Drug and Alcohol Dependence 205 (2019) 107701

Contents lists available at ScienceDirect

Drug and Alcohol Dependence

journal homepage: www.elsevier.com/locate/drugalcdep

Full length article

Geographic gender differences in traumatic unintentional injury hospitalization and youth drinking

Imelda K. Moise

Department of Geography and Regional Studies, University of Miami, 1300 Campo Sano Ave, Coral Gables, FL, 33124, United States

ARTICLE INFO

Keywords:
GIS
Illinois
Chicago
Adolescents
Substance use
United States
SaTScan
Clusters
Epidemiology
Young adults

ABSTRACT

Introduction: Few studies have used both spatial and non-spatial techniques to the study of alcohol outcomes. The objectives of this study were to identify clusters of traumatic unintentional injury hospitalizations by gender and blood alcohol concentration (BAC), and to determine trends and correlates by BAC levels.

Methods: State Trauma Registry data capturing unintentional injuries for those aged 10 to 24 hospitalized with negative and positive BAC levels (n = 6233) were analyzed from 2006 to 2015 for all Chicago block groups. Spatial clustering techniques were applied to detect spatial clusters and Generalized Estimating Equations to determine correlates and trends while controlling for correlation within block groups.

Results: Regardless of BAC level, hospitalization rates decreased for all age groups between 2006 to 2010 and 2011 to 2015 from 94.41 to 67.69 per 100,000 population. The decline for males hospitalized with positive BAC was 1.4 times greater than the decline for their female counterparts. Risk factors included being male, black or of a minority race, having no private insurance and living in a disadvantaged neighborhood. Male hospitalization rates clustered among 33 census block groups located in three Chicago Community Areas. No clustering was detected for female patients. Motor vehicle accidents were the leading cause of hospitalization.

Conclusions: Hospitalizations are decreasing in Chicago, yet the risk is concentrated, with greater decreasing rates among males than females. Spatial approaches can be valuable tools in analyzing substance abuse outcomes, to identify high-risk areas and shifts in risk within a large geographic area.

1. Introduction

The public health problems caused by harmful use of alcohol among young people in the United States (US) are widely acknowledged (Marshall, 2014; Swendsen et al., 2012), and Chicago, Illinois is no exception. It is also well established that in young people, alcohol use is a risk factor for various forms of violence (Boles and Miotto, 2003), sexually transmitted disease acquisition (Cook and Clark, 2005), partner risk characteristics (Staras et al., 2016), in-hospital trauma morbidity, mortality and injury (Swahn et al., 2004). In 2016 for example, and among 1–19 year-olds, injuries caused a majority of pediatric death (Cunningham et al., 2018), and remain within the top ten causes across the life span (Herbert et al., 2017). This suggests that in the US, more young people die from injuries than from all other causes of death combined (Sleet et al., 2010). Therefore, for those working towards prevention of underage drinking, understanding time trends in alcohol use and related consequences including knowledge of geographic distribution of at-risk drinkers is increasingly important, not only to improve youth safety and health equity but also to the design of targeted interventions.

Previous studies in the US have documented important relationships between neighborhood health and adolescent health-risk behaviors (e.g., crime, teenage parenthood, and school dropout rates) (Leventhal and Brooks-Gunn, 2000) including community environment in the context of adolescent substance use (Moise et al., 2019). However, the results of community environment in the context of adolescent substance use have been mixed (Reboussin et al., 2010), with some studies finding adolescents living in neighborhoods with less social cohesion (Brook et al., 1989), higher concentrated disadvantage (Duncan et al., 2002), higher perceptions of neighborhood disorder (Wilson et al., 2005) as more likely to use drugs and alcohol, and increased exposure to alcohol availability. Other studies findings are contradictory to these findings (Trim and Chassin, 2008; Chuang et al., 2005; Reboussin et al., 2010; Ennett et al., 1997) or found no association (Allison et al., 1999) between neighborhood factors (e.g., population density, high residential mobility, neighborhood advantage) and adolescent drug and alcohol use. Further, other researchers have investigated the spatial relationship between alcohol outlets and injuries (Nesoff et al., 2018a, 2018b, Branas et al., 2011, 2009; Treno et al., 2007) including alcohol policies (e.g., reduction in alcohol density) and reduction in alcohol use

E-mail address: moise@miami.edu.

https://doi.org/10.1016/j.drugalcdep.2019.107701
Received 9 August 2019; Received in revised form 13 October 2019; Accepted 15 October 2019
Available online 01 November 2019
0376-8716/

and related consequences (Gruenewald Paul and Remer, 2006; Markowitz et al., 2003; Britt et al., 2005; Jennings et al., 2014; Moise et al., 2019; Hadland et al., 2017). Extensive research using cross sectional data has also shown that communities with greater alcohol outlet density also tend to have higher rates of motor vehicle accidents (Fone et al., 2012).

Notably, recent national data show an "alarming" narrowing of the gender gap in drinking patterns (White et al., 2015). These findings suggest that while young males are more likely to report significantly higher prevalence of binge and daily drinking than females, females are initiating alcohol use earlier and engaging in more binge-like alcohol use (Dir et al., 2017). Previous research assigns diverse reasons to gender differences in young people's alcohol use and outcomes including biological influences on the etiology of alcohol-use disorders, neurobiological risk factors, individual risk factors, access, availability and personality-related factors (Conrod, 2016; Moise et al., 2014; Holmes et al., 2014; Heath et al., 1997; Duncan et al., 1998) and age at onset (Swendsen et al., 2012). However, while this stark gender difference in alcohol use and related consequences is highly apparent, gender differences in alcohol use and related harm are likely to vary across space and time, with potential concentration of high and low levels of use or related harm in specific geographic areas.

Therefore, there is potential to use spatial and non-spatial approaches to better understand the distribution of alcohol use outcomes among young people, and variation in the strength of individual and neighborhood level predictors across socioeconomically diverse communities such as those in Chicago. However, few studies have included both spatial and non-spatial techniques to the study of health outcomes nor alcohol use and related consequences in Chicago so far. One study by Whitman et al.,(Whitman et al., 2004) "examined 14 health status indicators for six Chicago Community Areas that reflect the substantial diversity of the city" to cover local-level disparities often masked by health estimates for large areas (e.g., cities, counties, states)." Another study used Geographical Information Systems (GIS) to show that decreased access to immediate care in certain areas of Chicago adversely affect mortality from gunshot wounds (Crandall et al., 2013). What is less clear is the nature of how gender differences in alcohol use vary or form patterns across socioeconomically diverse areas and overtime, and no study has systematically assessed whether and how the relationship between neighborhood of residence and alcohol use differs among young people in Chicago.

The current study has two specific aims. First, to identify clusters of high rates of traumatic unintentional injury hospitalization among young people aged 10–24 hospitalized with positive BAC over a ten-year-period based on their home address, including the frequency of these hospitalizations by age group, sex and BAC level (negative and positive BAC test results). Second, to determine time trends and correlates of these hospitalizations by cause of injury outcome, BAC and age group while controlling for correlation within census block groups. Such findings could have important implications for hospitalization rates in different geographic areas, an important aspect to evaluating community health status and for tailoring interventions to not only sex but also specific communities based on the pertinent individual and contextual factors.

2. Methods

2.1. Patients trauma data sources

A retrospective observational study involving patients hospitalized with negative and positive BAC levels (cases and controls, respectively) from January 2006 through December 2015. Included were all children (aged 10–14), adolescents (aged 15 to 19) and young adults (aged 20 to 24) identified in the Illinois State Trauma Registry (ISTR) following presentation to level I and level II trauma centers. The period and age range were selected to provide sufficient context for evaluating trends in unintentional injury hospitalization rates and facilitate comparison with previous analyses (Dellinger and Gilchrist, 2019; Gore et al., 2011; Salam et al., 2016). ISTR is a mandatory reporting database maintained by the Illinois Department of Public Health containing information about all traumas. Only about one-third of hospitals are designated in the ISTR as either Level I or Level II trauma centers. This database is de-identified with respect to name and hospital, but it also includes patient demographics (e.g., age, gender, and race), physiological data, injuries and discharge outcomes, patient home address; BAC test result and incident address information. The analysis was constrained to young people with a Chicago home address, zip code and unintentional injury principal diagnosis e-codes as listed in Supplemental File 1. The final sample used in the analysis was 4922.

2.2. Using patients trauma data to determine cause of injury

All trauma center hospitalizations in Illinois are coded using *International Classification of Diseases*, 9th revision, Clinical Modification (ICD-9-CM). ICD-9-CM coding for external causes of injury (E-Codes) were used to distinguish between intentional and unintentional injuries as used in our previous study (Moise et al., 2019) and in other studies of unintentional injuries (Runyan et al., 2005a, 2005b). Supplemental File 1 shows the included codes and causes. Because repeat hospitalizations more closely correlate with individual activities, which may inflate the overall rate, random hospitalizations were selected instead for patients with repeat patient encounters each year and were used in the analysis. Importantly, the percentage of repeat hospitalization was marginal (0.6%). In this study, a patient encounter was defined as a hospitalization to either trauma center departments, observation status, or transfer.

2.3. Using patients trauma data to define positive BAC levels

All patients presenting to trauma centers in Illinois undergo BAC testing within 24 h after first trauma center encounter. A benefit to testing for alcohol biomarkers, particularly BAC level is that it can identify high-risk patients admitted to trauma centers who denied excessive drinking (Fleming et al., 2009). In Illinois, blood alcohol concentration is determined using gas chromatographic. About 20% of the selected patients did not have BAC information on record. This is probably due to type II errors. For the current study, a positive BAC level refers to any young patient hospitalized after trauma with any trace of alcohol in his/her system (BAC test result > 0.0) at the time of hospitalization, which was converted to an approximate BAC (grams of alcohol per 100 milliliters of whole blood). This definition includes encounters for young patients who expired (died) with or without resuscitation and those who were dead on arrival (n = 86).

2.4. Patients trauma data source, measures

Because the interest of the current study was in factors that lead to positive BAC levels among hospitalized patients, the primary variable of interest was binary, an indicator of whether a patient tested negative (0 = negative) or positive (1 = positive) for BAC at the time of hospitalization. Independent variables were categorical with race classified as White and ethnic minority group (includes Black or African American and other minorities such as Chinese, Japanese, Hawaiian, Filipino, Korean, Asian Indian, Vietnamese, Other Guamanian; Samoan, American Indian; Alaska Native, Aleut and other race). Patients were categorized by age (0 = early adolescence ages 10–14), late adolescence (1 = ages 15–19) and young adulthood (2 = ages 20–24), gender (1 = female; 0 = male) and time (year of hospitalization). Insurance status was used as a proxy measure for a patient's socioeconomic status. Patients who reported self-pay or government-subsidized programs, including Medicaid/Medicare were considered to have "no private insurance" whereas those whose likely source of payment included any

kind or of private or commercial insurance were reported as having "private insurance."

2.5. Neighborhood correlates, socioeconomic status (SES) index

To estimate neighborhood disadvantage for each census block group, I obtained census block group level data from the 2011–2015 US Census American Community Survey (ACS) to create a SES Index for each block group based on previously published methods (Krieger et al., 2003; Krieger, 1992; Howard et al., 2016). The variables included the: 1) percentage of persons in the labor force who are unemployed 2) percentage of persons living below poverty level, 3) median household income, 4) median value of owner-occupied dwellings, 5) percentage of persons 25 years of age or older with less than a 12th grade education. Also included were the 6) percentage of persons 25 years of age or older completing four or more years of college, and 7) the percentage of households that average one or more persons per room. These characteristics are representative of the occupational, income, wealth, and educational characteristics of residents in each census tract. Principal component analysis was used to determine the weighting of each variable within the component, with "individual component values estimated by summing the weighted scores to reach the component"(Stern Scott et al., 2017). For easy interpretation, I standardized the continuous range of SES index scores to allow census block groups to be scored on a 0–100 scale, with lower values indicating greater disadvantage and higher values indicated greater advantage at the component level.

2.6. Data manipulation

All patient home addresses were geocoded and linked to the residential census block group (unit of analysis). The hospitalized patient's home address was used over scene of injury address since from a substance abuse prevention perspective, it is important not only to identify individuals or groups that have a high need for prevention programs but also the communities in which they reside. Addresses were geocoded using GIS batch geocoding (Moise et al., 2017), with matched addresses–having higher probability ($> 80\%$) included in the analysis. A major advantage of using census block groups is that they can be used as a neighborhood proxy and their characteristics have been shown to be robust predictors of health given their small geography and population size (Moise and Ruiz, 2016; Roux et al., 2001; Howard et al., 2016). For example, they are small enough to reflect spatial variation in hospitalization rates across Chicago and have large enough population to provide robust estimates for these hospitalizations.

2.7. Calculating hospitalization rates

To compare absolute unintentional injury hospitalization rates by gender, the initial qualifying primary diagnosis of unintentional injury encounters was used to calculate directly standardized rates for both negative and positive BAC hospitalizations rather than the relative standardized hospitalization rates derived by indirect standardization. Rates were calculated as the ratio of the total sum of all events over the total sum of all populations at risk (e.g., all male patients in Chicago over the city's male population). This was performed using GeoDa software (referenced as excess risk maps in GeoDa). Annual and five-year census block group level population estimates downloaded from the US Census Bureau's ACS (denominator) for gender specific age groups for an equivalent study period were used. For example, ACS population estimates from 2005 to 2009 were used for patients hospitalized during 2006 and 2007 and ACS population estimates from 2006 to 2010 for patients hospitalized during 2008, and so on.

2.8. Analytical methods

Chi-square test was used to assess the frequency and age group differences in traumatic unintentional injury hospitalization by sex and BAC level during 2006–2015. To detect spatial clusters (low and high rates) of traumatic unintentional injury hospitalization for young people hospitalized with positive BAC (based on home address) by gender, SaTScan version 9.6 was applied by using a retrospective, space-time and the space-time permutation model (Kulldorff, 1997). For detecting space-time clusters, SaTScan uses cylindrical windows with a circular geographic base and the height of the cylinder matching to a specific interval in time. Spatial locations are specified individually (e.g., centers of block groups) to SaTScan. Moreover, many researchers have used this method to detect potential spatial clusters of different human diseases (Lian et al., 2007; Moise et al., 2013; Odoi et al., 2004).

To observe change over time, the same block groups were used as previously used in our similar study (Moise and Ruiz, 2016). I assumed a maximum spatial cluster size of 5% of the total population. I performed 999 Monte Carlo replications for statistical inference and rejected the null hypothesis of no clusters for the primary cluster if the p-value was $\leq$ to 0.05 and if the p-value was 0.1 for the secondary clusters mostly because the latter have conservative p-values. The dataset was transformed to a case file and geographic locations for cluster analysis. The maximum cluster dimensions were set to 20,000 feet, temporal variable was month, with a start date of January 1, 2006 and end date of December 31, 2015 and time precision was year. I exported the output to ArcGIS version 10.5 for mapping at the block group level.

Next, a longitudinal regression analysis by using the Generalized Estimating Equations (GEE) in the statistical package R, version 3.3.1 (Bates and Maechler, 2009) was used to assess the relationship between hospitalizations for patients with a positive BAC test result and individual and neighborhood correlates. GEE models have been used to analyze correlated data with binary, discrete, or continuous outcomes. In the current study and because the outcome variable had a limited range, a GEE model was fitted with binary logistic regression and census block group-specific random intercepts to assess annual rates of hospitalization adjusted for calendar year, age group, gender, race, insurance status, and the interactions of time with gender and race to determine trends over time. Interactions assessed changes in the rate of hospitalizations for patients with a positive BAC test result stratified by year. They also allowed flexibility in modelling differences for subgroups in slope over time. To maintain the scale of the GEE model, time (year of hospitalization) was centered at year 2010, all other years were relative to 2010. In addition, because inference from a GEE model is robust to misspecification in the within-cluster correlation structure but may not be as robust to unmodeled between-cluster correlation, an unstructured correlation matrix was used. This allows for a robust inference about measurements that are potentially correlated over time and the ability to make determinations about trends. I also reviewed residuals and the clear majority had relatively equal residuals suggesting that the correlation structure specification performed well. Crude and adjusted odds ratio (OR) with a 95% confidence interval (CI) for each point estimate from the models were also calculated.

As a secondary objective, I calculated age-adjusted hospitalization rates with their 95% confidence intervals for traumatic unintentional injury using the age composition of each census block group by BAC level for two time points 2006–2010 and 2011–2015. A possible increase in traumatic unintentional injury hospitalization rates among young people or reduction of outcomes in recent years, if they exist, could be attributable to many factors, including the changing field of prevention (beyond short term goals to long term goals) and the timing of prevention efforts, in addition to implementation of a combination of environmental strategies. However, I assumed that such an increase would be an important safety signal warranting further monitoring. A p-value of < 0.05 was considered significant, and all tests were 2-sided.

Table 1
Frequency of traumatic unintentional injury hospitalization by age group, sex and BAC, Chicago, Illinois.2006–2015.

Age group	Males		Females		Total (Overall Hospitalization Rate)	
	BAC+* N (%)	BAC-** N (%)	BAC+* N (%)	BAC-** N (%)	BAC+* % (95% CI)	BAC-**% (95% CI)
10–14	8 (0.6)	165 (8.0)	6 (1.2)	84 (7.9)	0.8 (0.5, 1.4)	8.0 (7.1, 9.0)
15–19	260 (20.6)	816 (38.7)	124 (24.8)	425 (39.8)	21.8 (19.9, 23.8)	39.8 (38.0,41.5)
20–24	993 (78.7)	1072 (52.2)	369 (73.9)	559 (52.3)	77.4 (75.3, 79.3)	52.3 (38.0, 41.5)
Total	1261	2053	499	1068	1,760	3,121

* BAC+: Blood alcohol concentration positive.
** BAC−: Blood alcohol concentration negative.

3. Results

Overall, 6233 young people aged 10–24 were hospitalized due to traumatic unintentional injuries in Chicago, Illinois between 2006 and 2015 (an average of 519 per year). The excluded totaled 1,311, including those missing patient level factors (e.g., race), cause of injury and BAC information. The final sample was 4922. The mean age of patients was similar over time (20–24 years), and there was no evidence in favor of a difference by gender (males 20; 95% CI, 19.93–20.11 and females 20; 95% CI, 19.95–20.09), $p = 0.206$. Patients hospitalized with positive BAC accounted for about a little over one-third (35%) of all-cause hospitalizations (Table 1).

Regarding patients hospitalized with positive BAC using a GEE model, I found that the adjusted odds of hospitalization decreased for all age groups (OR 0.94, 95% CI, 0.91-0.98) between 2006 and 2015 (Table 2). The odds of hospitalization are lowest among children aged 10–14, females (OR, 0.79; 95% CI 0.69-0.90) and for those with private insurance (OR, 0.69; 95% CI 0.59-0.81). However, males, Blacks and minority patients have higher odds of hospitalization (OR, 1.48; 95% CI 1.31–1.69). These hospitalizations were associated with neighborhood disadvantage (socio-economic index) (OR, 0.69; 95% CI 0.59-0.81), but not with interaction terms and time.

Table 2
GEE logistic regression adjusted odds ratios for traumatic unintentional injury hospitalizations in young people hospitalized with positive BAC and associated patient and neighborhood predictors, Chicago, Illinois.2006–2015.
Source: Illinois Department of Health Trauma Registry

	Odds Ratio (95%CI)	Robust Z	P-value
Time[a]	0.95 (0.91–0.99)	2.4567319	< .001
Age group			
10–14 (reference)	1.000		
15–19	5.63 (3.24–9.78)	6.1343681	< .001
20–24	15.40 (8.91–26.59)	9.8059302	< .001
Gender			
Male (reference)	1.000		
Female	0.79 (0.69–0.90)	−3.4385501	< .001
Race/ethnicity			
White (reference)	1.000		
Blacks and other minorities[b]	1.47 (1.29–1.67)	5.8626568	< .001
Insurance status			
No private insurance (reference)	1.000		
Insurance Private	0.68 (0.59–0.80)	4.6501146	< .001
Insurance Unknown	0.78 (0.67–0.90)	−3.3610139	< .001
Socioeconomic status (SES) index	1.003 (1.000–1.005)	2.3195161	
Interactions			
Female* Year of Hospitalization	1.07 (1.02–1.12)	2.691227	.004
Blacks and other minorities [a] * Year	1.06 (1.02–1.11)	2.668806	.004
SES Index*Year	1.00 (0.999–1.001)	−0.2811735	0.39

Excluded in this table are patients with unknown BAC (n = 41).
Abbreviations: CIconfidence interval; SESsocioeconomic index.
N = 4881.
Robust Z score are like a t-test-like value adjusted for inter-correlations.
[a] Time, Year of Hospitalization.
[b] Includes Chinese, Japanese, Hawaiian, Filipino, Korean, Asian Indian, Vietnamese, Other Guamanian; Samoan, American Indian; Alaska Native, Aleut, African American and other race.

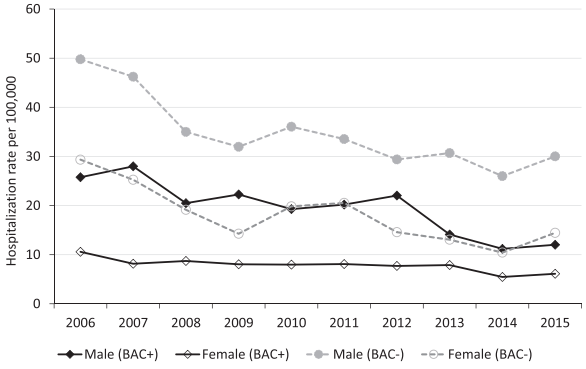

Fig. 1. Traumatic unintentional injury hospitalization by gender, BAC level and year.

Further analysis showed considerable gender differences in age-adjusted hospitalizations for patients hospitalized with positive BAC (Fig. 1). The hospitalization rate for males has declined since 2007 and the decline has accelerated in recent years. This can be illustrated by comparing 2006 and 2007 to 2014 and 2015 in which, the adjusted hospitalization rate declined for this subgroup. The adjusted rate in this subgroup declined from 2.2 per 100, 000 population between 2006 and 2007 to 0.8 by 2014 and 2015. The hospitalization rates for females decreased during 2014–2015 compared to 2006-2007.

Regardless of BAC test results, the overall hospitalization rate decreased for all age groups between the two study periods as suggested by the rates and 95% confidence intervals for the 2006–2010 and 2011–2015 periods. The adjusted hospitalization rate declined from 94.41 (95% CI, 90.98–97.95) during 2006–2010 to 67.69 per 100 000 population (95% CI, 64.72–70.78) by 2011–2015 (Table 3). However, among those hospitalized with positive BAC, the decline is much lower in males 23.16 (95% CI, 21.52–24.90) vs. 15.91 (95% CI, 14.54–17.39) than in females 8.69 (95% CI, 7.69–9.80) vs. 7.04 (95% CI, 6.13–8.06).

3.1. Geographic gender differences among those hospitalized with positive BAC

The space–time model detected one significant cluster ($p < 0.022$) for male hospitalizations, which occurred between January 1, 2015 and December 31, 2015 (Fig. 2). As shown in Fig. 2, a high proportion of hospitalizations for patients hospitalized with positive BAC detected by this most likely cluster is clustering in 33 block groups located in three Chicago Community Areas of South Lawndale, North Lawndale and Lower West Side. Surprisingly, there was no evidence of temporal clustering of females hospitalized with positive BAC (results not reported). This is an unexpected result.

Table 3
Age-standardized hospitalization rates of traumatic unintentional injury by BAC levels, Chicago, Illinois, 2006–2015.

	2006–2010			2011–2015		
	Rate BAC+[a] (95% CI)	Rate BAC-[a] (95% CI)	Rate Total[a] (95% CI)	Rate BAC+[a] (95% CI)	Rate BAC-[a] (95% CI)	Rate Total[a] (95% CI)
Total	31.86 (28.98-35.07)	61.49 (58.68-64.39)	94.41 (88.79-100.37)	22.95 (20.57-25.72)	44.54 (42.54-47.10)	67.69 (62.89-72.85)
Age group, years						
10–14	0.41 (0.20-0.76)	6.65 (5.67-7.76)	7.07(6.05-8.21)	0.18 (0.05-0.45)	3.87 (3.10-4.77)	4.05 (3.26-5.00)
15–19	9.24 (8.12-10.48)	27.08 (25.13-9.14)	36.73 (34.46-39.12)	5.68 (4.78- 6.71)	21.40 (19.59-23.30)	27.15 (25.12-29.30)
20–24	22.20 (20.67-3.83)	27.75 (26.03-29.57)	50.61 (48.28-53.04)	17.10 (15.74-18.55)	19.28 (17.84-20.83)	36.50 (34.50-38.59)
Gender						
Female	8.69 (7.69-9.80)	21.62 (19.97-23.38)	30.76 (28.80- 32.82)	7.04 (6.13- 8.06)	14.61 (13.22-16.11)	21.72 (20.05-23.51
Male	23.16 (21.52-24.90)	39.87 (37.62-42.22)	63.66 (60.85-66.57)	15.91 (14.54-17.37)	29.93 (27.92-32.04)	45.97 (43.53-48.52)
Cause of injury[b]						
Motor vehicle traffic	24.67 (22.98-26.47)	42.06 (39.75-4.47)	67.25 (64.37- 70.24)	17.11 (15.69- 18.64)	28.65 (26.70-30.71)	45.86 (43.43-48.40)
Falls	2.66 (2.12-3.31)	6.44 (5.56-7.44)	9.23 (8.17-10.40)	2.19 (1.70-2.79)	5.18 (4.37-6.12)	7.40 (6.43-8.47)
Cut/Pierce	0.56 (0.34-0.90)	0.94 (0.62-1.36)	1.57 (1.16- 2.08)	0.55 (0.32-0.91)	0.83 (0.53-1.25)	1.42 (1.02-1.95)
Fire/Burn	0.30 (0.15- 0.58)	2.76 (2.20-3.43)	3.10 (2.50-3.80)	0.088 (0.02-0.29)	1.47 (1.06-1.98)	1.55 (1.14-2.08)
Firearm	0.74 (0.47-1.13)	1.56 (1.13-2.10)	2.42 (1.88- 3.06)	0.38 (0.19- 0.70)	1.73 (1.26-2.32)	2.11 (1.59-2.75)
Struck by, against	0.33 (0.17-0.62)	2.46 (1.91-3.11)	2.79 (2.21- 3.48)	0.34 (0.17- 0.64)	2.38 (1.81-3.06)	2.72 (2.12-3.44)
Unspecified	0.32 (0.15- 0.60)	0.17 (0.05-0.41)	0.52 (0.29- 0.86)	0.22 (0.08- 0.50)	0.16 (0.05-0.40)	0.41 (0.21- 0.73)
Machinery	N/A	0.44 (0.24-0.74)	2.11 (1.59- 2.75)	N/A	0.30 (0.13-0.59)	0.30 (0.13-0.59)
Poisoning	0.12 (0.02-0.36)	0.18 (0.06- 0.44)	0.30 (0.13- 0.61)	0.041 (0.00-0.24)	0.20 (0.07-0.46)	0.24 (0.10- 0.52)
Drowning/Submersion	N/A	0.07 (0.01-0.27)	0.07 (0.01- 0.27)	0.03 (0.00-0.21)	0.14 (0.04-0.38)	0.17 (0.05-0.42)
Race						
White	11.05 (9.93- 12.28)	27.79 (25.90-29.79)	39.05 (36.84- 41.38)	8.05 (7.09-9.11)	21.52 (19.81-23.34)	29.67 (27.70-31.76)
Non-White[c]	20.80 (19.25-22.46)	33.69 (31.64- 35.85)	55.36 (52.76-58.07)	14.91 (13.57-16.35)	23.02 (21.28-24.87)	38.02 (35.81-40.33)
Insurance status						
Private	10.90 (9.77-12.13)	19.65 (18.06-21.35)	30.93 (28.95-33.01)	9.22 (8.17-10.38)	17.64 (16.09-19.32)	26.90 (25.01-28.91)
No private	8.22 (7.25- 9.29)	15.87 (14.48-17.37)	24.52 (22.80-26.35)	6.83 (5.95-7.82)	13.67 (12.35-15.10)	20.54 (18.94-22.25)
Unknown	12.74 (11.54-14.04)	25.97 (24.17-27.88)	38.97 (36.78-41.26)	6.90 (6.02-7.90)	13.23 (11.92-14.65)	20.25 (18.65-21.96)

Abbreviations: CI, confidence interval; BAC+ and BAC-, Positive and Negative Blood Alcohol Concentration test result; N/A,Rate ratios not calculated due to small numbers; TUI, Traumatic unintentional injury.

[a] External cause of injury is based on E-codes; Excluded in this table are patients with unknown BAC (n = 41).

[b] Age-adjusted hospitalization rates are based on age-specific hospitalization rates per 100, 000 population in 10–24 age group. Age-adjusted hospitalization rates are computed by the direct method, using as the standard population the age distribution of the total population of the United States for the year 2000.

[c] Chinese, Japanese, Hawaiian, Filipino, Korean, Asian Indian, Vietnamese, Other Guamanian; Samoan, American Indian; Alaska Native, Aleut, African American and other race.

3.2. Leading cause of traumatic unintentional injury hospitalizations

The results, as shown in Table 3, indicate that regardless of BAC level, motor vehicle traffic was the leading cause of hospitalizations for all age groups at 67.25 per 100 000 population (95% CI, 64.37–70.24) between 2006 and 2010 and 45.86 per 100 000 population (95% CI, 43.43–48.40) by 2011 and 2015. Falls were the second leading cause of hospitalizations and the third leading cause of hospitalization was struck by, against by 2011 and 2015. Overall, the rate of hospitalization for patients with a positive BAC ranged from 24.67 (95% CI, 22.98–26.47) for motor vehicle traffic to 0.12 (95% CI, 0.02-0.36) for poisoning during 2006 and 2010. It also ranged from 17.11 (95% CI, 15.69–18.64) for motor vehicle traffic to 0.03 (95% CI, 0.00-0.21) for drowning and submersion between 2011 and 2015.

4. Discussion

This study has identified trends and spatial patterning in rates of hospitalizations among young people in Chicago, Illinois between 2006 and 2015. Overall, hospitalization rates regardless of BAC level (negative or positive) showed decreasing trends over time especially for males, although the rates continue to be substantially higher for males than for females. Despite the lower rates for females, the decline for males with positive BAC between 2006–2007 and 2014–2015 was 1.4 times greater than the decline for females. This finding was unexpected and suggests that implemented underage drinking prevention strategies in Illinois, although may be resoundingly successful on males; they may have reached diminishing returns for females. This underscores the need to prioritize prevention interventions based on patient-centered goals and the relative impact and acceptability of these interventions.

The findings are also consistent with those of two other studies that reported gender differences, increasing age, being a minority, lack of insurance and residing in areas of lower socioeconomic status as risk factors for poor health outcomes (Swendsen et al., 2012; Heath et al., 1997). In the current study, I observed an increase in hospitalizations specifically among young adults and ethnic minorities, whose risk for alcohol related-injury increased with age, supporting evidence from previous studies (Snyder, 2011; Sorenson, 2011; Oyetunji et al., 2012). It has been previously documented that the increase in trauma hospitalizations in Chicago, particularly among urban African Americans is due to adolescent drinking (Green et al., 2011), which has been paralleled by an increase in crime, injuries, death and criminal persecution (Popovici et al., 2012; Branas et al., 2009; Brame et al., 2014; Smith et al., 1999). Other studies point to the effects of early experiences such as living in a violent neighborhood, poor schools, constrained social and economic success and mental health as important public health concerns (Moise and Ruiz, 2016; Burdick-Will, 2016). In this study, this elevated risk is due in part to the significant rate of motor vehicle traffic injuries.

Not surprising motor vehicle accidents were the leading cause of unintentional injury hospitalizations among young people regardless of BAC level. This finding has been clearly established (Heron, 2017; Pickett et al., 2012; Penning et al., 2010), and suggests that young drivers are more likely to become involved in a fatal collision than older drivers, even in the absence of alcohol. It is also somewhat surprising that motor vehicle accidents remain a major risk factor for traumatic unintentional injury despite the focus of a myriad of educational and regulatory interventions (Kempf et al., 2017). Further research should be undertaken to investigate the specific behaviors that render this subgroup at high risk. This may further our understanding of the

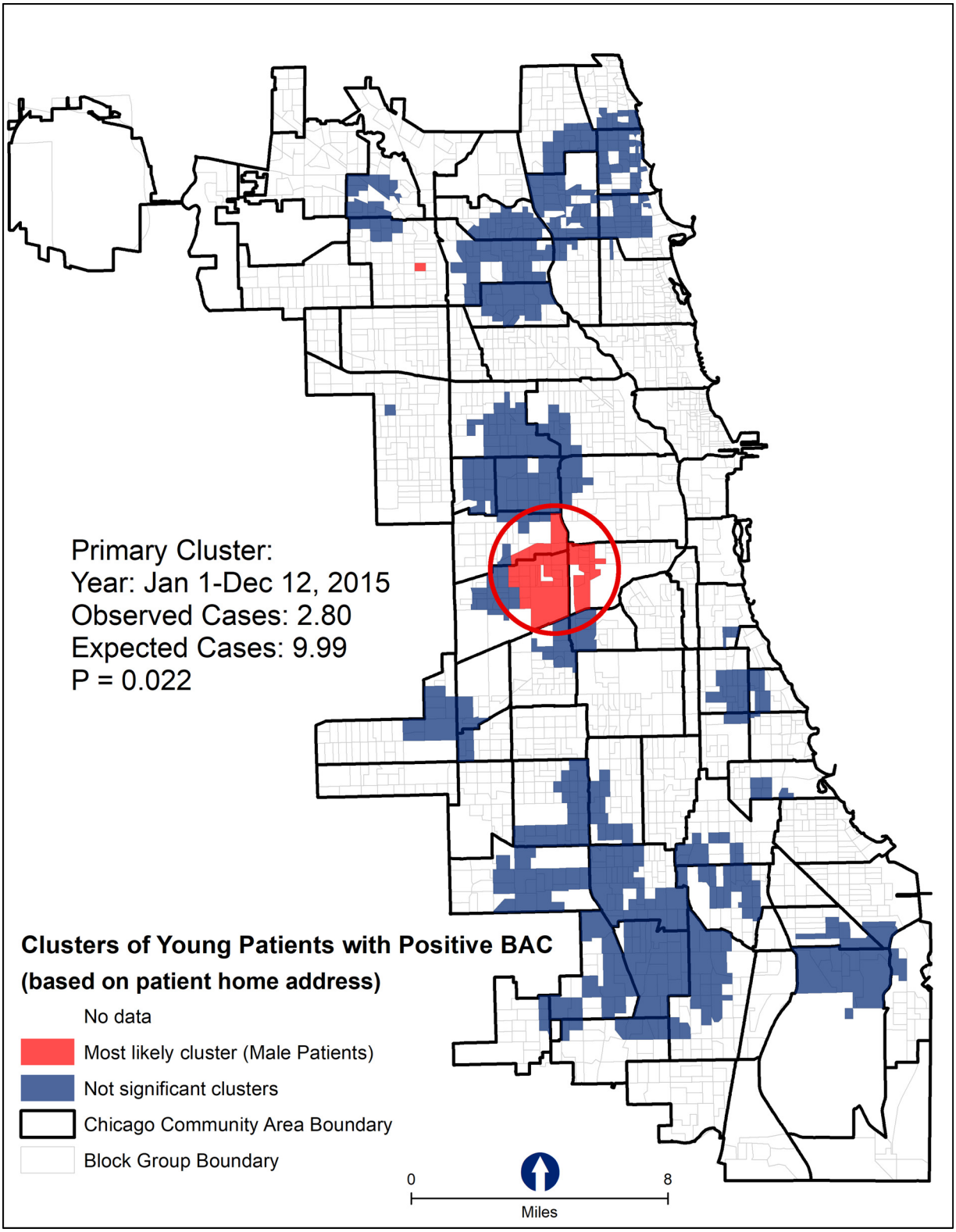

Fig. 2. Low and high-risk locations of young males hospitalized with positive BAC based on patient's census block group of residence, Chicago, Illinois, 2006–2015.

etiology of underage drinking problem, substance use behaviors and social conditions that shape such behaviors, and in determining the best entry points for deploying targeted and tailored interventions.

It is somewhat surprising that no spatial clustering was detected for females hospitalized with positive BAC but for their male counterparts. This finding is consistent with that of Veldhuizen and others (Veldhuizen et al., 2007) who found a high degree of spatial clustering of problematic substance use within major cities. It also accords our previous studies that reported elevated levels of substance use among males in New Orleans, after controlling for socio-economic factors (Moise and Ruiz, 2016) and greater hospitalization rates for those aged 10–19 in Illinois (Moise et al., 2019). This finding underscores the need

for continuous monitoring and adequate funding for state and community level underage drinking programs at this critical transitional life stage. These clusters are also located in Chicago Community Areas that also have high crime rates and poor individual achievement (Burdick-Will, 2018). This finding imply that underage drinking prevention interventions should tailor interventions to not only sex, but also specific communities based on the pertinent individual and contextual factors.

The trends identified in this study indicate that although there is an overall reduction in hospitalizations for traumatic unintentional injuries regardless of BAC level, the path is neither even nor stable. In some periods, rates show a sharp increase or no change. The observed overall decrease may be attributable to the State of Illinois' underage drinking prevention programs. Further research should be undertaken to determine the possible underlying factors.

4.1. Limitations

This study has several limitations. First, hospitalization data reported by the Illinois Department of Public Health (IDPH) Trauma Registry was used. Using trauma registry hospitalizations can be associated with issues of representativeness because IDPH designates only about one-third of hospitals as either Level I or Level II trauma centers in its trauma registry. Because of this, to calculate hospitalization rates, I only used a third of hospitals captured in the registry and excluded injured patients who died before reaching the hospital. In addition, the number of trauma centers and level designations have varied over time. However, because patient addresses were geocoded and analyzed at the census block group level, these findings suggest that not only are rates for these hospitalizations prominent in Chicago but also that the reported rates may be an underestimation at least in Chicago because trauma centers exist to treat the most serious, and often the costliest injuries. A further study that combines trauma registry data with hospital-based injury data is therefore, suggested.

4.2. Conclusions

This study is among the first to examine recent trends and geographic gender differences in unintentional injury hospitalizations among people hospitalized after trauma in Chicago. The findings demonstrate that traumatic unintentional injuries have continued to decrease among young people in Chicago, particularly among males but the risk is concentrated. Risk factors include being male, Black and being a minority race, older age and having no private insurance including living in disadvantaged neighborhoods. These trends present distinct risks and challenges to those working in the prevention of underage drinking and suggest the importance of prioritizing resources and a combination of individual and environmental strategies.

Contributors

IK Moise is responsible for this reported research. She conceptualized all aspects of the study (design, analyses, interpretation of results, drafted the manuscript, and manuscript revision).

Author contributions

All authors have read and approved the final manuscript.

Role of the funding source

Support for this research was provided by the Robert Wood Johnson Foundation, grant no.74738. The views expressed here do not necessarily reflect the views of the Foundation.

Declaration of Competing Interest

No conflict declared.

Acknowledgments

Thank you to the Illinois Department of Public Health for providing the patient data. The views expressed here do not necessarily reflect the views of the Illinois Department of Public Health.

Appendix A. Supplementary data

Supplementary material related to this article can be found, in the online version, at doi:https://doi.org/10.1016/j.drugalcdep.2019.107701.

References

Allison, Kevin W., Crawford, Isiaah, Leone, Peter E., Trickett, Edison, Perez-Febles, Alina, Burton, Linda M., Le Blanc, Ree, 1999. Adolescent substance use: preliminary examinations of school and neighborhood context. Am. J. Community Psychol. 27 (2), 111–141. https://doi.org/10.1023/A:1022879500217.

Bates, D., Maechler, M., 2009. lme4: Linear Mixed-effects Models Using S4 Classes.

Boles, Sharon M., Miotto, Karen, 2003. Substance abuse and violence: a review of the literature. Aggress. Violent Behav. 8 (2), 155–174. https://doi.org/10.1016/S1359-1789(01)00057-X.

Brame, Robert, Bushway, Shawn D., Paternoster, Ray, Turner, Michael G., 2014. Demographic patterns of cumulative arrest prevalence by ages 18 and 23. Crime Delinq. 60 (3), 471–486. https://doi.org/10.1177/0011128713514801.

Branas, C.C., Richmond, T.S., Ten Have, T.R., Wiebe, D.J., 2011. Acute alcohol consumption, alcohol outlets, and gun suicide. Subst. Use Misuse 46 (13), 1592–1603. https://doi.org/10.3109/10826084.2011.604371.

Branas, Charles C., Elliott, Michael R., Richmond, Therese S., Culhane, Dennis P., Wiebe, Douglas J., 2009. Alcohol consumption, alcohol outlets, and the risk of being assaulted with a gun. Alcohol. Clin. Exp. Res. 33 (5), 906–915. https://doi.org/10.1111/j.1530-0277.2009.00912.x.

Britt, Heather R., Carlin, Bradley P., Toomey, Traci L., Wagenaar, Alexander C., 2005. Neighborhood level spatial analysis of the relationship between alcohol outlet density and criminal violence. Environ. Ecol. Stat. 12 (4), 411–426. https://doi.org/10.1007/s10651-005-1518-3.

Brook, J.S., Nomura, C., Cohen, P., 1989. A network of influences on adolescent drug involvement: neighborhood, school, peer, and family. Genet. Soc. Gen. Psychol. Monogr. 115 (1), 123–145.

Burdick-Will, Julia., 2016. Neighborhood violent crime and academic growth in Chicago: lasting effects of early exposure. Soc. Forces 95 (1), 133–158. https://doi.org/10.1093/sf/sow041.

Burdick-Will, Julia., 2018. Neighborhood violence, peer effects, and academic achievement in Chicago. Sociol. Educ. 91 (3), 205–223. https://doi.org/10.1177/0038040718779063.

Chuang, Y.C., Ennett, S.T., Bauman, K.E., Foshee, V.A., 2005. Neighborhood influences on adolescent cigarette and alcohol use: mediating effects through parent and peer behaviors. J. Health Soc. Behav. 46 (2), 187–204. https://doi.org/10.1177/002214650504600205.

Conrod, Patricia J., 2016. Personality-targeted interventions for substance use and misuse. Curr. Addict. Rep. 3 (4), 426–436. https://doi.org/10.1007/s40429-016-0127-6.

Cook, R.L., Clark, D.B., 2005. Is there an association between alcohol consumption and sexually transmitted diseases? A systematic review. Sex. Transm. Dis. 32 (3), 156–164.

Crandall, M., Sharp, D., Unger, E., Straus, D., Brasel, K., Hsia, R., Esposito, T., 2013. Trauma deserts: distance from a trauma center, transport times, and mortality from gunshot wounds in Chicago. Am. J. Public Health 1103-9.

Cunningham, R.M., Walton, M.A., Carter, P.M., 2018. The major causes of death in children and adolescents in the United States. N. Engl. J. Med. 379 (25), 2468–2475. https://doi.org/10.1056/NEJMsr1804754.

Dellinger, Ann, Gilchrist, Julie, 2019. Leading causes of fatal and nonfatal unintentional injury for children and teens and the role of lifestyle clinicians. Am. J. Lifestyle Med. 13 (1), 7–21. https://doi.org/10.1177/1559827617696297.

Dir, A.L., Bell, R.L., Adams, Z.W., Hulvershorn, L.A., 2017. Gender differences in risk factors for adolescent binge drinking and implications for intervention and prevention. Front. Psychiatry 8, 289. https://doi.org/10.3389/fpsyt.2017.00289.

Duncan, S.C., Duncan, T.E., Biglan, A., Ary, D., 1998. Contributions of the social context to the development of adolescent substance use: a multivariate latent growth modeling approach. Drug Alcohol Depend. 50 (1), 57–71.

Duncan, S.C., Duncan, T.E., Strycker, L.A., 2002. A multilevel analysis of neighborhood context and youth alcohol and drug problems. Prev. Sci. 3 (2), 125–133.

Ennett, S.T., Flewelling, R.L., Lindrooth, R.C., Norton, E.C., 1997. School and neighborhood characteristics associated with school rates of alcohol, cigarette, and marijuana use. J. Health Soc. Behav. 38 (1), 55–71.

Fleming, Michael, Bhamb, Bhushan, Schurr, Michael, Mundt, Marlon, Williams, Andrea, 2009. Alcohol biomarkers in patients admitted for trauma. Alcohol. Clin. Exp. Res. 33 (10), 1777–1781. https://doi.org/10.1111/j.1530-0277.2009.01016.x.

Fone, David, Dunstan, Frank, White, James, Webster, Chris, Rodgers, Sarah, Lee, Shin,

Shiode, Narushige, Orford, Scott, Weightman, Alison, Brennan, Iain, Sivarajasingam, Vas, Morgan, Jennifer, Fry, Richard, Lyons, Ronan, 2012. Change in alcohol outlet density and alcohol-related harm to population health (CHALICE). BMC Public Health 12https://doi.org/10.1186/1471-2458-12-428. 428-428.
Gore, Fiona M., Bloem, Paul J.N., Patton, George C., Ferguson, Jane, Joseph, V.éronique, Coffey, Carolyn, Sawyer, Susan M., Mathers, Colin D., 2011. Global burden of disease in young people aged 10–24 years: a systematic analysis. Lancet 377 (9783), 2093–2102. https://doi.org/10.1016/S0140-6736(11)60512-6.
Green, Kerry M., Doherty, Elaine E., Zebrak, Katarzyna A., Ensminger, Margaret E., 2011. Association between adolescent drinking and adult violence: evidence from a longitudinal study of urban African Americans. J. Stud. Alcohol Drugs 72 (5), 701–710.
Gruenewald Paul, J., Remer, Lillian, 2006. Changes in outlet densities affect violence rates. Alcohol. Clin. Exp. Res. 30 (7), 1184–1193. https://doi.org/10.1111/j.1530-0277.2006.00141.x.
Hadland, Scott E., Xuan, Ziming, Sarda, Vishnudas, Blanchette, Jason, Swahn, Monica H., Heeren, Timothy C., Voas, Robert B., Naimi, Timothy S., 2017. Alcohol policies and alcohol-related motor vehicle crash fatalities among young people in the US. Pediatrics 139 (3), e20163037. https://doi.org/10.1542/peds.2016-3037.
Heath, A.C., Bucholz, K.K., Madden, P.A., Dinwiddie, S.H., Slutske, W.S., Bierut, L.J., Statham, D.J., Dunne, M.P., Whitfield, J.B., Martin, N.G., 1997. Genetic and environmental contributions to alcohol dependence risk in a national twin sample: consistency of findings in women and men. Psychol. Med. 27 (6), 1381–1396.
Herbert, Annie, Gilbert, Ruth, Cottrell, David, Leah, Li., 2017. Causes of death up to 10 years after admissions to hospitals for self-inflicted, drug-related or alcohol-related, or violent injury during adolescence: a retrospective, nationwide, cohort study. Lancet 390 (10094), 577–587. https://doi.org/10.1016/S0140-6736(17)31045-0.
Heron, Melonie, 2017. Deaths: leading causes for 2015. In: Division of Vital Statistics (Ed.), National Vital Statistics Reports. US DEPARTMENT OF HEALTH AND HUMAN SERVICES, Centers for Disease Control and Prevention, National Center for Health Statistics, National Vital Statistics System.
Holmes, J., Guo, Y., Maheswaran, R., Nicholls, J., Meier, P.S., Brennan, A., 2014. The impact of spatial and temporal availability of alcohol on its consumption and related harms: a critical review in the context of UK licensing policies. Drug Alcohol Rev. 33 (5), 515–525. https://doi.org/10.1111/dar.12191.
Howard, Virginia J., McClure, Leslie A., Kleindorfer, Dawn O., Cunningham, Solveig A., Thrift, Amanda G., Diez Roux, Ana V., Howard, George, 2016. Neighborhood socioeconomic index and stroke incidence in a national cohort of blacks and whites. Neurology 87 (22), 2340–2347. https://doi.org/10.1212/WNL.0000000000003299.
Jennings, Jacky M., Milam, Adam J., Greiner, Amelia, Furr-Holden, C.Debra M., Curriero, Frank C., Thornton, Rachel J., 2014. Neighborhood alcohol outlets and the association with violent crime in one mid-Atlantic City: the implications for zoning policy. J. Urban Health: Bull. N. Y. Acad. Med. 91 (1), 62–71. https://doi.org/10.1007/s11524-013-9821-z.
Kempf, C.édric, Llorca, Pierre-Michel, Pizon, Frank, Brousse, Georges, Flaudias, Valentin, 2017. What's new in addiction prevention in young people: a literature review of the last years of research. Front. Psychol. 8https://doi.org/10.3389/fpsyg.2017.01131. 1131-1131.
Krieger, N., 1992. Overcoming the absence of socioeconomic data in medical records: validation and application of a census-based methodology. Am. J. Public Health 82 (5), 703–710. https://doi.org/10.2105/ajph.82.5.703.
Krieger, N., Chen, J.T., Waterman, P.D., Soobader, M.J., Subramanian, S.V., Carson, R., 2003. Choosing area based socioeconomic measures to monitor social inequalities in low birth weight and childhood lead poisoning: The Public Health Disparities Geocoding Project (US). J. Epidemiol. Community Health 57 (3), 186–199. https://doi.org/10.1136/jech.57.3.186.
Kulldorff, Martin., 1997. A spatial scan statistic. Commun. Stat. - Theory Methods 26 (6), 1481–1496. https://doi.org/10.1080/03610929708831995.
Leventhal, Tama, Brooks-Gunn, Jeanne, 2000. The neighborhoods they live in: the effects of neighborhood residence on child and adolescent outcomes. Psychol. Bull. 126 (2), 309–337. https://doi.org/10.1037/0033-2909.126.2.309.
Lian, Min, Warner, Ronald D., Alexander, James L., Dixon, Kenneth R., 2007. Using geographic information systems and spatial and space-time scan statistics for a population-based risk analysis of the 2002 equine West Nile epidemic in six contiguous regions of Texas. Int. J. Health Geogr. 6 (1), 42. https://doi.org/10.1186/1476-072X-6-42.
Markowitz, S., Chatterji, P., Kaestner, R., 2003. Estimating the impact of alcohol policies on youth suicides. J. Ment. Health Policy Econ. 6 (1), 37–46.
Marshall, E.Jane., 2014. Adolescent alcohol use: risks and consequences. Alcohol Alcohol. 49 (2), 160–164. https://doi.org/10.1093/alcalc/agt180.
Moise, I.K., Green, D., Toth, J., Mulhall, P.F., 2014. Evaluation of an authority innovation-decision: brief alcohol intervention for pregnant women receiving women, infants, and children services at two Illinois health departments. Subst. Use Misuse 49 (7), 804–812. https://doi.org/10.3109/10826084.2014.880484.
Moise, I.K., Ruiz, M.O., 2016. Hospitalizations for substance abuse disorders before and after hurricane katrina: spatial clustering and area-level predictors, New Orleans, 2004 and 2008. Prev. Chronic Dis. 13, E145. https://doi.org/10.5888/pcd13.160107.
Moise, I.K., Verity, J.F., Kangmennaang, J., 2017. Identifying youth-friendly service practices associated with adolescents' use of reproductive healthcare services in post-conflict Burundi: a cross-sectional study. Int. J. Health Geogr. 16 (1), 2. https://doi.org/10.1186/s12942-016-0075-3.
Moise, Imelda K., Brown, Kenneth S., Riegel, Claudia, Kalipeni, Ezekiel, Ruiz, Marilyn O., 2013. Geographic Assessment of Unattended Swimming Pools in Post-Katrina New Orleans, 2006-2008. Ann. Assoc. Am. Geogr. 103 (5), 1160–1175.
Moise, Imelda K., Evan de Joya, Vinicius, Silva, Okada, Moise, Vanji, Farmer, Didi Bertrand, Orantia, Adelisa, 2019. Patient-level factors are more salient than a legislation prohibiting minors in bars in predicting unintentional injury hospitalizations. BMC Public Health 19 (1), 1010. https://doi.org/10.1186/s12889-019-7327-7.
Nesoff, E.D., Milam, A.J., Branas, C.C., Martins, S.S., Knowlton, A.R., Furr-Holden, D.M., 2018a. Alcohol outlets, neighborhood retail environments, and pedestrian injury risk. Alcohol. Clin. Exp. Res. 42 (10), 1979–1987. https://doi.org/10.1111/acer.13844.
Nesoff, E.D., Milam, A.J., Pollack, K.M., Curriero, F.C., Bowie, J.V., Knowlton, A.R., Gielen, A.C., Furr-Holden, D.M., 2018b. Neighbourhood alcohol environment and injury risk: a spatial analysis of pedestrian injury in Baltimore City. Inj. Prev. https://doi.org/10.1136/injuryprev-2018-042736.
Odoi, Agricola, Wayne Martin, S., Michel, Pascal, Middleton, Dean, Holt, John, Wilson, Jeff, 2004. Investigation of clusters of giardiasis using GIS and a spatial scan statistic. Int. J. Health Geogr. 3 (1). https://doi.org/10.1186/1476-072X-3-11. 11-11.
Oyetunji, Tolulope A., Stevenson, Adrienne A., Oyetunji, Aderonke O., Onguti, Sharon K., Ames, Sarah A., Haider, Adil H., Nwomeh, Benedict C., 2012. Profiling the ethnic characteristics of domestic injuries in children younger than age 5 years. Am. Surg. 78 (4), 426–431.
Penning, R., Veldstra, J.L., Daamen, A.P., Olivier, B., Verster, J.C., 2010. Drugs of abuse, driving and traffic safety. Curr. Drug Abuse Rev. 3 (1), 23–32.
Pickett, William, Davison, Colleen, Torunian, Michael, McFaull, Steven, Walsh, Patricia, Thompson, Wendy, 2012. Drinking, substance use and the operation of motor vehicles by young adolescents in Canada. PLoS One 7 (8). https://doi.org/10.1371/journal.pone.0042807. e42807-e42807.
Popovici, Ioana, Homer, Jenny F., Fang, Hai, French, Michael T., 2012. Alcohol use and crime: findings from a longitudinal sample of U.S. adolescents and young adults. Alcohol. Clin. Exp. Res. 36 (3), 532–543. https://doi.org/10.1111/j.1530-0277.2011.01641.x.
Reboussin, Beth A., Preisser, John S., Song, Eun-Young, Wolfson, Mark, 2010. Geographic clustering of underage drinking and the influence of community characteristics. Drug Alcohol Depend. 106 (1), 38–47. https://doi.org/10.1016/j.drugalcdep.2009.07.019.
Roux, A.V., Diez, C.I., Kiefe, D.R., Jacobs, M., Haan, S.A., Jackson, F.J., Nieto, C.C., Paton, Schulz, R., 2001. Area characteristics and individual-level socioeconomic position indicators in three population-based epidemiologic studies. Ann. Epidemiol. 11 (6), 395–405. https://doi.org/10.1016/S1047-2797(01)00221-6.
Runyan, Carol W., Casteel, Carri, Perkis, David, Black, Carla, Marshall, Stephen W., Johnson, Renee M., Coyne-Beasley, Tamera, Waller, Anna E., Viswanathan, Shankar, 2005a. Unintentional injuries in the home in the United States: part I: mortality. Am. J. Prev. Med. 28 (1), 73–79. https://doi.org/10.1016/j.amepre.2004.09.010.
Runyan, Carol W., Perkis, David, Marshall, Stephen W., Johnson, Renee M., Coyne-Beasley, Tamera, Waller, Anna E., Black, Carla, Baccaglini, Lorena, 2005b. Unintentional injuries in the home in the United States: part II: morbidity. Am. J. Prev. Med. 28 (1), 80–87. https://doi.org/10.1016/j.amepre.2004.09.017.
Salam, R.A., Arshad, A., Das, J.K., Khan, M.N., Mahmood, W., Freedman, S.B., Bhutta, Z.A., 2016. Interventions to prevent unintentional injuries among adolescents: a systematic review and meta-analysis. J. Adolesc. Health 59 (4S), S76–S87. https://doi.org/10.1016/j.jadohealth.2016.07.024.
Sleet, David A., Ballesteros, Michael F., Borse, Nagesh N., 2010. A review of unintentional injuries in adolescents. Annu. Rev. Public Health 31 (1), 195–212. https://doi.org/10.1146/annurev.publhealth.012809.103616.
Smith, Gordon, Branas, Charles, Miller, Ted, 1999. Fatal Nontraffic Injuries Involving Alcohol: A Metaanalysis Vol. 33.
Snyder, H.N., 2011. In: U.S. Department of Justice (Ed.), Arrest in the United States, 1980-2009. U.S. Department of Justice, Washington, DC.
Sorenson, Susan B., 2011. Gender disparities in injury mortality: consistent, persistent, and larger than you'd think. Am. J. Public Health 101 (Suppl 1), S353–S358. https://doi.org/10.2105/AJPH.2010.300029.
Staras, Stephanie As, Livingston, Melvin D., Komro, Kelli A., 2016. Increased partner risk characteristic among adolescents using alcohol in the moment. Sex. Transm. Dis. 43 (9), 537–541. https://doi.org/10.1097/OLQ.0000000000000481.
Stern Scott, Wares Amy, 2017. Social Progress Index 2017: Methodological Report.
Swahn, Monica H., Simon, Thomas R., Hammig, Bart J., Guerrero, Janet L., 2004. Alcohol-consumption behaviors and risk for physical fighting and injuries among adolescent drinkers. Addict. Behav. 29 (5), 959–963. https://doi.org/10.1016/j.addbeh.2004.02.043.
Swendsen, Joel, Burstein, Marcy, Case, Brady, Conway, Kevin P., Dierker, Lisa, He, Jianping, Merikangas, Kathleen R., 2012. Use and abuse of alcohol and illicit drugs in US adolescents: results of the National Comorbidity Survey-Adolescent Supplement. Arch. Gen. Psychiatry 69 (4), 390–398. https://doi.org/10.1001/archgenpsychiatry.2011.1503.
Treno, Andrew J., Johnson, Fred W., Remer, Lillian G., Gruenewald, Paul J., 2007. The impact of outlet densities on alcohol-related crashes: a spatial panel approach. Accid. Anal. Prev. 39 (5), 894–901. https://doi.org/10.1016/j.aap.2006.12.011.
Trim, R.S., Chassin, L., 2008. Neighborhood socioeconomic status effects on adolescent alcohol outcomes using growth models: exploring the role of parental alcoholism. J. Stud. Alcohol Drugs 69 (5), 639–648. https://doi.org/10.15288/jsad.2008.69.639.
Veldhuizen, S., Urbanoski, K., Cairney, J., 2007. Geographical variation in the prevalence of problematic substance use in Canada. Can. J. Psychiatry 52 (7), 426–433.
White, A., Castle, I.J., Chen, C.M., Shirley, M., Roach, D., Hingson, R., 2015. Converging patterns of alcohol use and related outcomes among females and males in the United States, 2002 to 2012. Alcohol. Clin. Exp. Res. 39 (9), 1712–1726. https://doi.org/10.1111/acer.12815.
Whitman, Steven, Silva, Abigail, Shah, Ami, Ansell, David, 2004. Diversity and disparity: GIS and small-area analysis in six Chicago neighborhoods. J. Med. Syst. 28 (4), 397–411. https://doi.org/10.1023/B:JOMS.0000032854.99522.0d.
Wilson, N., Syme, S.L., Boyce, W.T., Battistich, V.A., Selvin, S., 2005. Adolescent alcohol, tobacco, and marijuana use: the influence of neighborhood disorder and hope. Am. J. Health Promot. 20 (1), 11–19. https://doi.org/10.4278/0890-1171-20.1.11.