemented by local level policymakers. The results of this study suggest that while policies and interventions designed to affect alcohol availability and access may impact violence among adults, they have a limited ability to influence youth violence. Policymakers must proceed cautiously. These policies might be feel-good measures that make the community feel safer, but it remains unclear if they will decrease a neighborhood's youth violence problem. Additional research is needed to determine if these policies can change individual behaviors, such as violence and substance use, through changes in individual norms and neighborhood patterns of drinking behavior. Given the limitations of the current knowledge base, these policies should only be used as part of a larger multipronged effort to address youth violence within a community. The current study provides evidence of the need to continue to explore the multi-dimensional effects of alcohol availability on neighborhoods and specifically the issue of youth violence. Additional research focusing on adolescents, utilizing larger samples, and examining outlet characteristics is needed to inform more specific policies regarding alcohol availability (Roman et al. 2008).

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