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Youth's Daily Activities and Situational Triggers of Gunshot Assault in Urban Environments

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Abstract

Purpose—Although previous research has made progress in identifying individuals predicted to face an elevated risk of being shot, it is not clear how that risk varies within individuals based on the contexts they encounter as they navigate daily life. The current study examines how the convergence of individual risk activity and neighborhood disadvantage and disorder triggers the risk of being shot.

Methods—Using a novel geographic information system (GIS) application, 123 male gunshot assault victims between 10–24 years old in Philadelphia, Pennsylvania described their minute-by-minute movements over the course of the day of the gunshot assault. Through latent class analysis, the primary exposure was real-life circumstance where nine theoretically informed risk factors converged, compared with two other circumstances. Case-crossover analyses of subjects' 10-minute segments of full-day activities compared gunshot assault victims at the time of assault with themselves earlier in the day.

Results—Compared to when individuals were exposed to minimal situational risk or were mainly exposed to neighborhood disadvantage and disorder, the concurrence of risk activity and neighborhood disadvantage and disorder was associated with a 9.90 (95%CI: 2.72–36.14) and 6.06 (95% CI: 2.78–13.22) times higher risk of being shot. Importantly, the likelihood of being in the high-risk circumstance increased systematically over the course of the day leading up to the time when young individuals were shot.

Conclusions—After controlled individual's propensity to be shot (e.g. inherent traits), the concurrence of situational risks emerged as significant triggers of gunshot assault. The findings suggest potential for community-based gunshot violence interventions.

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Keywords

Gunshot assault; momentary analysis; risk profiles; routine activities; community-based intervention

Gun-related homicide kills approximately twelve 10 to 24 year olds each day; 75 others were treated in emergency departments for assault-related gunshot nonfatal injuries (1, 2). Such problems disproportionately affect males overall and African Americans males in particular, and are largely an urban phenomenon (3). Correlates of youth violence have been identified at the individual, family, peer/school, community and societal levels (4–7), including alcohol or drug use, neuropsychological deficits, chronic stress from exposure to violence, poor parent-child relationship, family conflict, and living in disadvantaged, disordered neighborhoods (8). Being relatively stable, these factors can help identify individuals predicted to face an elevated risk of being shot, and inform preventive interventions. Equally important are efforts to identify how the likelihood of being shot varies within individuals, even those at generally high risk, based on the contexts they encounter as they navigate daily activities.

Situational theories of crime suggest that proximal predictors of violent assault are found within individuals' immediate contexts (9). According to routine activities theory, most criminal acts require convergence in space and time of likely offenders, suitable targets, and the absence of capable guardians (10, 11). Knowing the situational context of where individuals are, whom they are with, and what they are doing is crucial, then, to understand why an individual is assaulted at a particular location and time rather than another (12). From an emergent transactional perspective, these situational or compositional factors also partially determine the schemas or scripts that youth bring into, and modify within, violent contexts and have important influence on the development and outcome of violent exchanges (13–15).

Research on situational correlates of crime and violence has identified 6 individual activities that are likely to increase an individual's likelihood of being assaulted, in particular, in the context of youth-on-youth street violence: *presence of friends*, *absence of guardians (e.g. without adult family members)*, *being in public/outdoor space*, *involvement in unstructured activities (e.g. wandering around without any purpose)*, *weapon carrying* and *substance use* (16–21). Yet no studies have monitored youth over time in a fashion that would enable an explicit test of whether risk is elevated during the convergence in time and space of these factors. Moreover, individuals' routine activities are embedded in a neighborhood context. *Low socioeconomic status (SES)*, *dilapidation (e.g. vacant properties)*, and *opportunities for crime (e.g. the presence of alcohol outlets or vandalism)* render a community incapable of maintaining effective social controls, thus attracting crime-prone individuals to the neighborhood and driving out the least deviant (22). *Neighborhood connectedness or collective efficacy (e.g. sense of belonging and mutual trust)* can confer protective effects, and also mediate the adverse contribution of structural disadvantage to violence (23–25).

Two obstacles have impeded empirical investigations of situational violence prevention. First, situational risks seldom operate in isolation, but interact with each other to predict

gunshot assault. Rather than modeling individual variables, a holistic approach is required that constructs risk profiles that map onto the multifaceted real-life situations individuals encounter (26, 27). Second, given the short induction period for time- and location- specific exposures for assault, *momentary* data are required that reveal how exposures emerge or subside intermittently during individuals' lived experiences. Although victims of assault are found more likely to engage in high-risk activities than non-victims (16, 21), previous work has not been able to establish whether violence erupts during specific, often fleeting moments when individuals are conducting high-risk activities.

We developed a novel approach that captured information on youths' step-by-step movements over a full day, up to and including the time when they were assaulted. Through latent class analysis, our analyses investigated when and how situational characteristics converged over the course of each individual's activities at specific locations and times, and whether these instances triggered the risk of being shot (28).

METHODS

Study Sample

We conducted the Space-Time Adolescent Risk Study in Philadelphia, Pennsylvania, which enrolled 123 gunshot assault victims, 175 victims of non-gunshot assault, and 274 community controls between 2005 and 2009. All were male and between 10 and 24 years old. The assault victims were enrolled from the emergency departments of a pediatric and an adult Level 1 trauma center located adjacently in central Philadelphia. Details of the methods of study have been reported previously (29). In the current investigation, we analyzed only the gunshot cases and used a case-crossover approach, in which participants act as their own control. This approach minimized the possibility that time-invariant characteristics of the individuals would bias results. The study was approved by the institutional review boards of the University of Pennsylvania and The Children's Hospital of Philadelphia.

Data Collection

A trained interviewer administered a GIS-assisted survey to each subject at our research office, at the subject's home, or in the hospital, on average four days after being shot. Each subject sequentially described his activities by time and location for the day they were shot, starting from the time of waking up. Whenever the subject reported a change in location or activity/behavior, a new data point was added into the GIS application with attribute information including time, companions, activity, indoors or outdoors, transportation mode, weapon carrying, substance use, and location latitude and longitude. Through drawing points on the street map, the interviewer created a graphic that provided a detailed record of how, when, where, and with whom the subject spent time over the course of the full day as he walked or otherwise traveled from location to location and from activity to activity up until and including the time of being shot. We divided each participant's data record into sequential ten-minute segments for analysis.

We accessed geographic data for the city of Philadelphia from the U.S. Census, the Philadelphia Housing Authority, the Philadelphia Police Department, and the Philadelphia Health Management Corporation's Southeastern Pennsylvania Household Health Survey. We converted each geographic variable to a raster map layer that spanned the entire area of Philadelphia. Each variable, measured on a continuous scale, represented the prevalence or nature of each characteristic at any specific location. We considered this a better approach than taking values aggregated within arbitrary administrative units (e.g. Census block groups). By appending these geographic data by latitude and longitude to each path point of each subject's activities, we derived estimates, with high spatial and temporal specificity, of the exposure history experienced by each subject.

Situational Risk Measures

All situational factors that subjects experienced over the course of their reporting period were classified as dichotomous variables. *Presence of friends* indicates whether the subject was with friends at a path point. *Absence of guardians* indicates whether any adult family members or other adults known to the subject such as friends' parents or adult neighbors were present at a path point. Participants were considered to have been at *an outdoor/public space* when they reported being outdoors at a given path point or in a car or on public transportation. Because participants reported their activities at each path point in the format of free text, we operationalized *unstructured activities* based on two criteria (17–19): indicating no agenda on how time was being spent; indicating wandering or socializing as their main activity. *Weapon carrying* indicates whether the subject carried any weapon at a path point such as a gun, a bladed, or a blunt weapon. *Substance use* indicates whether the subject used any illegal drugs or alcohol at a path point.

Informed by previous research and results from factor analysis, we created a latent measure of *neighborhood socioeconomic status (SES)* using five U.S. Census variables (See Appendix A). Using five questions from the Southeastern Pennsylvania Household Health Survey, *neighborhood connectedness* assesses whether neighbors feel close to and trust each other (See Appendix A). *Neighborhood opportunities for crime* was assessed by six variables representing the density of alcohol outlets, disorderly conducts, narcotic arrests, vacant properties, vandalism and criminal mischief, and exposure to violence at any location along a subject's activity path. Since we created neighborhood measures through factor analyses, they were continuous in nature; we dichotomized each at its median in order to use them in our statistical analysis.

In total, we classified the activities of each subject sequentially, at 10 minute intervals over a period of up to 24 hours, according to the presence or absence of 9 characteristics hypothesized as situational triggers for the risk of being shot.

Statistical Analysis

We generated descriptive information about situational characteristics the subjects were exposed to before and at the time of the assault. Then treating the path point when the shooting occurred as the outcome event, we modelled each of the 9 situational risk variables in crude and multivariate conditional logistic regression with robust standard errors to

examine whether there was something different about subjects' activities, or the conditions of their surroundings, at the time of being shot versus earlier in the day (i.e. during all prior 10-minute intervals). Next, we employed latent class analysis (LCA) to create risk profiles based on the 9 dichotomous variables, thereby identifying patterns of co-occurrences in terms of how activities, behaviors and experiences converged in real-life situations (30). Once situational profiles were constructed, we again used conditional logistic regression to derive estimates of whether certain profiles posed a heightened risk of gunshot injury or conferred protection. Statistical testing was 2-sided with a threshold of $P<.05$. Analyses were performed with using Stata (Version 14.1; StataCorp 1996–2015).

RESULTS

The data for the 123 subjects consisted of 8,162 points representing the paths of these individuals' activities. The vast majority (96%) of the respondents were African American. The median age was 19 years, 17% reported usually getting As and Bs in school and 55% got Bs and Cs, and the median household income of areas where they lives was $24,000. Most (73%) were shot between 6:00pm and 2:00am.

Table 1 summarizes situational conditions experienced during the subjects' activities. It is apparent that, except for substance use, subjects were more likely to experience these hypothesized risk factors at the time when they were shot than at times preceding being shot. The overall rates for weapon carrying and substance use during the day were low.

The results of the conditional logistic regressions estimating relationships between the situational conditions and gunshot assault are reported in Table A1. Presence of friends, absence of guardians, being at an outdoor/public space, unstructured activities, and low neighborhood SES were related to elevated odds of gunshot assault when examined in crude analyses. When included in a single multivariate model, only being at an outdoor/public space and in a neighborhood with low SES were related to increased odds of gunshot assault.

To enable the analysis of when these conditions occurred simultaneously as in real-life situations, we identified that a three-class LCA model was appropriate for the data, optimizing the balance between interpretability and model fit (See Table A2 for the fit statistics) (30). Figure 1 displays how situational conditions co-occurred in real-life situations. Profile 1 (15.2%) was characterized by path points when individuals were outdoors, without guardians, exposed to relatively low neighborhood disadvantage and disorder. Profile 2 (37.5%) comprised of path points when individuals engaged in weapon carrying, and were more likely to be in a neighborhood with high neighborhood disadvantage and disorder, than were conditions characterized under Profile 1. Profile 3 (47.3%) was characterized by path points when individuals experienced all of the 9 risk activity and environmental conditions.

Figure 2 shows a striking pattern by arraying these data over time, and reveals that the likelihood of being in a high-risk situation, Profile 3, increased systematically over the course of the day leading up to the time when young individuals were shot. Conversely,

fewer individuals were in the lower risk situations, Profile 1 and Profile 2, as time approached the moment of gunshot assault. These exposure patterns indicated that gunshot assault victims gradually travelled into the identified high-risk circumstance.

Table 2 reports estimates of whether and how time spent in each of the three situational profiles triggered a risk of being shot. Compared with Profile 1 or 2 as the reference category, individuals under Profile 3 conditions were 9.90 [95% CI: 2.72, 36.14] and 6.06 [95% CI: 2.78, 13.22] times more likely to be shot. Compared with Profile 1, individuals under Profile 2 conditions were not more or less likely to be shot.

Last, we used the models reported in Table 2 to examine how each individual activity related to the likelihood of being shot while embedded in a particular neighborhood context. Figure 3 plots the difference of the mean predicted probabilities of being shot (with 95% confidence interval) that were associated with each individual activity while in a high versus low level of environmental risk. High environmental risk path points were characterized by at least two of the three neighborhood risk measures; low environmental risk path points were characterized by at most one. The results indicate that the adverse effects of absence of guardians, and being at an outdoor/public space on gunshot assault were stronger in areas of high environmental risk, whereas the adverse impact of presence of friends was stronger at low environment.

DISCUSSION

To the best of our knowledge, this is the first study to accomplish a *momentary* analysis of situational exposures, rather than using aggregated measures of individual involvement in or experience with high-risk activities or contexts, and to take a holistic, real-life approach to examine why youth were shot when in their specific location and context as opposed to earlier.

We identified 9 factors that, based on theory, were thought to be triggers for gunshot assault. Two of these were found to be associated with gunshot assault when treated as independent covariates entered simultaneously in a single regression model. The large odds ratio associated with being at an outdoor/public space reflected that the vast majority of gunshot incidents occurred outdoors; yet it failed to capture the complex interrelationships among the situation-specific risk that subjects experienced during real-life circumstances. For instance, as Figure 1 shows, individuals under Profile 1 conditions had twice the probability of being at an outdoor/public space as individuals under Profile 2 conditions; however, the risk of gunshot assault was not higher under Profile 1 conditions than under Profile 2 conditions. Gunshot assault risks were not driven by a single isolated measure.

The associations between situational profiles and gunshot assault confirmed the value of taking a holistic approach and studying the constellation of risks. When individuals engaged in risk activities while in high-risk environments, their odds of being shot were 9.90 and 6.06 times higher than when they were under the other two real-life circumstances. Also, we observed that absence of guardians and being at an outdoor/public space acted more strongly as triggers for gunshot assault when in disorganized surroundings. It is not surprising that

being outdoors is more dangerous when in an area where the degree of disorganization is high, and adult guardians are to discourage violent acts (31). In contrast, presence of friends acted more strongly as triggers when in an area where the degree of environmental risk is low: when surroundings are relatively safe, hanging out with friends can enhance the likelihood of gunshot assault through impulsive/careless, “rowdy” behaviors (32).

A clear implication is that addressing high-risk situational contexts is critical for preventing gunshot assault. When an individual’s propensity to be shot (e.g. inherent traits or personal history) was controlled for using the case-crossover approach, situational profiles emerged as significant triggers of assault. Previous work has established the associations between situational correlates and violent assault at the *individual* level; however, for the first time, the current study shows that these associations function at the *momentary* or incident-level, representing important progress in understanding the etiology of urban violence. Our results also indicate the importance of studying real-life circumstances as they co-occur rather than as a set of distinct individual variables. The significance of any one exposure is contingent upon the states of other exposures at specific points in time. A valuable next step could involve conducting qualitative research to elucidate dynamics at play during the circumstances and in the settings represented by the three profiles we identified as relating differentially to the risk of urban gun violence. Prior work in this area includes Wilkinson’s emergent situational and transactional model of urban youth violence, where she developed a typology of youth violence situations and examined how conflict situations evolved from angry arousal to violence and the variety of roles different parties played in violent events (13–15).

At the same time, our results emphasize the importance of a comprehensive youth violence prevention strategy. From a situational crime prevention standpoint (33), we need to *increase the effort* required of youth to harm their opponent, *increase the risk* of committing violence, *reduce the rewards* of committing violence, *reduce the provocations* for violence, and *remove excuses* for violence. Making structural changes to the built environment, such as converting vacant lots to green spaces or remediating abandoned buildings and houses, can confer protection against gun violence. These changes encourage residents to go outside and take advantage of public spaces, thus increasing surveillance of prior unsupervised areas of neighborhoods. Strategies like these have recently been found to reduce violence in the surrounding area (34–36). Supportive relationships between youth involved in violence and adults are rare. Rather than allowing youth to seek social support from their near same-age peers and get violence-reinforcing messages, conventional social support from families and schools should be promoted. Networks of social support create a nurturing environment that provides acceptance and a sense of belonging and self-worth, and supply physical and human capital needed to refrain from violence and enhance prosocial modeling. In addition, social support creates the context in which informal and formal social control can be effectively realized (37–39). At a community level, enhancing community organization through social cohesion and shared expectations for action, and developing informal mechanisms to mediate conflict and assist youth in making sense of the violent event is a worthwhile strategy (15). By combining efforts from multiple agencies, we can keep youth from having lots of unstructured time with friends in unregulated public places.

Despite the many strengths of this study, there are limitations. First, we were only able to study subjects who survived an assault. We know of no literature or clinical evidence, however, suggesting that a disparity exists systematically between urban violent assault victims who live versus die (29). Second, situational triggers were measured retrospectively and thus subject to recall or social desirability bias. Recent analyses using data from the same study, however, have shown evidence that the activity path data accurately represent the experiences of the subjects being studied (29, 40). Third, though we measured the situational triggers thought relevant by theory, perhaps unobserved time-varying covariates contribute uniquely to the risk of gunshot assault. Results of sensitivity tests that included intermittent, time-varying covariates for temperature, precipitation, neighborhoods gun ownership, and police and fire station density (that could be hypothesized to confer protection) were similar to the results reported here. Fourth, we dichotomized the environmental measures at the median in order to conduct latent class analysis and facilitate interpretation. In doing this, we might have reduced capability to observe important influence of neighborhood contexts on gunshot assault. Fifth, the results are derived from a sample of mostly young black men in Philadelphia, Pennsylvania, USA. Replication efforts are needed to establish the generalizability of our findings across different settings. Finally, by comparing each subject at the time they were shot to themselves 10 minutes earlier and also at every previous 10-minute point that day, we treated the induction period as being as brief as 10 minutes. We took this approach because it was conservative (i.e. may produce bias toward the null) compared to if we had control observations that occurred earlier in the day (e.g., one, two, or more hours before) (28). Figure 2 supports this position by revealing how the likelihood of being in a high-risk situation decreased systematically with time elapsed before being shot. We have reserved an investigation into the duration of induction periods for situational triggers of violent assault for a separate study.

In sum, we demonstrated the value of documenting how individuals navigated their daily activity space, and examining the role of real-time situations and environments on health issue of being shot. Situational triggers co-occurred in space and time in meaningful patterns and put young people at risk to be shot at specific moments during their day. Importantly, these intermittent situational triggers were detected here only through our holistic analytic approach. Our results also suggest that activities and situations that individuals engage in may relate either more strongly or weakly to the risk of gunshot assault contingent upon the immediate context of their current surroundings. These results advance our understanding of gunshot assault from a real-time, real-life standpoint, and identify priority factors that can be targeted to confer protection for youth as they travel through contexts in the urban environment.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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Implications and Contribution

This study investigates proximal predictors of gunshot assault from a within-person angle. These results advance our understanding of gunshot assault from a real-time, real-life standpoint, and identify priority factors that can be targeted to confer protection for youth as they travel through urban environment.

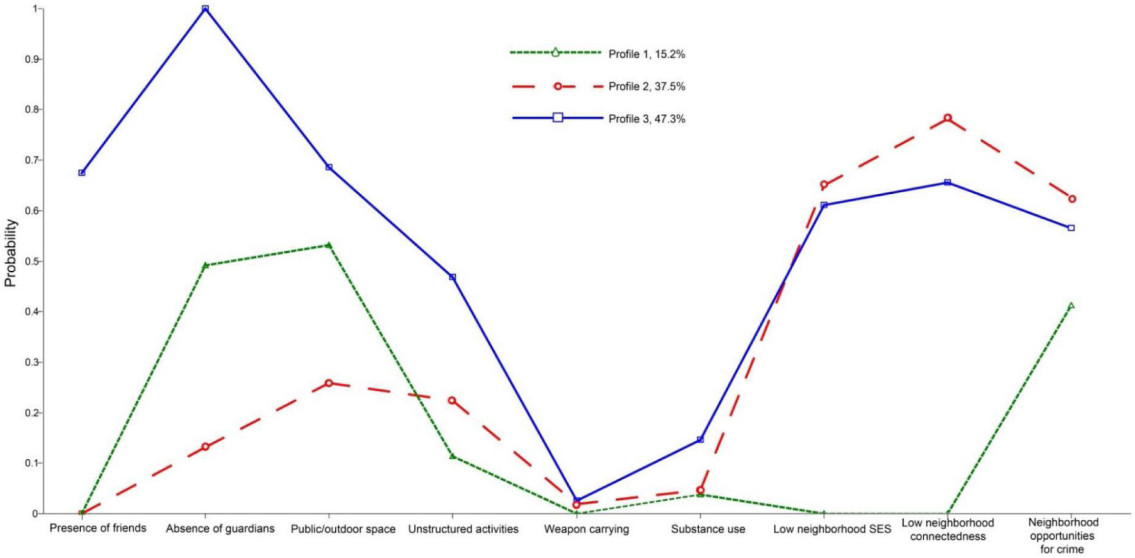
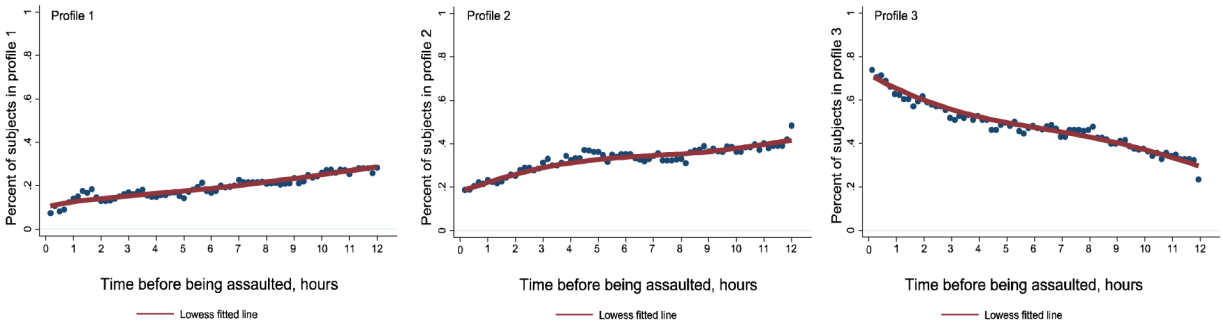


Figure 1.
Latent classification of situational risks surrounding youth at activity path points



	Profile 1	Profile 2	Profile 3
With friends			√
No guardians			√
Outdoors	√		√
Unstructured activities			√
Weapon carrying		√	√
Substance use			√
Low neighborhood SES		√	√
Low neighborhood connectedness		√	√
Opportunities for crime		√	√

Figure 2.

Percent of 10 to 24 year olds engaged in activities and circumstances defined as profile 1, profile 2, or profile 3 at the time of being shot and during every 10-minute period over the 12 hours leading up to the time of being shot

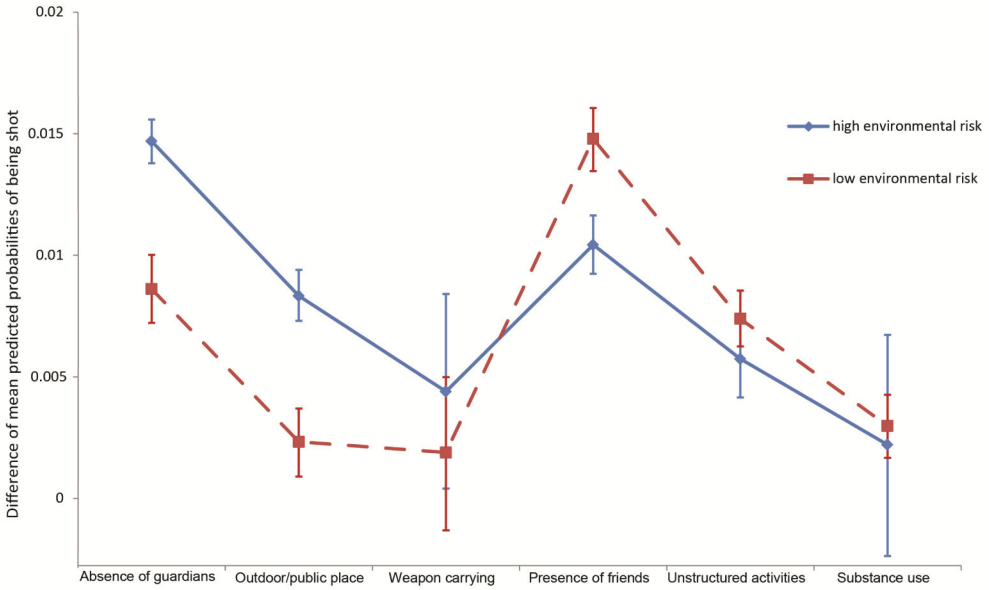


Figure 3.

Difference of mean predicted probabilities of being shot associated with each individual activity at high versus low environmental risk

Table 1

Descriptive Statistics of 10 to 24-Year-Old Study Subjects' Risk Activities and Environmental Characteristics over the Course of a Day

Variables	Injury points (*N*=123)	All path points (*N*=8162)
	Proportion	Proportion
Gunshot wound assault	1.000	0.015
Presence of friends	0.423	0.319
Absence of guardians	0.789	0.597
Outdoor/public space	0.927	0.502
Unstructured activities	0.423	0.314
Weapon carrying	0.041	0.019
Substance use	0.081	0.092
Low neighborhood SES	0.642	0.533
Low neighborhood connectedness	0.618	0.603
Neighborhood opportunities for crime	0.585	0.565

Table 2

Results of Conditional Logistic Regressions Comparing 10 to 24-Year-Old Study Subjects' Levels of Exposure to Situational Profiles at the Time of Being Shot Relative to Times Preceding the Gunshot

Situational profiles	Gunshot Wound Assault	Gunshot Wound Assault
	OR (95% CI)	OR (95% CI)
Profile 1 (low-risk)	-ref-	0.61 (0.14, 2.70)
Profile 2 (medium-risk)	1.63 (0.37, 7.21)	-ref-
Profile 3 (high-risk)	9.90 (2.72, 36.14)***	6.06 (2.78, 13.22)***

Abbreviation: OR = odds ratio; CI = confidence interval.

*** $p<0.001$;

** $p<0.01$;

* $p<0.05$ (two-tailed)